Message from the conference chair

The 9th International Workshop on Regional Innovation Studies (IWRIS2017)

On behalf of the Organizing Committee, as the General Chair of the Ninth International Workshop on Regional Innovation Studies (IWRIS2017), I am extremely honored to welcome all participants.

“Regional innovation” is one of the most important keywords in recent society, and the regional innovation need the interchange of the ideas and opinions by different regional people. Mie University planned the new graduate school (master course and doctor course) to study the regional innovation, which is independent from the undergraduate courses, and in the graduate school, professors and students will make a new original interdisciplinary by the combination of some disciplines. Based on the idea, Mie University established Graduate School of Regional Innovation Studies in April 2009.

The history of the International Workshop on Regional Innovation Studies (IWRIS) goes back to 2009, the year of establishment of our graduate school. On October 8, 2009, we held the “First International Workshop on Regional Innovation Studies” (IWRIS2009) at Mie University, and we invited three professors from Malaysia. Since the first IWRIS was held, we have convened eight times of the international workshop and invited 26 professors from foreign countries. The workshop has been growing up continuously and it is great pleasure that we can organize the ninth IWRIS on October 19 and 20, 2017 at Regional Innovation Hall in Mie University, Tsu-city, Japan. The members of our graduate school have been working extremely hard during the last six months to put together an outstanding program, including 4 invited lectures by professors from China, Korea, and Taiwan and 17 presentations by students of Mie University. I hope these activities will provide an important venue for making personal and professional connections that will last throughout your life.

I am firmly convinced that this workshop will be a great experience and much fun for all participants. I am looking forward to your continued support and participation for IWRIS2017.

Hideto Miyake, General Chair
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IWRIS2017 is supported by the Graduate School of Regional Innovation Studies, Mie University.

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The 9th International Workshop on Regional Innovation Studies

Workshop Room: Regional Innovation Hall, Building C, Regional Innovation Center, Mie University

Presentation time: total 15 minutes (presentation: 10 minutes + discussion: 5 minutes)
Bell Timing: 8 minutes, 10 minutes, 14 minutes

I. First Day: October 19 (Thursday)

10:10-10:15 Opening
Hideto Miyake (Dean of Graduate School of Regional Innovation Studies, Mie University)

Session 1 Social Engineering I for Regional Innovation
Session chairs: Hisatsuna Mori and Mikihito Kanou
1) 10:15-10:30
Reconsider the labor consciousness in the "Gender Equality" era in view of economic education for children
Naoko Ishida, Norihiro Nishimura and Hye-Sook Park
Graduate School of Regional Innovation Studies, Mie University

2) 10:30-10:45
Domestic cultivation of crude drug and development of pharmaceuticals: Cultivation of peony and regional activation by its comprehensive use
Hiroaki Kato and Norihiro Nishimura
Graduate School of Regional Innovation Studies, Mie University

3) 10:45-11:00
Japanese educational history compilation of intellectual properties
Kiyoshi Sera
Mie Prefectural Tsu Commercial High School
Session 2 Bio-Science for Regional Innovation
Session chairs: Issei Kobayashi and Yasuaki Kagaya

4) 11:15-11:30
Edible flower as new healthy food: Product in local market, antioxidants and chemical compositions
Sasicha Chensom, Takashi Mishima and Takeo Yano
Graduate School of Regional Innovation Studies, Mie University

5) 11:30-11:45
A method for preparation of oligosaccharides from carp glycophorin
Yohei Odaka and Takahiko Aoki
Graduate School of Regional Innovation Studies, Mie University

6) 11:45-12:00
A proposal for automatic disease stage classification in glioma histopathology images using deep CNN
Asami Yonekura¹, Hiroharu Kawanaka¹, V. B. Surya Prasath², Bruce J. Aronow³ and Haruhiko Takase¹
¹Graduate School of Engineering, Mie University
²Department of Computer Science, University of Missouri-Columbia, USA
³Division of Biomedical Informatics, Cincinnati Children’s Hospital Medical Center, USA

12:00-13:30 Lunch Time

Session 3 Invited Lectures
Presentation time: total 30 minutes (presentation: 20 minutes + discussion: 10 minutes)
Session chair: Norihiro Nishimura and Hye-Sook Park

13:30-15:30
(I-1) 13:30-14:00
A new drug development for osteoarthritis treatment-a new indication for PTH1-34
Mei-Ling Ho¹,², Je-Ken Chang¹,³, Chung-Hwan Chen¹,³, Ling-Hwa Chang¹, Yin-Chih Fu¹,³, Gwo-Jaw Wang¹,³
¹Orthopaedic Research Center, Kaohsiung Medical University, Taiwan
²Department of Physiology, College of Medicine, Kaohsiung Medical University, Taiwan
³Department of Orthopedics, Kaohsiung Medical University Hospital, Taiwan
AlGaN-Based Deep Ultraviolet Detectors
Xiaojuan Sun¹, Yuping Jia¹, Ke Jiang¹,², Jianwei Ben¹,², Yiren Chen¹, Hang Song¹ and Dabing Li¹
¹Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences, China
²University of Chinese Academy of Sciences, China

Air pollution management strategies in Seoul metropolitan area
Jong-In Dong
Department of Environmental Engineering, University of Seoul, Korea

Some innovative approaches regarding Emission Trading System (ETS) for the solution of environmental problems in North East Asian countries
Jeongin-Kim
Department of Economics, Chung-Ang University, Korea

Session 4 Engineering I for Regional Innovation
Session chairs: Naoya Torikai and Yusuke Hayashi
7) 15:45-16:00
A collaborative learning method using learner-participation database
Li Zhang and Hidehiko Kita
Graduate School of Engineering, Mie University

8) 16:00-16:15
Training algorithm of spikeprop accepting sequential patterns: A discussion on effective combined teacher patterns
Kengo Onoda, Haruhiko Takase, Hiroharu Kawanaka and Shinji Tsuruoka
Graduate School of Engineering, Mie University

9) 16:15-16:30
Verification experiments of robot system for emotions expressed by physical motions: Analysis from the view point of Comparative Culture
Shinobu Nakagawa¹, Shinji Tsuruoka², Hiroshi Taguchi³
¹Art & Science Design department, Osaka University of Art
²Graduate School of Engineering, Mie University
³Graduate school of Bioresources, Mie University
17:30-19:00
Banquet (Restaurant PASEO on campus)

II. Second Day: October 20 (Friday)
Session 5 Social Engineering II for Regional Innovation
Session chairs: Hye-Sook Park and Takeo Yano

10) 10:00-10:15
Verification of sales prediction method in tourist spot
Haruki Odajima
Graduate School of Regional Innovation Studies, Mie University

11) 10:15-10:30
Development of the classes applying the cooperative/collaborative learning model for robot
making learning in technology education
Toshihiro Yoshioka¹, Hiroyuki Muramatsu² and Mamoru Matsuoka³
¹Graduate School of Regional Innovation Studies, Mie University
²Shinshu University
³Faculty of Education, Mie University

12) 10:30-10:45
Difference of the consciousness on intellectual property of junior high second grade students
among Japan, China and Korea
JinXiu¹, Mamoru Matsuoka² and Jung Jin-Hyun³
¹Graduate School of Regional Innovation Studies, Mie University
²Faculty of Education, Mie University
³Daegu National University of Education, Korea

Session 6 Engineering II for Regional Innovation
Session chairs: Hideto Miyake and Xiao Shiyu

13) 11:00-11:15
Study on aerodynamic characteristics of vertical axis wind turbine
Alisa Nakai¹, Takao Maeda², Yasunari Kamada², Takuji Kasuya², Keiichiro Kawai², Yuhei
Hoshino² and Qingan Li²
¹Graduate School of Regional Innovation Studies, Mie University
²Graduate School of Engineering, Mie University

14) 11:15-11:30
The effect of pre-adsorbed polymer on dispersion state of carbon black in amorphous
plastics
Yudai Fukunaga¹, Yoshihisa Fujii² and Naoya Torikai¹
¹Graduate School of Regional Innovation Studies, Mie University
²Graduate School of Engineering, Mie University

15) 11:30-11:45
Experimental investigation on photovoltaic cell emulating system in series connection mode
Isamu Mizoguchi¹, Naoki Yamamura², Muneaki Ishida² and Vu Minh Phap²
¹Graduate School of Regional Innovation Studies, Mie University
²Graduate School of Engineering, Mie University

11:45-13:15 Lunch Time

Session 7 Engineering III for Regional Innovation
Session chairs: Takashi Mishima and Hisanori Yagami

16) 13:15-13:30
High temperature face-to-face annealing of AlN films grown by MOVPE
Shunsuke Okada¹, Shuichi Tanaka¹, Yusuke Hayashi², Hideto Miyake¹,² and
Kazumasa Hiramatsu¹
¹Graduate School of Engineering, Mie University
²Graduate School of Regional Innovation Studies, Mie University

17) 13:30-13:45
Preparation of high-quality a-plane AlN on r-plane sapphire using sputtering and annealing method
Ryo Fukuta¹, Yuta Yamaki¹, Yusuke Hayashi², Hideto Miyake¹,² and Kazumasa Hiramatsu¹
¹Graduate School of Engineering, Mie University
²Graduate School of Regional Innovation Studies, Mie University

13:45-13:50 Closing
Hideto Miyake (Dean of Graduate School of Regional Innovation Studies, Mie University)
Venue of IWRIS2017: Regional Innovation Hall (3rd Floor), Mie University
Reconsider the Labor Consciousness in the "Gender Equality" Era in view of Economic Education for Children

Naoko Ishida¹*, Norihiro Nishimura² and Hye-Sook Park³

¹,²,³ Graduate School of Regional Innovation Studies, Mie University,
1577 Kurimamachiya-cho, Tsu, 514-8507, Japan
*E-mail: 616D001@m.mie-u.ac.jp

Abstract— The Japanese government is currently encouraging women’s participation in the labor market to solve the labor shortage and preparing an environment where women can work. However, before preparing an environment for women’s labor, we think it is necessary to educate children so that they understand the necessity of labor and they get motivated to actively work. This education should be done for both male and female children, which will increase the active labor force among both men and women. Specifically, this study proposes a “Child Visit Program” in which children observe their parents as work in society. This experience would allow children to be aware of the relationship between labor and family finance, which may increase their motivation to work and further increase the labor population.

Keywords— Labor Consciousness, Gender Equality, Gender-role Distinction, Family Economy, Education for Children

I. INTRODUCTION

A conventional family economics in Japan has long been structured as the following: the husband works to earn money for family, the wife manages the money for the family, and the wife gives husband and children a fixed amount of monthly money as “okozukai”. Husbands and children keep their monthly private expenditures within the received okozukai, and wives are the ones who control the family expenditures, based on the amount of money that their husbands earn. This structure is not universally true for all the Japanese families, but there is a consensus that this is a prototypical image of a family in Japan at least after Confucian ideas were imported from China [1]. This gender-role distinction is different from many Western cultures.

Moreover, children do not play either role. They only receive monthly okozukai, and they may not truly understand that the okozukai for them is a part of their mothers’ management of the family budget and that their fathers made the money as a return to his labor.

The present study first reveals the senses of family economics of men, women and children, with questionnaire surveys. Upon the findings of the survey, the ultimate goal of this study is to suggest a model that provides a sense of economics particularly to children. An example element of the model is to provide children with opportunities in which they observe and partially participate their parents’ work. This type of experience allows children to realize that their parents’ work supports their family, how hard it is to work to make money, what kind of hardships they would encounter when they work, and what kind of skills or ability they should gain for work. The model suggested in this study is based on Christensen’s theory.

II. METHOD

This research is based on the analyses of questionnaire surveys (with multiple choice questions and essay questions) conducted by the authors. Survey 1 was conducted from April to September in 2015 with full-time housewives and working women and men in Mie prefecture as a visit detention survey, investigating their thoughts on women’s advancement to the working market. Survey 2, 3 and 4 were Internet questionnaire surveys with adult men and women nationwide, which were carried out in June 2017, in order to explore the family budget system between husbands and wives that between parents and children, and children’s awareness of parents’ work, respectively. As a part of Survey 3, we conducted an additional survey with elementary school children (5th and 6th grades) in 2015. Also, as a part of Survey 4, an additional survey was conducted with elementary school children (4th, 5th and 6th grades) in July 2015 and July 2017.

III. RESULTS

III.1 Survey 1: Thoughts on women’s participation on labor

Fig. 1 shows the results of a questionnaire survey with 97 full-time housewives, asking whether they would like to work in the future or not. Most housewives answered that they wanted to work, and more than 60% of the reasons were economic reasons. This survey further asked their desired job categories, which included "ones that allow Saturdays and Sundays off", "ones that allows higher priority on taking care of children", "other than customer service", and "anything" as well as "no desired work". These responses imply that, although the housewives want to work, the priority of work in their lives is low.

Fig. 1 “Do you want to work in future?”: Answered by full-time housewives (97 responses)

Fig. 2 shows the results of whether they want to work in a managerial position. Women who wish to
become a manager were overwhelmingly few. This result contradicts the analysis that, if more women take leadership in companies, women’s viewpoints will be more introduced in workplaces which would increase women-friendly workplaces [1].

Fig. 2 “Do you want to work in a managerial position?”: Answered by working women and full-time housewives (208 responses)

Fig. 3 shows the results of whether the spousal deduction system should be revised (including the abolition of the deduction) or should not be revised. In the current system, spouses who earn less than 1.03 million yen per year can receive the spousal deduction that lightens their tax burdens. However, there is an argument that the spousal deduction should be revised (and was actually revised; the new system will start in 2018) so that more women will be pushed to work outside home. In reality, many women keep their annual income down to 1.03 million yen, and many housewives seek not to revise the status quo, differently from working women and men who showed more positive opinions regarding the revision.

Fig. 3 “Should the spousal deduction system in taxation be revised or kept as it is?”: Answered by working women, men, and full-time housewives (320 responses)

Overall, Survey 1 indicated that a majority of women want to work but not in an important (management) position. They might want to work part time so that they keep the benefits from the spousal deduction.

III.2 Survey 2: Family budget system between husbands and wives.

Fig. 4 and Fig. 5 are the questionnaire results for the question, “do you desire more income for your spouse?” We analyzed the results separately between men and women. A significant difference was detected between their responses.

Fig. 4 “Do you desire more income for your spouse?”: Answered by adult women (138 responses)

Women desire a higher income for their spouse than for themselves, but men do not desire a higher income for their spouses than their own. These results also indicate that both men and women have a strong gender-role preference that the husband work outside the home and that women perform the housework and childcare. These results are in agreement with the result shown in the previous chapter that women are less motivated to be a leading position in workplaces.

The results showed that the okozukai system is dominant among married couples. This is a custom that is not common in Europe and the United States. For example, in France, where the ‘housewives’ concept is almost extinct among women who were born in the 1950s or later, it is common that both husband and wife have their own bank accounts in addition to a household account. Also, husbands do not totally rely on wives for the management of the common account. Therefore, French women typically do not take money from the common account for their pastimes; they earn their free money by working [2]. The okozukai system reflects that, in Japan, the full-time housewives entirely control the house budget, and her position in the family is strong. In contrast, in France, to become a housewife means to be put in a weak position in the family, losing their economic foundation. Yokota (2009) argues that women’s social advancement in France can be a product of women’s desire for free money in addition to that of the desire for free money and a feminist movement[3].

III.3 Survey 3: Family budget system between children and parents

Fig. 7 is the result of the question asking how participants received okozukai when they were elementary school children. The same question was asked to current elementary school children, whose results are shown in Fig. 8.
The majority of the responses both from adults and children indicated that they received a fixed amount of okozukai every month. In considering the results from the earlier survey (Fig. 6) where the majority of husbands receive okozukai from their wives, it can be implied that the okozukai system between parents and children continues even between married couples.

Also, the outcome from both surveys for adults and children show that only a small number of participants received(1) okozukai in return for their assistance in housework, which is a decisive difference between Japan and the other countries. For example, an earlier survey (Halifax, 2014) [4] in England indicated that, in order to receive okozukai, 65% of British children assist with housework such as bedmaking and washing clothes. 81% of these British children realize that family income is earned by labor, and 82% of their parents state that they are able to educate their children in family finance. There is a possibility that Japanese children who do not assist in housework may not realize that family income is earned through labor.

Fig. 9 shows the results of whether they knew the amount of their family income and living expenses when they were elementary school children. Overwhelmingly more participants (94.7%) answered that they did not know the income and living expenses of their families, as opposed to those who knew them.

The results of Survey 3 indicate that Japanese adults were not involved in family economics when they were children. They only received monthly okozukai and did not know the family income or living expenses.

III.4 Survey 4: Children’s awareness of parents’ work

This survey started with a question asking the reason for the choice on the first job of the participating adults. The results are shown in Fig. 10 below. By far the most common response was “somehow (no specific reason)”. This implies that many of the participants did not have a positive reason for choosing their first job.

Fig. 10 “What was the reason for choosing your first job?”: Answered by adult men and women (250 responses)

Fig. 11 is the result of whether they have seen their parents working and whether they have helped their parents work when they were elementary school children. Almost a half of participants answered that they have not seen their parents work. Also, only about 10% (for father) and 20% (for mother) have helped with their parents work.

Fig. 11 “Have you seen your parents working when you were a child?; Have you helped your parents work when you were a child?”: Answered by adult men and women (250 responses).

Fig. 12 shows the result of the question for 290 elementary school students, asking whether they want to see their parents working. The outcome indicates that the majority of them want to see the parents work.

The results contradict with the reality that most adults did not see their parents work when they were children (Fig. 11).

Overall, Survey 4 indicated that although Japanese children want to see their parents work, they do not have many opportunities for that. In short, their awareness of the parents’ job was poor. This fact might be linked to the outcome that they did not have a positive reason for choosing their first job. That is, having not seen their parents work in society, they were not stimulated to think about their future job when they were children. As a result, they chose their job for no reason.

IV. DISCUSSION AND CONCLUSIONS

According to Surveys 1 and 2, among many women, the motivation for active labor (such as that in a management position) is low. Also, Surveys 2 and 3 indicate that husbands and children similarly receive an okozukai from wives/mothers. Furthermore, the results of Survey 4 exhibit that nearly half of all adults had never seen their parents working when they were children and that they did not know the household income.
and living expenses when they were children. This situation may produce a problem where the children grow up and plunge into the society without the knowledge of how their house budget will run. For this reason, there may increasingly be cases where people do not truly realize that their lives are supported by the earnings from one’s labor. Those who grew up in the fixed okozukai system with no labor are not afraid of the risk of quitting a job and losing a salary.

The purpose of this research is to present a model that allows children to participate in household budget operations so that they can acquire the knowledge of family economy. Attempts to educate children about their family's economic awareness are being actively made in European countries. For example, a textbook of the social studies of the junior high schools in Sweden, “Your own society” (Lindquist & Wester, 2005) [5], explains that, since families function like one company, family income and expenditure have to be matched. It tells children that a child’s economy is determined by his/her family’s economy.

When assuming family as one company, Christensen’s (2006) [6] “Tools of Cooperation” can be used for family economics education. Tools of Cooperation is an important model to produce the necessary cooperation among employees who do not see the future change and to make them head towards a consistent direction.

![Fig. 13 Tools of Cooperation](image)

According to Christensen, the tool that many companies first use is “Power Tools” with which management teams play a decisive role in deciding what to do and how to do it. However, at this stage there is no consensus between the management team and the employees, and the employees may not work in the same direction as the management team. In order for the management team and employees to operate the company with a consensus, it is necessary for the management team to instruct employees in leadership (Leadership Tools) and to educate employees (Management Tools) at the same time. They ensure the effects of products and actions, and consensus will be formed. Christensen argues that, through these processes, management teams and employees will form a culture (Culture Tools) in the company, moving in the same direction.

We could apply Tools of Cooperation to family economics education of children. In a family also, “Power Tools” is the initial tool used by parents (equivalent to management team in a company). However, the power becomes ineffective as children (equivalent to employees in a company) grow up. Establishing a family culture where children actively cooperate with the family by themselves would lead to a situation where each family member considers the family budget and the budget will be appropriately operated based on the family members’ “consensus” in Christensen’s words. Specifically, parents take leadership (Leadership Tools) and educate children to make the household budget work well (Management Tools), the culture will be created, in which children know how to balance income, expenditure, and saving.

Our Children Visit Program is based on Christensen’s Tools of Cooperation. Children Visit Program will contribute to building the consensus between family members. For example, a child who sees his or her mother working in nursing care for the old people, will learn the reality of an aging society and care about a barrier-free environment. In addition, the child may acquire knowledge of taxes and pensions that support the aging society. The knowledge is “resources” in Christensen’s word. Furthermore, children who observe the labor scenes may be motivated to develop new types of barrier-free facilities. This is “Process” in Christensen’s word. Also, the children may think about work based on their desire to solve the problem that the elderly are suffering from and the desire to assist the elderly. This is “Priority” in Christensen’s word. As a result, children can acquire the ability to think and act on what they can do as a member of society. The authors think that such economic education for children will increase the number of workers who understands the meaning of work and will lead to an increase of motivation for work regardless of gender.

REFERENCES


Domestic Cultivation of Crude Drug and Development of Pharmaceuticals -Cultivation of Peony and Regional Activation by its Comprehensive Use-

Hiroaki Kato and Norihiro Nishimura

Graduate School of Regional Innovation Studies, Mie University, Mie, Japan
E-mail: katouhiroaki@themis.ocn.ne.jp

Abstract — We can see about 100,000 flowers of peony which bloom only at the farm field in Suzuka, Japan. A local farmer in Suzuka has cultivated the peony since 2003 and the group members of local companies, academia, and government have collaborated each other and developed the Suzuka Peony Project as a model of regional activation by its comprehensive use. The unique points of the project are not only use the roots for pharmaceutical products, but also use flowers and leaves for antibacterial deodorizing products, and the local small and medium size companies have created new business models merging the seed of technology with patents and their specialties, and developed value-added products using the peony. Moreover, the 100,000 flowers of peony can be valuable tourism resources and we have held Suzuka Peony Festival in May every year. In ordinal way of domestic cultivation of crude drugs, it is difficult to build a business since the high cost for cultivation and the sales channels as pharmaceutical raw materials. In order to establish a successful business model, it needs to draw the possible scheme of project that can sustainably lead to activate the entire region collaborating with industry-academia-government-citizens. In this study, we verify the cultivating business of peony in Suzuka as a case study and lead to a new business model of crude drugs and regional activation through the entire project.

Keywords — Industry-academia-government, Kampo pharmaceutical product, Domestic crude drug

I. INTRODUCTION

Recently, it is increasing demand for the cultivation of domestic crude drugs because of the self-sufficiency rate of crude drugs in Japan is only 13%, and the rate of imported crude drugs from China is exceed 80%[1]. On the other hand, for farmers, it is difficult to build its business because of mainly two reasons: the cultivation efficiency and the lack of experience. Also, for the pharmaceutical companies, there are the problems of the price and the scale of production of crude drugs.

The crude drugs are mainly used for crude drug preparations, Kampo medicine, quasi-drugs, cosmetics, etc. And usually, pharmaceutical companies buy the crude drugs as raw materials for pharmaceutical products. For major pharmaceutical companies, it is difficult to produce pharmaceutical products using only domestic crude drugs because one lot unit of production scale is large and these are not enough amount for their production. Also, the crude drugs from overseas especially from China are cheaper than domestic’s. These are less than the half price of domestic’s.

Peony roots are mainly use for Kampo medicine and the domestic consumption of peony roots is 1,226,311kg/year in 2010 (the amount of Import products form Chinese is 1,188,294kg and of domestic cultivation products is 38,017kg)[2]. In Suzuka-city Japan, a local farmer has been cultivating peony for 13 years and it is expanding to the field of 100a for only cultivation of peony.

The unique points of this project are that the group members of the project have established the high efficient cultivation of peony and the regional activation by its comprehensive use. In the case of predominantly harvesting of peony roots, in order to make accumulating nutrients for roots, all flowers are picked out before blooming[3]. In this project, all flowers of peony bloom and the farmer harvests flowers for antibacterial deodorizing products in May. Before harvesting the flowers, the Suzuka Peony Festival is held. And then, it harvests roots for pharmaceutical products in November. In other words, there is no place to see about 100,000 flowers of peony which bloom in the farm field except in Suzuka, Japan.

In this study, by effectively utilizing the above ground part (flowers and leaves) and the underground part (roots) of peony, and by additionally utilizing for tourism business and social contribution project, we verify the profitability of the whole project by examining the each project operators. And we consider the construction of this business scheme of peony cultivation as a model of crude drug business which can continue to develop for the future and apply for the cultivation of other varieties and products.

Fig.1 Peony farm in Suzuka in May 2017

II. METHOD

In this study, we comprehensively verified the construction, development and continuation of the business
by each operators by conducting to increase cultivation efficiency and developing and selling the products using peony roots, flowers and leaves. We also investigated the collaboration units of industry-academia-government-citizens hearing from each business operator of group.

(1) Survey Target:
Suzuka Peony Business Study Group: This group started in 2003 and mainly has been studying about the cultivation of peony and research and development of peony related products collaborating with companies-academia-government.

Regular members: Ito Green (farmer), Bellpeon, Health Stone, Ise Kusuri Honpo, Oboro Towel, Tokai-all-set.
Support members: Mie TLO, National institute of technology Suzuka College, Mie University, Suzuka University of Medical Science, Mie Agricultural Research Center, Suzuka Chamber of commerce.

Suzuka Peony Project Team: The project team is mainly conduct with Suzuka Peony Festival and Social contribution projects started in 2009. The secretariat of the team is Suzuka Chamber of commerce. Regular members: All regular and support members of Suzuka Peony Business Study Group, Suzuka University, Suzuka companies-academia-government Exchange Meeting.

(2) Survey Method:
This thesis author, Hiroaki Kato is the president of Ise Kusuri Honpo and a member of Suzuka Peony Business Study Group and Suzuka Peony Project Team. He investigated the reports of the study group and project team, and had meetings with each operator hearing their situation of business.

A. High efficient cultivation of peony and selection of excellent varieties.
B. Verification of the business of development of pharmaceutical products by using roots.
C. Verification of the business of development of antimicrobial deodorizing products by using flowers and leaves.
D. Verification of festival and social projects.

Above all, we verify the four projects comprehensively and find the possibility of continuous development of the project.

III. RESULTS AND DISCUSSION

A. The result of high efficient cultivation of peony and selection of excellent varieties.

The local farmer has received the assistance of specialists in cultivation of crude drugs supported by the department of health and welfare in Mie prefectural government for promoting efficiency in cultivation of crude drugs. As a result, it could select excellent medicinal variety of peony called Bonten[3]. It could expand the fields of excellent variety of Bonten and could organize and separate ornamental and medicinal varieties. It could improve the work efficiency for harvest flowers and roots, and the harvest rate of flowers and roots was increased. Also, it could introduce the system of Good Agricultural Practice (GAP) and by following GAP, the cultivation conditions, the prevention of plant diseases, and the procedure for harvest are systematically established[4]. And it could improve the quality control as a pharmaceutical raw material of crude drugs.

B. The result of verification of the business of development of pharmaceutical products by using roots.

The yield of roots without picking flowers in 2014, 2015 and 2016 in Suzuka is as follow:

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield of the year</th>
<th>Yield for Are</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>2300kg/10a</td>
<td>230kg/a</td>
</tr>
<tr>
<td>2015</td>
<td>1650kg/7a</td>
<td>236kg/a</td>
</tr>
<tr>
<td>2016</td>
<td>1530kg/8a</td>
<td>191kg/a</td>
</tr>
</tbody>
</table>

As the yield of peony roots (raw roots) with picking is 200~500kg/a in Toyama prefecture[4] and the variation of yield is large by varieties of peony. In the other report of Medicinal Plant Resources Research Center, it could be good yield for Bonten as 127kg/a in 3years roots and 167 ~ 234kg/a in 5years roots [5].The yield of roots in Suzuka is lower than the standard with picking all flowers but it is near to the standard.

Active ingredient Paeoniflorin which is the standard substance of peony root and the content should be above 2.0% which is calculated on the basis of dried material as a pharmaceutical ingredient by the standard test of Japanese Pharmacopoeia[7]. The content of Paeoniflorin in peony roots of Suzuka is 2.9 ~ 3.3%. The results are above standard of JP.

Local pharmaceutical company Ise Kusuri Honpo has submitted the approval application for a Kampo Pharmaceutical product Peony and Licorice roots Extract (SHAKUYAKU KANZOTO EXTRACT) [8] as a Kampo pharmaceutical product in the end of De-
December 2016 and will start selling in December 2017.

Fig. 3 Kampo medicine Peony and Licorice Roots Extract (a) its granule powder and (b) the package of product produced by Ise Kusuri Honpo.

Ise Kusuri Honpo purchases peony roots (raw roots) at Yen500/kg even though the price of Chinese peony roots are Yen200/kg. By expressly specifying the use of Suzuka peony root and differentiating from other companies' products, the product will be able to sell as a value-added product which is trusted by customers.

C. The result of verification of the business of development of antimicrobial deodorizing products by using flowers and leaves.

National institute of technology Suzuka College identified the substance Penta-galloyl-glucose (PGG) and the related substances which are high antibacterial properties on flowers and leaves and made the patent registration of the results (P2003-321488).

The local companies, Bellpeon, Oboro-towel, and Tokai-all-set, have been developing the products that last for antibacterial deodorant effects such as mist spray, soap, towel, clothes, etc. These products became as high value added products and started selling at famous department stores and at their own web-site. As a purpose of enhancing the brand value of Suzuka peony related products, we are going to promote them using branding method as Suzuka Peony Brand.

Fig. 4 (a) Peonish antibacterial deodorant spray produced by Bellpeon Fig. 4 (b) School uniform processing antibacterial deodorizing effect produced by Tokai-all-set.

D. Verification of festival and social projects.

Suzuka Peony Festival was held in May 2017 supported by Suzuka City Commerce and Industry Association. There were about 4000 visitors for 2days. Manufacturers of peony related products exhibited and sold their products and could use the opportunities as business recognition for the area. Also, it held sketch competition by local elementary school children and photography sessions for Suzuka citizens. At festival, the farmer sold cut flowers and stocks of peony for visitors and sold 1,000 cut flowers for Yen100/flower and the total sales was about Yen100,000. It could find the value in terms of revenue, business recognition, social contribution, in this festival.

Fig. 5 Poster of Peony Festival in Suzuka 2017 held in the 13th and 14th of May, 2017.

Fig. 6 (a) Peony related Products were exhibited and sold at the festival. Fig. 6 (b) Sketch competition by local elementary school children.

Fig. 7 (a) About 100,000 of flowers were bloomed. Fig. 7 (b) The farmer sold cut flowers at the festival.
In this study, we verified the entire business viability and profitability hearing from the farmer and we summarized as Table 2.

Table 2: Achievements and plan in Peony Project (Yen, 1,000)

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cut Flowers (Yen)</td>
<td>1,000</td>
<td>1,000</td>
<td>2,000</td>
<td>4,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Dried Flowers (kg)</td>
<td>20</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Dried Flowers (Yen)</td>
<td>200</td>
<td>500</td>
<td>1,000</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Dried Leaves (kg)</td>
<td>0</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Dried Leaves (Yen)</td>
<td>0</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Raw Roots (kg)</td>
<td>2,000</td>
<td>2,000</td>
<td>3,000</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Raw Roots (Yen)</td>
<td>1,000</td>
<td>1,000</td>
<td>1,500</td>
<td>2,500</td>
<td>2,500</td>
</tr>
<tr>
<td>TOTAL SALES (Yen)</td>
<td>1,300</td>
<td>1,650</td>
<td>2,800</td>
<td>5,100</td>
<td>5,100</td>
</tr>
<tr>
<td>Cost for Material</td>
<td>1,200</td>
<td>600</td>
<td>300</td>
<td>1,200</td>
<td>300</td>
</tr>
<tr>
<td>Cost for Cultivation (Yen)</td>
<td>900</td>
<td>900</td>
<td>1,200</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Ordinary income (Yen)</td>
<td>▲800</td>
<td>150</td>
<td>1,300</td>
<td>1,900</td>
<td>2,800</td>
</tr>
</tbody>
</table>

In this project, the farmer, Ito Green has not gained profit. But the sales of flowers have started since 2011 and the sales of roots have started since 2013 and the amount of them are increasing. And it will start selling roots for a Kampo product of Peony and Licorice Extract which will launch in market in 2018 and can be expected the stable income. Also, at Suzuka Peony festival in 2017, it could sell flowers and stocks for visitors, and it will be more revenue in 2018. Finally, the farmer will become profitable from 2018 and will be upward revision of business revenue by improving the work efficiency of cultivation of peony and by promoting and branding of product.

IV. Conclusions

As an example of cultivation of crude drug in peony, we could find a way of its comprehensive use of roots, flowers and leaves, and held a festival not only from the point of business but also social contribute aspect.

In ordinal way of crude drug business, it is difficult to build as a business for farmer and companies in domestic production. There is a successful model of crude drug business in Nara and the business operators cultivate crude drug Toki (Dong Qui) and use the roots for pharmaceutical raw material and use the leaves for foods such as herbal seasoning and food supplements. This is a good model that each business operators including farmer could developed value-added products. In addition, they could develop into citizen activities as a project named “Kampo Mecca Project” using the image of historical story in Nara.

We think that one of the most important points in the project is to make sustainable development as an entire region though the project. It is important that farmer makes a profit and expand the field stably, and use all flowers, leaves and roots by local companies after harvesting. Since 2017, the entire project can be expected the profitable business and stood at the starting point that could lead to activate the region by the business model of crude drug cultivation.

From now on, we will develop further by selecting excellent variety of peony and solving tasks such as improving work efficiency and quality control as industrial materials. And we plan to make a brand for promoting the related products as “Suzuka Peony Brand”.

Overall, we could lead to the business model of crude drug business in peony as an example of success model of its comprehensive use. Also, we plan to challenge cultivation of other crude drugs and varieties using the experience of the Suzuka Model in crude drugs business.

REFERENCES

Japanese Educational History Compilation of Intellectual Property

Kiyoshi Sera

1 Mie Prefectural Tsu Commercial High School

Abstract—A progress process of the Intellectual Property Education of Japan is reported in this paper. I examined the constitution, and sorted the literature and data. As a result, the history of Intellectual Property Education was divided into several stages.

Keywords—Intellectual Property, Intellectual Property Education, Intellectual Property Education Study

Ⅰ. INTRODUCTION

Japan have released national Intellectual Property in 2002, and then, the Intellectual Property Education Branch of Intellectual Property Association of Japan, one academic organization devoted to Intellectual Property Education studies, was established in 2007, which will come to tenth years in 2017. Hereafter, the Cabinet Office starts "The Creation educational consortium of Intellectual Property", it will go to the new phase.

In order to leave the historical record of last 10 years, I start to initiate compilation of the history of Japanese Intellectual Property Education. After writing recorded history of the invention education which can also be called the prehistory as well as surveyed the longitude and latitude of Intellectual Property Education after a nation building declaration of Intellectual Property for the most part, the construction of the educational history of Intellectual Property is considered.

Ⅱ. What is Intellectual Property Education?

After all, what is Intellectual Property Education? Intellectual property was originally defined as interdisciplinary existence. For example, in the scientific and engineering approach, such as invention and contrivance will be discussed, also, in the legal or economical approach, such as patent, copyrights, and the economy values will be analyzed.

In other words, Intellectual Property Education includes both the respect of natural science educations and the respect of humanity and social science educations. Therefore, in my submission, possibly we can catch Intellectual Property Education by 2 axes (figure 1). A transverse classified an intellectual property right as a literary property aiming at cultural development and an industrial property right aiming at industrial development and development. The longitude and latitude of the establishment and history or the administrative structure is also different, and both of them are often caught with an exception. "To learn and acquire an industrial property right of service mark right and a patent." is "industrial property right education" or "intellectual property right education", and or vertical axis is "education of intellectual property in a narrow sense".

On the other hand, I touch a writer and an originator with regard or to utilize the thing which creates an ingenious solution and invents an idea personally and also an industrial property right for a business, it's said to be "education of intellectual property of a broad sense", it'll be. There is also comment that a distinction with "invention education" "creation sex education" is inarticulate, but the Intellectual Property Education of a broad sense integrated "Copyright Education" and "Industrial Property Right Education" which are education of intellectual property in a narrow sense, and is placed as a foundation of education of intellectual property.

Ⅲ. Educational prehistory of Intellectual Property

When telling history of Japanese annual educational of intellectual property, there are Japan Institute of Invention and Innovation established by a name of "industrial property right protection society" and existence of "invention education" by an invention promotion society in 1904 for being not possible to overlook. It was being developed in the whole country after "invention club of boys and girls" was established in Kariya-city and Chiba-city in 1974 (1974) year for young people's creativity development upbringing and upbringing of the talent with the technical knowledge who supports a industrial property right system. "More all-Japan student child invention device exhibitions" continue up to now more than the prewar days, and the relation with the school education is small, but it's possible to catch as education of intellectual property at a place by the social education and place as educational prehistory of intellectual property.

Ⅳ. Start of a nation building charter of intellectual property and education policy of intellectual property

A Japanese policy of intellectual property "will make the nation building of intellectual property best in the world in 2010" with a call of Director-General of the Patent Office in 2001, and, a state strategy forum of intellectual property is formed, and that it was proposed over 6th triggers. Radical reform about intellectual property was proposed by a university, education, an enterprise, polity and a salesman in 7 fields of the legislation and the judiciary. Creation of intellectual property and a step about protection and utilization "are promoted in view of the situation that necessity of planning for reinforcement of the international competitiveness of the country industry with a change in the social economy situation of the inside and outside of the country increases" in March, 2003, a strategy head office
of intellectual property saved and was established by a ministry. Annual "promotion plan of intellectual property" has been announced as after a while officially. The importance of the education of intellectual property is written by a promotion plan clearly, and Japanese education of intellectual property has developed. Or the one which makes ki a starting point of a policy of intellectual property likewise can catch history of Japanese education of intellectual property establishment of fundamental law of intellectual property with a nation building declaration of intellectual property and that.

By the fundamental law 21st article of intellectual property concluded in 2002, "We assume that a country takes a necessary measure for the spread of knowledge about intellectual property through promotion of education about intellectual property and learning and publicity campaign, etc. so that the people can achieve the public opinion by which an Intellectual Property right is respected by understanding to intellectual property and the thing in which they grow interested widely.", as when education for school children and education for teachers about education of intellectual property were promoted, it was made an impurity "a promotion plan of intellectual property, 2003".

V System maintenance of education research of intellectual property.

After that "a promotion plan of intellectual property, 2007" then, "I make them promote education of intellectual property in school." and, it was written clearly. The description which is intellectual property in curriculum guidelines of the junior high school where I receive this and have been revised and a high school, it's incorporated, I came.

It's important to learn an industrial property right as well as a literary property widely to tell interest to ingenuity and respect of originality, and intellectual property are introduced to the curriculum a country sets in this way, and education research which universalizes the contents of learning of intellectual property for that has been piled up.

The study system that education of intellectual property is academic installed an educational subcommittee meeting of intellectual property in a Japanese academic meeting of intellectual property in 2007, and was maintained. An educational subcommittee meeting of intellectual property, "Cooperation of a teaching staff member in school site and the educational subcommittee meeting of intellectual property, 2007" then, "National consciousness of intellectual property is improved." please, "I make them promote education of intellectual property in school.", "such as necessity of education of intellectual property tells interest to a difference device and respect of originality from fiscal year 2008, being based on reconsideration of clarified curriculum guidelines, education of intellectual property according to each stage of school is promoted.". "Education of intellectual property" was used for the usage unified by "education of intellectual property" up to now for the first time. "Education of intellectual property" and "education of intellectual property" were a just abbreviation, but while "education of intellectual property" was being fixed at a place by the education research, the reality was reflected. Cooperation in school and an area and substantiality of experience education describe. "An educator of intellectual property is trained." "A course about education of intellectual property and an educational tool are developed." "Education of intellectual property in a professional high school is promoted." it was done.

After that because an Intellectual Property Education subcommittee session "promotes Intellectual Property Education at the sixth intellectual property society annual scientific study presentation held in Nippon University in 2008 in Japan," advance with Intellectual Property Education subcommittee session "progress - course of study and Intellectual Property Education - of the Intellectual Property Education" at a scientific study presentation in the seventh Japan intellectual property society annual held in Tokyo Institute of Technology in 2009, and "tell me, and the home delivery of cooked foods which utilized an expert to go along the demand from a school teaches respect for interest and originality for the inventive idea through extracurricular activities about the creation of the Intellectual Property such as a manufacturing classroom, the invention classroom saying, "bringing up an intellectual talented person contributing to innovation creation" by "Intellectual Property education in the area", and promote the Intellectual Property education that accepted for each school stage"; there is. "Train a school teacher teaching Intellectual Property" with "a list of measures"; was said," supported curriculum development about the Intellectual Property".

VI. Development of the Intellectual Property Education ( The First Phase).

In this way, Japanese education of intellectual property begins the 1st stage development. "Support of education of intellectual property and research business about the spread" are begun by industrial property right information and a training house in 2008. As a person of merit of intellectual property, Mr. Kimura Tomohisa, Director-General of the Patent Office commendation, it's received, there was a visible movement. "A promotion plan of intellectual property, 2008" then, "National consciousness of intellectual property is improved." please, "I make them promote education of intellectual property in school.", "Such as necessity of education of intellectual property tells interest to a difference device and respect of originality from fiscal year 2008, being based on reconsideration of clarified curriculum guidelines, education of intellectual property according to each stage of school is promoted.". "Education of intellectual property" was used for the usage unified by "education of intellectual property" up to now for the first time. "Education of intellectual property" and "education of intellectual property" were a just abbreviation, but while "education of intellectual property" was being fixed at a place by the education research, the reality was reflected. Cooperation in school and an area and substantiality of experience education describe. "An educator of intellectual property is trained." "A course about education of intellectual property and an educational tool are developed." "Education of intellectual property in a professional high school is promoted." it was done.
Intellectual Property Education in a beginning class, the secondary education, there is not a past description either; in the eighth Japanese intellect property society annual of 2010 at a scientific study presentation an Intellectual Property Education subcommittee session "roundtable :" Although push forward an argument at the location of the problem in the Intellectual Property Education; October of the year. In the third (the first half) by Government Revitalization Unit, "Intellectual Property education seminar holding business" was judged with the abolition as a result of special accounts budget screening, and it was a headwind for promotion of the Intellectual Property Education. Since a budget screening was education whether it was Ministry of Economy, Trade and Industry, the Patent Office where a master managed an industrial property right to have jurisdiction over Intellectual Property Education, an argument that it should be Ministry of Education, Culture, Sports, Science and Technology was deep-rooted, and it followed that I stayed.

VII. Progress of the Intellectual Property Education(The Second Phase)

However, Intellectual Property Education was not dispensed with. Afterwards by "Intellectual Property promotion plan 2011" with "an intellect property management person property axis "build a network strengthening the cooperation between the specialties person property such as dispute solution or the foreign countries system centering on an intellect property management person property supporting the development of the Intellectual Property strategy for reinforcement of the industry competitiveness" about the construction of the network with the specialty person property that did". About (for a short term) (Ministry of Economy, Trade and Industry), "more improvement of intellect property teaching materials" "expand the available intellect property teaching materials on the Internet still more to intellect for intellect property person property upbringing in each field". About (for a short term) (Ministry of Economy, Trade and Industry), "a match to raise understanding and interest in Intellectual Property of small junior and senior high school students" "perform an action including the school education to bring up originality, and to raise understanding and interest in invention for small junior and senior high school students". In addition, I enhance an education effect by promoting cooperation, the cooperation between groups performing Intellectual Property Education. I assume it (for a short term) (Ministry of Education, Culture, Sports, Science and Technology, Ministry of Economy, Trade and Industry), and "the research business about support and the spread of Intellectual Property education" changed with "creativity, practice about the Intellectual Property, utilization development business" in 2013, but I continue it now and am carried out.

In 2011, carries out an Intellectual Property Education subcommittee session for "the construction of the Asia Intellectual Property Education network" for cooperation of the Intellectual Property Education with neighboring countries in Asia at the Japanese intellect property society ninth annual scientific study presentation in Senshu University. In 2012, an intellect property becomes the class contents by the revision enforcement of the junior high school course of study that Ministry of Education, Culture, Sports, Science and Technology notifies in a technique, a home economics technical area, and steady progress is seen.

By "Intellectual Property promotion plan 2012. ", I included a measure example of "the expansion of the foot of the intellect property person property". Hiroyuki Muramatsu wins a Japanese intellect property society special prize, and, in 2012, TEPIA Intellectual Property arts and sciences prize for encouragement has big progress from the viewpoint of the propertyIntellectual Property Education study. At Japanese intellect property society tenth annual scientific study presentation of the same year an propertyIntellectual Property Education subcommittee session "the roundtable "propertyIntellectual Property Education what". What is a problem? "Intellectual Property promotion plan 2013" duties invention as "promotion of the appropriate handling of the invention of the students such as universities", about "free invention (invention of the student whom a hiring does not have) except the duties invention, investigate the actual situation of the action for the invention in universities, and promote the handling that is appropriate by publicizing the information". Ministry of Economy, Trade and Industry has released "the revision enforcement of the high school course of study, an intellect property became the class contents in specialized subjects such as Industry, the commerce" in 2003. "Document "intellectual creation activity and Intellectual Property" industrial property information, training building for learning about the Intellectual Property were shown, and I published it very much from a development white peach bookshop of the Intellectual Property Education, and, in the same year, it was with form the result of the Intellectual Property Education study more (Germany) practice and theory - small, average of the intellect property society tenth anniversary of the foundation business Intellectual Property Education in Japan".

Is Japanese intellect property society eleventh annual scientific study presentation of 2013 sequentially; a theme session (intellect property education subcommittee) "roundtable :": For a rule formation - effect-like Intellectual Property Educational practical of upbringing and the training -Intellectual Property Education personnel training of the Intellectual Property Education person in charge - "Personnel training special feature in the intellect property" was taken out in Japanese patent attorney bulletin "monthly publication PATENT" in Aoyama Gakuin University, 2014 and advanced smoothly. Matsuoka Marnou caught the Director-General of the Patent Office commendation in the same year as an intellect property person who has rendered distinguished services.

IX. Slump of the Intellectual Property Education

However, "is Intellectual Property promotion plan 2014"; about "contents person property upbringing" test a special vocational school, a university and the proof that stood on the result of the curriculum development that went about the upbringing reinforcement business of the creator who utilized university-industry research collaboration consortium by the trade group in 2013, and support it so that the action of person property upbringing in the private enterprise is promoted". There was it with (short term, the middle) (Ministry of Education, Culture, Sports, Science and Technology), but was not touched about the general Intellectual Property Education.

For 2014 years, is Japanese intellect property society twelfth annual scientific study presentation; an Intellectual Property Education subcommittee session the "roundtable "problem and prospects of the Intellectual Property Education", "For Science University of Tokyo), 2,015 years, joint an Intellectual Property Education subcommittee, intellect property studies seminar at Japanese intellect property society thirteenth annual scientific study presentation; the session "writing of the
"seminar qualitative improvement - intellectual property (education) article of the intellectual property (education) study promotion "promotion of the Intellectual Property Education in universities" of Intellectual Property Education, the intellectual property enlightenment "by Intellectual Property promotion plan 2015": while, "for example, the compulsory subject of the subject about the Intellectual Property refers to the examples such as the actions at a university adopting making it it in a department, a subject to bring up a future intellectual property person property such as a law of nature, law, economy, the art departments such as universities, promote that push forward voluntary actions such as the establishment of the subject about the Intellectual Property". "Is (short term, the middle) (Ministry of Education, Culture, Sports and Technology, Ministry of Economy, Trade and Industry) promotion of the Intellectual Property Education": in "school, plan promotion of the education about the Intellectual Property in order to improve consciousness and the knowledge for the young intellectual property, and to connect it with the foot expansion of the intellectual property person property": (short term, the middle) (Ministry of Education, Culture, Sports and Technology), "is steady promotion of the enlightenment activity for the nation" more, for "the knowledge of the nation for an imitation product, the pirated edition and improvement of the consciousness that does not purchase easily, each ministries and government offices, relations engine promote united enlightenment activity". (Short term, the middle) (Ministry of Finance, National Police Agency, Ministry of Economy, Trade and Industry, Ministry of Education, Culture, Sports, Science and Technology, Ministry of Agriculture, Forestry and Fisheries, Consumer Affairs Agency)) and a reference. In addition, "is the cross-sectional inspection, examination of intellectual property person property upbringing": "inspect the action of intellectual property person property upbringing by various main constituents in "the Intellectual Property personnel training broad strategic view" as "a review of the intellectual property person property upbringing strategy" transversely, and examine an intellectual property person property image and the way of upbringing demanded in future". I was considered to be (short term, the middle) (the Cabinet Secretariat, ministry of prefecture concerned), but the reference to an elementary and secondary education was not seen, and a feeling of slump came to be seen.

X. Progress of the Intellectual Property Education (the Third Phase)

On the other hand, I developed aggressive lobbying including the participation in planning to taskforce in the Headquarters for Promotion of Intellectual Property strategy of Cabinet Office when there was the receiving a prize of five Intellectual Property Education researchers and pressured Ministry of Education, Culture, Sports, Science and Technology to work on Minister of Education, Culture, Sports, Science and Technology commendation (technology prize understanding increase section) led by these five people including Cabinet Office in 2015. In four chapters constitution, a chapter of "the spread, the penetration of intellectual property awareness, the intellectual property activity" is put up, and, through these, there is "Intellectual Property promotion plan 2016" with "improvement of Intellectual Property Education, intellectual property personnel training". It "is a talented person carrying it out to become the key in every scene propelling an intellectual property strategy". When it is education, it is defined definitely that it becomes the base raising these talented people and does it when "I promote the Intellectual Property Education that collaborated with society depending on a beginning class, a medium grade, each stage of the higher education" as the measure that should wrestle in future. "Utilize Intellectual Property Education promotion consortium (tentative name), and is wide, and gather contents in conjunction with the Intellectual Property Education that can provide including the topic about the intellectual property which can utilize in each subject in the educational front, and is wide, and, about the construction of the learning support system which collaborated with an area, society, "the construction of the Intellectual Property Education promotion consortium (tentative name) makes," build "intellectual property education promotion consortium" (tentative name) to be comprised of relations prefecture province, an affiliate, an educational front, the company to support the construction of the learning support system for collaboration with an area, the society by the end of 2016" known to everyone": " "(about the formation of local consortium (tentative name), included, "promoted construction of "area consortium (tentative name)") to develop the Intellectual Property Education that got the participation in planning such as the affiliates of the industry-university co-operation official to support protection, the inflection of the intellectual property and learning about the understanding of the significance with cultivation of the originality in the educational front, and was united with a community")."

As a result, by "Intellectual Property promotion plan 2017 , " each nation raises promotion of the Intellectual Property Education, intellectual property personnel training to be an intellectual property talented person" and raises base maintenance to push forward, (1) high school, the construction , ② Intellectual Property Education, intellectual property enlightenment of the learning support system which collaborated with promotion ,③ area, society of the Intellectual Property Education in the university as support of collection, the making ,①" area consortium of the systematization ,② educational program (subject) of the ,③" intellectual property creation education, the measure that should wrestle in future more as the present conditions and a problem. As for these, a figure of the Intellectual Property Education was actualized backed by the process of Intellectual Property Education ten years in Japan. What led to the foundation of "the intellectual property creation education consortium" by a country can mention that it became a big event specially among other things in carving with the history of the Intellectual Property Education.

XI. CONCLUSIONS

In this paper, I edited history of Intellectual Property Education of last ten years in Japan; of the historical fact acted in leaving a record by digging it, and spinning raising and them. I examined the constitution, and sorted the literature and data after the national intellectual property strategy was released. As a result, the history of Intellectual Property Education was divided into several stages.

Citation and Reference
- National Center for Industrial Property Information and Training "intellectual creation activity and Intellectual Property" 2013
- Association of invention "association of invention 100 years history", 2006
Edible flower as new healthy food: product in local market, antioxidants and chemical compositions

Sasicha Chensom¹, Takashi Mishima¹ & Takeo Yano¹

¹Graduate School of Regional Innovation Studies, Mie University, Mie Prefecture, Japan
E-mail: 61T005@m.mie-u.ac.jp

Abstract— Recently, the healthy food is increasing its popularity worldwide because the consumers know the relationship between food and health outcome. Edible flower (EF) is new healthy food source because it contains many health-beneficial compounds e.g. polyphenols, flavonoids, anthocyanin, and carotenoids. In addition, these compounds also exhibit antioxidant activities i.e. ability to scavenge free radicals and reactive oxygen species (ROS). Besides, the aesthetic appearance, unique fragrance of the EFs are the reason why they become interested. From the study of EFs eating’s trend, we have found that the EFs are becoming popular observed by the increase of the EF’s dishes in local restaurants and the number of small to mid-sized EF farmers. According to this, the EFs maybe deserve to study in the further research because of their health benefits and the opportunity to introduce the EF to the local market as new healthy food.

Keywords— Edible flower, antioxidants, chemical compositions, local market

I. INTRODUCTION

Recently, the consumers more believe that foods contribute directly to health [1]. The Mintel’s report forecast that, in 2017 the current consumers demand for healthy, convenient and trustworthy food and drink. Plant foods such as fruits, vegetables, nuts, seeds, grains and botanicals, are one of leading food trends [2]. Thus, to respond the consumer needs, food derived health-beneficial compounds are interesting to introduce to the market.

The pathogenesis of diseases involve to the excess of the reactive oxygen species (ROS), which the by-products of normal metabolism. Therefore, The balance between ROS and neutralize molecules is key to maintaining a healthy body system. However, the body produced antioxidants are inadequate to prevent the damage completely, so food-derived antioxidants (e.g. vitamins, amino acids and peptides, organic acids, polyphenols, and carotenoids), which have the ability to scavenging the ROS and termination the chain reaction of ROS, are important. [3, 4, 5, 6]

The many studies revealed that vegetables, fruits and herbs are source of antioxidant compounds such as phenolic compounds, flavonoids, vitamin C and E, and carotenoids. [7, 8, 9] In addition, the EFs are other sources of biologically active compounds. They have been used in ancient Greece, Rome and China as garnish, relishes and flavour enhancers of many sweet and savory dishes [10]. Besides of their aesthetic appearance, unique fragrance, and color, the EFs also contain phytochemicals, which exhibit antioxidant activities.

In this review, to suggest EFs as alternative healthy food source, the antioxidant activities, the chemical compositions of EFs and their products were gathered. Moreover, the present market situation of EFs, product, and development were discussed.

II. EXPERIMENTAL

A. Studying of edible flower and its product in local market

The study was conducted by the interviewing the staffs of Toyoake Agricultural Cooperative, located at Aichi prefecture and Akatsuka Co., Ltd. located at Mie prefecture.

B. Antioxidant activities and chemical compositions of edible flowers

Antioxidant activities and chemical compositions of EFs were studied from the several literature.

III. RESULTS & DISCUSSION

A. Edible flower and its product in local market

To study the present market situation and trends in EF, we have visited the two local company in Aichi and Mie prefecture.

Frist, at the Toyoake Agricultural Cooperative in Aichi prefecture. We have visited the EF’s farm of the small-sized local farmer. Many types of EF (e.g. marigolds, viola, pentas, jasmine, verbena, and dianthus) are cultivated in the greenhouse.

The cooperative and EF farmer’s group are currently dealing the business to business (B2B) with the restaurants and cafés in Toyoake-city.

Type of the EF is a factor, which associated to the consumer's demand. Some of the consumers prefer to buy the EF, which available at that time, but some of the consumers require a specific EF.

The usage of EF in product is decided by the EF’s post-harvest change and its nature. For example, the petals of marigold have shredded after removing their base. Thus, the most of the marigolds are used for enhancing the color and fragrance of syrup. The petunia flower also has unpleasant changes after post-harvest, thus they also used for the syrup ingredient too, whereas, the EFs, which have good appearance and condition after post-harvest,
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Fig 1. Edible flowers use for quiche decoration, selling at the local café called Brown beans in Toyoake city.

...are used as the ingredients of the salad, dessert, and food decoration, i.e. topping on the quiche, cookies, brownies, and cakes.

For the public relation about local EF products, the project called 'Toyoake Hana Marche' is established to give the information about the event and where to eat and buy EF foods and products in Toyoake-city.

In the future, the EF farmer's group and company, are aimed to be central to the EF production of Japan. However, the issue of using fresh EF is concerned by food hygiene regulation. Therefore, the quality control and production management will apply to EF cultivation in the future.

To study the EF’s market situation in Mie prefecture, we have conducted the interview with the Akatsuka Co., Ltd.’s research and development staff.

The demand of EF is increasing observed by the number of the small and mid-sized farmers and the consumers, who desire to buy and try to eat the EF. The company currently have the product "Mizu-Manju", which uses the EFs, e.g. viola, torenia, and diana, as the ingredient. Besides, they also launch the menu called "Hana-Plate", which is now selling at the community farmers market. The company is interesting to expand the EF product line. They have been arranged the “Edible flower’s recipe competition” for 2 years and plan to continue. However, they have encountered the issue relate the change of EF’s color, appearance, and properties while food processing step. As well as, the food hygiene regulation, which using fresh EF in the product is unable to guarantee the safety.

In the future, the company plans to produce the EFs itself. The four main types of the EFs, including seasonal EF, herbs like an EF, vegetable like an EF, and the EF, which suitable for mass production, are interesting to cultivation. In addition, they also interest to selling and distribution the EF’s product to the other regions of Japan. However, now the company’s priority is to build the strong community (the project of Takanoo- farmers group) between the local companies and small to mid-sized farmers. The objective is to produce safety and high-quality agricultural products, to support the local small and mid-sized farmers, to provide the stable supply of agricultural products for the further food production, and to revitalize the local economy.

B. Antioxidant activities of edible flowers

The antioxidant activities can determine by various methods, based on the ability to be antioxidants, for example, the ability to scavenge DPPH free radicals [11], and harmful radicals, e.g. superoxide, nitric oxide, and hydroxyl radical [4]. The ability to act as reductant by assessing total antioxidant power of antioxidant using Ferric reducing antioxidant power (FRAP), the redox-linked colorimetric method [12]. The ability to scavenge peroxyl radical is also determined by method called oxygen radical absorbance capacity (ORAC) assay, which assess degree of inhibition of free radical against time. [13]

The antioxidant activities of EF and its product are reported by several literatures. The report of [14] investigated that tea prepared by 12 selected cultivars of rose petals had high antioxidant activity, compare with green and black teas. The research of [15] also investigated that the hydrophilic and lipophilic extracts of the selected roses had antioxidant activity, which difference by cultivars. Tea infusions of water lily flowers also investigated to have ability to scavenging free radicals determined by DPPH and ABTS, as well as reducing power determined by FRAP assay. Tea infusions prepared by water lily named “Conqueror” and “Virginia” possess ABTS radical scavenging activity better than green tea, blank tea and peppermint tea [16]. Furthermore [17] also revealed that rosella flower beverage exhibited ABTS radical scavenging activity and FRAP. The rosella flower beverage shows similarly antioxidant activities to white wine, but lower than black tea or orange juice, while its ORAC value was comparable to red grape juice. In addition, the antioxidant activities 19 Chinese EFs were evaluated by [18] and antioxidant capacities of 10 common EFs were investigated according to the report of [19].

According to the information describe above, many EFs may be defined as “natural antioxidant source” owing to their ability to scavenging free radicals or synthetic stable free radicals as well as ability to retard the oxidation in vitro. Furthermore, the products derived from EFs, mainly the infusions and tea are also possessing antioxidant activities. These antioxidant activities of EF are mostly affected by biological constituents, which will be discuss in the next section.

C. Chemical composition of edible flowers

Several types of plant materials such as vegetables, fruits, leaves, oilseeds, cereal crops, barks and roots, spices and herbs are contain large varieties of substances called “plant chemicals” or “phytochemicals”, which have antioxidant activities. [7, 8]
The EFs contain the varieties of phytochemical too, as mentioned by [20], polyphenols and 26 flavonoids and their derivatives were found in 6 cultivars of tree peony yellow flowers. These polyphenols show the relationship with DPPH, ABTS, hydroxyl radical scavenging activity and FRAP at R² of 0.664, 0.969, 0.854 and 0.961, respectively. By the way, the relationship between flavonoids and antioxidant activities were lower than polyphenols. The similar trend also reported by [19], which total phenolic contents of 10 common EFs from China show strongly correlated with antioxidant activities determined by DPPH, ABTS, ORAC and FRAP. Furthermore [16] have also found that the polyphenols of water lily extracts show high correlation with DPPH, ABTS and FRAP. For the rose species, antioxidant activity of the rose may be partly affected by anthocyanin. The anthocyanin isolated from Korean red edible rose and the rose cultivar “San Francisco”, are confirmed to possess antioxidant activity. The anthocyanins are correlated with petal colors, relatively high to red-flower cultivars. So, the antioxidant activities of the roses with other color petals maybe also contribute to other phytochemicals e.g. polyphenols like gallic acid, quercetin and keampferol [14, 15, 21]. The EF with the color in the range of yellow to orange, carotenoids are mostly found among of these EFs. The Tropaeolum majus L. is source of lutein, which the highest lutein content was observed in yellow flower of T. majus. However, the other carotenoids, including violaxanthin, anthoxanthin, zeaxanthin, zeinoxanthin, β-cryptoxanthin and β-carotene are also found in yellow T. majus [22]. The marigolds (Tagetes erecta L.) are also source of lutein, lycopene and β-carotene. In addition, phenolic compounds and flavonoids are found in marigolds as well [23]. Similarly to the report of [24], which found that Indian marigold with orange, yellow and red cultivars are source of lutein. Moreover, their extracts also possess antioxidant activities e.g. DPPH, ABTS, hydroxyl radical scavenging and reducing power. For calendula flowers with different colors, the Double Esterel Orange variety, which has dark orange color, exhibited higher total carotenoid contents than calendula with orange, yellow-orange and lemon yellow. The dark orange and orange calendulas show β-carotene higher than those of yellow. In contrast, the lemon yellow and orange-yellow calendula had flavoxanthin and luteoxanthin=Auro. [25]

According the information above, it can demonstrate that the EFs are source of phytochemicals, which correlated to antioxidant activities. The different EFs and cultivars have their own phytochemical profile. In addition, color of EFs is also contributed to kind of phytochemical i.e. the red and yellow color, contribute to anthocyanin and carotenoids, respectively.

IV. CONCLUSIONS

The EFs are good source of phytochemicals such as polyphenols, flavonoids, anthocyanin and carotenoids. These phytochemicals correlate to antioxidant activities of EFs, which determined by various methods, mainly related to their free radical scavenging abilities.

Each EF has its own unique chemical compositions. The anthocyanin found in rose cultivars with red petal color. In contrast, carotenoids are mostly found in EFs with petal in the range of yellow to orange colors. However, the main constituent, which found in EFs are phenolic compounds. In addition, there are studies demonstrated that one phytochemical show synergic effects with other phytochemicals. The report of [26] investigated that curcumin and resveratrol, and curcumin with quercetin shows antioxidant activities in hemin-based antioxidant assays better than singular compound. The similarly result was found in the combination of green tea polyphenols (GTP) called catechin. The combination of two or more catechins, show stronger antioxidant activity [27]. Moreover, catechin also possess synergic antioxidant activities with sulfur dioxide, which antioxidant found in wine products [28]. The other research also suggested that phytochemicals derived from fruits, vegetables had potent antioxidant effect. In addition, the consumption of orange, grape, apple and blueberry, shows the EC50 value on antioxidant effect 5 times lower than each fruit alone [29]. Thus, it suggesting that phytochemicals found in these fruits may be play synergic effect on antioxidant activity. Therefore, EF may suggest as alternative phytochemicals source. The combination of the EFs with other vegetables, fruits or edible plants, e.g. salad, soups, drinks, may be associate with good health outcome.

The EFs maybe suggested as the potential healthy food to the local market in the future, because of their health-beneficial properties and the trends in local market, which the EFs are currently use as food ingredients in many dishes and products. Furthermore, the local companies also set the plans to expansion of EFs cultivation and product development in the nearly future, thus the EFs may be worth to further research in health-beneficial properties and chemical compositions.

ACKNOWLEDGEMENT

We would like to express our gratitude to the staffs of Toyoake Agricultural Cooperative and Akatsuka Co., Ltd. for giving the time and opportunity for field visit and kindly provide the information related this research.

REFERENCES


A Method for Preparation of Oligosaccharides from Carp Glycophorin

Yohei Odaka and Takahiko Aoki

Graduate School of Regional Innovation Studies, Mie University, Tsu, Mie, Japan
E-mail: [616m002@m.mie-u.ac.jp]

Abstract—The carp glycophorin is a membrane glycoprotein in carp red cells membranes. Glycophorins exist mainly in human blood but also in other mammals and tereostei. In our laboratory, oligosaccharides from carp glycophorin has detected as a bacteriostatic activity. In this research, we aim to improve the method to prepare oligosaccharides from carp glycophorin by β-elimination. As a result, we could not release oligosaccharides completely by removing excess NaCl and detergent. It was necessary to denature protein moiety of glycophorin for oligosaccharides preparation with a high yield.

Keywords—carp, fish blood, glycophorin, oligosaccharide, sodium cholate, LIS (Lithium 3, 5-diiodosalicylate)

I. INTRODUCTION

Glycophorin is a membrane glycoprotein in red blood cells and contains a large amount of sialic acid in their oligosaccharides. Glycophorin is prone to aggregation due to the hydrophobicity protein moiety which becomes a spherical polymer and not reacted easily by β-elimination. In our laboratory, the glycophorin from blood of live carp (Cyprinus carpio) blood is revealed that their sialo-oligosaccharides have a bacteriostatic activity. Therefore, it is suggested that these oligosaccharides are seen to potential antibiotic reagents. However, preparation of oligosaccharides by using the extract method (LIS-phenol method) is not adequate because this yield is significantly low (ca.1.0%). To improve the yield of oligosaccharides, we adapted the anion-exchange chromatography [1]. Although the yield of glycophorin is nearly 100%, β-elimination for the preparation of oligosaccharides is not reacted sufficiently. This reason is supposed to be the existence of NaCl and excess detergent in the glycophorin fraction. To reduce NaCl and detergent, the fraction was applied to the desalting column (Econo-Pac 10DG, Bio-Rad co. Ltd.) followed by β-elimination. We aim to improve the method of oligosaccharides preparation by removing excess NaCl and detergent followed by β-elimination.

II. METHODS

Materials

Live carp (Cyprinus carpio) were obtained from a local fish market. The erythrocyte membranes were prepared using the method for human blood with a slight modification [2]. Carp were anaesthetized with ethyl 3-aminobenzoate methanesulfonate (MS-222). Once anaesthetized, the blood was collected from dorsal aorta using a heparinized syringe that was inserted through the mouth. The blood was diluted 1:1 with fish Ringer (145 mM NaCl, 5 mM CaCl₂, 1 mM MgSO₄, 4 mM KCl, 10 mM Hepes and 5 mM glucose pH 7.9) [3]. The diluted blood was placed on a Ficoll-Paque PLUS (GE Healthcare, Sweden), then centrifuged at 40× g for 40 min and the red cells were collected.

Preparation of red blood cell membranes

The red cells were washed three times with fish Ringer[3], then hemolyzed by dilution in a 1:10-15 mixture of ice cold 5 mM Tris-HCl (pH 7.6) containing 5 mM CaCl₂ and 0.15 mM phenylmethylsulfonyl fluoride (PMSF). The suspension was placed on ice for 5 min and centrifuged at 40,000× g for 20 min. The upper precipitate layer was collected and then suspended in ice-cold 5 mM Tris-HCl (pH 7.6) containing 0.15 mM PMSF, then centrifuged at 40,000× g for 20 min. The precipitate was collected and suspended in a two-
fold dilution of Buffer A (75 mM Tris, 12.5 mM MgCl₂ and 15 mM EDTA, pH 7.5) [3] containing 5 mM CaCl₂ and 0.15 mM PMSF. The suspension was then homogenized with a tight-fitting Dounce homogenizer (10 strokes) and centrifuged at 40,000× g for 20 min. The resulting membrane pellet was re-suspended in Buffer A and homogenized (20 strokes). The membrane suspension was then placed on a sugar cushion (40% sucrose, 10 mM Tris-HCl and 10 mM MgCl₂, pH 7.5) and centrifuged at 700× g for 15 min in a swing-out rotor. The overlay and inter-phase fractions were collected and centrifuged at 40,000× g for 20 min. The membrane pellets were re-suspended in Buffer B (20 mM Tris-HCl, 2 mM EDTA, pH 7.5) and homogenized (10 strokes). The final membrane preparation was stored at −80°C.

**Isolation of glycophorin from the red blood cell membranes**

The carp erythrocyte membranes which had been stored at −80°C was thawed with running water. Membrane preparation (1.5 ml) was collected and added to 0.6 ml of 40 mM Tris-HCl (pH 7.5) and 0.9 ml of 0.3 M LIS to solubilize red cell membranes followed by centrifugation at 43,000× g for 30 min. Solubilized red cell membranes (3.0 ml) was applied to an Econo-Pac 10DG column. The membrane solution was fractionated 1 ml per tube. The eluate was collected and added with 90μl of 2.0 M NaCl and 40μl of 10 % sodium cholate, and the final concentration was adjusted to be 130 mM NaCl and 0.4 % sodium cholate. This fraction (ca. 3.0 ml) was applied to a DEAE Toyopeal 650M column. Since the all about of sialic acid containing in glycophorin, the fraction contained sialic acid as a glycophorin was used in following experiment [4].

**Preparation of oligosaccharide from carp glycophorin**

Preparation of oligosaccharides was carried out by different detergent as following Methods 1 and 2.

**Method 1:** The collected glycophorin fraction (ca, 3.0 ml) was applied to an Econo-Pac 10 DG column to remove NaCl and excess sodium cholate. Obtained glycophorin fraction (3.0 ml) was reacted by β-elimination [9]. β - Elimination was carried out under the following condition. Adding 0.1 ml of 5.0 M NaBH₄ (containing 0.5 M NaOH) to 0.4 ml of the fraction in a dark room under N₂ gas (37°C for 48h).

**Method 2:** Approximately 4.0 ml of the obtained glycophorin fraction (ca.4.0 ml) was dialyzed with deionized water using Seamless Cellulose Tubing, Size 18 (Wako) to remove NaCl and sodium cholate and then inner solution was centrifuged at 43,000× g for 45 min. The resulting precipitation was collected, and was...
discharged using a pipette with 4.0 ml of 0.3 M LIS to solubilize again. After that, dialysis was carried out again under the same conditions to remove excess LIS. Following by β-elimination was carried out under the same condition as Method 1.

III. RESULTS AND DISCUSSION

At the start of this research, we predicted that the existence of NaCl and excess detergent in glycophorin fraction inhibited the reaction of β-elimination. So, desalting treatment by using an Econo-Pac10 DG column was performed (Method 1). As a result of β-elimination, no resulting protein aggregate was formed in reacted solution. Again the experiment with the preparation replaced deoxy cholate with LIS also no sign of forming protein aggregate. Among the two methods, no forming protein aggregate in each fraction leads to inefficiently reaction of β-elimination. From these results, it was not effect on the β-elimination when using glycophorin fraction contained sodium cholate or LIS as the detergent. However, oligosaccharides preparation was successfully by using the LIS-phenol method [2]. Therefore, in order to prepare oligosaccharides from glycophorin efficiently, it is suggested that denaturation of the protein moiety by phenol or other reagents is required [10]. We will research the adequate method by using a weak acidic or alkaline protein denaturing agent other than phenol for oligosaccharides preparation from glycophorin.

REFERENCES

A Proposal for Automatic Disease Stage Classification in Glioma Histopathology Images Using Deep CNN

Asami Yonekura1, Hiroharu Kawanaka1, V. B. Surya Prasath2, Bruce J. Aronow3, and Haruhiko Takase4

1 Graduate School of Eng., Mie University, Mie, Japan
2 Department of Computer Science, University of Missouri-Columbia, OH, USA
3 Div. of Biomedical Informatics, Cincinnati Children’s Hospital Medical Center, OH, USA
4 E-mail: 417m246@m.mie-u.ac.jp

Abstract—In the field of histopathology, computer-assisted diagnosis systems are important in obtaining patient-specific diagnosis for various diseases and help precision medicine. Therefore, many studies on automatic analysis methods for digital pathology images have been reported. One of the severe brain tumors is the Glioma which can provide unique insights into identifying and grading disease stages. However, the number of tissue samples to be examined is enormous, and is a burden to pathologists because of the tedious manual evaluation required for efficient decision-making and diagnosis. Therefore, there is a strong demand for quick and automatic analysis to do that. In this study, we consider feature extraction and disease stage classification for Glioma images using automatic image analysis methods with deep learning techniques. We have already considered this method using 10 images each grade. It is not, however, enough images to improve the generalization of CNN. Therefore, in this paper, we constructed the data-set using 100 images each grade and checked classification accuracy.

Keywords—Histopathology Images, Brain Tumor, Deep Convolutional Neural Network, Disease Stage Classification.

I. INTRODUCTION

Recently, in the field of histopathology, many studies on evaluation methods for tissue images have been reported for analysis of tissue specimens [1]. In these analyses, pathologists analyze these images for precision medicine and patient-specific diagnosis. However, depending only on manual analysis has several problems. First, the number of images for a patient data is typically enormous. Therefore, it becomes a burden when the pathologists manually analyze them. In certain cases, pathologists diagnose tissue images during surgery. This means they have time constraints. The combination of a large number of images to be analyzed and time pressure for quick diagnosis places a heavy burden on pathologists. Second, the criteria for diagnosis are different of each pathologist. Evaluation criteria heavily depend on the experiences and subjectiveness of each pathologist. Therefore, the results of the analysis are usually not quantitative. For these reasons, the new scheme that could automate and standardize the overall process is required. These studies show progress toward the goals for quick, efficient and quantitative analysis. In one such study, computer-assisted diagnosis (CAD) systems have been used to detect tumors from histopathology tissue images. This method required strong feature extraction and further classification analysis to determine the prognosis of a patient. However, most of such reports only applied these techniques to some specific diseases, like breast cancer, or esophagitis, but not others such as the brain tumor.

Previously, the authors also discussed disease stage classification in Glioma histopathology images. Glioma is one of the most malignant tumors occurring in the brain. The prognosis of Glioma is usually quite poor in clinical practice. In this paper, we discuss a new scheme for histopathology image analysis to acquire efficient feature descriptors and a classification scheme at the same time.

The authors proposed a disease stage classification method with Deep Learning for Glioma histopathology images. In particular, Convolutional Neural Network (CNN) was employed as a Deep Learning model. In this paper, we constructed the data-set using 100 images each grade and checked classification accuracy.

The organization of this paper is as follows. Section 2 describes the outline of experimental materials. Section 3 shows the proposed methods. In section 4, we conduct evaluation experiments and discuss the performance of the proposed method. Finally, we conclude this paper and show future works in section 5.

II. EXPERIMENTAL MATERIALS

A. Glioma histopathology images

In this study, we used Glioma histopathology images. Generally, Glioma can be categorized into four grades based on their disease stages. For example, Glioma of Grade 1 has a slight illness, and Grade 4 is so serious and has a poor prognosis. In particular, the average life expectancy of Grade 4 is 18 months in general. In addition, this is infiltration growth. Therefore, it is difficult to remove all of them by surgery. From these things, disease stage classification of Glioma is required for effective treatments.

The images used in this study were obtained from the publicly available The Cancer Genome Atlas (TCGA) [2] database that has many histopathology images. TCGA contains two types of images, i.e. Lower-Grade Glioma (LGG) and Glioblastoma multiforme (GBM). LGG includes images of Grade 1 and 2, GBM includes images of Grade 3 and 4. In this study, these two distinct type images were used as the experimental imagery for automatic analysis. Figure 1 shows exam-
ple images. In these images, the nuclei were stained deep purple, and other tissues were stained pale purple and red by Haematoxylin and Eosin (H&E) staining. Image features with respect to the nuclei appear different based on the grade, and features of the organization are different from each other. Generally, these differences are believed to result from the disease progression, including changes in gene and protein expression.

B. Construction of datasets

In this paper, we used 100 LGG images and 100 GBM images respectively. Obtained images from TCGA Data are .svs format. These are very big size, for example one of the image is about $30000 \times 30000$ pixels. Therefore it is unsuited for processing. For that reason, we divided the original images to patched images whose sizes were $1000 \times 1000$ pixels, and then the patched images including sufficient nuclei were used as experimental materials. Figure 2 shows how to dividing original image to patched images and the criteria as experimental material. In this paper, we used 100 svs images in each category, and we obtained 100 patched images from a single svs image. Therefore, we used 10000 patched images in each category. In addition, to reduce the amount of necessary memory and calculation, we resized the patched images to $100 \times 100$ pixels and the images were converted to gray scale images.

III. EXPERIMENTAL METHODS

A. Overview

In this paper, we utilized a Deep Learning method for the histopathology image analysis to acquire efficient feature descriptors and a classification scheme at the same time. Figure 3 shows an example of a model of disease stage classification for Glioma histopathology images. By using Deep Learning method, feature descriptors are extracted from the data (image, sound, etc.) automatically, and we can not only extract feature descriptors from the given images but also construct a classifier for the problem automatically at the same time. Deep learning is currently popular in the field of computer vision and pattern recognition [3]. Also, it showed outstanding performance in solving various biomedical image analysis problems [4]. One of the popular Deep Learning techniques is Convolutional Neural Network (CNN), which is increasingly applied in various image analysis problems. There have been recent applications of these CNN to adapt to biomedical applications [5, 6]. In this study, we utilize CNN for Glioma histopathology image to learn and extract features and check the classification accuracy.

B. Our CNN architecture

In this study, we utilized deep CNN for the purpose of disease stage classification from Glioma histopatho-
logy images. Our adapted CNN receives 100 x 100 pixels of the Glioma histopathology images, and outputs two classes for GBM grade and LGG grade. This network has been built on Mxnet framework [7]. Originally, we tried to adopt a network that was used for the previous study [8], which consists of 2 convolution layers, 2 pooling layers, and 2 tanh as shown in Figure 4. In this study, we built the same CNN architecture for the 100 images each grade and learned.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

To evaluate the performance of our deep CNN method, 90% and 10% of data-set were randomly sampled and these were used for training and testing, respectively. As with any classification and deep learning approaches, the network needs to be trained first and then used that model to test the images. In the training phase, the goal is to let the network learn how to identify a given patch as GBM or LGG. Figure 5 and Table 1 show the final results of training and classification accuracy of our CNN configuration, respectively. Training and classification accuracies were 97.7% and 81.6%, and it showed a potential for practical use.

In the previous study [8], we obtained final classification accuracy of 99.3%. Compared to the previous study, the classification accuracy of the proposed CNN was lower than the previous CNN. However, since the classification accuracy was lower than training accuracy, the generalization capability is insufficient with our new CNN. From these results, we found that our CNN architecture was not deep enough to capture the properties for our complex Glioma images. Therefore, we are currently working on optimizing the parameters of our new CNN architecture to obtain better classification. These experimental results are promising in improving the generalization of disease stage classification for Glioma histopathology images with deep CNN.
Table 1. Classification Result

<table>
<thead>
<tr>
<th>Input</th>
<th>GBM</th>
<th>LGG</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBM</td>
<td>739</td>
<td>261</td>
</tr>
<tr>
<td>LGG</td>
<td>107</td>
<td>893</td>
</tr>
</tbody>
</table>

V. CONCLUSIONS

In this paper, we proposed a disease stage classification method with Deep Learning for Glioma histopathology images. In particular, Convolutional Neural Network (CNN) was employed as a Deep Learning model and utilized more patient data than the previous work. By using the proposed method, we obtained a final classification accuracy of 87.2%. As further works of this study, we will investigate to discover new subtypes using the obtained feature matrices and confirm the relationships between the disease stage and the result of gene expression analyses.

REFERENCES

A new drug development for osteoarthritis treatment-a new indication for PTH1-34

Mei-Ling Ho1,2, Je-Ken Chang1,3, Chung-Hwan Chen1,3, Ling-Hwa Chang1, Yin-Chih Fu1,3, Gwo-Jaw Wang1,3

1 Orthopaedic Research Center, Kaohsiung Medical University, Kaohsiung, Taiwan
2 Department of Physiology, College of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan
3 Department of Orthopedics, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan
E-mail: [homelin@kmu.edu.tw]

Abstract—This presentation focuses on the pharmacologic effect of PTH1-34 on OA in a serial of preclinical studies. It is a new drug development of PTH1-34 for the new indication, osteoarthritis (OA) treatment, and new administration way, intra-articular (IA) injection. In pharmacology, we proved the concept in different animal models and different causes of OA using papain-induced OA in SD rats, anterior cruciate ligament transection (ACLT)-induced OA in SD rats as the post-traumatic OA with IA injection of PTH1–34 (40 μl of 10 nM once every 3 days or 7 days for 5 weeks), and aging related OA in Hartley guinea pigs for 3 months. The pharmacological effect was also confirmed in large animals (goats) (2ml of 10 nM once every 7 days for 3 months). We also found that the effective dose range of PTH is 0.1–100 nM that is 500-1000 folds less than that used in osteoporosis. This provides one of the key information for applying clinical trial. PTH1-34 is a potential new drug to inhibit articular chondrocytes degeneration and restore the matrix formation, and thus suppress OA progression.

Keywords—PTH1-34, osteoarthritis, articular cartilage regeneration

I. INTRODUCTION

Osteoarthritis (OA) becomes one of the most concerned chronic joint diseases for developed countries where population of elderly people is increasing. It was reported that 80% of people over 75 yr-old have OA by 2006 [1], and 9.6% in men and 18% in women with age over 60 years old has OA symptom by 2008 [2]. Current treatments for OA majorly are using anti-inflammatory drugs, analgesics, and lubricating supplements to relieve symptomatic. Our study aims to develop agents that can suppress the progression of OA at an early stage. Parathyroid hormone (1-34), PTH1-34, has been used as an osteoporosis drug clinically by subcutaneous administration. Based on our in vitro study that PTH1-34 can suppress the terminal differentiation of chondrocytes that occurs in OA progression [3], (Fig.1), the serial in vivo studies is to test the effect on OA treatment. This is a new drug development of PTH1-34 for the new indication, osteoarthritis (OA) treatment, and new administration way, intra-articular (IA) injection. It is essential to conduct the pre-clinical studies and clinical trials for translating the finding from bench to bedside. Preclinical studies are mainly to prove the effectiveness by pharmacological doses in OA animal models, drug distribution, and toxicological responses with extreme large doses. This presentation focuses on the pharmacologic effect of PTH1-34 on OA. In pharmacology, we proved the concept in different animal models and different causes of OA using papain-induced OA in SD rats, anterior cruciate ligament transection (ACLT)-induced OA in SD rats as the post-traumatic OA, and aging related OA in Hartley guinea pigs. The pharmacological effect was also confirmed in large animals (goats).

II. EXPERIMENTAL

A. Animal experiments

All the animal experiments were approved by the Animal Care and Use Committee of Kaohsiung Medical University.

A) Papain-induced and ACLT-induced OA models in rats

The 12-week-old male Sprague-Dawley (SD) rats (250–300 gm) were purchased from BioLASCO Taiwan and housed under standard laboratory conditions (temperature 24°C, 12-hour light-dark cycle) with food and water ad libitum. The animals were acclimatized to the laboratory environment for 1 week before the experiments. Rats were divided into the following 3 groups: OA (OA induction without PTH1–34 treatment), OA+PTH (PTH1–34 treatment followed by OA induction), and PTH (PTH1–34 treatment without OA induction). Each left knee, which served as the contralateral control joint, was injected with vehicle without PTH treatment or OA induction. The right knees were the study joints. Papain-induced OA was induced in the...
right knees of rats in the OA and OA+PTH groups with IA injections of 20μl of 4% papain solution and 20μl of 0.03M cysteine on days 1, 4, and 7 of the experiment. The ACLT-induced OA was induced by transection of the anterior cruciate ligament and medial collateral ligament in right knees while rats under anesthesia (IM injection of a mixture of ketamine 40-80mg + Xylazine 5-10mg/kg). PTH1-34 was treated in OA+PTH group, after OA induction, the right knees were injected intra-articularly with 40μl of 10 nM PTH1–34 every 3 or 7 days until rats were killed. In the PTH group, the same PTH1–34 treatment was performed but without OA induction. Each group of rats were killed by CO2 inhalation at the same time points as rats in which PTH1–34 treatment was given for 1, 3, or 5 weeks.

B) Aged related OA model in guinea pigs

The 6-month-old Hartley guinea pigs (GPs) were divided into two groups by body weight and their ability to endure the treadmill test: the aging (AGE) group, and the OA with PTH1-34 treatment (AGE+PTH) group. The 3-month-old GPs were served as young age control group (YOUNG). The PTH1-34 administration is as the same as that in rat models. After PTH1-34 treatment for 3 months, all the GPs were killed by CO2 inhalation at 9-month-old in AGE and AGE+PTH groups and at 6-month-old in YOUNG group.

C) Large animal OA model: PMM-induced OA in goats

The large animal OA model is to confirm the effectiveness that found in small animals. The 2-year-old mixed Nubian goats were divided into 3 groups: OA, OA+PTH1-34, PTH1-34. The OA was induced by partial medial meniscectomy (PMM). PTH1-34 was treated for 3 months.

B. Evaluations of drug effect on OA.

The evaluations were functional tests (Fig. 2) and histological studies (Fig. 3).

A) Functional tests include running endurance by treadmill test and weight bearing test. Treadmill test was with speed of 30 m/min for rats and 40m/min for GPs for 10 minutes. The weight bearing test is to measure the weight loading ratio of hind limbs of OA to non-OA sides.

B) Histological studies were to examine macro- and micro-changes of articular cartilage by OARSI scoring, and the molecular changes of glycosaminoglycan (GAG), collagen type II and X, and cell apoptosis. GAG was stained with Safranin O–fast green (1% Safranin O counterstained with 0.75% hematoxylin and then 1% fast green; Sigma) (Fig. 3-a). Localized type II collagen and type X collagen were examined by immunohistochemistry. Apoptotic cells in cartilage were by TUNEL staining (Fig. 3-b).

Fig. 2 Functional tests were used to evaluate the drug effect on OA.

Fig. 3 Cartilage tissue staining and qualification: (a) Safranin-O-fast green staining for GAG content & (b) TUNEL staining for chondrocyte apoptosis.
III. RESULTS AND DISCUSSION

In the papain-induced rat model of OA, our results showed that IA treatment with PTH1–34 (40μl of 10 nM once every 3 days or 7 days) for 1–3 weeks attenuated the decrease in GAG and restored type II collagen, and treatment for 5 weeks returned GAG to normal levels and enhanced type II collagen to greater than normal levels in OA cartilage. Furthermore, treatment with PTH1–34 for 3–5 weeks appeared to suppress the expression of type X collagen caused by OA induction. Apoptosis of chondrocytes caused by OA induction was significantly suppressed by 1–5 weeks of PTH1–34 treatment [3]. In ACLT-induced rat OA model, PTH1-34 (40μl of 10 nM once every 7 days) significantly improved the running endurance and weight wearing, and suppressed the loss of GAG and collagen type II in articular cartilage. The pharmacological effects of PTH1-34 on OA treatment were also confirmed in aged related GP OA model and PMM goat model. We also found that the effective dose range of PTH is 0.1-100nM that is 500-1000 folds less than that used in osteoporosis.

IV. CONCLUSIONS

The presented serial pre-clinical studies of a new drug development demonstrated the effectiveness for PTH1-34 on OA treatment, which is one of the key information for applying clinical trial. PTH1-34 is a potential new drug to inhibit articular chondrocytes degeneration and restore the matrix formation, and thus suppress OA progression.

ACKNOWLEDGMENT

We acknowledge the grants supported from the Ministry of Economic Affairs, Taiwan (100–104-EC-17-A-19-S1-176), and the research resources provided by Orthopaedic Research Center at Kaohsiung Medical University.

REFERENCES

AlGaN-Based Deep Ultraviolet Detectors

Xiaojuan Sun¹, Yuping Jia¹, Ke Jiang¹,², Jianwei Ben¹,², Yiren Chen¹, Hang Song¹ and Dabing Li¹∗

¹ State Key Laboratory of Luminescence and Applications, Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences, Changchun 130033, China
² University of Chinese Academy of Sciences, Beijing 100039, People's Republic of China
*Corresponding author: ldb@ciomp.ac.cn

Abstract—Our previous work on growth of high quality AlN/Sapphire template and optimizing of AlGaN based DUV detectors will be detailedly introduced during at IWRIS conference.

Keywords— AlN/Sapphire template, AlGaN DUV detector

I. INTRODUCTION

Deep Ultraviolet (DUV) Detectors have attracted much attention because of the wide applications in flame detection, medicine and environment monitor, non line-of-sight communication, missile warming and so on. AlGaN is one of the best candidates for DUV detectors due to direct wide bandgap from 3.4 eV to 6.2 eV corresponding to 365 nm to 200 nm, as well as good thermal and radiation stability. However, up to now, the performances of AlGaN based DUV detectors are far from the expectation. The basic problem is the quality of AlGaN based materials. Since lack of the homo-substrate, AlGaN based materials are usually grown on hetero-substrates, such as sapphire. As a result, high density defects existed in the material, leading to the poor performance of AlGaN based detectors. To realize high quality AlGaN, AlN/Sapphire template was regarded as an effect way. So how to obtain high quality AlN/Sapphire templates became a great issue. What's more, the structure of the DUV detectors should be optimized. Novel design may bring an enhancement to the performance of AlGaN based DUV detectors.

II. RESULTS AND DISCUSSION

A. Progress of AlN/Sapphire template

In our previous work, we focused on how to obtain high quality AlN/Sapphire templates and thus to grow high quality AlGaN based material. We proposed the two-step growth method to grow AlN/Sapphire and the mechanism of the AlN/Sapphire growth was also investigated. To further improve the quality of AlN template, regrowth of HVPE AlN/sapphire template in MOCVD had been done and better quality AlN/sapphire templates was obtained, as shown in Fig.1. Additionally, HT annealing processing on sputtered AlN and HVPE AlN had also been studied. It was found that HT annealing processing had positive effects on improving the AlN/sapphire template quality. According to the change of FWHM of AlN XRC measurement the density of threading dislocation was decreased by one order of magnitude after HT annealing.

Fig 1 The weak beam dark field cross-section TEM images of the regrowth HVPE-AlN template substrate. The colorized arrows and the rectangular boxes mark the screw and edge dislocations.
B. Progress on optimizing AlGaN DUV detector

To optimize the performance of AlGaN based DUV detectors, we introduced the metallic surface plasmon (SP) into the AlGaN detectors. We realized high-performance GaN detectors by fabricating Ag nanoparticles on the surface of the GaN epilayer. The responsivity of the GaN detectors increased by over 30 times. Moreover, Al nanoparticles were used in the deep ultraviolet AlGaN detectors and the performance of the detectors was also improved. The localized SP effect was considered to be the reason for this enhancement, however, the direct evidence for this hypothesis should be found out. To reveal the physical origin behind the SP enhancing the performance of semiconductor photoelectric devices, we proposed and developed a feasible method to explain the SP enhancement, i.e., Kelvin probe force microscopy (KPFM). Based on the theory that the localized field enhancement by SP will adjust the dispersion of the electrons in the GaN epilayer, KPFM was adopted here to verify the existence of the plasmon-enhanced field. Under ultraviolet (UV) illumination, the surface potential around a Ag nanoparticle on the GaN epilayer was reduced, thereby providing direct evidence for the SP-induced localized field enhancement. Our direct observation of the SP effect can open ample avenues to integrate SP into future optoelectronic devices.

Fig 2. The characterization using AFM. (a) Surface morphology image of a Ag nanoparticle on GaN epilayer; (b) the section profile along the red and green lines crossing the isolated Ag nanoparticle in a surface morphology image. (c, d) are surface potential images obtained by KPFM in dark c and under UV (365 nm) illumination d. (e, f) are the section profile of surface potential obtained from c and d, respectively, along the red and green lines crossing one isolated Ag nanoparticle shown in a. (g, h) are the section profile of surface potential obtained from c and d, respectively, along the black line crossing dimer Ag nanoparticles shown in a.

ACKNOWLEDGMENT

This work was supported by the National Key R&D Program of China (2016YFB0400101, 2016YFB0400900), the National Natural Science Foundation of China (grant nos 61574142, 61322406), the Special Project for Inter-government Collaboration of the State Key Research and Development Program (2016YFE00118400).
Air Pollution Management Strategies in Seoul Metropolitan Area

Jong-In Dong

The University of Seoul, Department of Environmental Engineering
(E-Mail: jidong@uos.ac.kr)

1. Introduction

Ambient air is considered the most important environmental media where the human being should breathe as long as they stay in this world. This air quality was mostly impacted by fuel combustion, specially solid fuel like coal or wood in the past in Korea. This situation has changed a lot because there exist so many different kinds of emission sources including motor vehicles and manufacturing processes.

The air quality of Seoul metropolitan area has rapidly improved for relatively short period in terms of conventional air pollutants. Until 1980, they used anthracite coal as a main fuel for electricity generation and domestic heating, so there were many obstacles to improve air pollution phenomena such as acidic air pollutants and particulate matters.

Korea established a legal framework by promulgating Air Environment Preservation Act in 1990. By that time, they started to utilize gas fuel like liquefied natural gas and non-lead gasoline fuel and they started to apply newly adopted long-term emission standards. Due to this strong environmental policy, they could successfully reduce conventional air pollutants like sulfur dioxide and total suspended particulates. However, there has been an increasing concern on human health-based air pollution management, which has increased interest on secondary air pollutants and fine particulate matters.

They introduced ambient air quality standards of PM10 (PM less than 10 micrometers) in 1994 and has strengthened its level. In 2010, they introduced another ambient air quality standard of benzene with the purpose of reducing cancer-related human impacts while they introduced different standard of particulate matter of PM2.5 (2015) which requires totally different approach of air pollution management.

Even though the air quality standard level of PM2.5 is relatively high compared with those of advanced countries and WHO standards, they still try very hard to achieve the PM ambient air quality standards.

2. Air pollution management efforts to improve air quality

In city area like Seoul metropolitan area, the major air pollution sources are motor vehicles. Specifically, there have been relatively large number of diesel vehicles which emit high level of smoke or fine particulates. The initial stage of air pollution management strategy has focused on PM reduction of old-fashioned diesel bus and trucks.

The performance of old diesel vehicle engines showed very high level emission of PM, specially in the operation condition of high load. Through Sudokwon (Seoul-Incheon-Gyonggido) Air Pollution Special Control Strategy, Seoul has introduced 7,500 CNG buses during phase 1(2002-2014) and the rest during phase 2(2015-2024) which means that they finish all the city bus fuel change to natural gas. They had also installed DPF (Diesel Particulate Filters) to in-use diesel cars for 292,000 cars. They also introduced street-cleaning cars including water-straying cars (208 cars) and vacuum-cleaning cars (35 cars). They will continue to introduce more efficient vehicles for road cleaning work. For the stationary sources, they have introduced efficient low-NOx burners to small and medium-scale industry (commercial) sector (3,323 units) and 1,500 household boilers by 2015.

In order to activate the participation of citizens, they organized Clean Air Seoul Committee consisting 43 members from NGO groups, academia and representatives of different industry...
groups and public organizations by which they have conducted many cooperative tasks and campaigns. There have been several international meetings for Northeastern Asia International Forum on Air Quality Improvement.

3. Future Perspectives
They are trying to expand policy for reducing emissions from diesel vehicles by banning step-by-step operation of old diesel cars which started to run before 2005 (app. 113,000 cars less than 2.5t).
They are now trying to install PM2.5 reduction facilities at Grill(B-B-Q) restaurants. It is in its pilot test period, however, they are intending to adopt mandatory installation.
Construction machines are now in the process of improvement by engine replacement and DPF installations.
An ambitious policy is now activated to introduce significant number of zero emission vehicles by supporting the purchase of electric cars.
They are preparing a new legal system of Green Traffic Improvement Area covering the inside area of 4 main gates in the city center (CBD area).
Future strategies are considered to be focused on total emission reduction by total traffic control through citizen’s voluntary involvement and international cooperation in Northeast Asian region.
Some Innovative Approaches regarding Emission Trading System (ETS) for the Solution of Environmental Problems in North East Asian Countries

Jeongin, KIM, ChungAng University, Department of Economics, jeongin@cau.ac.kr

Abstract— By introducing traditional manufacturing based ETS (traditional emissions trading system (M-ETS) government can to ease the air pollution problem. personal carbon allowance trading system for eco-car (eco-car-PCT) for the improvement transportation and climate change can allow to accept eco friendly automobile. It is also desirable to build a personal waste trading system for household (Waste-PCT). REDD ++ projects (F-Double ETS) for the seriously threatened forestry countries including North Korea among the Northeastern countries should be started

Keywords— ETS, waste, personal, eco-car, household

I. INTRODUCTION

According to the World Bank (2012), and University of Royal College in London, about 1.4% of economic growth loss is coming out of the social cost such as environmental degradation every year. Especially, in case of air pollution, increasing coal fired power plant in every region cause serious smog, micro dust, and health problems.

Over 1.7 billion people are currently living in river basins where water use exceeds recharge. So, water stress has also significantly increased and sustainable water supply is becoming a top priority in developed and developing countries alike. 2.6 billion people have gained access to improved drinking water sources since 1990, but 663 million people are still without it. At least 1.8 billion people globally use a source of drinking water that is contaminated. But water scarcity affects more than 40 per cent of the global population and is projected to rise. We need to introduce some innovative approaches for the solution of environmental problems. This paper is dealing with some innovative economic measures for the environmental problem.

A number of community groups in UK have experimented with various forms of PCT, under the heading of carbon rationing action groups (CRAGs). A CRAG is a group of people who have decided to act together to reduce their individual and collective carbon footprints. They do this in an annual cycle. The general model is that first they set themselves an annual emissions target or ‘carbon ration’. Then keep track of their emissions over the year by recording their household energy use, private car and plane travel. Finally, at the end of the year, they take responsibility for any ‘carbon debt’ (i.e., emissions over and above their ration) that they have built up. All carbon debts are paid into the group’s ‘carbon fund’ at an agreed rate per kilo of CO2 debt. The fund is then distributed as agreed by the members of the group. However, some groups do not have a fixed ration and many do not have a financial penalty for over-achievers [31]. At its most active, there have been tens of UK-based CRAGs and a handful elsewhere in the world involved in the CRAG website [102]. Currently, these groups are less numerous and active than was the case in earlier years. This may be linked to the strong rise in low-carbon community groups [32] – providing more ‘competition’ for members than when CRAGs first formed. In addition, the CRAG organizational structure of very small, independently operating, self-learning (rather than outward-focused) groups makes growth, and even maintenance, difficult. Based on personal experience, after 2 or 3 years membership in a CRAG most members feel they have learnt what they can, and the CRAG may close. No doubt the decline in wider societal interest in PCT has also influenced the CRAG movement. A study of the opinions and experiences of individuals involved in CRAGs reported that interviewees made significant behavioral changes and emissions reductions as a result of membership [31]. However, the author urged caution in applying these findings from small, self-selecting groups to the wider population. 1

II. Literature Reviews

1 *Environmental Change Institute, University of Oxford
Personal carbon trading: is now the right time? Carbon Management (2012) 3(3), 283–291
The increase in frequency and intensity of heavy rainfall due to rapid climate change and the increase in the impervious surface due to urbanization deepen problems such as natural disasters and water pollution caused by floods and droughts, groundwater depletion, stream drainage, shortage of fresh water, etc. Particularly for South and Northeastern Asia and Africa because of rapid urbanization due to population concentration and changes in industrial structure, many social and environmental problems arise from the lack of proper infrastructure.

Among North East Asian countries, China has shown serious environmental problems too due to the economic development over the past 20 years. Hendry, A, Armstrong, B, Smart, W & Webb, G (2013) already estimated some resulted of their work. Main purpose of the paper was to assess whether personal carbon allowances are effective in reducing an individual’s carbon footprint and what impact this has on health behaviour associated with obesity,

Although individual emissions trading system is similar to emissions trading system, biggest feature is that many people participate in it and it is aimed at the individuals. Additionally, an incentive can be provided for the low income group according to the target setting and allocation method, an equity is protected because the emission is assigned to each individual in accordance with the same standard and it has a beneficial effect on achieving environmental goals. However, it is expected that it will cost a lot to establish, operate and manage a system due to large number of the participants. Nevertheless, various theories on individual emissions trading system such as TEQs ( Tradable Energy Quotas), PCAs (Personal Carbon Allowances), Cap & Share, Decentralized Transferable Permit System and Rate All Products and Services have been studied in Britain, the United States and Ireland.

II. SOME INNOVATIVE CASE

This paper is dealing with some innovative economic measures for the environmental problem.

Firstly, by introducing traditional manufacturing based ETS (traditional emissions trading system (M-ETS) government can to ease the air pollution problem. China and Korean government was initiated ETS recently. China tried to have case studies in five cities and two prefectures from 2013 to present and would enforce the trading scheme from 2017 including eight industrial sectors across the country such as oil refinery, iron and steel, chemicals, cement, etc. Target companies are around 30,000–40,000 companies, which will cover almost more than 50% of China’s total greenhouse gas emissions. Volume of economics in Northeast Asia accounts for 20% of world GDP, and for greenhouse gases it is about 30% or more.

Secondly, it is worthwhile to promote a successful personal carbon allowance trading system for eco-car (eco-car-PCT) for the improvement transportation and climate change if we can allow to accept eco friendly automobile such as EV, hybrid car and Fuel cell car. Hendry, A, Armstrong, B, Smart, W & Webb, G (2013) already estimated some resulted of their work. Main purpose of the paper was to assess whether personal carbon allowances are effective in reducing an individual’s carbon footprint and what impact this has on health behaviour associated with obesity. If consumers purchase eco-friendly car then, government issues personal allowance carbon credit after the calculation of old ownership and driving pattern of fuel consumption in average.

Thirdly, it is also desirable to build a personal waste trading system for household (Waste-PCT). In Newzealnds, each household has certain amount of garbage bag for allowance per month. Once they used it all they should buy from the other household or from the government.

In order to have the innovative emission trading system work in realty, KSP (knowledge sharing platform) between civilian experts for the emissions trading among Northeast Asia countries is very important at the beginning. To promote an expert network configuration and joint workshops, conferences on a regular basis will be necessary.

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\(^2\) Hendry, A, Armstrong, B, Smart, W & Webb, G (2013) 'Influences on attitudes to a personal carbon trading system', Proceedings of the 24th Australasian Conference on Information Systems, RMIT University, Melbourne, Australia, 4-6 December

\(^3\) Hendry, A, Armstrong, B, Smart, W & Webb, G (2013) 'Influences on attitudes to a personal carbon trading system', Proceedings of the 24th Australasian Conference on Information Systems, RMIT University, Melbourne, Australia, 4-6 December
Forth, REDD ++ projects (F-Double ETS) for the seriously threatened forestry countries including North Korea among the Northeastern countries should be started. The main idea is that when there is good practice of REDD or reforestation project, then give double credit for the investors. It is a good to foster and support a venture company for carbon offset projects between Northeast Asian countries by allowing tax exemption, job creation, free consulting for the companies.

When one of these, ETS can work in each countries and show transparent Measuring Reporting and Verification (MRV), then we can try to have Northeastern carbon market for each sector or several sectors in the future.

A Collaborative Learning Method Using Learner-participation Database

Li Zhang\textsuperscript{1} and Hidehiko Kita\textsuperscript{1}

\textsuperscript{1} Graduate School of Engineering, Mie University, Mie, Japan
E-mail: [416de52@m.mie-u.ac.jp]

Abstract—The purpose of this study is to develop a collaborative learning method for Japanese language learners where they share each other’s essays and learn from one another’s errors. Targeted learners of this method are those able to write short compositions in Japanese.

The procedure for this activity was as follows: first, each learner wrote a composition of about 300 words in Japanese about a four-frame comic of a story from Aesop’s Fables. The learners then broke into groups of three, and each group collectively looked for errors in their compositions, discussed these errors, and made corrections. Next, they recorded their findings on error-analysis cards designed by the authors and entered the contents of the cards into a database of learners’ writing errors. Finally, each learner reviewed not only his or her own writing errors but also those of others using the database. The authors used this activity with 11 Chinese speakers with Japanese skills of Level 2 or higher on the International Japanese Language Proficiency Test.

The results of the activity are as follows: the learners’ post-test scores for Japanese skills after the practice were higher than their pre-test scores. The learners found about 80% writing errors in their compositions. The most common errors were the misuse of intransitive and transitive verbs. The learners learned their writing-error patterns by reviewing sentences with errors in the error database. We conducted the learning activity four times. According to the experimental results, we found that it was an effective way to learn Japanese. Also, we found something that need to improve.

Keywords—Collaborative learning, Japanese language learning, learner-participation database, learning from errors

I. INTRODUCTION

When learning a foreign language, it is important to learn from one’s errors rather than fear making mistakes. Usually, a teacher only points out and corrects errors in compositions written by learners; thus, learners do not know why they made these errors. Normally, learners think that errors are bad, so they rarely write down or memorize incorrect structures or the reasons for the errors. As a result, they frequently repeat their mistakes. Recording errors is a way of stopping learners from repeating mistakes. Toward that end, we have proposed a learner-participation database of writing errors [1].

Teramura [2] made a database of Japanese errors made by foreign learners for language researchers, and Koyanagi and Mochiduki [3] formulated an online dictionary of Japanese errors aimed primarily at Japanese language teachers. Both databases were made by specialists in Japanese language education. In this study, however, the learners themselves created the contents of the database of errors.

Because China employs a traditional teacher-centered method, which focuses on rote learning and memorization of words in Japanese language education, learners are required to understand the writing errors in their compositions independently.

The purpose of this study was to develop a collaborative learning method in which students seek, share, and learn from the errors in composition. In addition, we compiled a database of the errors found by learners to enable them to share these with other learners and reflect on their own learning.

II. A COLLABORATIVE LEARNING METHOD USING AN ERROR DATABASE

A. General

This study adopted the concept of a learner-participation database [4]. We designed a learner-participation error database of errors in learners’ compositions. We developed a collaborative learning method that emphasized sharing writing errors and learning using the error database. The flow of the collaborative learning method is shown in Fig. 1. The error database was made using the database function of Moodle, a popular e-learning system. The database consisted of learners’ names, a classification of error types, composition themes, and the contents of errors. We based our error classification on that of Murata [5], which we then segmented into 18 items, including vocabulary, grammar, and expression.

Fig. 1, The sequence of the cooperative learning method.
B. The Sequence of the Cooperative Learning Method

- **Writing activity**
  In order to reduce the writing burden on learners, the activity uses four-frame comics as the composition material. The four-frame comics consisted of four Aesop's Fables stories, familiar to learners. Each learner writes a composition of about 300 words in Japanese about one of the comics.

- **Looking for errors as a group activity**
  After writing their compositions, the learners divide into groups of three, first look for mistakes in each of their compositions, then discuss them, and finally consider the correct alternatives.

- **Using the error-analysis cards**
  The learners in each group write their findings about the errors on the error-analysis cards shown in Fig. 2, designed by the authors. The cards comprise columns for incorrect sentences, correct sentences, interpretations, and classification of errors.

<table>
<thead>
<tr>
<th>Error-Analysis-Card</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Categories</strong></td>
</tr>
<tr>
<td>writer</td>
</tr>
<tr>
<td><strong>Correct sentence</strong></td>
</tr>
<tr>
<td><strong>Error sentence</strong></td>
</tr>
<tr>
<td><strong>Interpretation</strong></td>
</tr>
</tbody>
</table>

Fig. 2, Error-Analysis-Card.

- **Recording data in the error database**
  Each learner registers his/her own errors in the error database, one at a time, from the cards.

- **Using the error database**
  The error database can be used in two ways: first, learners can use it to reflect on their own errors. Second, they can learn not only from their own errors but also from those of others. An example of use of the error database is shown in Fig. 3. For example, when reviewing his or her own errors, he or she can notice that other learners made similar errors.

| Fig. 3 The example of using error database. |

III. AN EXPERIMENT WITH THE COLLABORATIVE LEARNING METHOD

To confirm the effects of this collaborative learning method, we conducted the activity four times. The participants were Chinese speakers with intermediate or high proficiency in Japanese (Japanese Language Proficiency Test Level 3 or higher). Before the activity, we created a guide explaining how to use the e-learning system Moodle and the sequence of the collaborative learning method. To verify the effectiveness of the learning method, we administered a questionnaire and test before and after the practice.

IV. THE RESULTS OF THE COLLABORATIVE LEARNING ACTIVITY

A. Errors Registered in the Error Database

After four trials, a total of 247 errors were registered in the error database. Error types in descending order of frequency are shown in Fig. 4.

| Fig. 4, Error types in descending order of frequency. |

Some errors may be in one sentence, or one error falls into some error classifications. In order to make it easier for learners to treat these cases, for one sentence including several errors, learners select and register only one classification of only one representative error. For example, the following error belong to both "particle" and "error of verb". We classified it as "verb mistake" so that the learner can use it easily.

| 誤:突然，音は後ろに出しました． |
| 正:突然，音が後ろから聞こえました． |

Learners may not find errors in their compositions. One of the authors who is Japanese and a university teacher (not a teacher of Japanese language) reviewed all of the compositions.

Top three categories that the learners are likely to mistake are "Not natural", "Intransitive/Transitive verb", and "Verb". Examples of each are given below.

- "Not natural" (grammar is right but unnatural expression)
  誤:農夫は後悔しても，追いつかなかった．
  正:農夫は後悔しましたが，取り返しがつきませんでした．

- "Intransitive/Transitive verb" (Proper use of intransitive and transitive verb)
  誤:自分で川を渡す．
  正:自分で川を渡る．

- "Verb" (The selection of the appropriate verb)
  誤:農夫は鷹を追いかけます．
  正:農夫は鷹を追いかけました．

Besides above, there are errors as follow.
• “Particles’が‘” (inappropriate use of the particle “が”)
   誤：農夫は蛇を見つけた。
   正：農夫は蛇を見つけた。
• “The practical use of the verb”
   誤：運ぶたい。
   正：運びたい。

For Japanese language learners of intermediate level and higher, it is difficult for them to judge naturalness of Japanese expressions, to use selectively an intransitive verb or a transitive verb, and to select a proper verb.

B. Total Number of Error Changes

Changes in the number of errors detected by learners in the four trials are shown in Fig. 5. From the first through third trials, little change was observed in the number of errors or the number of words in the compositions. After the third trial, the authors instructed the learners to reflect on the error database. In the fourth trial, the number of errors decreased by more than 25%, although the number of characters in the compositions remained the same. It is likely that retrospective study using the database reduced the number of errors. Therefore, it would be beneficial to conduct the retrospective study after practicing a few times.

Fig. 5, Changes in the number of errors.

V. ANALYSIS OF THE EFFECTIVENESS OF THE COOPERATIVE LEARNING METHOD

A. Awareness of the Patterns of Writing Errors

As shown in Fig. 6, 90.9% of learners responded “yes” or “mostly yes” to the question “Are you aware of your own error patterns?” When learners reviewed their errors using the error database, they noticed that similar errors occurred multiple times, thus recognizing their own tendencies toward that error. Recognizing such tendencies of error kept the students from repeating these errors.

B. The Effect of Collaborative Learning

The learning effects of the collaborative learning method were as follows:
• Error detection rate by cooperative learning
   In this collaborative learning method, we analyzed the number of errors detected between learners and calculated the error detection rate. As shown in Table 1, the result of the detection rate showed that the rate of error detection in practical tasks was about 80%. In other words, it indicated that this collaborative learning method was effective for error detection among learners. However, there were about 20% errors not detected by learners. It is one of future challenge that how to deal with such errors.

Fig. 6, Awareness of the patterns of writing errors.

Table 1 Error detection rate (excluding errors related to the natural expression)

<table>
<thead>
<tr>
<th>Writing theme</th>
<th>1st time</th>
<th>2nd time</th>
<th>3rd time</th>
<th>4th time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error number</td>
<td>68</td>
<td>57</td>
<td>65</td>
<td>57</td>
</tr>
<tr>
<td>Natural error</td>
<td>18</td>
<td>9</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Excluding naturalness</td>
<td>50</td>
<td>49</td>
<td>54</td>
<td>41</td>
</tr>
<tr>
<td>Learners detection</td>
<td>44</td>
<td>43</td>
<td>43</td>
<td>32</td>
</tr>
<tr>
<td>Detection rate</td>
<td>88%</td>
<td>88%</td>
<td>80%</td>
<td>78%</td>
</tr>
</tbody>
</table>

• Pre-test and Post-test results
To confirm whether or not the learners’ Japanese writing fluency improved after the trials, we administered the same test before and after the trials. The result was shown in Fig. 7. The extent of improvement varied among the learners. The maximum score of improvement was 53.7 points, while the minimum was 6.6 points.

Fig. 7, The result of pre and post-test.
C. Satisfaction with the Collaborative Learning Method

About 90.9% of the learners said that they were satisfied with this learning method. Among the feedback posted on Moodle were the following:

- “I am glad that I found my own error tendencies with the error database.”
- “The mistakes I didn’t notice were caught by others. When I discovered someone else’s mistake, I was careful not to make the same mistake.”
- “Studying while talking was pleasant. Registering my own errors in the error database was very helpful, because I could review it at any time.”
- “I understood deeply by discussing our errors”.

Therefore, through this method, learners realized the importance of learning from their own errors by sharing errors and mutual learning, and were able to discover their own error tendencies.

VI. Future Challenges

We intend to repeat the activity with more participants, since the 12 participants in this exercise comprised only a small sample. We are asking Chinese universities for cooperation. We plan to increase the number of materials and repeat exercises to enrich the data in the error database. Here, we conducted a post-test immediately after practice, but to confirm the permanence of the learning effect through cooperative learning, in the future, we will conduct a fixation test one month after collaborative learning. To increase learners’ error detection rates, we will also investigate how to respond to errors that cannot be detected by learners, such as the naturalness of their Japanese expressions.

VII. Conclusions

In this research, we developed and put into practice a collaborative learning method of sharing errors and learning by using error databases. We found that it was possible for learners to detect errors with others’ help, and their awareness led the learners to stop making certain errors. In addition, the rate of the learners’ detection of the errors was about 80%. Learners’ skills in Japanese written expression were thus enhanced. We obtained useful information for future Japanese teaching, such as a better understanding of error-prone items and undetectable errors. Future tasks will focus on improving learners’ error detection rates and repeating the activity with a larger number of subjects.

References

Training Algorithm of SpikeProp Accepting Sequential Patterns
—A Discussion on Effective Combined Teacher Patterns—

Kengo Onoda, Haruhiko Takase, Hiroharu Kawanaka, and Shinji Tsuruoka

Graduate School of Engineering, Mie University, Mie, Japan
Email: [417m211@m.mie-u.ac.jp]

Abstract — SpikeProp, which is proposed by Booij, is a kind of spiking neural networks. It is a feedforward network of spiking neurons (units) and its training algorithm. It expresses information by timing of spikes. In previous training method, when receives the single pattern, number and time of output spikes can be trained. However, when a trained network by previous training method receives sequential input patterns, its output would not be desired one. There are two reasons for this. One is networks train patterns individually with previous training methods. The other is previous input patterns affect next input patterns of SpikeProp. In this article, we discuss that this problem is caused by SpikeProp’s output mechanism, and propose a new training method to combine multiple patterns for training. Also, effectiveness of this method would depend on the number of patterns and interval of patterns in each combined pattern. For that reason, we discuss the appropriate combination number and combination interval. By the proposed method, we succeed more than 72.6% by using an appropriate number of combinations and intervals even under succeed 0% using the previous method.

Keywords — Spiking Neural Network, SpikeProp, Time Series Signal Processing

I INTRODUCTION

Recently, Spiking Neural Networks (SNNs) attract many researchers attention[1]. They are based on the fact that biological neurons communicate by electrical spikes and perform time series signal processing. Since they are inspired from the mechanism of the human brain, they would perform human-friendly information processing. SNNs consist of spiking neurons, which represent information by spikes, i.e., spike density or spike time. Representing information by spike time is more preferable than the method by spike density in the point of view of response speed[2].

There are various training methods for SNN encoding information by spike time[3]. Bohte et al. proposed SpikeProp, which is a kind of multi-layer spiking neural networks and its training algorithm to adjust a timing of the first spike based on the error back propagation algorithm[4]. It outputs only one spike per one output unit. In other words, SpikeProp network cannot perform time series signal processing. Booij et al. extended SpikeProp to emit multiple spikes for each unit[5]. Matsumoto et al. proposed to train number and time of spikes[6]. However, when a trained network by this training method receives sequential input patterns, its output would not be desired one. The reason is that the network trained patterns individually. To consider the case, we propose a method that trains combined patterns instead of individual patterns. This allows network to train the influence of previous patterns.

II PREVIOUS METHODS

In this section, we simply explain previous methods. First, we explain the SpikeProp in section A. Second, we show a problem of SpikeProp when receiving sequential input patterns in section B.

A SpikeProp

SpikeProp is a feedforward network of spiking neurons (units) and its training algorithm. It expresses information by timing of spikes. Inputs and outputs for networks are spike trains. Booij’s SpikeProp model can handle multiple spikes on each connection. Fig.1 shows a typical SpikeProp network. To simplify discussion, we treat three-layer networks as shown in Fig.1, though the training algorithm for SpikeProp networks requires only feedforward network. Each connection consists of sub-connections that have individual delay and weight. Here, all weights are adjusted by training, and delays are fixed values. Each unit emits spikes based on the spike response function (SRF). Unit $i$ fires when its activity $x_i$ reaches threshold $\theta$. Here activity $x_i$ is defined as follows:

$$ x_i(t) = \begin{cases} 
0 & (t \leq 0) \\
\exp\left(\frac{t}{\tau_s}\right) - \exp\left(\frac{-t}{\tau_r}\right) & (t \geq 0)
\end{cases} $$

$$ x(t) = \begin{cases} 
0 & (t < 0) \\
-\theta \exp\left(\frac{t}{\tau_r}\right) & (t \geq 0)
\end{cases} $$

$$ x_i(t) = \sum_{i' \in F_i} x(t - t_{i'}) + \sum_{j \in M} \sum_{k=1}^m w_{ij}^k \epsilon(t - t_{i'} - d^k) $$
\( \epsilon(t) \) and \( \kappa(t) \) are the spike response function and the function for refractoriness. \( \tau_m, \tau_r \) and \( \tau_e \) are time constants for each exponential. \( \theta \) is the threshold for firing each unit. When activity \( x_i(t) \) reaches to the threshold \( \theta \), the unit emits a spike and its activity falls to zero. \( F_j \) and \( \nu_j \) are the set of spike time of unit \( j \) and spike time of \( f \)-th spike on unit \( j \). \( \Gamma_i \) is the set of presynaptic units for unit \( i \). \( w_{ik}^f, d^h \) and \( m \) are the weight for the \( k \)-th sub-connection from unit \( i \) to unit \( j \), the delay on \( k \)-th sub-connection and the number of sub-connections.

Training algorithm for SpikeProp is based on the error back-propagation algorithm. To adjust spike time, the error from unit \( i \) the method uses \( \eta \)

\[
E = \frac{1}{2} \sum_{p \in P} \sum_{j} \left( \hat{f}_j^p - f_j^p \right)^2 .
\]

\( P \) is the set of teacher patterns. \( J, \hat{J}_j \) and \( \hat{I}_j^p \) are the set of output units, the number of desired spikes for unit \( j \), and desired spike time of the \( f \)-th spike on unit \( j \).

All weights are gradually adjusted repeatedly. The update rule for each cycle is as follows:

\[
\Delta w_{ij}^k = -\eta \frac{\partial E}{\partial w_{ij}^k} .
\]

\( \eta > 0 \) is a training rate. In a training process, some units may not fire because of too small activity. In such case, we enlarge weights connected to them.

Matsumoto proposed a training method that can adjust both timing and number of spikes. It method expand weight decay. Weight decay is a classical training technique to improve input-output characteristic of conventional (non-spiking) neural networks[7]. It weakens redundant connections by modifying the error to be minimized by a training algorithm. The modified error is defined as follows:

\[
E' = E + \frac{\rho}{\eta} \sum_{w \in W} w^2 .
\]

\( W \) is the set of all weights. \( \rho \) is a parameter to determine the strength of weight decay effect. The first term in equation (6) intends to minimize the output error, and the second term intends to weaken redundant connections. Consequently, trained networks will behave well, i.e. good generalization. To minimize the evaluation function \( E' \), equation (5) is replaced by following:

\[
\Delta w_{ij}^k = -\eta \frac{\partial E}{\partial w_{ij}^k} - 2\rho w_{ij}^k .
\]

This method trains a network until satisfying two conditions: less error \( E \) and no redundant output spikes. It switches \( \rho \) and \( \eta \) by the progress of the training process.

\( \eta \), the method uses \( \eta_H \) or \( \eta_L \) \( (\eta_H > \eta_L) \). At first, the method uses \( \eta_H \) to decrease \( E \) below \( E_{\text{th}} \). Then the method uses \( \eta_L \) to suppress the effect of decreasing \( E \) and to enhance the effect of suppressing redundant spikes. If \( E \) is increased up to \( E_{\text{th}} \), the method uses \( \eta_H \) again. For parameter \( \rho \), the method uses \( \rho_H \) or \( \rho_L \) \( (\rho_H > \rho_L) \) for each weight. The method uses \( \rho_H \) for weights that are connected to units that output redundant spikes, and use \( \rho_L \) for others. It intends to weaken the effect of weight decay and to encourage reducing the error for units that are decreased output spikes enough.

**B Problem of previous training method**

SpikeProp adds SRF to each unit internally as shown in equation (3). Therefore, when sequential patterns input, the SRF generated by previous patterns add. That is, the input pattern influenced by the previous input pattern. In previous training method, since network trains patterns individually, it cannot deal with influence by previous input patterns. Also, from equation (1), SRF decreases over time. Therefore, smaller pattern interval at sequential input patterns, the greater influence of the previous pattern.

**III Proposed Method**

If network trained patterns individually, when it receives sequential input patterns, its output would not be desired one. We should consider the case of sequential input patterns in training algorithms. To consider the case, we propose a method that trains combined patterns instead of individual patterns as shown Fig. 2. Obviously, the number of combined patterns is enormous. So, we adopt online training technique. Equation (7) was used for the updating weight. In other words, the Matsumoto method is expanded, combined patterns are input, and error is updated by online training.

The effectiveness of this method would depend on the number of patterns and interval of patterns in each combined pattern. By changing the number of patterns, the number of training patterns affected by previous input pattern changes. Since the SRF attenuates in time, the influence of previous input pattern varies depending on the pattern interval.

Next section, we discuss the issue by simple experiments.

**IV Experiment**

In this section, we discuss the influence of the combination interval and the number of patterns of the proposed method in a simple experiment.
### Table 1 Network structure for experiments

<table>
<thead>
<tr>
<th># of input units</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td># of hidden units</td>
<td>10</td>
</tr>
<tr>
<td># of output units</td>
<td>3</td>
</tr>
</tbody>
</table>

- $m = 8$
- $d^k = 1-8$
- $\theta = 7.0$

### Table 2 Parameters for training algorithms

<table>
<thead>
<tr>
<th>$\rho_H$</th>
<th>0.002</th>
<th>$\rho_L$</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\eta_H$</td>
<td>0.05</td>
<td>$\eta_L$</td>
<td>$\eta_H/4$</td>
</tr>
<tr>
<td>$E_{th}$</td>
<td>225</td>
<td>$E_{th}$</td>
<td>105</td>
</tr>
</tbody>
</table>

### A Experimental setup

In experiments, we train networks for Iris benchmark problem encoded with spike time. Four input values are encoded with 0ms to 6ms. Three logical values are encoded with 10ms and 16ms. 150 patterns were divided into 75 patterns for training and testing. The network parameters are shown in table 1. The training parameters are shown in table 2.

The combination interval was changed from 20ms to 100ms, the number of the combination was changed from 2 to 4, and online training was conducted 30,000 times for each combination. For the network after training, we entered four successive patterns with the input interval changed from 20ms to 100ms. At this time, when the number of outputs for all four input patterns is as desired, and the output time is within the error plus minus 3ms from the desired one was defined as success. It did 100 times for each input interval and determined success rate.

### B Result

First, we describe a relationship between the success rate of sequential input patterns and the number of combined patterns at training. Fig.3, Fig.4 and Fig.5 show the relationship between successive input intervals and success rate when train at combined intervals 35ms, 40ms and 60ms, respectively. In case of the training interval of 40ms, there was no difference in success rate depending on the number of combined patterns. However, in case of the training interval of 35ms, the success rate was 60% to 75% in case of 2 combined patterns under the condition that success rate in case of 4 combined patterns is 20% to 40%. In addition, when training interval is large as in case of training interval of 60 ms, success rate is about 70% in case of two combined patterns even under condition of less than 10% in the others number of combined patterns. From these results, it can be said that performance of sequential input patterns are good when the number of combined patterns is 2. As a reason, Iris benchmark problem was a relatively simple problem and it can be thought that 2 patterns of combined were enough. In addition, as the number of combinations increases, the number of training times required increases, and as a result, it is considered that the number of training has become insufficient at 30,000 times.

Secondly, we will describe the relationship between the success rate of sequential input patterns and the combined interval at training. Fig.6 shows the relationship between successive input intervals and success rate when training with combined 2 patterns. Comparing the previous method with the proposed method at training interval of 35 ms, in case of the input interval of 40 ms, the success rate was 0% in the previous method, success rate improved to 72.6%. In addition, when comparing interval 35 ms and interval 45 ms at training, the success rate at the large interval is same,
but at interval 35 ms, the success rate at the smaller interval is good. However, in case of training interval 25 ms, the success rate was less than 15% in all input intervals. From these results, it can be said that performance at sequential input patterns is better as the combined interval at the time of training is smaller, but success rate becomes very poor when the combined interval is too small. The reason why the success rate is very poor when the combined interval is too small is considered to be training has failed because the influence of previous input patterns are too large when the combined interval is too small.

V Conclusion

In this paper, we proposed a training method for Spike-Prop to accept sequential input patterns. Then we discussed the effective number of patterns and the effective interval of patterns in each combined pattern. Even in the sequential input that could not be accepted by the previous method, the success rate was 72.6% by the proposed method. In addition, as a result of investigating the number of combinations and combination intervals of appropriate patterns, it was found that best of the number of combinations is two this time. The smaller the combination interval is, the more it is accepted to cope with a sequential input of patterns at various intervals, but training fails if pattern interval is too small.

In the future, we will investigate the change in the required number of training by the number of combination patterns. Then we consider a training algorithm that can accept with sequential input at smaller intervals.

References


Verification Experiments of Robot System for Emotions expressed by Physical Motions.  
—Analysis from the view point of Comparative Culture—

Shinobu Nakagawa¹, Shinji Tsuruoka², Hiroshi Taguchi³

¹ Art & Science department, Osaka University of Arts, Osaka, Japan  
² Graduate school of Engineering, Mie University, Tsu, Mie, Japan  
³ Graduate school of Bioresources, Mie University, Tsu, Mie, Japan  
E-mail: [shinobu@osaka-geidai.ac.jp]

Abstract—“Communication Robots” are expected to become a best partner for human. However the motion designs of the robots are mechanical, and the motion of the emotion is not friendly for human. To solve the problem of the motion design, we had extracted the way of expressing their emotions from the motion of the Japanese “Bunraku” puppeteer. We built a new robot with an expandable body to express many emotions, and we had some experiments to evaluate the effect of the robot, subjective evaluation and objective evaluation was conducted by measuring the brain waves. For these experiments, we prepared 3 motion patterns of this robot, not-expandable body, expandable body, and expandable body with tilt neck.

According to these results of subjective evaluation, an expandable robot with tilt neck was better and higher affinity than the other 2 motions of robot for subjects. The expandable robot with tilt neck was highly praised in those evaluation points, emotional, lively, not mechanical, warm, and so on. From the result of measuring brain wave of subjects, the expandable robot with tilt neck was the highest evaluation, too. However, there were distinct differences of evaluation for robot between Japanese subjects and foreign nationality subjects. Foreign nationality did not tend to accept the exaggerated motion of the robot.

From these results, we confirmed that most human prefers the exaggerated emotional motion of robot like Bunraku puppet. And we confirmed that the proposed emotional expressions by the expandable robot were useful to communicate with human friendly. However, foreign nationality did not necessary prefer the exaggerated emotional motion of the robot same as Japanese.

Keywords—Robotics Design, Motion, Emotion, Communication Robot, Bunraku, comparative culture

I. INTRODUCTION

“Communication Robots” are expected to become a best partner for human [1]. However the motion designs of the robots are mechanical, and the motion of the emotion is not friendly for human. For example, when a pet animal made a careless mistake, human allowed it for the emotional motion. However, when manufactural product made a careless mistake, human almost could not allow it. Because human recognizes that it handles all works without fall. Recently, elderly patients don’t hope to be cared by robots. As the reason for that, they latently hate to be treated like things by robots. Robots must be designed that it will be contributed to enhancing and protecting human dignity.

To solve the problems, especially the motion design of robots, H.Ishiguro and A.Takanishi had developed emotional robots [2,3], these were designed the structure on the basis bone of human. However we had a sense of discomfort with emotional expression of these robots, so we had extracted the emotions from the motion of the Japanese “Bunraku” puppeteer. Because we tend to see things as illusions included exaggeration and omission. “Bunraku” is the traditional puppet theater of Japan. In this same way, he makes Bunraku puppet seem more“real”for us. By effectively using motions included exaggeration and omission, he manipulated Bunraku puppet just like that illusion [4]. We built a new robot with an expandable body to express many emotions, and we evaluated the effect of the robot.

II. BACKGRAUND

To discover the essence of this research, we searched two conventional fields. The first field is animated cartoon and the second field is Japanese “Bunraku”. As the result, the Bunraku puppet appears the emotion by the body motion, and the cartoon character appears the emotion by facial expression. By comparison of the making cost on two type robots, Bunraku motion is more effective and cheaper than the cartoon.

The mechanism of “Bunraku” is the expansion and contraction of the neck and body and arm by the Bunraku puppet. To verify this hypothesis, we made a real
Bunraku robot shown in Fig. 1. It can perform the same act (expands and contracts) as the emotional expressions of Bunraku puppet. This robot has a new mechanism to express the emotions.

III. EXPERIMENTS AND RESULTS

3.1 Experiment
(1) Purpose: We had experimented to verify the impressions of subjects (including foreign nationality students) of this new robot. Because Christian nations tend to despise Robots from the factors of their religious idea or work ethic, we verified the comparative culture that was the view of their Robots between Japanese and foreign nationality.

Especially Europeans tend to hate humanity in the Robot, and they tend to like better mechanical Robots because of their views. However, from the result of advanced experiments [4], most subjects felt this new robot (expandable body) like humanity, biotic, emotional. We wanted to verify these views of differences for this between Japanese and foreign nationality.

(2) Method: Subjects were next, 11 students were Japanese, 10 students were foreign nationality (Swedish:1, American:2, Russian:3, French:1, German:1, Chinese:2). All subjects saw the rejoicing and surprising motion patterns in front of the robot (1m). After that, they were provided subjective evaluation and objective evaluation (brain wave average, each brain wave) and analyzed from the view of comparative culture. To evaluation method were adapted the method of Prof. Taguchi [5].

(3) Results: We show the comparison results of Japanese subjects (Fig.2, Fig.4, Fig.6) and foreign nationality subjects (Fig.3, Fig.5, Fig.7).

Fig.2 (rejoicing motion) shows that expandable and tilt neck was the highest evaluated 21 positive words in 22 words, and second evaluated was expandable body, third was not-expandable body. Other results of surprising motion shows the same. Especially, plain-complicated, cheerful-gloomy, humanity-mechanical, lively-dull, biotic-artificial, emotional-inanimate, in these pairs of adjective, this expandable and tilt neck moving pattern was evaluated highly.

However, Fig.3 (rejoicing motion) shows that the highest evaluation of their positive impressions was not same. Especially, Fig.3 shows that foreign nationality subjects evaluated these 3 moving patterns of robot almost the same, the number of the highest evaluated positive wards / not-expandable body: 10 / expandable body: 10 / expandable body and tilt neck: 7. Their evaluations on this were divided. On the other hand, surprising motion tended to be same as the results of the Japanese subjects, expandable and tilt neck was the highest evaluated 21 positive words in 22 words. However, it shows that the amount of difference between the highest evaluation and the lowest one were smaller than the results of Japanese subjects.

Fig.2 Results of Experiment (rejoicing, 11 Japanese subjects).

Fig.3 Results of Experiment (rejoicing, Not Japanese subjects).

Fig.4 shows the results of experiment (rejoicing motion) that are the average ratios of $\alpha$ wave / $\beta$ wave for each three moving patterns of robot. This higher average is positive impression. From these results, the highest evaluation of the Japanese average is expandable body (average ratio: 1.56). The second highest is expandable body and tilt neck (1.55), and the third highest is not-expandable body (1.47).

Fig.4 Average Brain wave of Experiment (rejoicing, Japanese).

However, Fig.5 shows the highest evaluation of the foreign nationality is not-expandable body (average...
The second highest is expandable body (1.33), and the third highest is expandable body and tilt neck (1.30). These results are quite in the opposite direction. 

From the results of surprising motion experiment, the highest evaluation of the Japanese average is expandable body (1.64). The second highest is expandable body and tilt neck (1.60), and the third highest is not-expandable body (1.56). And the highest evaluation of the foreign nationality is expandable body (1.50). The second highest is expandable and tilt neck (1.44), and the third highest is not-expandable body (1.29). In this case, both evaluated same pattern. However, the results of the foreign nationality date were smaller than the Japanese results.

From the results of surprising motion experiment, we confirmed that Japanese subjects tend to prefer exaggerated emotional motion of the robot like Bunraku. However, foreign nationality did not tend to accept the exaggerated motion of it perfectly. There were distinct differences of evaluation for robot between Japanese and foreign nationality.

(5) Conclusion:
From these results of experiments, Japanese subjects prefer exaggerated emotional motion of the robot. However, foreign nationality did not tend to accept the exaggerated motion of it perfectly. There were distinct differences of evaluation for robot between Japanese and foreign nationality.

IV. CONCLUSION

In this research, we had extracted the emotions from the motion of the Japanese “Bunraku” puppeteer. We made a new Bunraku robot with an expandable body to express many emotions. This mechanism was the expansion and contraction of the body and the tilt of the neck. We had experimented to verify the impressions for subjects of this new robot. We experimented three moving patterns of the robot, that is, not-expandable body, expandable body, expandable body and tilt neck.

From the results of experiments, we verified the comparative culture that was the view of their Robots between Japanese and foreign nationality. From the results of the Japanese subjects, they prefer exaggerated emotional motion of the robot. The highest evaluation of their positive impressions was the expandable body and tilt neck (21 positive adjective words in 22 words, 21 positive adjective words in 22 words) (average ratio: 1.55, average ratio: 1.39).

However, the results of foreign nationality subjects were quite different from the Japanese. The results of
foreign nationality subjects (subjective evaluation), they evaluated these 3 moving patterns of robot almost the same, the number of the highest evaluated positive wards (not-expandable body: 10 / expandable body: 10 / expandable body and tilt neck: 7). Their evaluations on this were divided. On the other experiment, they tended to be same as the results of the Japanese subjects, expandable and tilt neck was the highest evaluated (21 positive words in 22 words). The highest evaluation of the foreign nationality (measuring brain wave) was not-expandable body (average ratio: 1.39). The other was expandable body (average ratio: 1.50).

From these results, we confirmed that Japanese tends to prefer exaggerated emotional motion of the robot like Bunraku puppet, and that the proposed emotional expressions by the expandable robot are useful to communicate with Japanese friendly.

However, foreign nationality did not tend to accept the exaggerated motion of it perfectly, from the result of experiments. There were distinct differences of evaluation for robot between Japanese subjects and foreign nationality subjects. The reason was not clear, but we thought it might be caused by the difference of culture. So, we considered that the world people do not necessary prefer the exaggerated emotional motion of the robot same as Japanese.

REFERENCES


[4] Shinobu Nakagawa, Shinji Tsuruoka, Motion Design of Emotional Expressions for Robot to Communicate with Human -Analysis of “Bunraku” Puppet Motion - IWRIS2013 Mie University, pp.8-11

Verification of sales prediction method in tourist spot

Haruki Odajima
Mie University, Department of Regional Innovation Studies Mie City, Japan.
610d003@m.mie-u.ac.jp

Abstract—By focusing on the tourism consumption and the purchasing behavior in Ise city which is the typical tourism-rich area of Mie prefecture in Japan, we developed “sales prediction method” based on open data which is freely available to everyone to use. By applying this method, we predicted the sales amount of products which are made by local resources, and verified the usefulness of “sales prediction method”.

Keywords—Ise, pearl salt cider, correlation coefficient, sales prediction

I. INTRODUCTION

In recent years, it becomes that various open data and many type of open software which are freely used by anyone are released and can be used. If data analysis can be utilized in regional business to forecast future sales volume, it is possible to grasp the purchasing trend of consumers, the number of appropriate stocks and products, efficiency improvement of product development, optimization of distribution. I think that it will lead to the resolution of anxiety about business.

II. Method

In this case, we used our product called “pearl salt soda” as an example to verify if there is any correlation between various data and the actual sales quantity by utilizing the statistical analysis software called “R”. The sales prediction formula is created by consulting various data of tourist spot to find some data with high correlation factor, and conducting multiple regression analysis.

1 The highest temperature in Ise city
2 The average temperature in Ise city
3 The number of customers attracting neighboring restaurants
4 The web access number of neighboring restaurant
5 The prediction of congestion of Ise Jingu

We conduct multiple regression analysis based on items with high correlation coefficient and apply it to the following formula to derive the future "pearl salt cider" sales.

\[
\text{Pearl salt cider sales} = A_1 \times (1-5) + A_2 \times (1-5) + b
\]

III. RESULTS

We will investigate the correlation of 1 ~ 5 below based on the number of "pearl salt cider" sale.

1 The highest temperature in Ise city
#Correlation coefficient R -0.16

2 The average temperature in Ise city
#Correlation coefficient R -0.1

3 The number of customers attracting neighboring restaurants

4 The web access number of neighboring restaurant

5 The prediction of congestion of Ise Jingu

3 The number of customers attracting neighboring restaurants  
Correlation coefficient R -0.76

4 The web access number of neighboring restaurant  
Correlation coefficient R -0.36

※ The correlation coefficient is 0.7 or more, it is said that there is a strong relationship.

Select a factor that has high correlation coefficient and leads to future information.

a1: The highest temperature in Ise city
a2: The average temperature in Ise city

Pearl salt cider sales = 
\[ a1 \times (22.998) + a2 \times (1.202) + (-718.488) \]
The following is the calculation result of multiple regression analysis. Estimated standard values and adjusted figures for the maximum temperature and the number of customers attracting neighboring restaurants are applied to this analysis result.

Call:

```
lm(formula=shio$sales.total~shio$temperature.highest + shio$Number.of.visitors)
```

Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-168.10</td>
<td>-50.95</td>
<td>-11.20</td>
<td>32.27</td>
<td>303.43</td>
</tr>
</tbody>
</table>

Coefficients:

|                | Estimate | Std. Error | t value | Pr(>|t|) |
|----------------|----------|------------|---------|---------|
| (Intercept)    | -718.488 | 202.183    | -3.554  | 0.00142 ***|
| shio$temperature.highest | 22.998 | 7.111 | 3.234 | 0.00321 ***|
| shio$Number.of.visitors | 1.202 | 0.156 | 7.710 | 2.272e-08 **|

---

Signif. codes: 
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 93.62 on 27 degrees of freedom (2 observations deleted due to missingness)

Multiple R-squared: 0.6965, Adjusted R-squared: 0.674
F-statistic: 30.98 on 2 and 27 DF, p-value: 1.023e-07

---

IV. Conclusion

The number of pearl salt cider sales is as follows.

<table>
<thead>
<tr>
<th>Period</th>
<th>Estimated sales</th>
<th>Actual sales volume</th>
<th>Difference</th>
<th>Match rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017/8/1~31</td>
<td>12,771</td>
<td>10,571</td>
<td>-2,199</td>
<td>82.8%</td>
</tr>
</tbody>
</table>

The result was a high hit rate of 82.8%, but the actual sales volume was less than the predicted sales number of the sales quantity. The reasons are as follows.

A, Physical limit of sales situation
- The number of Register
- Discontinuance of the street stall sales.
- Capacity of refrigerator

B, Customers decreased compared with the previous year
- Decreased by 16% in July and by 10% in August compared to 2016
Because we are developing a prediction formula based on the number of visitors last year, decrease in customers is reflected in prediction and deviation.

The main reason for 17.2% of the deviation from the forecast is the occurrence of unpredictable situations in sales.
① Change sales method
② Stoping the production line
③ Sales restrictions
④ Changes in the trend of tourist spots
⑤ Weather conditions such as typhoons

I think that it is affected by the unexpected event as above.
In the future, based on various factors, we will increase the correlation coefficient and work on the development of the prediction formula.

Finally, the result of this verification was a predicted value of 82.8% against the predicted value. Considering this 82.8% as a business, you can fully utilize it as sales forecast.

Also, we are currently developing restaurant forecasting expressions,
As of the previous month, we have achieved a correlation coefficient of R - 0.902.
Development of the Classes Applying the Cooperative/Collaborative Learning Model for Robot Making Learning in Technology Education

Toshihiro Yoshioka\textsuperscript{1}, Hiroyuki Muramatsu\textsuperscript{2}, Mamoru Matsuoka\textsuperscript{3}

\textsuperscript{1} Graduate School of Regional Innovation Studies, Mie University, Tsu, Mie, Japan \textsuperscript{2} Faculty of Education, Shinshu University, Nagano, Nagano, Japan \textsuperscript{3} Faculty of Education, Mie University, Tsu, Mie, Japan

E-mail: 615D004@m.mie-u.ac.jp

Abstract—We developed a lesson program for robot making learning in technology education in junior high school, applying a hypothetical model named “the cooperative/collaborative learning model” and confirmed the validity as well as its educational effectiveness. One of the authors practiced 12 hours of class for 182 junior high school students, in which the students devised and fabricate original automatic cleaning robots. We confirmed the style of their activities varied from cooperative learning to cooperative/collaborative learning. We also confirmed the students extended their cooperative/collaborative technological activities.

Keywords—Robot making learning, technology class, cooperative/collaborative learning, junior high school students, learning model

I. INTRODUCTION

It is one of the important issues to cultivate “cooperative/collaborative technological activities” with which students proceed technological projects cooperatively and collaboratively [1]. The authors verified the educational effect of power-saving competition car production learning in a club activity and proposed “cooperative/collaborative learning model” (hereafter, “the learning model”) as a hypothetical model with which cooperative/collaborative technological activities are cultivated effectively. Under the model, the learning style gradually transitions from cooperative learning having separate roles to cooperative/collaborative learning having separate roles and sharing their roles. The purpose of this research is to construct a lesson program of robot making learning for regular lessons on the basis of the learning model, to verify the validity of the learning model, to confirm the learning model applicable to regular lessons and the educational effect of the learning model.

II. METHOD

A. Construction of lesson program based on the learning model

According to the learning model, we constructed the lesson program has the cycle of idea $\rightarrow$ share $\rightarrow$ expression $\rightarrow$ respect $\rightarrow$ idea $\rightarrow$ … We selected “life-affair type robot making learning” for the material because students are easy to image. In addition, we considered the following points.

\textbf{Issue setting:} We selected automatic cleaning robot which students are familiar with and handle easily.

\textbf{Material:} We selected materials easy to be handled, as the students can realize their idea and make trial and error many times.

\textbf{Presentation:} We set the opportunity of final presentation with robots in each class for the students to share their achievements, which means a message to the students that there is a clear deadline to make robots.

\textbf{Sharing:} We prepared four sharing; design, assembly, programming and poster production for each student. We decided to call each sharer “responsible person” as group members cooperate with each other and their activities can easily vary from cooperation to cooperation/collaboration.

\textbf{Expected transition from cooperation to cooperation/collaboration is illustrated in Fig. 1, which is modified from a figure in the references [2, 3].}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|}
\hline
\textbf{Tab. 1 Contents of the lessons.} & \\
\hline
1. Programming & 4 \\
\hline
2. let’s design an automatic cleaning robot Cleaner/Programming/Poster & 2 \\
\hline
3. Think together in a team Discuss in a team to combine in one idea & 1 \\
\hline
4. Make an automatic cleaning robot Cleaner/Programming/Poster & 4 \\
\hline
5. Presentation and evaluation Summary of study and review & 1 \\
\hline
\end{tabular}
\end{table}
III. RESULTS AND DISCUSSION

One of the authors (TY) performed the lesson practice for 182 students (male: 102, female: 80) of the second grade in Tsu municipal I junior high school.

Some photos of students’ works are shown in Fig. 2; a) programming (training), b) design, c) fabrication, d) programming (application), e) presentation, and f) completion of robot.

Transition from cooperative learning to cooperative/collaborative learning: The result of chi-square test is shown in Table 2. Here we prepared 3 selections; my role, the other’s role, and not done anything. As we use the phrase “responsible person” to call each sharer, the number of the other’s role is high from the initial (6th) stage. But the number increase significantly higher at the 8th stage at the 5% level statistically. Higher trend is also observed at the 9th stage. Except these stages, there is no significant difference. The activity contents in 8th and 9th stages is to fabricate cleaners. We observed cooperative/collaborative activities to complete the cleaning robot in a limited time. Many records showing the activities beyond each role were found in the reflections sheets. These results indicate the transition from cooperative learning to cooperative/collaborative learning in the practice of automatic cleaning robot making learning.

Change of cooperative/collaborative technological activities: The number of effective respondents in the survey was 140 (76.9%). For the answers to the questionnaire, we counted “one thinks pretty” as 5 points to “I do not think at all” as one point. The results of non-parametric test (signed rank order test of Wilcoxon) are shown in Table 3.

“Problem recognition” and “self evaluation” in creative thinking, “expressive ability” in creative skill and “communication power” in communication ability increase significantly at 1% level. “Intensive thinking” in creative thinking “information gathering ability” in creative thinking, “autonomy” and “openness” in creative attitude and “cooperativeness” in teamwork ability also increase significantly at 5% level. There is no significant change in other points.

From these results we concluded that the students realized the improvement of their cooperative/collaborative technological activities.

IV. CONCLUSIONS

The purpose of this research is to construct a lesson

![Diagram showing cooperative sharing work and collaborative work gradually spreading during cooperative work.]

Fig.1 From cooperation to cooperation / collaboration (Modified partially from [2]).

Tab.2 Survey result of change from cooperation to cooperation / collaboration.

<table>
<thead>
<tr>
<th>Lesson times</th>
<th>My role</th>
<th>Non-role</th>
<th>None</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea</td>
<td>Sixth</td>
<td>42</td>
<td>77</td>
<td>14</td>
</tr>
<tr>
<td>Share</td>
<td>Seventh</td>
<td>38</td>
<td>88</td>
<td>7</td>
</tr>
<tr>
<td>Eighth</td>
<td>31</td>
<td>91</td>
<td>11</td>
<td>*</td>
</tr>
<tr>
<td>Ninth</td>
<td>32</td>
<td>90</td>
<td>11</td>
<td>↑</td>
</tr>
<tr>
<td>Tenth</td>
<td>46</td>
<td>76</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Eleventh</td>
<td>62</td>
<td>59</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

N=133 *: p < .05, **: p < .01, ↑: .05 < p < .10
program for robot making learning in junior high technology education applying the cooperative/collaborative learning model and to confirm the validity and educational effect of the model. We obtained the following two results through practice and survey;

1) We confirmed the transition from cooperation to cooperation/collaboration in the practice based the hypothetical cooperative/collaborative learning model. We conclude that the learning model is reasonable from this result.

2) We confirmed the significant increase of creative thinking, creative skill, creative attitude, communication ability and teamwork ability in the components of cooperative/collaborative technological ability.

We plan to apply the learning model to other contents in technology education in junior high school.

ACKNOWLEDGMENT

This research is based on the grant of JSPS Grant-in-Aid for Scientific Research 17H01978.

REFERENCES


Tab.3 Survey result of collaborative/collaborative technical activities.

<table>
<thead>
<tr>
<th>Component</th>
<th>Item</th>
<th>Negative Rank</th>
<th>Ordinal Rank</th>
<th>Same Rank</th>
<th>z values</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ave.Order</td>
<td>Rank sum</td>
<td>Ave.Order</td>
<td>Rank sum</td>
<td></td>
</tr>
<tr>
<td>Creative Thinking</td>
<td>Problem Recognition</td>
<td>40</td>
<td>61.01</td>
<td>89</td>
<td>66.79</td>
<td>5944.50</td>
</tr>
<tr>
<td></td>
<td>Memory</td>
<td>34</td>
<td>37.32</td>
<td>45</td>
<td>42.02</td>
<td>1891.00</td>
</tr>
<tr>
<td></td>
<td>Diffuse Thinking</td>
<td>35</td>
<td>44.59</td>
<td>52</td>
<td>43.61</td>
<td>2267.50</td>
</tr>
<tr>
<td></td>
<td>Intensive Thinking</td>
<td>38</td>
<td>44.89</td>
<td>56</td>
<td>49.27</td>
<td>2759.00</td>
</tr>
<tr>
<td></td>
<td>Self Assessment</td>
<td>36</td>
<td>53.85</td>
<td>74</td>
<td>56.30</td>
<td>4166.50</td>
</tr>
<tr>
<td>Creative Skills</td>
<td>Expression</td>
<td>43</td>
<td>53.99</td>
<td>75</td>
<td>62.66</td>
<td>4699.50</td>
</tr>
<tr>
<td></td>
<td>Planning Power</td>
<td>54</td>
<td>58.24</td>
<td>62</td>
<td>58.73</td>
<td>3641.00</td>
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<tr>
<td></td>
<td>Information Gathering</td>
<td>37</td>
<td>38.12</td>
<td>51</td>
<td>49.13</td>
<td>2505.50</td>
</tr>
<tr>
<td></td>
<td>Observability</td>
<td>44</td>
<td>43.77</td>
<td>52</td>
<td>52.50</td>
<td>2730.00</td>
</tr>
<tr>
<td>Creative Attitude</td>
<td>Curiosity</td>
<td>49</td>
<td>46.45</td>
<td>50</td>
<td>53.48</td>
<td>2674.00</td>
</tr>
<tr>
<td></td>
<td>Autonomy</td>
<td>36</td>
<td>51.58</td>
<td>65</td>
<td>50.68</td>
<td>3294.00</td>
</tr>
<tr>
<td></td>
<td>Openness</td>
<td>36</td>
<td>38.98</td>
<td>48</td>
<td>39.82</td>
<td>1911.50</td>
</tr>
<tr>
<td>Communication Skills</td>
<td>Fellowship</td>
<td>39</td>
<td>40.53</td>
<td>47</td>
<td>45.97</td>
<td>2160.50</td>
</tr>
<tr>
<td></td>
<td>Transmission Force</td>
<td>30</td>
<td>42.53</td>
<td>64</td>
<td>49.83</td>
<td>3189.00</td>
</tr>
<tr>
<td></td>
<td>Debate</td>
<td>44</td>
<td>37.66</td>
<td>42</td>
<td>49.62</td>
<td>2084.00</td>
</tr>
<tr>
<td>Team Work Force</td>
<td>Cooperativeness</td>
<td>36</td>
<td>44.40</td>
<td>58</td>
<td>49.42</td>
<td>2866.50</td>
</tr>
<tr>
<td></td>
<td>Support</td>
<td>46</td>
<td>53.33</td>
<td>54</td>
<td>48.09</td>
<td>2597.00</td>
</tr>
</tbody>
</table>

N=140  *p < .05, **p < .01
A) Programming (Training)
B) Design
C) Fabrication
D) Programming (Application)
E) Presentation
F) Completion of robot

Fig. 2 Activity process.
Difference of the Consciousness on Intellectual Property of Junior High Second Grade Students among Japan, China and Korea

JinXiu¹, Mamoru Matsuoka² and Jung Jin-Hyun³

¹ Graduate School of Regional Studies, Mie University, Tsu, Mie, Japan
² Faculty of Education, Mie University, Tsu, Mie, Japan
³ Daegu National University of Education, Daegu, Korea
E-mail: 614D006@m.mie-u.ac.jp

Abstract—We examined the difference of the consciousness on intellectual property of junior high second grade students among Japan, China and Korea using questionnaire sheet. As a result, we found the students in Korea have higher consciousness on intellectual property than the others at most of items, though the number of data is still limited and additional data are required for more probable conclusion.

Keywords—Intellectual property, consciousness survey, Japan, China, Korea

I. INTRODUCTION

In the previous report, we showed the preliminary result that the comparative survey of the consciousness on intellectual property (IP) from elementary to university students among Japan, China and Korea previously [1]. We asked 10 questions; a-d) four items on creativity with consciousness of IP, e-g) three items on knowledge and understanding of IP, h-i) two items on attitude to respect IP, and j) one item on internationality of IP. The students selected one of 6 answers; 1) think so much, 2) think so, 3) neither, 4) do not think so much, 5) do not think so, and 6) do not know. As a result, we observed significant difference in the tendency on grade among countries. But we need to pay attention to the differences between ordinary or special high schools, among faculties in universities and so on while the data were taken from limited high schools and universities.

On the other hand, we can expect homogeneous education to general (non-selected) students in public schools in compulsory education stage to some extent. In this report, we show the result of the comparison of junior high second grade students mainly in public schools among Japan, China and Korea statistically in more detail in this report.

II. METHOD

The data used in this report are shown in Table 1; a school in Nanano prefecture and a school in Mie prefecture in Japan, a school in Daegu city in Korea, and two schools in Inner Mongolia autonomous region in China, all of which are the part of the data used in the reference [1]. Only one school in China is attached school to university. We notice that the number of schools is insufficient for statistics and is to be increased.

In Korea, most of "invention class" is located in the building at elementary and junior high school and is familiar with students. This is one of the most reasons why the consciousness on IP is high in Korea [2].

III. RESULTS

In Fig. 1 we show the result of the analysis. The bar graphs indicate 1) think so much, 2) think so, 3) neither, 4) don’t think so much, 5) don’t think so and 6) don’t know, from top to bottom. As the distributions of the answers are in various shape, We adopted non parametric statistical analysis; Kruskal - Wallis’ H test and multiple comparison (Siegel and Castellan). As a result, we confirmed significant difference in all except b) by H test. The difference is significant at 0.1% level except h) at 5% level. The result of multiple comparison is shown in the right most column. Korea is the top of three at eight of 10 items and there is a significant difference at 1% level for 6 items among them. Japan is the top at d) but no significant difference for the second of Korea. We should notice that the data is available for only one school in Korea at the time of writing while this second grade data is similar to the data for the first grade and the third grade of the other four schools (see Fig. 2 of the reference [1]). In Korea, most of “invention class” is located in the building at elementary and junior high school and is familiar with students. This is one of the most reasons why the consciousness on IP is high in Korea [2].

IV. CONCLUSIONS

We examined the difference of the consciousness on intellectual property of junior high second grade students among Japan, China and Korea, by analyzing the questionnaire results. Though the data is insufficient, we observed significant difference, especially between Korea and two other countries. We continue to get further data to get more probable result.

REFERENCES


<table>
<thead>
<tr>
<th>Area</th>
<th>Japan</th>
<th>China</th>
<th>Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nagano pref.</td>
<td>Mie pref.</td>
<td>Inner Mongolia autonomous region</td>
</tr>
<tr>
<td>School type</td>
<td>public</td>
<td>public</td>
<td>public</td>
</tr>
<tr>
<td>Date</td>
<td>October 2016</td>
<td>December 2013</td>
<td>May 2014</td>
</tr>
<tr>
<td>Number of valid data</td>
<td>69</td>
<td>33</td>
<td>28</td>
</tr>
</tbody>
</table>

Table 1 Data of junior high second grade.
<table>
<thead>
<tr>
<th>Questions</th>
<th>J</th>
<th>C</th>
<th>K</th>
<th>Multiple comparison (Siegel and Castellan)</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. I can produce new ideas through investigation, at being given a task such as a plan for cultural festival or product development.</td>
<td></td>
<td></td>
<td></td>
<td>K</td>
<td>J</td>
<td>C</td>
<td>0.1%</td>
</tr>
<tr>
<td>b. I can explain the ideas I come up with.</td>
<td></td>
<td></td>
<td></td>
<td>No significant difference</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>c. I know the rules when I use anything the others thought and made such as in the investigation study.</td>
<td></td>
<td></td>
<td></td>
<td>K</td>
<td>J</td>
<td>C</td>
<td>0.1%</td>
</tr>
<tr>
<td>d. I like to create something new (sentences, painting, music, product development, etc.).</td>
<td></td>
<td></td>
<td></td>
<td>J</td>
<td>K</td>
<td>C</td>
<td>0.1%</td>
</tr>
<tr>
<td>e. I understand it is important to protect original works and patents.</td>
<td></td>
<td></td>
<td></td>
<td>K</td>
<td>J</td>
<td>C</td>
<td>0.1%</td>
</tr>
<tr>
<td>f. I can explain the reason why there is a patent system.</td>
<td></td>
<td></td>
<td></td>
<td>K</td>
<td>C</td>
<td>J</td>
<td>0.1%</td>
</tr>
<tr>
<td>g. I can explain the reason why there is a copyright system.</td>
<td></td>
<td></td>
<td></td>
<td>K</td>
<td>C</td>
<td>J</td>
<td>0.1%</td>
</tr>
<tr>
<td>h. I have a high consciousness to respect intellectual property, such as not copying illegally.</td>
<td></td>
<td></td>
<td></td>
<td>5%</td>
<td>K</td>
<td>C</td>
<td>J</td>
</tr>
<tr>
<td>i. I have a high consciousness to respect the others' idea, such that I do not copy the other's composition without permission.</td>
<td></td>
<td></td>
<td></td>
<td>0.1%</td>
<td>K</td>
<td>C</td>
<td>J</td>
</tr>
<tr>
<td>j. I understand we receive the benefit of original works and patent created in the other countries.</td>
<td></td>
<td></td>
<td></td>
<td>0.1%</td>
<td>K</td>
<td>C</td>
<td>J</td>
</tr>
</tbody>
</table>

Fig.1 Comparison of the consciousness of intellectual property. J: Japan, C: China, K: Korea.
Study on Aerodynamic Characteristics of Vertical Axis Wind Turbine

Alisa Nakai¹, Takao Maeda², Yasunari Kamada², Takuji Kasuya², Keiichiro Kawai², Yuhei Hoshino², Qingan Li³

¹ Mie University, Graduate School of Regional Innovation Studies, Tsu, Japan
² Mie University, Division of Mechanical Engineering, Tsu, Japan
³ E-mail: [616m005@m.mie-u.ac.jp]

Abstract— With the increasing focus on renewable energy, the application of small wind turbines has been increasingly contributing to the energy demand. Vertical axis wind turbines (VAWTs) have attracted attention as small wind turbines. However, VAWTs are still facing severe challenges in the development process. Firstly, the studies on features and behaviors of VAWTs are not enough because the wind flows which pass through a VAWT become complicated. Secondly, the manufacturing costs of VAWT is expensive, because the components and forms of VAWTs are various without a uniform design standards. Therefore, it is very necessary to clarify the features of different types of VAWTs in the development, such as the power generation efficiency and the forces received from inflow. The purpose of this study is to evaluate the effects of number of blade and the rotor size on the aerodynamic performances of VAWT with wind tunnel experiments. The number of blade is set from two to five. The rotor diameters of wind turbine are selected as 1.0 m and 2.0 m. The power coefficient which means the power generation efficiency is calculated from a torque meter. The thrust coefficient which is an index of the force acting on the entire wind turbine is calculated from a base six-component balance. As a result, it is confirmed that the power coefficient illustrates the maximum value at the number of blade of two and the rotor diameter of 2.0 m, which has the minimum solidity. Meanwhile, the maximum power coefficient decreases with increasing the solidity. Therefore, the power generation efficiency of VAWT is higher at a smaller solidity. And, the tower of VAWT needs a higher strength as the number of blades increases.

Keywords— Vertical axis wind turbine, Renewable energy, Aerodynamic, Wind tunnel experiment, Number of blade

I. INTRODUCTION

Renewable energies have attracted attention to resolve energy security and environmental issues. Feed-in tariff (FIT) [1] came into force to familiarize renewable energies in Japan in 2012. The price of energy which is generated by a small wind turbine is 55 yen/kWh and is the highest in all renewable energies. Therefore, pressing forward with introduction of small wind turbines is expected. Compared with a horizontal axis wind turbine, a small VAWT has advantages such as being able to manufacture at low cost because it has a simple structure that does not require a wind direction following mechanism and low noise due to low rotation speed. On the other hand, a VAWT has a problem of cost reduction through component sharing because a VAWT is not standardized. And, the fluid phenomenon of a VAWT is complicated and is not sufficiently clarified. Until now studies in wind tunnel experiment have been conducted to research the change of generation efficiency when the rotor size and number of blade are changed. And, measurements of the load acting on tower have been conducted when either a rotor diameter or number of blade is changed, but the change of loads when both of them are changed has not been measured. Besides, the loads of a support structure have never been measured directly so far, it was investigated from the computer-aided fluid dynamics (CFD) calculations. The current VAWT design formula [2] increases the safety factor for the part where the phenomenon is not sufficiently clarified. As a result, there is a possibility that the design is excessive strength with a risk of cost increase. Therefore, it is necessary that the margin of safety factor is reduced as securing reliability to popularization of VAWT. For this purpose, it is essential to clarify characteristics such as the power generation efficiency and fluid forces in the development of VAWT. In this study, in order to standardize a VAWT, the characteristics of VAWT are clarified by verifying such as power generation efficiency and forces which each part receives from wind with the changes of rotor diameter and number of blades.

II. NOMENCLATURE

\[ c \] : airfoil / blade chord [m]
\[ D \] : rotor diameter [m]
\[ F_T \] : thrust of a base six-component balance [N]
\[ F_{T\_single} \] : thrust of support structures of single blade [N]
\[ H \] : blade span length [m]
\[ N \] : number of blade
\[ Q_r \] : torque of rotor shaft [Nm]
\[ Q_{single} \] : torque of support structures of single blade [Nm]
\[ U \] : wind speed [m/s]
\[ \theta \] : azimuth angle [°]
\[ \rho \] : air density [kg/m³]
\[ \sigma \] : solidity
\[ \omega \] : angular velocity [rad/s]
\[ C_p \] : power coefficient
\[ C_T \] : thrust coefficient of a base six-component balance
\[ C_{T\_single} \] : thrust coefficient of support structures of single blade
CQ\textsubscript{single} : torque coefficient on support structures of single blade

III. EXPERIMENTAL APPARATUS

This study was conducted by using the test VAWT which is installed in the wind tunnel. Fig. 1 shows the main structures and measurement devices of the test VAWT, which is composed of blades, support structures and a rotor shaft. The number of blade is set from two to five. The rotor diameters of wind turbine are selected as 1.0 m and 2.0 m. By the combination of those parameters, a solidity of the wind turbine can be changed. As shown in Eq. (1), the solidity is defined as the ratio of sum of chord length of all the blades against a length of locus through which a blade pass. The solidity is non-dimensional parameter which can compare characteristics even if the size of the wind turbine and the number of blade are different.

\[
\sigma = \frac{Nc}{\pi D} \quad (1)
\]

For the experimental VAWT, as shown in Fig. 1, the loads acting on the entire wind turbine are measured by a base six-component balance, and the loads acting on the support structures and the blade are measured by six-component balance of a support structure. And, in order to measure the torque generated by the wind turbine, a torque meter is attached inside the rotor shaft. Fig. 1 Main structures and measurement devices of the test VAWT.

IV. RESULTS AND DISCUSSION

A. Power coefficient

In this section, the power coefficients for different solidities of VAWT are compared. The power coefficient which means generation efficiency is calculated from rotor torque \( Q \) and angular velocity \( \omega \) by Eq. (2).

\[
C_p = \frac{Q \omega}{\frac{1}{2} \rho DHU^3} \quad (2)
\]

Fig. 2 shows the maximum power coefficients of the experimental VAWT for the solidities which are calculated from combination of rotor diameter with number of blade. The vertical axis shows power coefficient, and the horizontal axis shows solidity. Each number of blade \( N \) is shown by the shape of plots: two by circles, three by triangles, four by squares and five by diamonds. Rotor diameters \( D \) are shown by the color of plots: 2.0 m by white plots and 1.0 m by black plots. According to Fig. 2, it is found that the power coefficient illustrates the maximum value at the number of blade of two and the rotor diameter of 2.0 m, which is the smallest solidity. And, the maximum power coefficient decreases with the increase of the solidity. Therefore, the power generation efficiency of VAWT is higher at a larger rotor diameter and smaller number of blade.

Fig. 2 Maximum power coefficients for different solidities.

B. Torque coefficient

In this section, the torque coefficients on support structures of single blade for different number of blade are compared. The torque coefficient of single blade is calculated from the torque \( Q\textsubscript{single} \) of two support structures supporting the single blade by Eq. (3).

\[
C_{Q\textsubscript{single}} = \frac{Q\textsubscript{single}}{\frac{1}{2} \rho DHU^2} \quad (3)
\]

According to comparing the torque coefficients on support structures of single blade for different number of blade, it can be shown how the energy of wind turbine is obtained. Fig. 3 and Fig. 4 show the torque...
coefficients on support structures of single blade for different number of blade at the rotor diameter of 2.0 m and 1.0 m, respectively. The vertical axis shows torque coefficient of single blade, while the horizontal axis shows solidity. Each number of blade \( N \) is shown by the shape of plots: two by circles, three by triangles, four by squares and five by diamonds. Fig. 5 shows the definition of azimuth angle. Azimuth angle is the angle which represents a rotational position of the single blade. The angle which is located most upstream is 90° and the angle which is located most downstream is 270°. According to Fig. 3 and Fig. 4, it is found that the torque coefficient is the maximum at the upstream region around the azimuth angle of 90°. On the other hand, the torque coefficient is small at the downstream region from 180° to 360°. Therefore, it is found that the blade of VAWT gains great force in the upstream region. Then, the torque coefficient of smaller number of blade is larger than large number of blade in the downstream region. Because the torque coefficient in the downstream region is small to decrease significantly wind velocity (wake flow) with the blade upstream in case of large number blade. Therefore, the power generation efficiency of VAWT is higher at a smaller number of blades because the force which is gained from wind is large during rotation in case of small number of blade.

\[ C_T = \frac{F_T}{\frac{1}{2} \rho DHU^2} \]  

(4)

Fig. 6 shows the maximum thrust coefficients for different solidities of the entire wind turbine which are calculated by the base six-component balance. The vertical axis shows thrust coefficient, while the horizontal axis shows solidity. Each number of blade \( N \) is shown by the shape of plots: two by circles, three by triangles, four by squares and five by diamonds. Rotor diameters \( D \) are shown by the color of plots: white plots for 2.0 m and black plots for 1.0 m. Fig. 6 reveals that the maximum thrust coefficient of the entire wind turbine increases with the increase of the number of blades. Therefore, the strength of the tower of VAWT needs to gain higher at larger number of blade.

\[ C_{T_{\text{single}}} = \frac{F_{T_{\text{single}}}}{\frac{1}{2} \rho DHU^2} \]  

(5)

Fig. 7 shows the maximum thrust coefficients for different solidities of the single blade which are calculated by the six-component balances of a support structure. The vertical axis shows thrust coefficient of single blade, while the horizontal axis shows solidity. Each
number of blade $N$ is shown by the shape of plots: circles for two, triangles for three, squares for four and diamonds for five. Rotor diameters $D$ are shown by the color of plots: white plots for 2.0 m and black plots for 1.0 m. According to Fig. 7, it is found that the maximum thrust coefficient of the single blade increases with the decrease of the number of blade. Therefore, the strength of the support structure needs to gain higher at smaller number of blade.

![Fig. 6 Maximum thrust coefficients of the base six-component balance for different solidities.](image1)

![Fig. 7 Maximum thrust coefficients of the six-component balances of a support structure for different solidities.](image2)

V. CONCLUSIONS

In order to clarify the aerodynamic characteristics of VAWT with different solidities, wind tunnel experiments were conducted using experimental VAWT in which the number of blades and the rotor diameter were changed. It is found that the generating efficiency of VAWT is higher at a larger rotor diameter and smaller number of blade. Considering the torque coefficient on support structures of single blade in one rotation, the VAWTs at small number of blade gain large generation amount because there is generation the torque in upstream and in downstream when the VAWT has small number of blade. Then, the strength of the tower of VAWT needs to gain higher at larger number of blade, because the maximum thrust coefficient of the single blade increases with the decrease of the number of blade. From the above, it is possible to clarify the force acting on the support structure of the VAWT which was not previously known.

REFERENCES

The Effect of Pre-adsorbed Polymer on Dispersion State of Carbon Black in Amorphous Plastics
Yudai Fukunaga¹, Yoshihisa Fujii², Naoya Torikai¹
¹Graduate School of Regional Innovation Studies, Mie University,
²Graduate School of Engineering, Mie University
E-mail: 616m010@m.mie-u.ac.jp

Abstract—The effects of pre-adsorbed polymer on dispersion state and aggregate structure of carbon black (CB) in polystyrene (PS) matrix were investigated for the solvent-cast films, which were prepared from their suspension in different dispersion media: chloroform, tetrahydrofuran (THF), and toluene, by using transmission electron microscopy (TEM) and combination of ultra-small-angle and small-angle X-ray scattering (USAXS and SAXS). It was clarified by TEM in a micrometer scale that the dispersion and aggregation state of the CB in the solvent-cast film were affected by the pre-adsorption of polymer. The size of CB aggregates was smaller with increasing the amounts of pre-adsorbed polymer. The mass and surface fractal dimensions, $D_m$ and $D_s$, of CB aggregates in PS matrix were evaluated by the X-ray scattering in a nanometer scale. The value of $D_m$ was almost constant, about 2, irrespective of the polymer adsorption. The CB inherent aggregate structure with the nanometer scale accessible by the X-ray scattering techniques is not affected by the PS adsorption on the particle surface. On the other hand, $D_s$ was slightly increased due to the polymer adsorption, but it was irrespective of the adsorption amount of polymer. These results suggest the possibility that the dispersion state and aggregate structure with the relatively large scale of CB in polymer matrix, which affect physical properties of polymer composites, could be controlled by using different dispersion medium.

Keyword—carbon black, polymer composite, dispersion state, aggregate structure, polymer adsorption

I. INTRODUCTION

Carbon black (CB) is a particulate carbon having a hierarchical structure in different length scales, of which primary particle size is nanometer order (Figure 1), and is used in various fields as reinforcing agents for paints and rubber products. One of examples of polymer composite using CB particles found in daily life is tire material. The addition of a small amount of particles could greatly improve the material physical properties of polymer composite such as mechanical strength. The physical properties of polymer composites depend not only on the nature of respective constituent components, but also on the dispersed state and aggregate formation of the particles in the polymer matrix [1]. Thus, it is important for formulation of polymer composite to control the dispersion state of particles in polymer. In general, the polymer composites are prepared by mechanically mixing the particles in a polymer melt at a high temperature, so that the dispersion state of the particles is dominated by mechanical mixing conditions. On the other hand, in the solvent-cast method, a polymer composite film is obtained by evaporating the dispersion medium from the suspension, in which the dispersion state of the particles is determined by various colloidal interactions [2].

Previously, we reported that the dispersion state and aggregate structure of CB in the solvent-cast films, which were prepared by using different dispersion media [3]. In this study, we investigated the dispersion and aggregation state of CB in solvent-cast film to control them through colloidal interactions induced by polymer adsorption on the particles.

II. EXPERIMENTAL

A. Sample

The CB used in this study was kindly supplied from Mitsubishi Chemical Cooporation. It has 16 nm for the diameter of primary particles and its mass density is 1.8 g/cm³. The CB powders were sufficiently dried under vacuum before use. The polystyrene (PS) with the molecular weight of $100\times10^3$ was purchased from the Polymer Source Inc., and used without further purification. Chloroform, tetrahydrofuran (THF), and toluene were used as a dispersion medium.

B. Preparation of CB Suspensions and Solvent-Cast Films

The weighted CB was ultrasonicated in each dispersion medium for 1 hr. The resulting CB suspension was mixed with the separately-prepared PS solution, and mechanically shook in an incubator at 25°C for 24 hrs.
Then, the PS pre-adsorbed CB was separated as a lower phase by centrifugation. The upper supernatant was used for estimating the adsorption amount of PS to CB by the oven method. The volume fraction of CB for PS was fixed at 2.7 vol%. The suspension was decanted into a Teflon beaker. The film specimens were prepared by solvent casting for 8-48 hrs at room temperature. The films were dried for a couple of hours at the temperature below the glass transition temperature of PS to remove the residual solvent, and then were annealed at 150°C for 24 hrs in a vacuum.

C. TEM Observation

The solvent-cast films were microtomed into ultrathin sections using ultramicrotome. The transmission electron microscopy (TEM) observation was made on the ultrathin sections of the films without staining. The TEM was conducted on JEM-1011 (JEOL) at 80 kV at the Ultrastructural Research Center, Mie University.

D. USAXS and SAXS Measurements

The ultra-small-angle and small-angle X-ray scattering (USAXS and SAXS) measurements were conducted at the BL03XU (advanced soft-material beamline, FSBL), SPring-8, Hyogo [4]. The detailed conditions of USAXS was described in the previous report [3]. The wavelength, λ, of X-ray and camera length for SAXS were 0.1 nm and about 2 m, respectively.

III. RESULTS AND DISCUSSION

A. Adsorption Isotherm of PS on CB

The adsorption isotherms of PS on CB for three different dispersion media are shown in Figure 2. The adsorbed amount, A (g), of PS for 1g of CB gradually increased with increasing the polymer concentration of supernatant, and reached at a plateau region for all the dispersion media used in this study. The saturated adsorption amount of PS on CB was the largest in THF, which was 0.0912 g/g, among the three. In chloroform and toluene the saturated adsorption amounts were almost the same: 0.0524 g/g for chloroform and 0.0482 g/g for toluene.

Fig. 3 Stability of the CB suspensions prepared in the different dispersion media: (a) chloroform at 72hrs, (b) THF at 24hrs, and (c) toluene at 1hr after the preparation. The left and right pictures for each figure are corresponding to CB suspension without and with PS, respectively.

Fig. 4 TEM images of CB in suspensions prepared using different dispersion media: (a) chloroform, (b) THF, and (c) toluene. The left and right images for each figure are corresponding to CB suspension without and with PS, respectively.
B. Stability of CB Suspensions

The dispersion stability of the CB suspensions without the polymer pre-adsorption in the different solvents was visually compared as shown in Figure 3. The suspension in chloroform without PS was the most stable among the three. TEM images of CB aggregates formed in the suspensions are shown in Figure 4. The size of CB aggregates was the smallest in THF compared with the other two. The stability of the suspensions without polymer reflects the size of CB aggregates as well as physical properties of the dispersion medium such as mass density and viscosity. In the case of chloroform, stability was lowered by the addition of PS. On the other hand, in the other two dispersion media, the stability of the suspensions was improved by the addition of PS, implying that the aggregation of CB could be suppressed by the steric repulsion between the PS adsorption layers.

C. Dispersion State of CB in PS Matrix

Figure 5 shows TEM images of the PS composites containing CB, on which PS was physically pre-adsorbed in different dispersion media. In the images a dark and bright regions are corresponding to CB and PS phases, respectively. In the case of chloroform, the relatively large aggregates settled in the lower part of the film. In the case of toluene, large and bulky aggregates were observed over the entire PS matrix. In the case of THF, significantly smaller, more discrete CB particles are observed in the PS matrix than for the others, and their size is not affected by the polymer pre-adsorption. The aggregates formed by PS pre-absorbed CB were smaller than those by the non-absorbed CB. The reason for this is that the PS adsorption layer could suppress the aggregation of CB by steric interaction.

D. USAXS and SAXS

Figure 6 indicates a typical two-dimensional USAXS intensity pattern for the PS composite film with CB. All the films exhibited isotropic pattern, so that the pattern was circularly averaged into the scattering intensity profile as a function of wavevector, \( q \), which is defined as \((4\pi/\lambda)\sin\theta\), where \(2\theta\) is the scattering angle. Figure 7 shows USAXS profiles combined with SAXS data for the PS composite films with CB, on which PS was pre-adsorbed with different adsorption amounts in chloroform. The combined profiles cover the wide \( q \)-range from 0.008 to 4 \( \text{nm}^{-1} \). All the profiles exhibited almost the same \( q \)-dependence irrespective of the polymer pre-adsorption. However, the low-\( q \) upturn reflecting the larger CB aggregates was slightly different according to the sample. The mass and surface fractal dimensions, \( D_m \) and \( D_s \), of CB aggregates in PS were evaluated by using quantitative analysis based on the unified (UF) equation of Beaucage [5,6], given by

\[
I(q) = A \exp(-q^2 R_{ss}^2 / 3) q^{D_m} + B \exp(-q^2 R_{ss}^2 / 3) q^{D_s} + C \text{erf}(qR_{ss} / \sqrt{6})^{3(6-D_s)} q^{-6-D_s} \quad (1)
\]

where \( R_{ss} \) is the diameter of primary particle, and \( A \), \( B \), and \( C \) are proportional constants. The results of the fitting are shown in Table 1. The evaluated values of \( D_m \) were almost the same irrespective of the dispersion medium as reported in our previous study [3]. Also, there was no significant difference caused by PS pre-adsorption on CB in \( D_m \). Therefore, the inherent aggregate structure of CB evaluated by the X-ray scattering is not affected by the difference in dispersion medium as well as polymer pre-adsorption. On the other hand, the surface fractal dimension \( D_s \) of CB aggregate is slightly larger than that of CB without the polymer adsorption, but is almost constant irrespective of the adsorbed amount of polymer.

Fig. 5 TEM images of PS composites containing CBs pre-adsorbed with different amount of adsorbed polymer prepared using (a) chloroform, (b) THF, and (c) toluene.

Fig. 6 Typical two-dimensional USAXS intensity pattern for the PS composite film with CB.
IV. CONCLUSIONS

The adsorption isotherms of PS on CB were obtained for different dispersion media, and the saturated adsorption amount was the largest in THF compared with chloroform and toluene. The aggregation structure of CB in PS matrix, observed by TEM in a micrometer scale, was affected by the dispersion medium. The aggregate size was smaller with increasing the adsorption amount of polymer for chloroform and toluene, though it was not affected by the polymer adsorption for THF. The mass fractal dimension of CB, evaluated by a combination of USAXS and SAXS in a nanometer scale, was independent on the polymer adsorption. On the other hand, the surface fractal dimension was slightly increased by polymer pre-adsorption. These results imply the possibility that the aggregate structure of CB affecting the physical properties of polymer composite could be controlled by polymer adsorption.

ACKNOWLEDGMENT

We are deeply indebted to Mr. S. Ogawa of the Ultrastructural Research Center, Mie University for his kind technical support on TEM observation. We are also very thankful to Mr. S. Inada and Dr. M. Asada of Kuraray Co., Ltd. for their support in USAXS and SAXS at BL03XU FSBL, SPring-8.

REFERENCES


Table 1. The parameters obtained from the fitting of the scattering profiles shown in Figure 7.

<table>
<thead>
<tr>
<th></th>
<th>$R_m$</th>
<th>$D_m$</th>
<th>$D_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0g/g</td>
<td>10.5±0.03</td>
<td>1.99±0.01</td>
<td>2.27±0.01</td>
</tr>
<tr>
<td>0.032g/g</td>
<td>10.4±0.06</td>
<td>1.99±0.01</td>
<td>2.40±0.01</td>
</tr>
<tr>
<td>0.056g/g</td>
<td>10.3±0.05</td>
<td>2.03±0.01</td>
<td>2.43±0.01</td>
</tr>
</tbody>
</table>

Fig. 7 The combined profiles of USAXS and SAXS for PS composites with the pre-adsorbed CB using chloroform as a dispersion medium.
Experimental Investigation on Photovoltaic Cell Emulating System in Series Connection Mode

Isamu MIZOGUCHI¹, Naoki YAMAMURA¹, Muneaki ISHIDA¹, Vu Minh PHAP¹
¹Mie University, Tsu, Japan
E-mail:[m177m005@m.mie-u.ac.jp]

Abstract—At the present, the grid-tied solar power system is the most promising as a renewable energy technology for replacing the fossil energy sources. The usage efficiency of the power conditioner system in the grid-tied solar power system is not high because the electricity generation from solar panels depends on the weather. The utilization rate of the power conditioner system can be increased by adding the small scale wind turbine to the existing grid-tied solar power system. In this paper, we research the experimental test to verify that the PV cell emulating system using the small scale wind turbine can connect with the PV array in series and operate the power conditioner system of the grid-tied solar power system.

Keyword—Small scale wind turbine; PV array; Control system; PV cell emulating system; Power conditioner system.

I. INTRODUCTION

Nowadays, the cost of the solar power systems is reduced and it leads to these systems are widely installed in many countries in the world. However, the utilization rate of the power conditioner system (PCS) in the solar power system as can be seen in Fig.1 is low because the operation of the photovoltaic (PV) cells depends on the solar irradiation which becomes weakly in the cloudy and rainy weather.

The utilization rate of the PCS can be improved by using a hybrid power system with the small scale wind turbine and the solar panel.

The typical small grid-tied solar-wind hybrid power system as shown in Fig.2 including the wind power generator and the PV array can supply the continuous maximum power from the wind and solar energy sources by using the maximum power point (MPP) control techniques [1]. However, the wind turbine is not controlled in an optimal way by the PCS in the solar power system because of the difference of the output characteristics between the wind turbine and the solar panel. Therefore, the connection of the small scale wind power generating system to the PCS of the solar power system for residential applications by emulating technical characteristics of the solar panel is an important research topic and the configurations of this novel hybrid power system were proposed in our previous studies [2-4].

Fig. 2 The typical small grid-tied solar-wind hybrid power system

Fig.3 shows the configuration of the grid-tied PV cell emulating system in series connection mode which comprised of the small scale wind turbine, a battery and the power converter circuit. In this mode, the small scale wind turbine is able to connect with the solar panel in series with the help of the battery and the power converter circuit. The PCS is used to convert DC power to AC power with maximum power point tracking (MPPT) technique and generate the power to the utility grid by the boost type DC/DC converter and the grid-tied DC/AC inverter.

Fig. 3 Configuration of the grid-tied PV cell emulating system in series connection mode

Fig. 4 shows the current - voltage characteristic in the series connection mode. The input voltage and the input
power of the PCS are enhanced to correspond the total of output voltages and the output powers of the PV cell emulating system and the solar panel, respectively.

![I-V characteristic in series connection mode](image)

**Fig. 4** I-V characteristic in series connection mode

## II. CONTROL METHOD OF THE SYSTEM

### Control system of the PV cell emulating system

Fig. 5 shows the control method of the PV cell emulating system in series connection mode. In this research, the bi-directional chopper circuit is used as the power converter circuit to decrease the battery voltage because the input voltage value of the PCS is limited and the total of the output voltages of the PV array and the power converter circuit supplied to the input terminal of the PCS can not exceed the rated voltage of the PCS. The input filter with the inductor L1 and the capacitor C1 suppresses the ripple at the input terminal. The control system structure of the PV cell emulating system comprises a voltage control loop and a current control loop. In the first stage, the reference voltage value $V_{\text{ref}}$ is calculated as follows.

$$V_{\text{ref}} = \frac{P_b}{i_0}$$  \hspace{1cm} (1)

where, $P_b$ is reference battery output power and $i_0$ is the output current of the solar array.

![Power converter circuit with control design](image)

**Fig. 5.** Power converter circuit with control design

After that, the PV cell emulating system output voltage $v_2$ is regulated to match the reference voltage value $V_{\text{ref}}$ the voltage control loop. The emulating system output current $i_2$ is controlled to be the similar value with the output current $i_0$ of the PV array by the current control loop because they are connected in series as shown in Equation (2).

$$i_0 = i_2$$  \hspace{1cm} (2)

where, $i_0$ is the MPP output current of the solar array and $i_2$ is the output current of the PV cell emulating system.

In the real operation condition, the output current value $i_0$ of the PV array and the output current value $i_2$ of the PV cell emulating system are dependent on the changing of the solar irradiation value $S$. Finally, the switches of the bi-directional chopper circuit are regulated by the output gate signal from Pulse Width Modulation (PWM) system.

## III. SIMULATION RESULTS

The control method of the grid-tied PV cell emulating system in series connection mode is confirmed by using PSIM electronic circuit simulation software. Simulation circuit structure is same as Fig.5. The system parameters for the simulation are listed in Table 1.

<table>
<thead>
<tr>
<th>TABLE I. PARAMETER OF THE SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power of solar array</strong></td>
</tr>
<tr>
<td>in solar radiation of 600 W/m²</td>
</tr>
<tr>
<td><strong>Power of battery E</strong></td>
</tr>
<tr>
<td><strong>Inductor L1, L2</strong></td>
</tr>
<tr>
<td><strong>Capacitor C1, C2</strong></td>
</tr>
</tbody>
</table>

Fig.6 shows the simulation results of the output current $i_2$ and the output voltage $v_2$ of the PV cell emulating system in series connection mode. These results describe three operation modes of the PV cell emulating system.

In the operation mode 1, only the PV array generates the output current $i_0$ and operates the grid-tied PCS which also performs the MPPT control. The PV cell emulating system does not work in this mode and the value of the current $i_{D3}$ which flows to diode D3 equals the value of the output current $i_0$ of the solar array.

In the operation mode 2, the value of the diode D3 current $i_{D3}$ is controlled to reduce to zero while the PV cell emulating system generates output current $i_2$ and starts to connect to PV array in series. The output current $i_2$ of the PV cell emulating system is regulated to match the PV array output current $i_0$ in this mode.
In the operation mode 3, when the value of the diode D3 current $i_{D3}$ becomes to be zero, the output voltage $v_2$ of the PV cell emulating system is controlled to follow the reference voltage value $V_{ref}$ which is achieved by dividing the reference battery output power $P_b$ by the output current $i_o$ of the solar array. Hence, the PV cell emulating system can connect to the PV array in series in the steady state and both the output power of the PV cell emulating system and the output power of the PV array can be supplied to the grid-tied power conditioner.

Fig. 7 and Fig. 8 shows the simulation results of the input voltage $V_{inpcs}$ and the input power $P_{inpcs}$ of the PCS. The results show that the input voltage $V_{inpcs}$ of the PCS equals output voltage sum of the PV cell emulating system ($v_2$) and PV array ($v_{pv}$) after the PV cell emulating system connects to solar panel in series mode from approximately 19th second. As a result, it causes the increasing of the input power $P_{inpcs}$ of the PCS.

### IV. EXPERIMENTAL RESULTS

Firstly, only the PV array including 7 solar panels 125Wp operates the grid-tied power conditioner SUNVISTA JH-S402 when receiving the sunlight. In the next stage, the PV cell emulating system, including DC source system and Power converter circuit, is regulated to connect to the solar array in series mode. The DC source system which comprises a DC power supply device and a power amplifier device is used to generate DC voltage of about 52 V and DC power of 50 W. A bi-directional chopper circuit is made as the power converter circuit to decrease the DC source voltage into the appropriate value under the changed solar irradiation condition. The grid-tied power conditioner SUNVISTA JH-S402 performs the MPPT control and injects the power from the PV cell emulating system and the PV array into the utility grid. The Graphitec GL900-8 channel Data Acquisition Data logger measures the output voltage values and output current values of this system.

**Table II. Parameters of the experimental system**

<table>
<thead>
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<th>DC power supply device</th>
<th>Maximum power</th>
<th>80 W</th>
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<tbody>
<tr>
<td>DC output rating</td>
<td>0 to 8V/8A</td>
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<tr>
<td><strong>Power amplifier</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum DC output power</td>
<td>2500 W</td>
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</tr>
<tr>
<td>Rated DC output current</td>
<td>15 A</td>
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</tr>
<tr>
<td>Rated DC output voltage</td>
<td>170 V</td>
<td></td>
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<tr>
<td><strong>Power converter circuit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type: bi-directional chopper circuit in buck mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC input voltage</td>
<td>52 V</td>
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<tr>
<td><strong>Solar panel</strong></td>
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<tr>
<td>Power</td>
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</tr>
<tr>
<td>MPP voltage</td>
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<td>MPP current</td>
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<td>Open circuit voltage</td>
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<tr>
<td>Short circuit current</td>
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<td><strong>Grid-tied power conditioner</strong></td>
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<tr>
<td>Power</td>
<td>3000 W</td>
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</tr>
<tr>
<td>DC input operating voltage</td>
<td>80 - 320 V</td>
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<tr>
<td>Grid voltage</td>
<td>202 V</td>
<td></td>
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<tr>
<td>Grid frequency</td>
<td>50 Hz</td>
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</table>
Firstly, the grid-tied PV cell emulating system in series connection mode is tested under stable solar irradiation condition. It can be seen in Fig. 9, the output current \( i_2 \) of the PV cell emulating system is controlled to follow PV array output current \( i_o \) by the current control loop and the PV cell emulating system starts to connect with the PV array in series after the PV array generates the output current \( i_o \) in the initial 10 seconds.

As a result of the experimental test in Fig. 10, after the PV cell emulating system connects completely with the PV array in series from about 19th second, the voltage control loop regulates the output voltage \( V_2 \) of the PV cell emulating system to match the reference voltage value \( V_{ref} \) which is obtained by dividing the reference battery output power \( P_b \) by the output current \( i_o \) of the PV array.

It is clearly seen in Fig. 11 that the input power \( P_{inpcs} \) of the PCS is increased because the input voltage \( V_{inpcs} \) of the PCS as shown in Fig. 10 always equals output voltage sum of the PV cell emulating system \( (v_2) \) and PV array \( (v_{pv}) \) when the PV cell emulating system operates in the steady state. Thus, these results in accordance with proposed idea and the simulation results. Additionally, the results also display that the PV cell emulating system does not affect the operation of PV array under stable solar irradiation condition when both systems work in the series connection mode in the steady state.

V. CONCLUSION

In the present study, the operation modes are analyzed by the improved simulation results and the experimental investigation results confirm that the utilization rate of the grid-tied PCS is enhanced because the PV cell emulating system in series connection mode can run the grid-tied PCS of the solar power system in the daytime. Moreover, the results also indicate that the operation of the PV array in practice is not influenced by the PV cell emulating system in series connection mode in the steady state.

However, when the solar irradiation value becomes very weak, the operation of the PV cell emulating system is restricted because the input voltage of PCS is higher than maximum voltage of PCS.

REFERENCES

High temperature face-to-face annealing of AlN films grown by MOVPE

Shunsuke Okada¹, Shuichi Tanaka¹, Yusuke Hayashi², Hideto Miyake¹,², Kazumasa Hiramatsu¹

¹ Graduate School of Engineering, Mie University, Tsu, Japan
² Graduate School of Regional Innovation Studies, Mie University, Tsu, Japan
E-mail: [415d002@m.mie-u.ac.jp]

Abstract—High quality thick AlN films are very important in the field of UV optoelectronic devices, like LEDs, LDs and detectors. However, it is very difficult to grow thick AlN films because of the lack of homogeneous substrates. The large lattice mismatch between epilayer and heterogeneous substrate introduces dislocations and defects, such as threading dislocations and pits. Here, the fabrication of different thicknesses of high-quality AlN films by metalorganic vapor phase epitaxy (MOVPE) and high temperature face-to-face annealing (FFA) has been studied. In terms of structural characterization, the FWHMs of (0002) and (10-12) XRCs of AlN films decrease drastically after FFA procedure. Especially, the FWHMs of XRCs become smaller as the thicknesses of the AlN epilayers get bigger. For 1000-nm-thick AlN film, the FWHMs of XRC for (0002) and (10-12) reflections drop to 57 and 138 arcsec respectively after FFA, measured with a Ge (440) monochromator. In terms of morphology characterization, after FFA procedure, the disarayed steps on the surface of 1000-nm-thick AlN epilayer are replaced by smooth steps and terrace structures, meanwhile the surface pits are disappeared. This work provides potentials for high performance AlN-based deep UV applications.

Keywords—AlN, Metalorganic vapor phase epitaxy (MOVPE), Face-to-face annealing

I. INTRODUCTION

AlGaN based deep-ultraviolet (DUV) light-emitting diodes (LEDs) have caught much attention for their potential of water purification, sterilization, and disinfection [1 - 4]. However, the performance of DUV LEDs is limited due to lack of suitable underlying substrates. AlN has been expected for the underlying substrates for DUV LEDs due to their wide bandgap (6.01 eV) and excellent thermal and chemical stability. Although it’s reported that high quality freestanding AlN substrates can be fabricated by the sublimation method, the high cost and small size are still problems comparing to AlN films grown on sapphire substrates [5, 6]. Nevertheless, due to large lattice mismatch and difference of thermal expansion coefficient between AlN and sapphire high density of threading dislocations (TDs) generate in AlN films grown on sapphire substrates [7].

Our group recently reported the high temperature face-to-face annealing of sputter deposited AlN films, which can drastically improve crystallinity of AlN films [8]. MOVPE is an effective method to obtain thick AlN films with low impurity incorporation comparing with sputter method. Meanwhile MOVPE could fabricate AlGaN based device structure.

In this work, the effects of film thickness on MOVPE AlN crystal quality is investigated and high quality AlN films grown on sapphire substrates by MOVPE is obtained using high temperature face-to-face annealing.

II. EXPERIMENTAL

AlN films were grown on c-plane sapphire substrates by MOVPE. The misorientation angle of the substrates was 0.2° toward the [10-10] direction. Trymethylaluminium (TMAl) was used as a precursor. Nitrogen (N₂) was used as a carrier gas. The growth temperature and reactor pressure were maintained at 1400 °C and 17.3 kPa. The flow rates of carrier gas and TMAl were 12 slm and 25 sccm, respectively. The thickness of MOVPE grown AlN films was varied from 10 to 1000 nm. Then, the AlN films were thermally annealed at 1700 °C in an ambient N₂ using face-to-face configuration as shown in figure 1 for 3h. Crystallinity was measured by X-ray diffraction (XRD) with Ge (220) or Ge (440) monochromator. Surface morphology was evaluated by atomic force microscope (AFM). In-plane stress was evaluated by Raman scattering spectroscopy.

Figure 1. Illustration of face-to-face configuration.

III. RESULTS AND DISCUSSION

A. MOVPE growth of AlN films

Figure 2 (a) and (b) shows the full widths at half maximum (FWHMs) of X-ray rocking curve (XRC) (0002) and (10-12) reflection measured by Ge(220) monochromometer as a function of AlN film thickness. The FWHMs of XRC (0002) reflection are independent from AlN film thickness as shown in figure 2 (a). These are less than about 70 arcsec for all film thickness. In contrast, the FWHMs of XRC (10-12) reflection are drastically improved with increasing AlN film thickness up to 500 nm, whereas
they are almost same value for film thickness over 500 nm. The FWHMs of XRC (0002) and (10-12) reflection are 71 and 755 arcsec, respectively.

Figure 2. The FWHMs of XRC (a) (0002) reflection and (b) (10-12) reflection.

Figure 3 shows AFM images of 20-, 300-, 500-, 1000-nm-thick AlN films. Small grains formed for AlN film thickness from 10 to 50 nm. Growth proceed as three-dimensional-growth (3D-growth), resulting in appearance of large hexagonal islands for AlN film thickness from 200 to 300 nm. These hexagonal islands are coalesced for AlN film thickness over 500 nm. As a result, pits form and step and terrace structure is observed on surface for 1000-nm-thick AlN film. Figure 4 shows root mean square (RMS) values that indicates surface roughness as a function of AlN film thickness. Surface roughness increases with increasing AlN film thickness up to 300 nm due to 3D-growth mode in this region. On the other hand, Surface roughness improve with increasing AlN film thickness over 300 nm. This is due to promotion of coalescence of hexagonal islands.

Figure 3. AFM images of 20-, 300-, 500-, 1000-nm-thick AlN films. Scanning area of AFM was 1 x 1 µm².

Figure 4. Surface roughness of AlN films with different thickness.

B. Face-to-face annealing of MOVPE grown AlN films

Figure 5 (a) shows the FWHMs of XRC (0002) reflection before and after face-to-face annealing as a function of film thickness. The FWHMs of XRC (0002) reflection are slightly deteriorated compare to the that of before face-to-face annealing for all AlN film thickness. Nevertheless, these are less than 120 arcsec, and maintain high crystal quality. Figure 5 (b) shows the FWHMs of XRC (10-12) reflection before and after face-to-face annealing. Crystal quality of AlN films are drastically improved after face-to-face annealing. Crystal quality trend after annealing is similar to that of before annealing. The FWHMs of XRC (0002) and (10-12) reflection for 1000-nm-thick AlN film measured with a symmetric Ge(440) monochromator were 57 and 138 arcsec, respectively. We assume that the mechanism of crystal quality improvement was related to solid-phase reactions and dislocation climb due to high temperature annealing [9, 10]. High temperature annealing causes coalescence of grain boundaries and reduction of dislocation density.

Figure 6 shows AFM images of AlN films before and after face-to-face annealing. Surface morphologies are improved by face-to-face annealing. Small grains are coalesced and are formed step and terrace structure
for 20-nm-thick AlN film. However, grains are not completely coalesced for 200- and 500-nm-thick AlN films. On the other hand, pits are eliminated and the surface is covered by smooth step and terrace structure for 1000-nm-thick AlN film. Therefore, suitable AlN film thickness is 1000 nm in the view point of surface morphology.

Lattice constant c as a function of film thickness before and after face-to-face annealing is shown in figure 7. Lattice constant c decreases with increasing AlN film thickness before face-to-face annealing. On the other hand, lattice constant c after annealing increases comparing with that of before annealing. It shows certain value around 4.990 Å for AlN thickness over 50 nm. Lattice constant c of stress free AlN has reported at 4.982 Å [11].

Figure 5. The FWHMs of XRC (a) (0002) reflection and (b) (10-12) reflection before and after face-to-face annealing.

Figure 6. AFM images of the AlN films before and after face-to-face annealing. Scanning area of AFM was 1 x 1 µm².

Figure 7. Plot of lattice constant c before and after face-to-face annealing.

IV. CONCLUSIONS

The effects of film thickness on MOVPE AlN crystal quality is investigated. The FWHMs of (10-12) reflection decreased with increasing AlN film thickness. Step and terrace structure with pits was formed for 1000-nm-thick AlN film. The FWHMs of (10-12) reflection drastically improved by face-to-face annealing. Pits were eliminated and smooth step and terrace structure was formed for 1000-nm-thick AlN film.
structure was formed after annealing for 1000-nm-thick AlN films. The FWHMs of XRC (0002) and (10-12) reflection after annealing were 57 and 138 arcsec, respectively for 1000-nm-thick AlN film. We concluded that optimum MOVPE growth thickness of AlN films was 1000 nm in the viewpoint of surface morphology and crystal quality.

Figure 8. Plot of Raman shift value after face-to-face annealing.

ACKNOWLEDGMENT

This work was partially supported by JSPS Grant-in-Aid for Scientific Research (15H03556, 16H06415, 16H06418, 17H06762), JST CREST (16815710), JST SICORP Japan - EU Joint Research and Japan - China Collaborative Research, Kinki Bureau of Economy, Strategic foundation technology advancement support project.

REFERENCES

Preparation of high-quality a-plane AlN on r-plane sapphire using sputtering and annealing method

Ryo Fukuta¹, Yuta Yamaki¹, Yusuke Hayashi², Hideto Miyake¹,², Kazumasa Hiramatsu¹

¹ Graduate School of Engineering, Mie University, Tsu, Japan
² Graduate School of Regional Innovation Studies, Mie University, Tsu, Japan
E-mail: [417M233@m.mie-u.ac.jp]

Abstract—High-quality (11-20)-plane AlN film on r-plane sapphire was prepared using sputtering and annealing methods. The experiment includes 3 steps. The first step, (11-20)-plane AlN films were deposited on r-plane sapphire substrates by sputtering method. Then thermal treatment of AlN films was conducted at 1600 ºC for 30 minutes under N₂ atmosphere by face-to-face annealing (FFA) in order to improve the crystallinity. At last, high quality (11-20)-plane AlN templates after annealing were used as substrates for MOVPE growth of 1-μm-thick AlN. The full width at half maximum values (FWHM) of the XRCs for MOVPE grown AlN (11-20) // [1-100] and (11-20) // [0001] were 816 arcsec and 805 arcsec respectively.

Keywords—AlN, Sputtering, Annealing, Thick film growth

I. INTRODUCTION

Aluminum nitride (AlN) is a promising material for various applications in the deep-ultraviolet (UV) region, like sterilization lamp, light therapy machine and diode laser, due to its excellent physical properties such as wide band gap, chemical stability, high thermal conductivity and so on [1, 2]. In order to realize the full potential of such UV devices, high-quality AlN is desirable. AlGaN LEDs fabricated on c-plane (polar face) AlN show low luminous efficiency caused by quantum confined stark effect (QCSE) while high-Al-molar-fraction a-face (non-polar plane) AlGaN LEDs exhibit high external quantum efficiency (EQE) [3]. As our knowledge know, it is difficult to obtain high quality (11-20)-plane AlN films on r-plane sapphire substrates due to complicated growth condition [4-7]. Even though our group has already improved morphology and crystallinity of (11-20)-plane AlN template by optimizing growth recipes and post-growth annealing conditions using MOVPE method, the further improvement is still desirable [8, 9].

RF sputtering is a suitable growth method for AlN because of its high growth uniformity and relatively low cost. Moreover, our group reported the significant improvement of sputtering c-plane AlN films quality by high temperature annealing [12]. In this work, sputtering and high temperature face-to-face annealing methods are used to improved crystallinity of (11-20)-plane AlN (11-20) on r-plane (1-102) sapphire.

II. EXPERIMENTAL

(11-20)-plane AlN films were deposited on r-plane sapphire by RF sputtering with a mixture of argon (Ar) and nitrogen (N₂) ambience. The schematic illustration of RF sputtering shows in Figure 1. The target source was polycrystalline AlN. Temperature, chamber pressure, and RF power were set to be 300 ºC, 0.6 Pa, and 200 W, respectively. The time of pre-sputtering was 1 hour to remove the impurity on AlN target. The AlN film thickness deposited by RF sputtering was varied from 30 to 400 nm. Table 1 shows the deposition conditions of the AlN films deposited by RF sputtering.

Subsequently, we performed face-to-face annealing (FFA) under the following conditions: a chamber pressure of 1.0 atm of ambient N₂, an annealing temperature of 1600 ºC, and an annealing time of 30 minutes. Finally, 1-μm-thick (11-20)-plane AlN were grown on annealed Sp-AlN by metalorganic vapor phase epitaxy (MOVPE) at 1500 ºC. Trimethylaluminum (TMAI) and ammonia (NH₃) were used as the Al and N precursors, respectively.

A four-circle X-ray diffractometer (Philips X’pert) using a Ge (220) monochromator was used to determine the crystallinity of (11-20)-plane AlN epi-layers. The full width at half maximum (FWHM) of the X-ray rocking curves (XRCs) for (11-20)-plane AlN with the X-ray incident direction along [1-100] and [0001] are denoted as AlN (11-20) // [1-100] AlN and AlN (11-20) // [0001] AlN, respectively. Atomic force microscopy (AFM) was used to observe the surface morphology and to determine the surface roughness by using the root-mean-square (RMS) roughness. In this study, we investigated sputtering conditions for (11-20)-plane AlN films deposited on r-plane sapphire substrates.

Fig. 1 Schematic illustration of RF sputtering films
III. RESULTS AND DISCUSSION

A. Deposition of (11-20)-plane AlN films on r-plane sapphire by sputtering

Figure 2 shows the full width at half maximum (FWHM) values of the X-ray rocking curves (XRCs) for (11-20)-plane AlN with X-ray incident direction along [1-100] and [0001] after sputtering. The FWHMs of XRCs have anisotropy corresponding to X-ray incident direction. The FWHMs of the XRCs along [0001] direction is smaller than that along [1-100] direction. The FWHM of XRCs shows the lowest value 7272 arcsec at a thickness of 100 nm in the case of X-ray incident along [0001] direction. On the other hand, the FWHMs value both directions decrease with increasing film thickness under 100 nm, whereas that show almost same value at film thickness over 100 nm in the case of X-ray incident along [1-100] direction. This anisotropy is probably caused by lattice mismatch between r-plane sapphire and (11-20)-plane AlN. According to ref.4, lattice mismatch between r-plane sapphire and (11-20)-plane AlN is 13.3 % in the [1-100] AlN direction and 2.9% in the [0001] AlN respectively. The larger lattice mismatch along the [1-100] AlN direction is thought to induce larger mosaicity in the [1-100] AlN direction than the other direction [4].

Figure 3 shows AFM images of (11-20)-plane AlN surface and root-mean-square (RMS) roughness after sputtering. Dense granular grains form on surface at a thickness of 30 nm. Granular grains become larger observed with increasing film thickness. As a result, some high granular grains are also formed at a thickness of 400 nm. RMS monotonically increases with increasing film thickness due to promotion of 3D-growth. This result has the same tendency as (11-20)-plane AlN films on r-plane sapphire substrates grown by MOVPE and c-plane AlN films on c-plane sapphire substrates deposited by sputtering. [8]

Fig. 2 FWHMs of XRC for AlN (11-20) // [1-100] AlN and AlN (11-20) // [0001] with different thickness after sputtering.

B. Face-to-face annealing of (11-20)-plane AlN films deposited by sputtering

Figure 4 shows the FWHMs of XRCs of (11-20)-plane AlN before and after annealing with different X-ray incident direction. The FWHMs value drastically decreases after annealing for both [0001] and [1-100] incident direction. The anisotropy of the FWHM of XRCs is also improved after annealing. The FWHMs value of (11-20)-plane AlN // [0001] AlN at 100 nm thick is the best values, 1159 arcsec. Figure 5 shows AFM images of sputtering (11-20)-plane AlN films before and after annealing. According to Fig.6, surface morphology is improved after annealing. The surface of (11-20)-plane AlN films exhibit dense and granular grain structure before annealing. Coalescence of grains is promoted and is expanded along [1-100] direction after annealing. We assume that lattice mismatch anisotropy and crystal orientation anisotropy probably cause this shape anisotropy [13]. Different crystal plane such as (0001), (000-1) and [10-10] plane is probably formed on the top surface and sidewall of grains. It causes anisotropic migration length of atoms corresponding to crystal orientation.

Table 1 Deposition conditions for preparation of AlN films

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Pre-sputtering time [h]</td>
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<tr>
<td>Power [W]</td>
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<tr>
<td>Pressure [Pa]</td>
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</tr>
<tr>
<td>Temperature [°C]</td>
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</tr>
<tr>
<td>Ambient gas</td>
<td>N2 and Ar</td>
</tr>
<tr>
<td>[N2]/[Ar] ratio</td>
<td>4</td>
</tr>
<tr>
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<td>AlN</td>
</tr>
<tr>
<td>Target-substrate distance [mm]</td>
<td>64</td>
</tr>
</tbody>
</table>
C. High temperature regrowth of AlN films on 100-nm-thick annealed (11-20)-plane AlN film layer by MOVPE

Figure 6(a) shows the FWHMs value of sputtering (11-20)-plane AlN, AlN films after face-to-face annealing and after regrowth by MOVPE. X-ray incident direction is along [0001]. The thickness of AlN film is 100 nm because the 100nm is the best crystallinity after FFA. The FWHM of XRCs (11-20)-plane AlN drastically decreases after face-to-face annealing. Moreover, the crystallinity is improved comparing to AlN films after annealing by high temperature regrowth of AlN film by MOVPE. The FWHM of XRCs (11-20)-plane // [0001] before annealing, after annealing, and after MOVPE growth is 7272, 1159, and 805 arcsec respectively. Crystallinity improvement probably is caused by high temperature growth(MOVPE?) and the effect of thickness increasing. C.-H. Lin et al. [9] reported that the FWHM of XRCs of (11-20) which indicates surface normal direction improved with increasing AlN film thickness. According to Lin et al., the improvement of crystallinity reached the peak at thickness over 400 nm [9]. The growth mechanism of (11-20)-plane AlN along the surface normal direction is followed by geometric selection [14].

Figure 6(b) shows AFM image of (11-20)-plane AlN film on annealed sputtering AlN film after MOVPE growth. The surface roughness before(RMS=2.651nm) and after(RMS=2.382nm) MOVPE growth is almost the same. Disarrayed step and terrace structure and quadrangle shape pits formed after MOVPE growth. Pits formation are probably caused by low pressure at 30 Torr. Ichikawa et al. reported that pit free surface semi-polar AlN film can be grown at relatively high-pressure growth at 500 Torr [15]. Improvement of surface roughness would be investigated in future study.

IV. CONCLUSIONS

High-quality (11-20)-plane AlN was grown on r-plane sapphire using (11-20)-plane AlN films deposited by sputtering was investigated. The suitable (11-20)-plane AlN film thickness is 100 nm as deposited (11-20)-plane AlN films by sputtering. Face-to-face annealing can drastically improve the crystallinity of AlN film. High temperature MOVPE growth of AlN film on annealed film is excellent crystallinity. The FWHMs value of (11-20)-plane is 805 arcsec. AlN film deposited by sputtering and face-to-face annealing were effective to preparation of high-quality (11-20)-plane AlN film.
ACKNOWLEDGMENT

This work was partially supported by JSPS Grant-in-Aid for Scientific Research (15H03556, 16H06415, 16H06418, 17H06762), JST CREST (16H15710), JST SICORP “Japan - EU Joint Research” and “Japan - China Collaborative Research”, Kinki Bureau of Economy, Strategic foundation technology advancement support project.

REFERENCES