

International Internship's Report

Mie University, Mie, Japan

From April 1st to May 17th, 2013

Prepared by

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Abstract

I'm Natnari Chunprasert who is studying at faculty of Engineering, Kasetsart university. I went to apprentice in Electro Mechatronic laboratory, Mie pref., Japan. I stayed here for 1.5 month, from April 1st to May 17th. I got my jobs about control and the kind of jobs are R&D. The first job is "Design PID controller for device which has disturbance from mechanic". I research about this because it's problem for robot's movement. The result from this, I can find PID controller for this device. Next jobs, They are "Design ladder diagram for Traffic signal's working and the elevator's working". I must design them which can use in the robots.

Acknowledgement

This program is provides a good opportunity for students to has experience of working. I would like to thanks Mie university and Kasetsart university who establish The International Cooperative Education and Career Development program. Ms.Mika Deguchi is member of Center for International Education Research(CIER) who manage and help about this program. Prof.Junji Hirai is my adviser. Doi Akihiro is my tutor. He and his friends who working with me at Electro Mechatronic laboratory. Member of Fuji Machine Manufacturing teach me many things and take care me very well. Finally, thank to everybody who take care me all the time when I live in Japan.

Ms.Natnari Chunprasert

Schedule of internship

Date	Internship's activity
30 March 2013	<ul style="list-style-type: none">- I left from Bangkok at 12.05AM.
31 March 2013	<ul style="list-style-type: none">- I arrived Chubu Centrair International airport at 8.00AM and went to Mie by speed boat with someone who come from Mie university. When I arrived there , I went to dormitory by taxi.
1 April 2013	<ul style="list-style-type: none">- I reported at Center for International Education and Research(CIER).- I met Prof. Hirai Junji at his room. He is my professor. He explained my schedule for internship.- I met my tutor and other members. My tutor's name is Doi Akihiro. They took me go to the laboratory.- My tutor explained me about the base of PLC and motion control.
2 April 2013	<ul style="list-style-type: none">- Prof. Hirai and my tutor took me meet a dean of Mie university.- I learnt Japanese language and teach Thai words to my Japanese friends.
3 April 2013	<ul style="list-style-type: none">- I practiced about motion control laboratory.- I learnt Japanese language.
4 April 2013	<ul style="list-style-type: none">- I had the experiment about motion control all day.
5 April 2013	<ul style="list-style-type: none">- I learnt Japanese language.- I had a banquet with the members of this laboratory. This banquet was Hanami. It's Japanese's culture. We had dinner under the cherry blossom trees.
8 April 2013	<ul style="list-style-type: none">- I practiced Japanese language.- I learnt about motion control.
9 April 2013	<ul style="list-style-type: none">- I learnt Japanese language.- I read about control.
10 April 2013	<ul style="list-style-type: none">- I searched the information about control from the internet.- I consulted about motion control with my tutor.
11 April 2013	<ul style="list-style-type: none">- I researched and prepared about the new topic of motion control.- I had Japanese class.

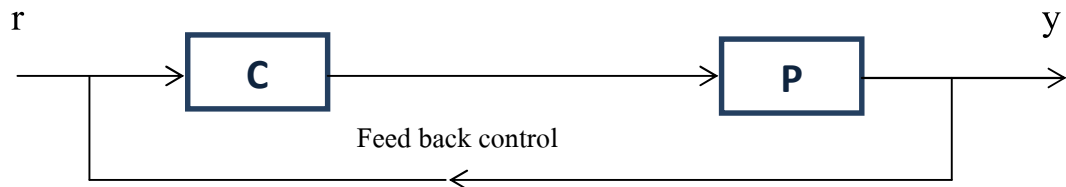
Date	Internship's activity
12 and 15 April 2013	- I learnt about DC Motor Position and DC Motor Speed by Matlab program.
16 April 2013	- I researched and learnt about P , PI and PID controller by Matlab program.
17 April 2013	- I used Matlab program for analyzing and used the data from Two Inertia Resonant experiment.
18 April 2013	- I tried to design controllers by Matlab program.
19 April 2013	- I learnt about approximated derivative. - I designed controller again.
22 April 2013	- I repeated about motion control and consulted my tutor about it.
23 April 2013	- I researched about approximate derivative and consulted about this with my tutor. - I had Japanese class.
24 April 2013	- I used value of controller for testing with two inertia and research new controller which is better more.
25 April 2013	- I learnt sequence control. - I tried to design basic of ladder diagram by FXGPWIN program.
26 April 2013	- I designed traffic signal's ladder diagram.
30 April 2013	- I did internship presentation. - I remade traffic signal's ladder diagram.
1 May 2013	- I tried to test traffic signal and searched wrong point. - I met Prof. Ehara Hiroshi and told him about going up of my presentation.
2 May 2013	- I prepared about my presentation. - I had new Japanese students welcome party at night.
7 May 2013	- I searched wrong point in traffic signal's ladder diagram and tested it - I practiced to present my presentation with my tutor.
8 May 2013	- I had presentation at 9.30AM and got the certificate about my internship. - I had meeting about my report with Prof. Hirai Junji.

Date	Internship's activity
9 May 2013	<ul style="list-style-type: none"> - I started to design new ladder diagram. It's the elevator.
10 May 2013	<ul style="list-style-type: none"> - I went to Fuji Machine Manufacturing.
13 to 16 May 2013	<ul style="list-style-type: none"> - I remade the elevator's ladder diagram and tested it.
17 May 2013	<ul style="list-style-type: none"> - I asked some questions about internship with my tutor. - I had the last party with my professors and my Japanese friends in this laboratory.

About Internship

1) Motion control

Concept of motion control



You should enter the input for PC and the PC sent information for the instrument. The disk will rotate and you can get the output. In this time the input of PC is degree's value. The output of PC and input of plant are voltage. The output of plant is actual degree.

We can divide 3 cases and suppose the input of PC is A rad .

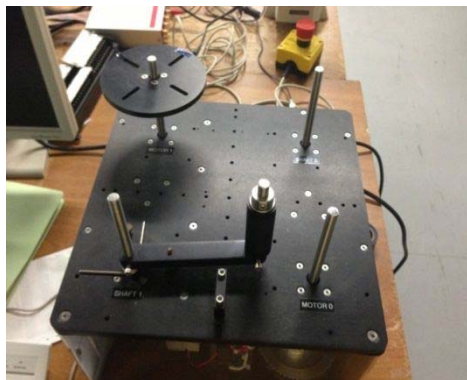
-Case1 : If disk rotate equal A rad, it's OK. The control finish. The PC stop to send input signal. Now the disk doesn't rotate because output and input don't have error. This case is ideal.

-Case2 : If disk rotate over A rad, it's not good and it has the feedback signal. The control is continue.

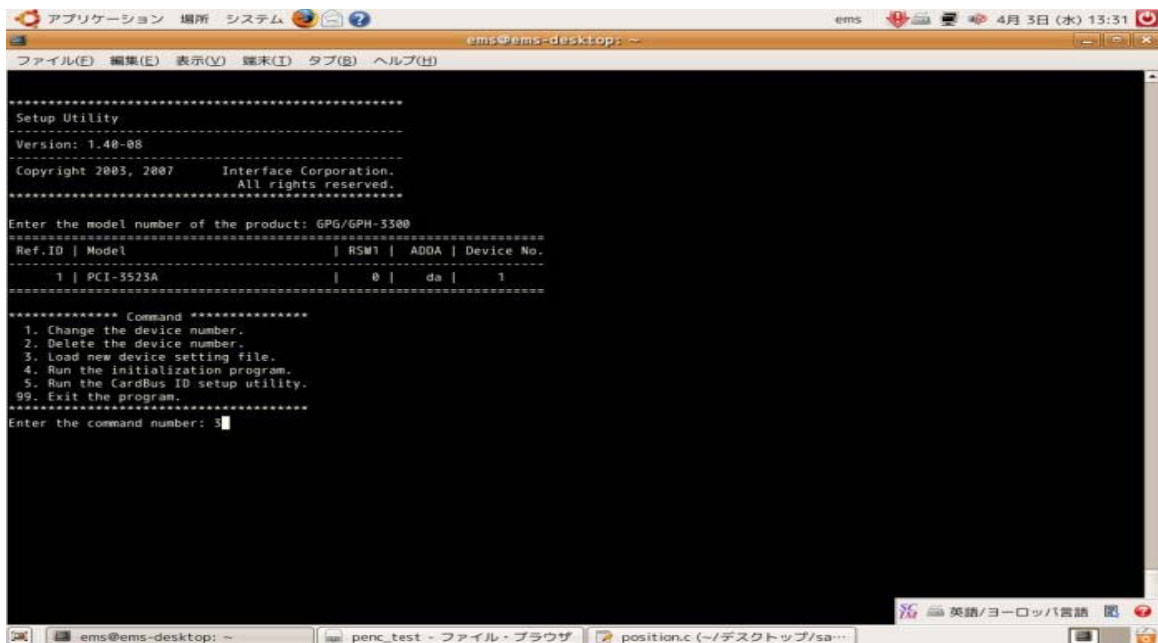
-Case3 : If disk rotate under A rad, it's not good and it has the feedback signal. The control is continue.

And I use this concept to apply for IMDU experiment.

1st Experiment(Industrial Mechatronic Drives Unit (IMDU))



IMDU is a reconfigurable system and is extremely versatile. It uses to research basic and advanced servo control. The device is supplied with two experiments. They are DC Motor Position Control and DC Motor Speed Control. The IMDU can be run on a PC by controlling through Matlab program.



This picture show “Enter the number of boards”

Solution

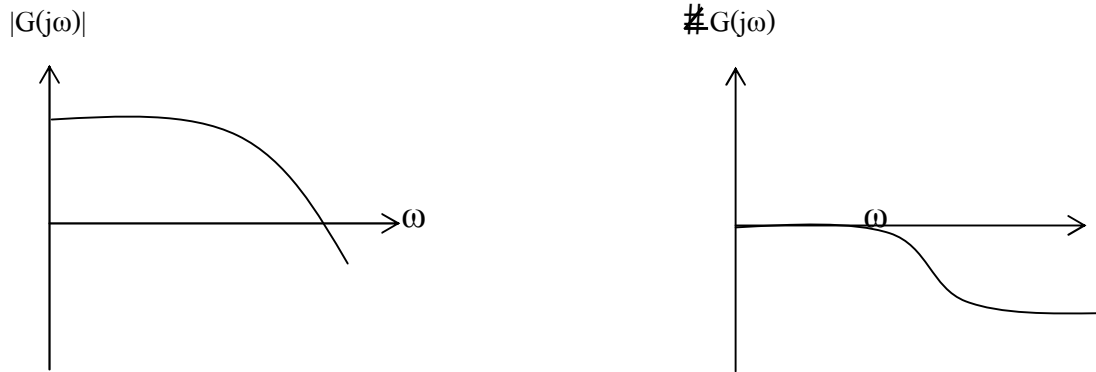
>>In this experiment I have three boards. In the first step I enter the number of 3 boards. The board's numbers are 3100,3300 and 6204.3100 is A/D(Analog number to Digital number) board's number.3300 is D/A board's number.6204 is counter board's number. The counter board send value of degree to PC. The duty of 3100 and 6204 boards are input. The duty of 3300 board is output. Now you can run the “position.c”.(program is position.c)Then you can insert the command(the motor degree) to PC and the disk rotate. While the disk is rotating , the feedback signal run also. And the value of feedback compares with the value of initial input. If it's not equal input , the disk is rotating still.

This experiment is easy for controlling and basic of using IMDU. I learn this experiment for testing the second experiment.

2nd Experiment(Two Inertia Resonant System)

Bode Diagram

Bode Diagram can divide 2 parts are 1)Gain Diagram 2)Phase Diagram

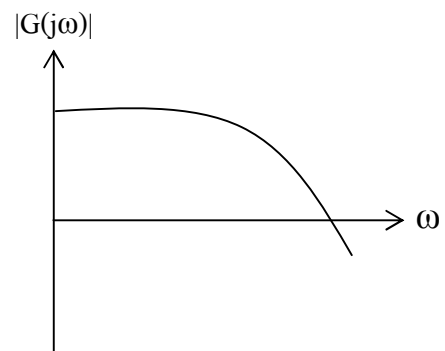


In this experiment we interest in Gain Diagram only and I would like to compare between the test don't have disturbance and have it.

PART 1



From PART1 you can write the bode diagram as

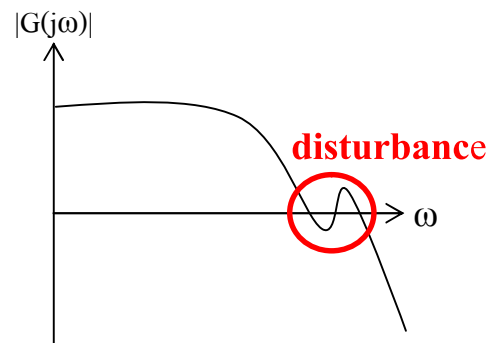


From above picture : The motor control one disk only. It's easy for controlling.

PART 2



From PART2 you can write the bode diagram as



From before picture : It's difficult to controlling because the big disk connect the small disk by rubber. We can suppose that it's as same as disturbance signal. You can call disturbance is resonance.

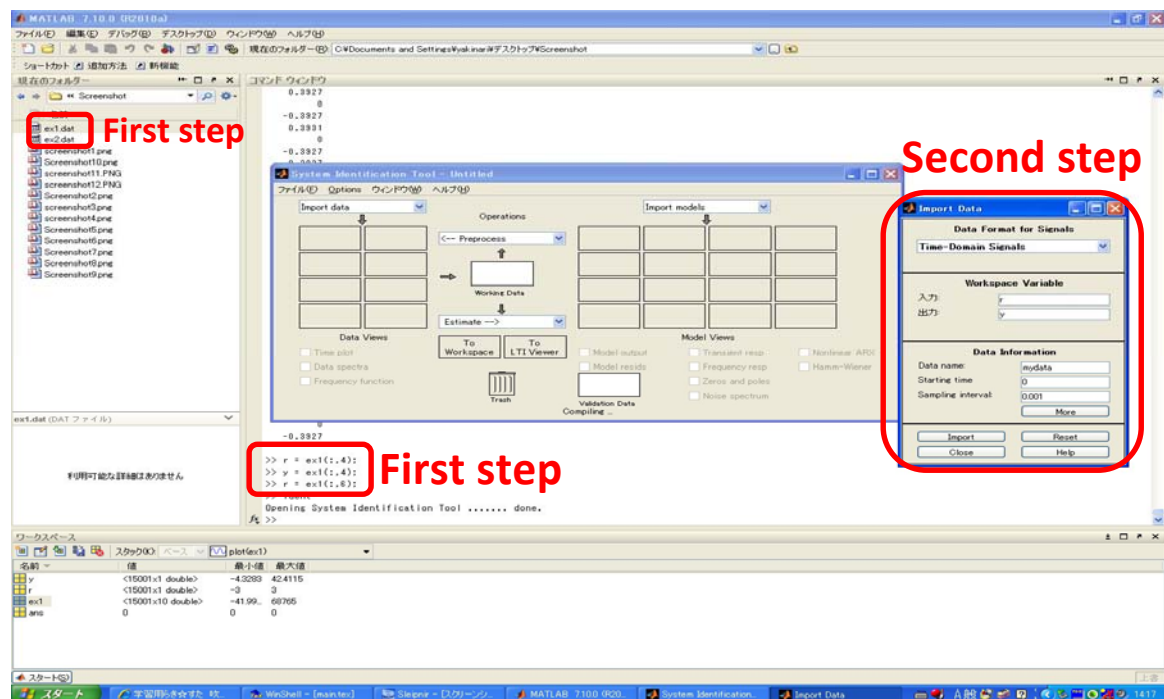
Solution for writting the bode plot

>> You must set between PC and boards as same as first experiment by C language program.

Then you save the data and take the data use in the Matlab.

I can write the bode plot by Matlab, so you must take the data from C Language program and open in Matlab.

IN MATLAB



This picture show “Step of writing bode diagram by Matlab program (1)”

First step : Open the data(ex1) in Matlab and set variable input and output are “r=ex1(:,6); , y=ex1(:,4); respectively. And then I order by “ident”.This program open System Identification Tool.

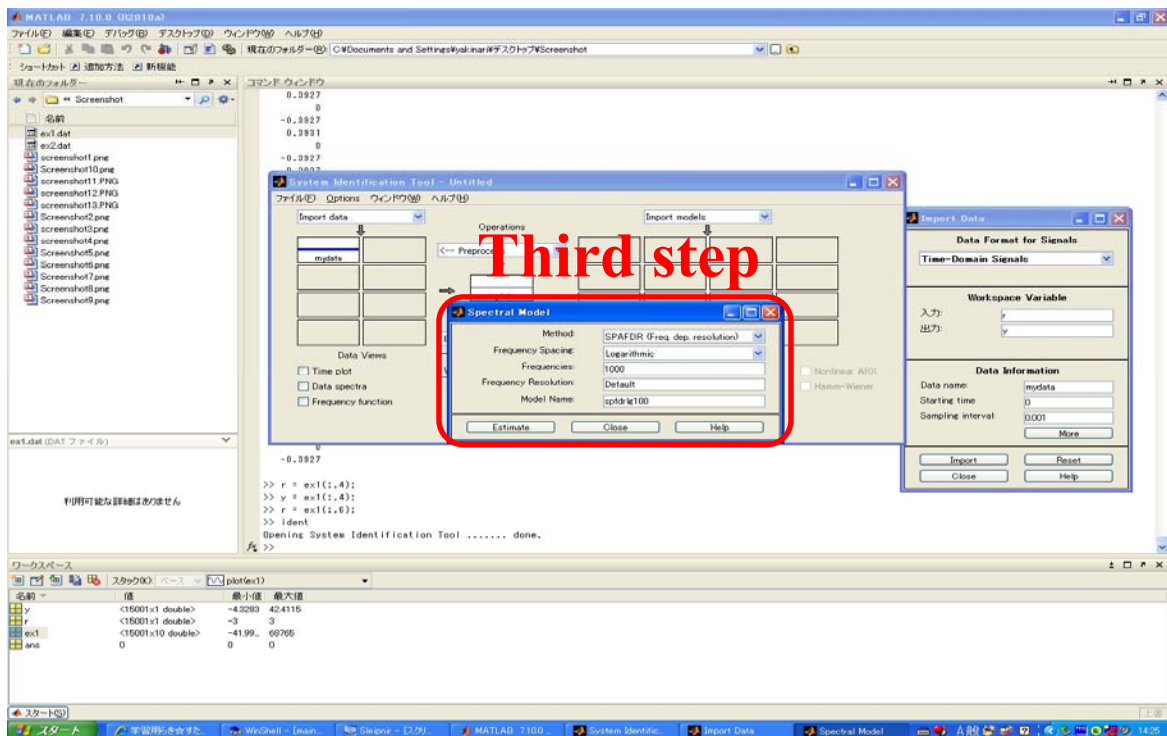
Second step : In System Identification Tool

Import data ———> I choose Time-Domain Signal and then it show Import Data.

In Workspace Variable : I should insert “r” in the first space and insert “y” in the second space.

In Data Information : I set Data name is “mydata”, Starting time is zero and Sampling interval is 1ms.

When I finish to set variable for everything, I can click Import. Mydata show in Data Views. Now you can go to Estimate. Then you click the symbol and choose Spectral model. Spectral model is show on the monitor.



This picture show “Step of writing code diagram by Matlab program (2)”

Third step : In Spectral model

Method —————> You choose SPAFDR.

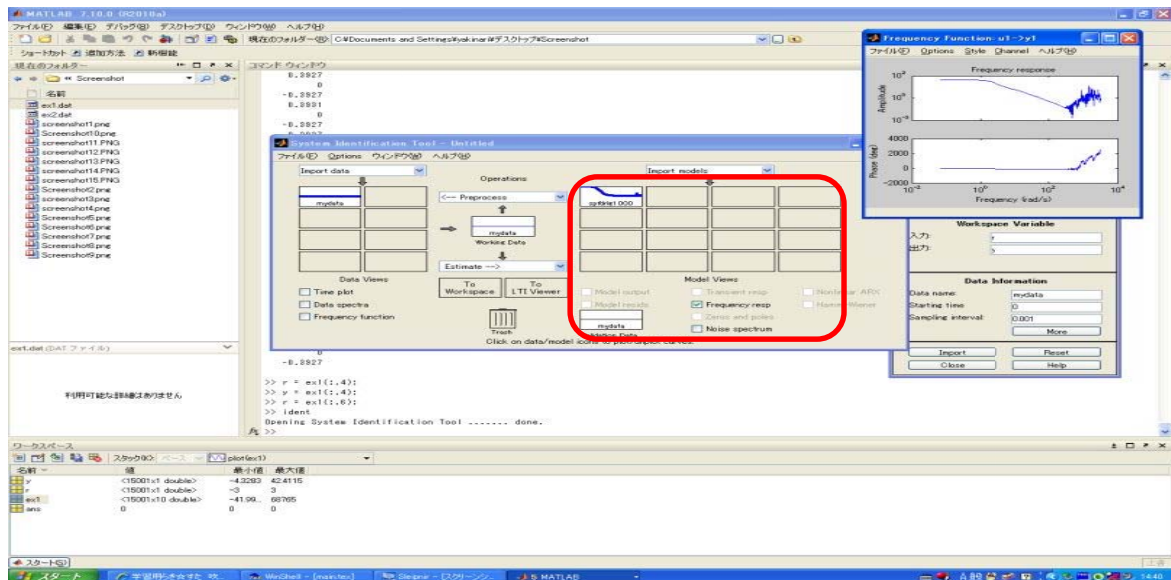
Frequency Spacing —————> You choose Logarithmic.

Frequency —————> You can enter any numbers but now I enter 1000.(1000 mean 1000 points in graph)

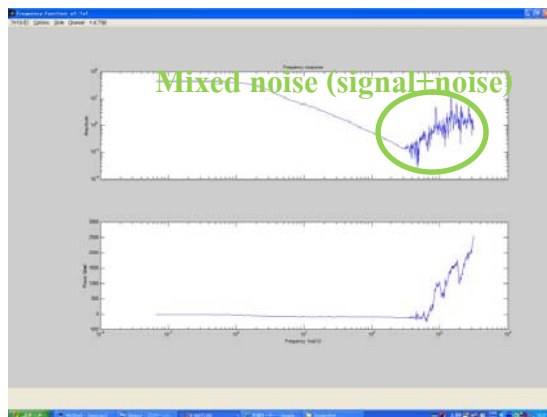
Frequency Resolution —————> You keep Default in it.

Model name —————> I enter spfdrlg1000.

You can click Estimate and then it show Frequency data(spfdrlg1000) in Model Views as same as the following picture.



Now frequency is chosen already and you must check Frequency response. Finally, you can show frequency response in the bode diagram. In part2(ex2) you can do it as same as part1(ex1).



part1



part2

Summary : From picture of part2, When this system has resonance, it's difficult to controlling. Because frequency of the input signal become resonance frequency and then output signal become vibration signal. This is danger, so we research controller design method which reduce the resonance of this system.

DESIGN CONTROLLER : It has 3 steps to do it.

1) Make Model(Pss)

I use the data from Two Inertia Experiment(PART2). I must write the frequency response by Matlab program as same as second experiment. When you finish, you drag “spfdrlg100” and put it in “to workspace”. Spfdrlg100 show in “Workspace”. Then you command “p=arx(spfdrlg100,[6,4,0])”. You can write Arx model by this command. Then you enter “Ptf = tf(P)”, “Pss = ss(Ptf)” and “Pss = mineral(d2c(Pss, ‘tustin’))”. Now we finish about system identification and then you can start to design controller.

Define the command in Matlab program.

Arx model : Discrete time domain => “ $A(z)y(t) = B(z)u(t) + e(t)$ ”

“p=arx(spfdrlg100,[6,4,0])” : write Arx model.

“Ptf = tf(P)” : Transform Discrete-time to Transfer Function Model.

“Pss = ss(Ptf)” : Transform Transfer Function model to State Space Model.

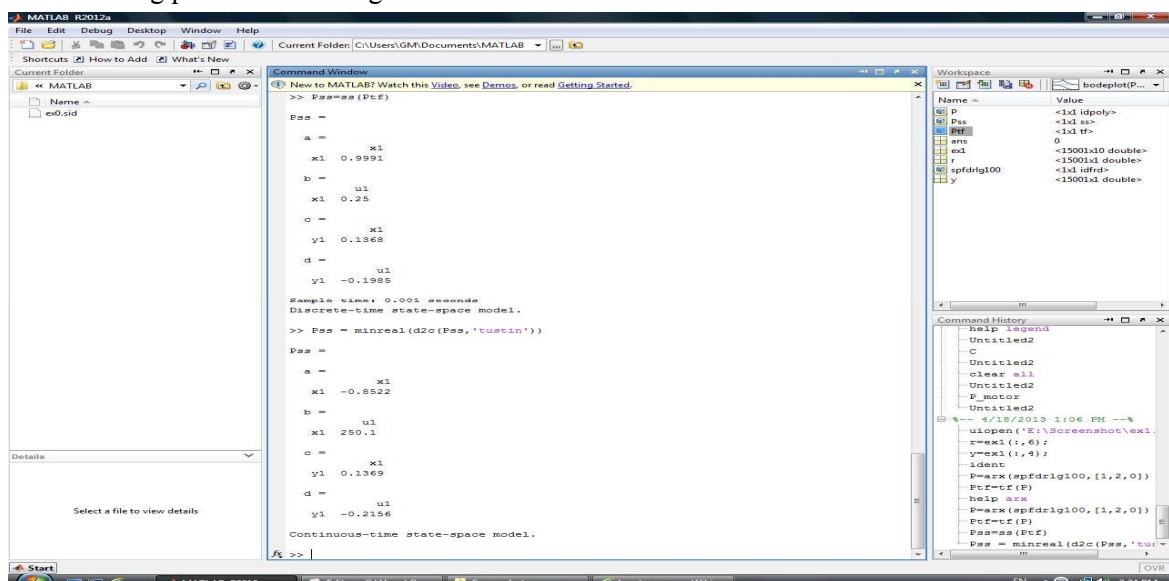
“Pss = mineral(d2c(Pss, ‘tustin’))” : Transform Discrete-time state space model to

Continuous-time state space model.

“Pf = frd(spfdrlg100)” and “bode(Ptf, Pf)” : If you would like to show frequency

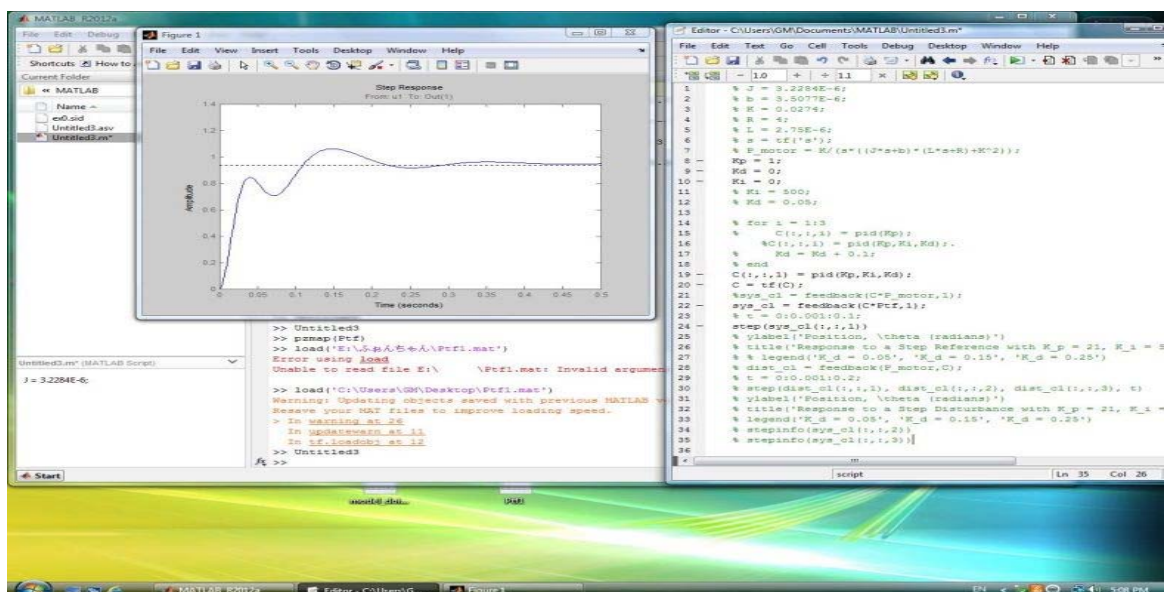
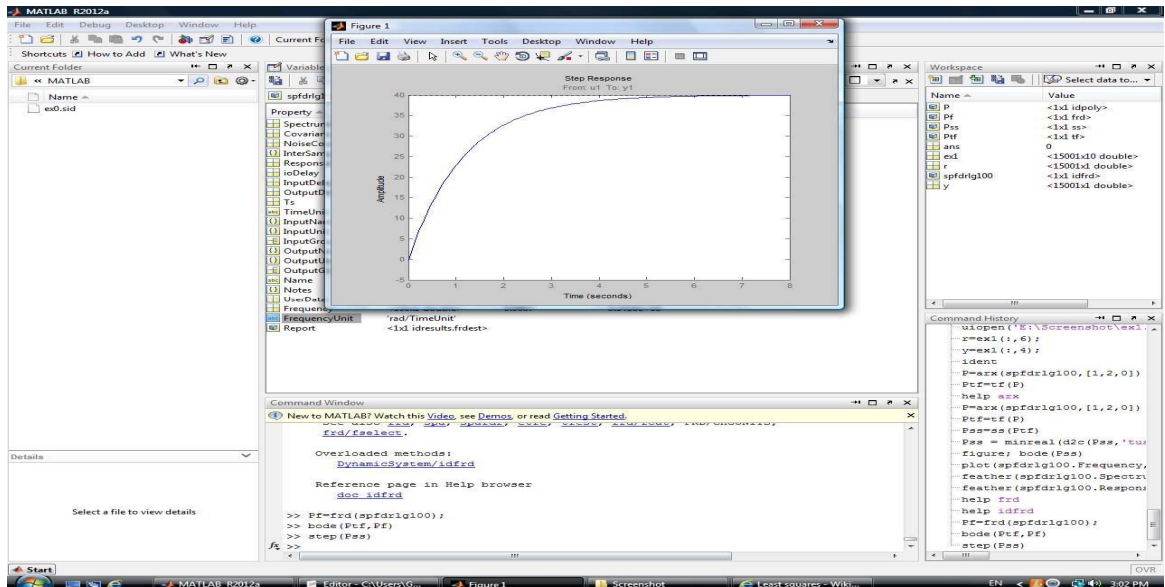
response, you can use this command.

The following picture are making model.



2) Show step response

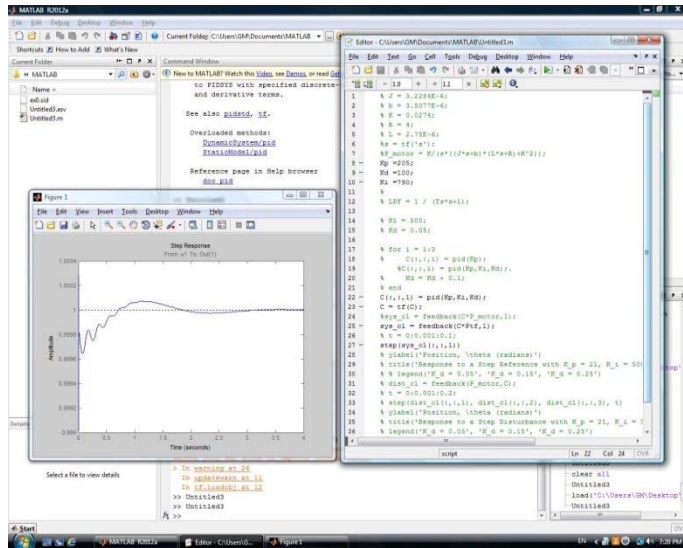
You enter “`sys_cl = feedback(Ptf,1)`” and “`step(sys_cl)`”. You can show the step response same the following picture.



From this picture $K_p=1$: It has setting time = 0.38 second, rise time = 0.0319 second and overshoot = 0%.

3) Design controller

Now you use new commands for designing. The new commands are “`sys_cl = feedback(C*Pf,1)`” and “`step(sys_cl)`”.



From this picture :

This signal's specification is

-rise time : 0.02 second

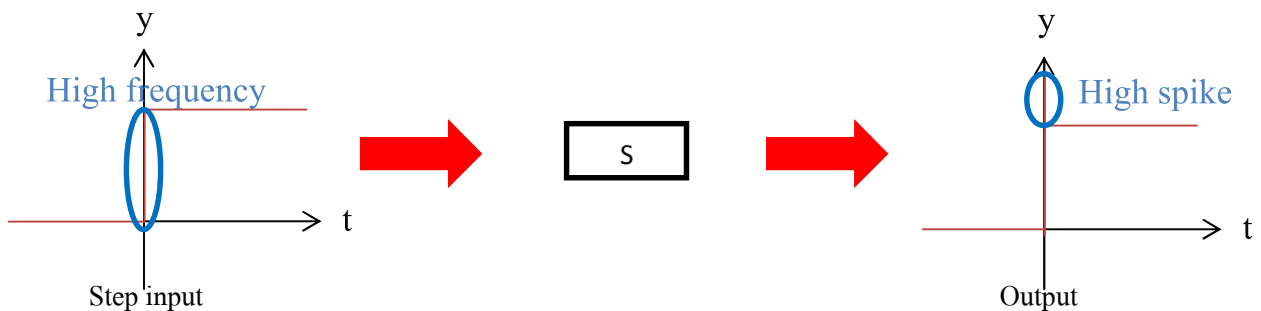
-setting time : 0.3 second

-overshoot : 8% and don't have undershoot.

Although I choose values of K_p , K_d and K_i many times , I can't find values of K_p , K_d and K_i which are correct. I observe step response and I know that the first period of graph have high spike. In this case nobody set values of K_p , K_d and K_i except you use "Approximated Derivative".

Approximated Derivative is s sum low pass filter $\Rightarrow \frac{s}{s^2 + 2\zeta\omega_n s + \omega_n^2}$

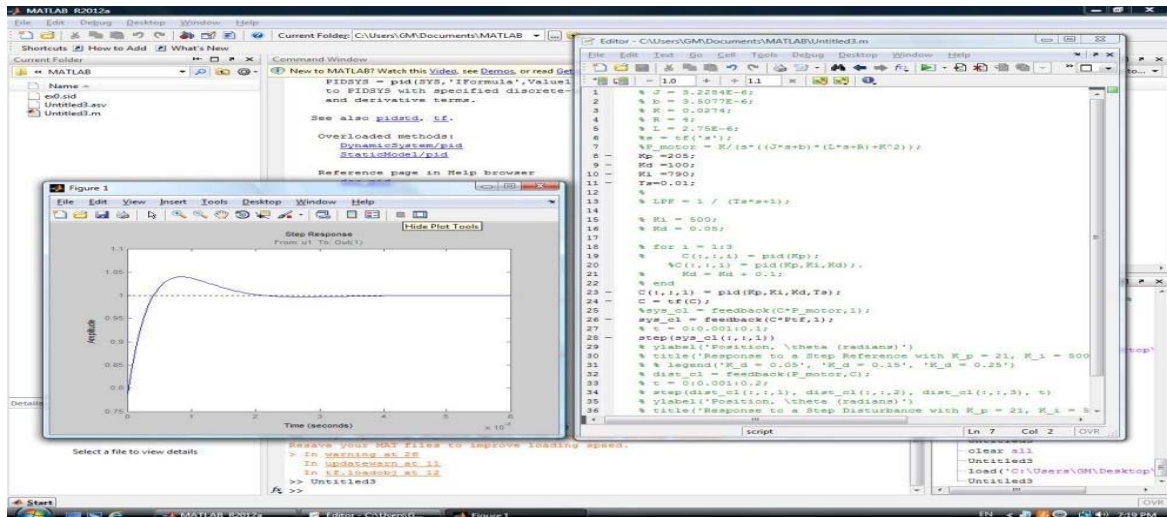
S (Differential operator) : If you enter the input(unit step) pass it , the output has high spike(overshoot) in short times. Because the component of step input has high frequency in that times. I can explain in the following picture.



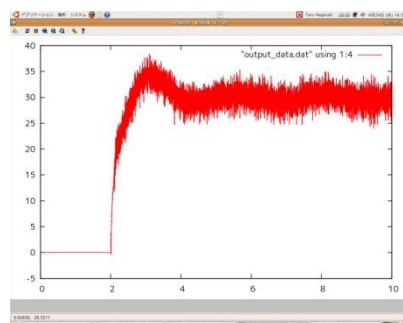
Form $s = j\omega$ and $\omega = 2\pi f$. If f is high frequency , s is high gain. The output has high spike(overshoot) in this time.

Low pass filter $(\frac{1}{s^2 + 2\zeta\omega_n s + \omega_n^2})$: When the input has high frequency and low frequency, low frequency can pass it only. In this case I apply it for cutting high frequency, so the output doesn't have spike.

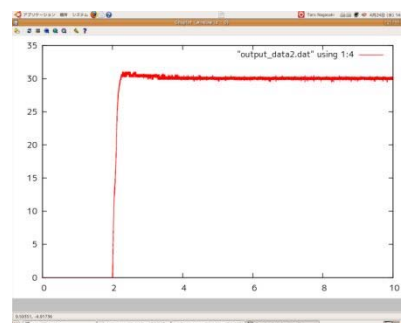
When I use Approximated derivative also, I can adjust K_p , K_i , K_d and T for designing controller. The result is shown in the following picture.



I take the data about my designing controller to C language program and set the plant's operating. Then I test by my controller but it's not good. It cause bad sound and it's dangerous for the plant. Maybe the plant is broken , so I use the new controller.



1ST CONTROLLER



2ND CONTROLLER

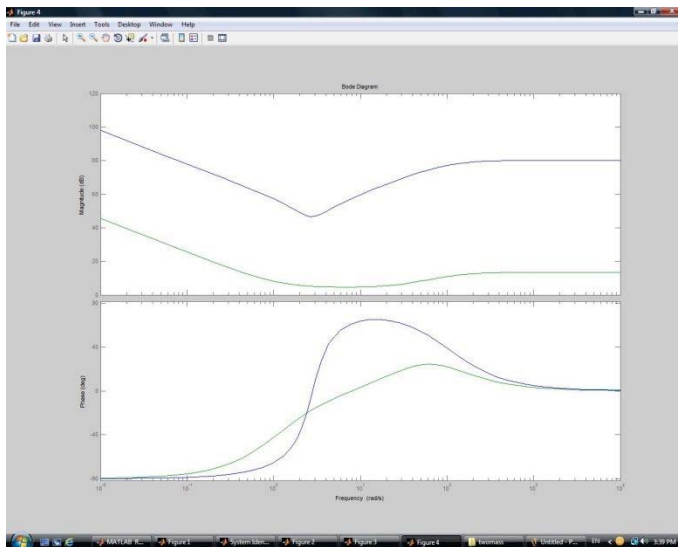
1ST CONTROLLER : $K_p = 205$, $K_d = 100$, $K_i = 790$, $T_s = 0.01$

2ND CONTROLLER : $K_p=1.7$, $K_d = 0.03$, $K_i = 1.9$, $T_s = 0.01$

From the above information and pictures : The first picture has high vibration at high frequency because the first controller has high gain. It cause a lot of noises and bad sound. When I use second controller , the plant work smoothly. You can observe from the second picture. It has noises less than the first controller. While the plant is working , it has good sound and low vibration at high

frequency. Finally, The second controller is better than the first controller and I choose it to use for improving about disk's rotating.

The following picture show gain between the first controller and second controller.



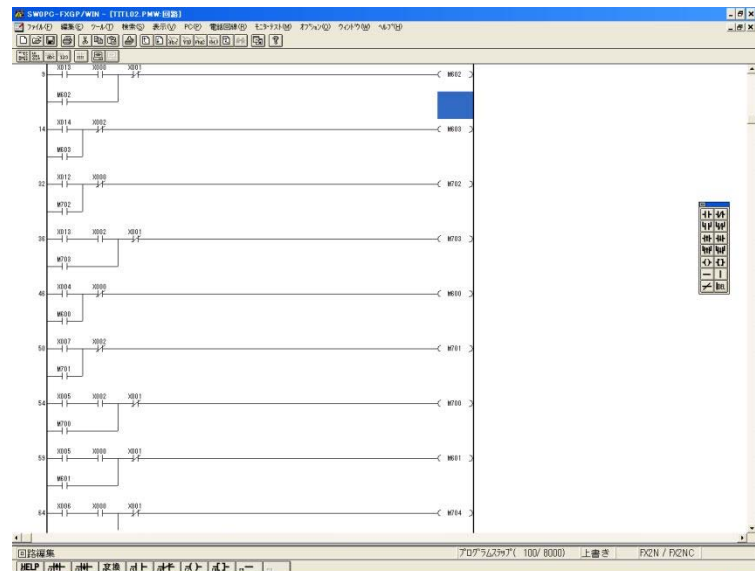
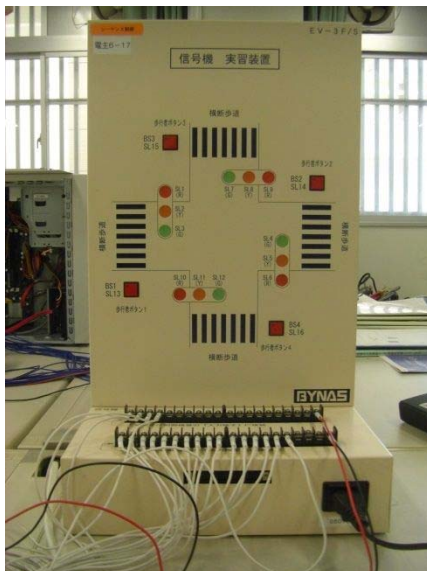
Blue line : The first controller

Green line : The second controller

2)Sequence control

About my jobs : I design their ladder diagrams by FXGPWIN program.

Traffic signal



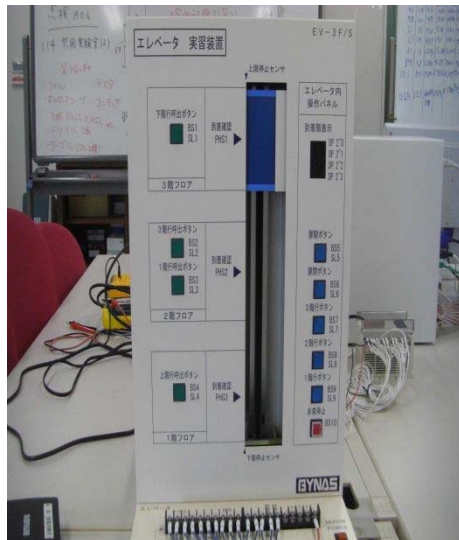
Traffic signal

Traffic signal's ladder diagram

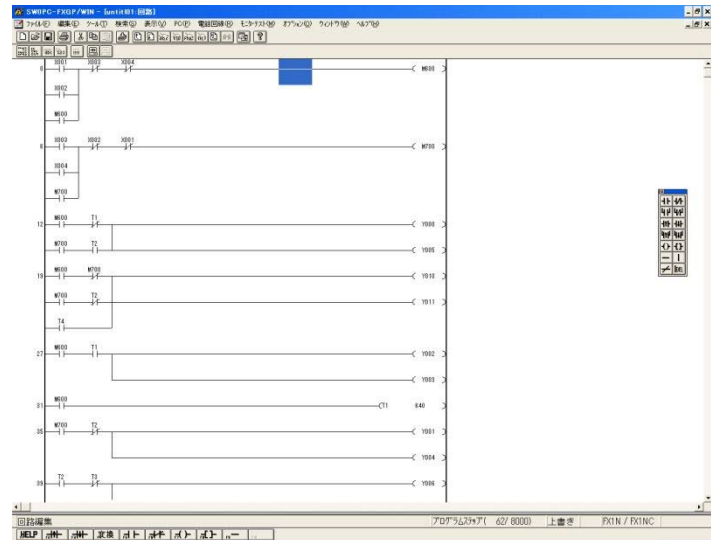
This picture is shown traffic signal's ladder diagram. It's shown traffic signal's working. The first , It shows red all. Next time, it changes to yellow and green. You can choose to push any buttons.

If you would like to show the vertical road's light before, you can push the upper button or the lower button. In the horizontal road's light, you can choose the right button or the left button.

The elevator



The elevator



The elevator's ladder diagram

This picture is shown the elevator's ladder diagram. It's shown the elevator's working. The green buttons are the outside elevator. They are up and down buttons. The blue buttons is inside the elevator. The two buttons is open and close buttons and three buttons are number of floor's button. The red button is emergency button.

3)Fuji Machine Manufacturing



I went to Fuji Machine Manufacturing for seeing about machine's processing and product of Fuji machinery such as PCB of iphone5 and ipad , Automatic assembly equipment , Headings , Tough plasma and Smart FAB.

SMT equipment

Surface mount boards can be found in most daily product such as Electronic devices , Automotive , Public transportation etc. Fuji Machine Manufacturing is continuing to offer technology that supports everyone's lifestyle.

Surface mount processes

Merged Production of SMDs and bare dies



Example products: Automotive, modules, sensors

From above picture

Before placing → Printing → Mounting → Reflow → After placing



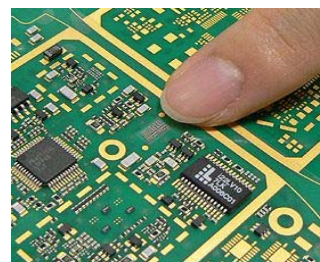
This industry produce PCB for iphone5 , ipad and smart phones.

NXT II

Fuji Scalable Placement Platform

NXT II

Flexible and highly productive
high-speed multi-function
modular placing machine



Processing >>> The duty of this machine is setting equipment on the PCB board.

The NXT II, you are completely free to choose the combination of heads, parts supply units and conveyor types that matches your exact needs. Exchanging units is quick and easy and even placing heads can be swapped without tools.

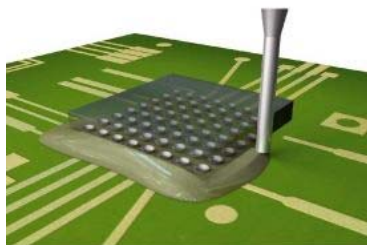
It has Dual lane production : With double conveyor machines, different panels can be produced simultaneously. Another bonus of dual lane conveyance is that loading time becomes zero, thereby boosting productivity.

Tough Plasma

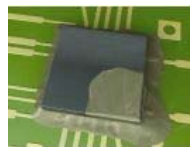
This technology use to clean and modify the surface of various materials such as resin , glass and metal.

For example :

Improved permeability of resin underfill



>> Improved permeability compared to unprocessed with plasma.



Before plasma processing



After plasma processing

After plasma processing, underfill infusion and panel wettability have both improved.

Polyimide sheet surface modification



Before plasma processing : The droplet is repelled by contaminants on the surface.



After plasma processing : Increased hydrophilicity means the droplet spreads.

Smart FAB



>> Use for placement large equipment such as capacitor , transformer , relay etc. , cut and clinch unit available as an option.

Summary

Benefit

1. Get working experiences
2. Apply my knowledge in working
3. Learn to use Matlab program
4. Improve my responsibility
5. Punctuality
6. Japanese language and Japanese culture
 - garbage separation
 - daily routine
 - Japanese manner etc.
7. Met many good people

Problem

- Sometime speaking different language makes a problem but it's not too big trouble for me.

I think it is the good chance to practice myself and learn other things not only their words.

- This internship is so short, so it's not enough for learning other things.