A Field Image Monitoring System based on Embedded Linux

Chiaki Yamaguchi, Ryoei Ito
Graduate School of Bioresources, Mie University, JAPAN

Introduction

Agriculture in Japan has many problems; decreasing and aging the person engaged in farming, the low food self-sufficiency rate and so on. In order to pass the good agricultural cultivation practices down to future generation and to reduce time and labor in farming, it is suggested to change over from "Traditional Agriculture" to "Scientific Agriculture".

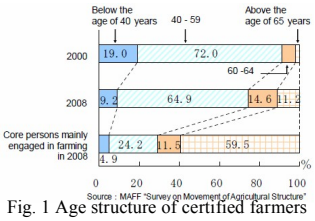

Fig. 1 Age structure of certified farmers (MAFF, 2008)

Since "Scientific Agriculture" should be based on theory and data, demands for the field monitoring system are increasing. In addition, real time data is essential for monitoring the field condition from remote site. Therefore, some field monitoring system developed in previous studies had the way to the Internet connection.

However, Internet connection services in rural areas are less provided than populated regions. In mandarin orange farm in Kumano district, satellite Internet was selected, because other wired Internet services were unavailable. And such these monitoring systems have some problems. Some are too expensive for farmers to find benefits of it, the others were not so tough for enduring in the field condition.

Objectives

To develop a field image monitoring system using USB devices and Embedded Linux to match the following requirements:

1. Low cost
2. Tough for enduring in the field condition
3. The Internet connection in rural areas

What is "Embedded Linux"?

Embedded Linux is one of the Operating System (OS) to control and manage the Embedded system. Such system is designed to perform a few dedicated functions and run with less resource than ordinary computers. Cell phones, air conditioners and many other consumer electronics are based on Embedded systems these days. Many OSs for Embedded system have been developed and some of them are available free on the Internet. Then we chose one of the famous Embedded Linux named "OpenWrt" to lower the system cost and to utilize many USB devices.

Developed System

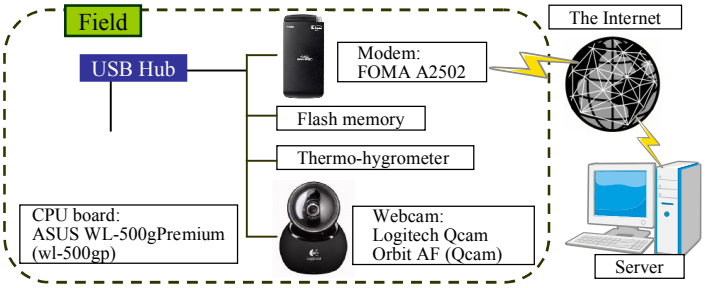

Fig. 2 The schematic diagram of the field image monitoring system

Fig. 2 shows schematic diagram of our field image monitoring system. The system captures a image using a Webcam and measures temperature and relative humidity with a USB thermo-hygrometer at first. Then data synchronization was carried out through the Internet connection established by a USB modem. Once the data transfer to the server had succeeded, collected data would be deleted on field site. If failed, these data would be remained for future trial.

Results

1. Low Cost

Total cost of the our field monitoring system was estimated as shown in Table 2. It becomes $300 excluding Data communication fee. Although data communication fee seems expensive, it is still cheaper than the other way and it is decreasing now.

Table 2: Estimation of the system cost

CPU board (wl-500gp)	$100	
USB camera (Qcam)	$100	
USB thermo-hygrometer	$50	
Data Communication		$100/month
Misc.	$50	
Total	$300	$100/month

2. Toughness for Enduring in the Field Condition

Two field experiments were carried out from Aug. 1, 2008 to Jan. 27, 2009, and from Aug. 18, 2009 to Oct. 8, 2009. In these experiments, the system was put into closed box and installed in the experimental farm of Mie University under the sunlight without shade.

Fig. 2 shows the temperature and relative humidity change in the closed box on 2nd experiment. Daily maximum temperature change in Tsu city of August and its averaged value from 1970 to 2000 are shown on Fig. 4. These figures indicate that the maximum temperature in the closed box exceeded 50 degree Celsius in Aug. 19, 2009. Moreover that day is not a particularly hot day and there are many other days whose daily maximum temperature are higher than that date. Hence the system was supposed to have been often experienced 50 degree Celsius during the 1st experiment.

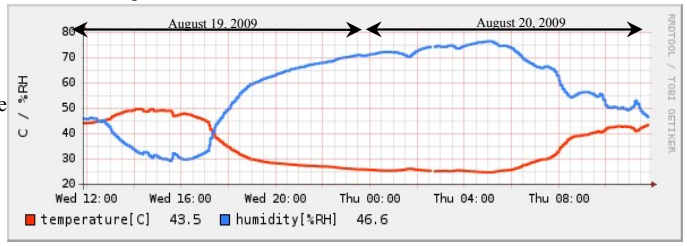

Fig. 2 Change of temperature and humidity

3. The Internet Connection in Rural Areas

This monitoring system equips 2 routes to the Internet. One is a wired Ethernet, the other is a mobile data communication. Even though the wired one is an easy and low cost method to connect the Internet, wired connection is only available at few spots in the farm land. Mobile data communication is available in the area of 3G CDMA mobile services. Since our system has a mobile router function, the Internet connectivity in rural area was extended.

4. Image Capturing

Our monitoring system can get a 2 mega-pixel (1600x1200 pixel) image such as Fig. 3. This resolution is the highest resolution in the image captured by commercial USB cameras.

Fig. 3 The image captured by this system

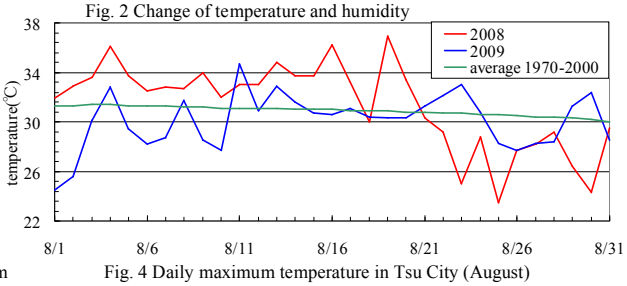

Fig. 4 Daily maximum temperature in Tsu City (August)

Conclusions

Embedded Linux based field image monitoring system using USB devices was developed to satisfy three requirements; low cost, toughness, the Internet connection. Total cost of the system becomes almost $300. In the field experiments, the system endured under high temperature condition and continued monitoring stably during 6 months. Furthermore, the system extended the Internet connectivity in rural areas using data communication.

From these results, the system is regarded to satisfy aimed requirements. Moreover it also provides high-resolution captured images constantly. Therefore, it becomes the useful system for monitoring and collecting data in the field.

Since the technologies used in this system are general ones, it would also be applicable to many other issues; observation of ecosystem by images, ICT based environmental education, monitoring in slope disaster site and so on.