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Anomaly Monitoring System for Mandarin Orchard

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Abstract

Orchard workers of empirical rule has been inherited successors in Japan. However, em-pirical rule has been lost by the deserted garden due to the death of the farmers and lack of successors. We construct the low-cost system for acquiring meteorological data using the single board computers as a solution to this problem. In this paper, we consider the new feature of anomaly monitoring in order to prevent a crop of theft as based on our system.
Keywords: Sensor processing, Remote system, Agricultural support, Abnormal measure

1 Introduction

Fruit orchard farmers are cultivating fruits by their own rules of thumb and intuition over the years. Therefore, most of these rules of thumb and intuition are in their own memory and written in the notes that only the person can understand. The statistical meteorological data about the fruit of the growing environment such as temperature and humidity hardly exists except for official facilities of National Agricultural Experiment Station. Recently, companies sell weather sensors for agriculture[1, 2]. It is difficult to invest for the facilities of acquiring the meteorological data and the running costs due to succession planning in the financial condition of many of the orchard farmers in Japan. However, it has become diffi-cult to earn stable income in agriculture over the last few decades because the environment surrounding agriculture such as liberalization of agricultural crops has changed completely. As a result, the number of successors has decreased, and the number of cases of becoming abandoned has increased due to aging of producers and death.

Young people who are interested in the crops of fruit do not have the opportunity to learn the rule of thumb of fruit cultivation, so it is quite difficult to newly enter the fruit orchards. Moreover, it is difficult to obtain a reward commensurate with the amount of work in the orchard farmer. It is also a problem that young people tend to avoid them. Many fruits such as oranges, apples and grapes must be harvested manually, and the cost of harvesting (personnel expenses) tends to be high. Furthermore, the farmers have to sell their crops directly at the station or residential area to sell for a high price in Japan.

The fruit tree-planted area is about 10% less than few years ago and production volume of the mandarin orange is also decreasing in Figure 1[3].

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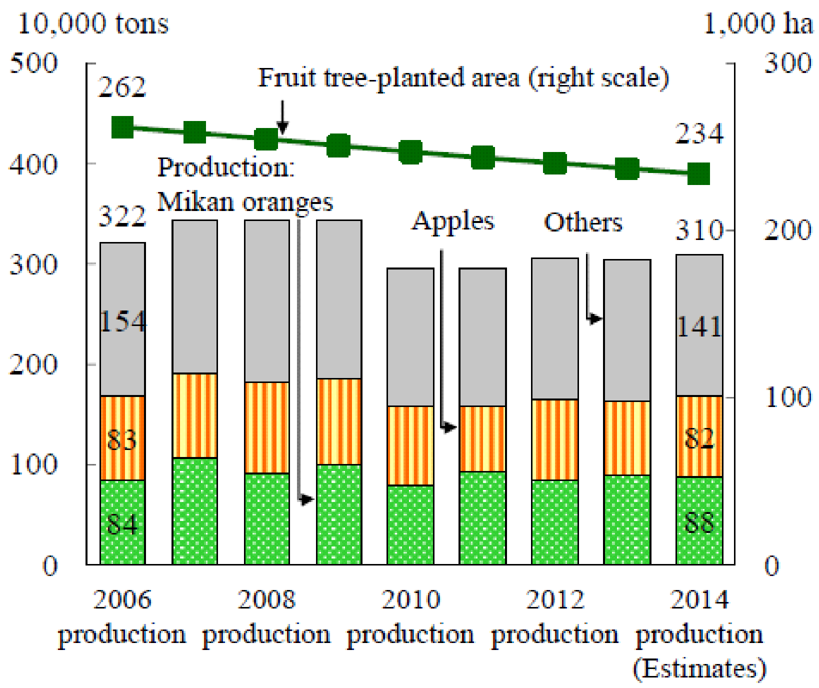

Figure 1: Changes in the total fruit tree-planted area and fruit production volume

fruit tree area is stated that ”the waste garden advanced with the aging of producers” in the statistics[4, 5].

In addition, farmers suffer in theft of crops. Damage number in 2012 is about 3,700 by the statistics of the National Police Agency announcement. And it is necessary to consider safety aspects since the machine is operated in an unmanned warehouse. Therefore, we construct the low-cost system for digitizing of heuristics of fruit cultivation and visualization of acquiring meteorological data for orchard (especially mandarin oranges) [6, 7, 8, 9]. In this paper, we provide the functionality of the anomaly detection and monitoring features to our system in order to strengthen the safety.

The paper is organized as follows. In Section 2 we mention the outline of the research. We describe the experimental environment and our proposal system in Section 3. Our conclusions and future works can be found in Section 4.

2 Outline of Our Study

The mandarin oranges can keep the quality by managing the amount of moisture until they reach to the consumer after harvest. In generically, the mandarin oranges are stored for a period of time determined by producer in the warehouse in order to save them and make the adjustment of their taste. The storage period is about one to two weeks and they are storage in the shade and well-ventilated place in case of mandarin oranges.

We have been measuring weather information of oranges plantation. In this research we also acquire meteorological data in the warehouse storing oranges. In particular, we aim a low-cost system using single-board computer such as Raspberry Pi and Arduino. This computer transfers the meteorological data (temperature, humidity, atmospheric pressure, etc.) in the warehouse to the server in our laboratory automatically.

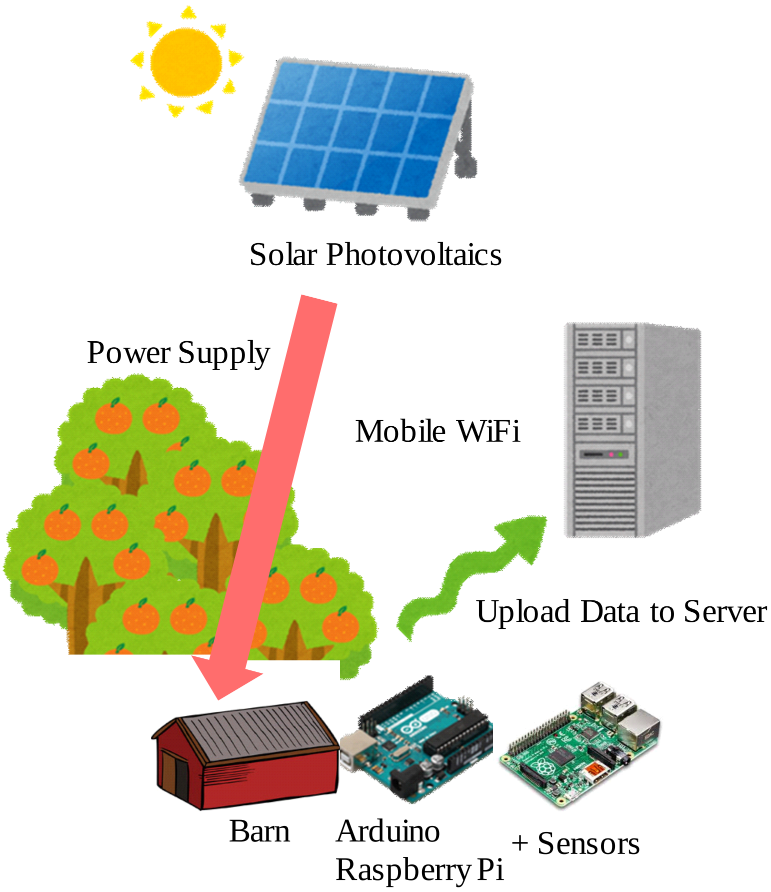

Figure 2: Out line of weather data acquisition

The visualization of data and anomaly monitoring are performed on the server side. It leads to prevention of crops and agricultural machinery of theft and fire, etc. if the system can detect anomaly using the acquired data and inform farmers.

3 Anomaly Monitoring System

We describe our system of weather data acquisition. Figure 2 shows outline of our system. Each sensor is connected to Arduino or Raspberry Pi and transfers data to the server via Wi-Fi router. In addition, the power supply of sensors and mobile Wi-Fi is covered with solar power because mandarin oranges are cultivated in places with a lot of sun's rays.

3.1 Equipment used in our system

The equipment used in our system is shown below.

Temperature and humidity sensor module

We use the 'USBRH' can be connected via USB made by a venture company. The humidity has a margin of error of 3% one way or the other and the temperature have a margin of error of 0.4 degree one way or the other.

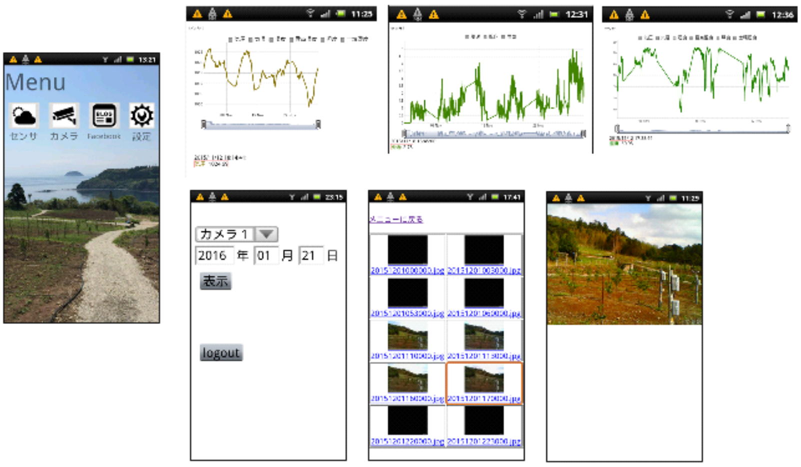

Figure 3: Application practice screen

Atmospheric pressure sensor module

We use the ‘BMP085’ can be connected via I2C made by a venture company. This sensor can be measured from 300hPa to 1,100hPa with the absolute precision of 2.5hPa.

Wireless communication module

For wireless communication, we use the Wi-Fi adapter of USB connection made by Buffalo for the Raspberry Pi. And we also use the Wi-Fi-enabled SD card made by Toshiba corporation for the Arduino. In order to use public data communication, we use the Wi-Fi router (L-04 D) made by LG Electronics Incorporated. We used SORACOM SIM which has low basic charge. The basic fee is 10 yen per a day and the data traffic is based on 0.2 yen per 1MB since this price plan is optimized for IoT devices in this SIM. In addition, upload data traffic and the communication charge in the late-night time zone are set at a low price. It is possible to greatly reduce the cost of communication because the IoT device keeps uploading small data periodically. We confirmed that it is possible to conduct stable data communication at an orange farm where sensor equipment was installed.

First, we generate a text file that the observational data acquired by the weather sensors. Next, we created a series of commands as a shell script that sends the text file to the server. Finally, executing the shell script every 5 minutes using crontab command, the observational data is transferred from the Wi-Fi router to the server via the 3G line.

3.2 Farm monitoring system

We are doing the verification of the proposed system from March, 2015 in mandarin fields of Ama Town. The screen of the Android application is shown in Figure 3. The user select the display period and the type of data in order to display the weather data. There are two types of specification of the display period. One is a method to specify the number of days from today such as‘ one day ago ’, three days ago ’ etc. The other is a method to directly specify the period of date you want to view. The users can select several kinds

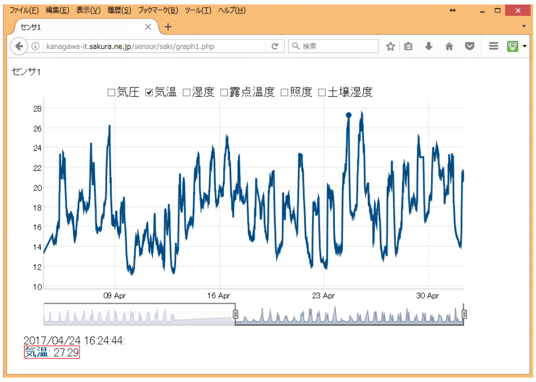

Figure 4: Temperature graph

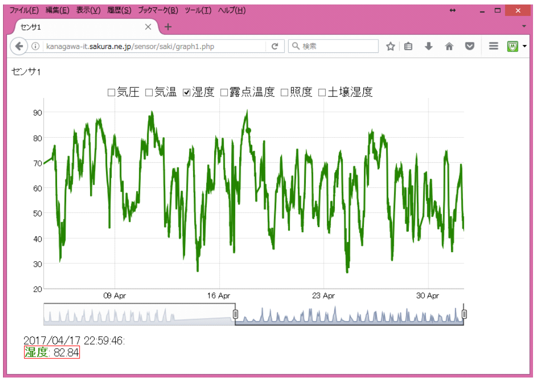

Figure 5: Humidity graph

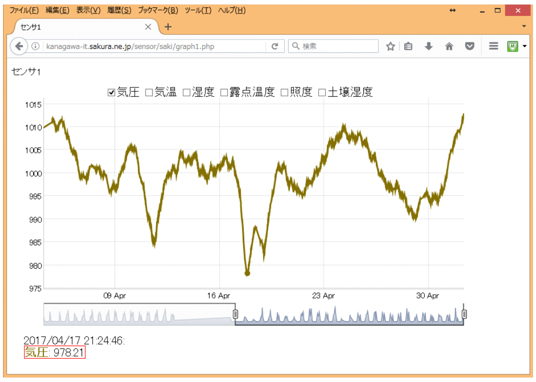

Figure 6: Atmospheric pressure graph

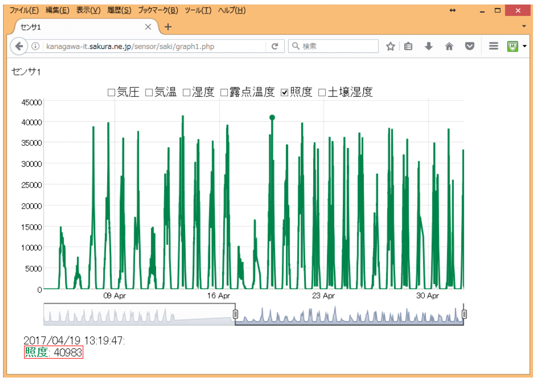

Figure 7: Illuminance graph

Figure 8: Soil wetness graph

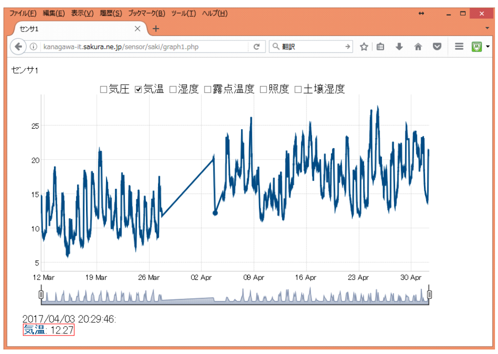

Figure 9: Change of temperature (Two months)

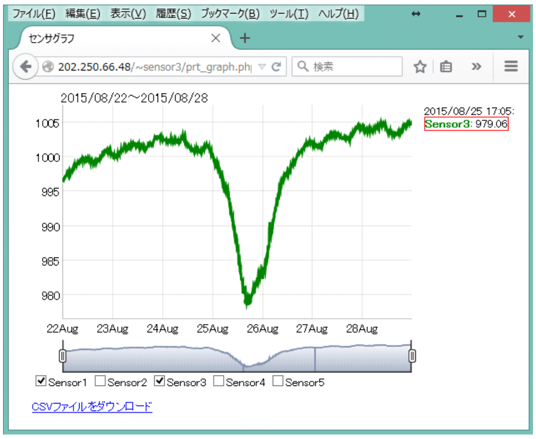

Figure 10: Change of atmospheric pressure at the time of the typhoon

of data types such as air temperature, atmospheric pressure, illuminance and so on. The future is increasing the types of available display sensor.

The display examples from April 2017 shown in Figure 4,5,6,7,8. Each figures shows air temperature, humidity, atmospheric pressure, illuminance and soil wetness. We confirm that it is possible to acquire the weather data continuously. Figure 9 is an example of displaying air temperature data during two months period from March to April 2017. Data transfer can be operated using the solar system only although loss of some data can be seen. In addition, we can confirm that the temperature in April is higher than in March in Figure 9. We cannot specific of actual cause of data loss. However, we conjecture that a failure has occurred in the temporary data communication network for some reason because the transmission of the data is restored automatically.

Further, we confirm that it is possible to identify when the typhoon approaches from air pressure data. The typhoon No.15 approached the Ama Town in late August 2015. It can be seen that had been re-close the evening on Aug. 25 from air pressure data in Figure 10.

3.3 Flow of Anomaly Monitoring System

The flow of the anomaly monitoring system is shown below and the concept diagram is shown in Figure 11.

1. Farmers register the e-mail address in the system.
2. Registered e-mail address is stored in the server.
3. The system monitors the meteorological data that are sent on a regular basis.
4. The system sends alert e-mail to the farmers when detecting an abnormal value.

It is possible to register using web-page and the system checks duplication entry. Currently, we can get the temperature, the humidity and the atmospheric pressure only. We measure abnormally using the temperature data for assumed fire. Further, it is also possible to view the visualization data using Web browser as shown. Hence, the farmers can know the status of the warehouse at any time.

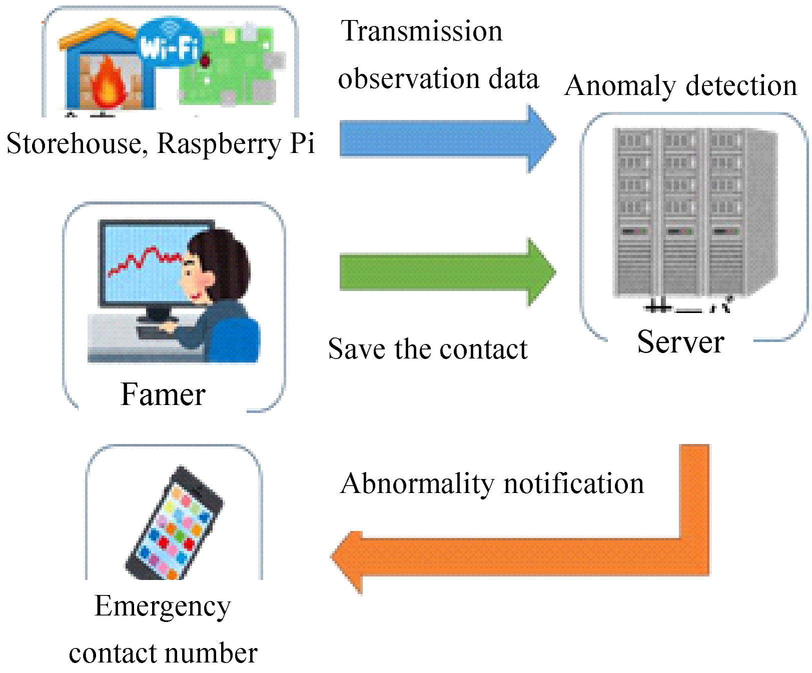

Figure 11: Anomaly monitoring system

4 Conclusion and Future Works

In this paper, we construct the acquisition system of meteorological data in cultivation environment for orchard farmers and propose the anomaly monitoring system. It is possible to make the initial investment cost with about $100 per one set using cheap hardware in our system. Therefore, our system is possible to introduce in the orchard farmers. And we can install new sensors base on the opinions of the farmers of the mandarin orange because we use single-board computer. We believe that it is sufficiently possible to support successor training and quantify numerical rule of agricultural experience using our system.

As a future Work, if we can know the correlation between the environmental data in the warehouse and the taste of the mandarin oranges, it is possible to digitize the taste of mandarin oranges and control the taste quality. And we discuss methods of crime prevention measures to add new sensors by taking advantage of the scalability of the Raspberry Pi and Arduino.

Acknowledgment

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