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# Rice Cultivation Support System Equipped with Water-level Sensor System

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Abstract: Farmers are aging in Japan. They must pass along their wisdom to the future generations to protect the safety of own food. Currently, research on the cultivation management of using a field server has been made widely conducted. Traditions that leverage the data obtained from a field server is considered to be an effective technology. As system that utilizes a field server is proposed (Fujitsu 2015, Vegetalia 2015, Norio 2011). Fujitsu's Akisai (Fujitsu 2015) and e-kakashi (Norio 2011) do not equip water-level sensor that used in rice field management because these are multipurpose agricultural management system. Paddy Watch (Vegetalia 2015) equips water-level sensor, but it cannot take a photos of the rice field and transmit them. The growing management of rice is required to the leaf color and the height of rice plant such as image analysis, but it is difficult to manage only by the sensor. In addition, water-level is a vital part of any rice field management, thus, it must be adjusted carefully. Furthermore, those systems request an access fee to networks because those systems use a 3G network. Therefore, we made a rice cultivation support system utilizing the field server operated by a mobile battery, equipped with a camera, and uses free local networks. Moreover, we made a water-level sensor system which works directly with a field server. We created a movable field server because a big one becomes a hindrance to the farm work. The data which is acquired from a field server and a water-level sensor system is uploaded to the web server automatically. Therefore, we have created a web page which can see the data and create a diary. The field server has been field tested outdoor. Results, confirm the operation of the rice cultivation support system.



*Keywords:* agriculture; short-range communication; rice field; field server; sensor network

## 1. INTRODUCTION

In Japan, aging of farmers has progressed. The average age of the agricultural working population was 66.8 years old in 2014 (Ministry 2011). We need to pass on the skilled technology of farmers to the next generations to protect the safety of eating habits. Currently, research on agricultural management of utilizing a field server has been made widely. Old traditions that support data that can be obtained from the field server are considered to be an effective technology. The data of skill and wisdom can be visualized by performing data mining and machine learning. For inexperienced users, it is important to be supported with reference to the visualized data to perform efficient agriculture.

In Japan, the cultivation of staple food of rice is thriving. However, the introduction of a field server system has progressed in mainly tangerine fields and tea plantations. Their introduction in rice fields has not progressed much. The reason is because that rice fields do not have a power supply. It is difficult to install a power supply, because of cost.

In addition, it is difficult to install solar panels because solar panels are big and get in the way of farming. For examples, Fujitsu's Akisai (Fujitsu 2015) requires power to the rice fields, and the installation fee is high. Management of rice fields is often done by individual farmers.

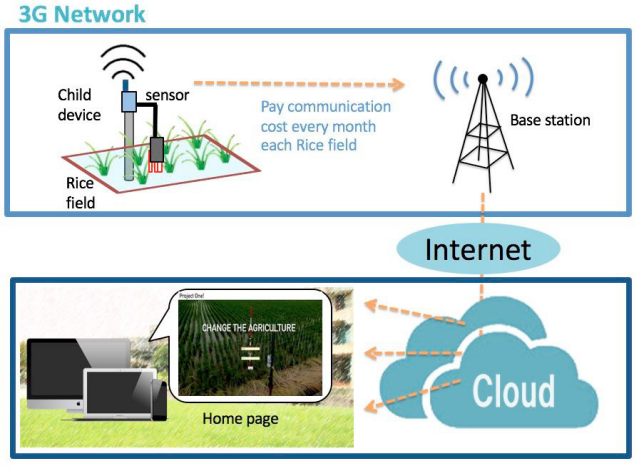


Fig. 1. Overall Configuration of conventional field server

Therefore, it is difficult to perform large investment. PaddyWatch (Vegetalia 2015) and e-kakashi (Norio 2011) do not need power. They operate by battery cell. However, they have only sensors for power reduction. Therefore, the system cannot transmit rice field images. The growing management of rice is linked to the leaf color and the height of rice plants and is assessed through image analysis, but that is difficult to manage only by the sensor. In addition, Fujistsu's Akisai (Fujitsu 2015) and e-kakashi (Norio 2011) are not equipped


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with a water-level sensor that is used in rice field management because these are multipurpose agricultural management system. The water-level is the vital part of rice field management. Thus it must be adjusted carefully. Therefore, they are a system which cannot be made to reduce the cost of the patrolling rice field. In addition, the sensor data are transmitted by 3G network. For this reason, operating costs (communication cost) are high, and has made the introduction of these systems difficult. Fig. 1 shows the image of the overall view of the conventional field server.

Therefore, we made a rice cultivation support system for rice field utilizing field servers which work with mobile battery, have the camera and use free local networks. Because a big field server become a hindrance to the farm work, we have created a movable field server. In addition, we made water-level sensor system which works directly with the field server. The proposed system provides the homepage as a first step of management of the rice. Therefore, the proposed system is excellent in the point of cheap operational cost and the introduction cost. The proposed system is also easy-to-use system and the field server can easily be moved. We installed the field server outdoors and did field tests. Also we tested the rice cultivation support system. In the results, we could confirm the operation.

In section 2, we explain the overall configuration of the rice cultivation support system. Especially, we explain the child device subsystem, the parent device subsystem, the repeater subsystem, the cloud subsystem and the smart device subsystem. In section 3, we explain the child device system. In section 4, we explain the configuration of the water-level sensor system. In section 5, we show the operation experimental result of the rice cultivation support system. In section 6, we show the comparison result with the existing systems. In section 7, we describe our conclusions.

## 2. OVERALL CONFIGURATION OF RICE CULTIVATION SUPORT SYSTEM

We explain the overall configuration of the proposed rice cultivation support system. Fig. 2 shows the overall structure of the rice cultivation support system. This system is constructed of the following six subsystems. The free local wireless network is used in the child device subsystem, the parent device subsystem and the repeater subsystem. In many cases, the farmer already has a network connection which needs an access fee. The network is used for the upload to the cloud and the confirmation of the data.

- Child device subsystem

This system is the field server which is placed in the rice field for data collection. The available data are air temperature, air humidity, the soil temperature, soil moisture, the water-level, and the rice field images.

- Parent device subsystem

This system is the subsystem that receives the data sent from the child device, and is be uploaded to the Cloud server. The subsystem is placed in the home or the work place.

- Repeater subsystem

This subsystem is for the prolonged communication over distances. It is not possible to perform the data communication when the distance between the parent device and the child device is too far. By placing the repeaters between the parent device and the child device, data can be transferred further away.

- Cloud subsystem

This subsystem saves the sensor data and the image data of the rice fields and performs the analysis. The analysis results are converted to the homepage format automatically. Therefore, it has become a mechanism that allowing the latest results to be checked at all times from any location.

- Smart device subsystem

This subsystem is for viewing the acquired data outdoors. It can see the data from the homepage by using the personal computer or a smart phone at any time and from anywhere.

- Water-level sensor subsystem

This system is for measuring the water-level and transmitting the value to the field server. The system consists of several subsystems. In addition, the system calculates the average water-level by using several subsystems. The system is placed in rice field.

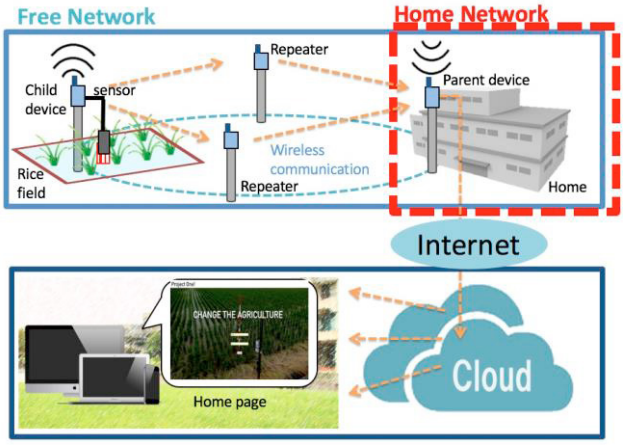


Fig. 2. Overall configuration of rice cultivation support system

### *2.1 Child device subsystem configuration*

We will explain the child device subsystem configuration. Fig. 3 shows the structure of the child device subsystem. The child device subsystem is equipped with three types of sensors and camera system. The device is equipped with a power on-off circuit for turning on only the power supply at the time of transmitting the data. Table 1 shows a list of sensors that were installed in the child device subsystem. Sensors can be added as needed. The air temperature and the air humidity are measured by the temperature humidity sensor (hereinafter referred to as T & H sensor). The soil temperature is measured by the soil temperature sensor, and the soil moisture content is measured by the soil moisture sensor. Also, the rice field image is obtained by the camera.