Design and Application of Farming Visualization System FVS for Human Resources Development in Agriculture

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ABSTRACT

In modern farming, it is indispensable to monitor the field environment, crop conditions, and farming operations. To support these activities at farm level, we have developed several types of farm operation monitoring systems based on various needs of farms. FVS (Farming Visualization System) is one of such systems and designed in order to record and replay all the information of farming operations based on combinations of data from several kinds of sensors including GPS, RFID readers and CCD cameras. These systems can be applied for various application fields of agriculture. One of the major fields is to record precious and detailed farm operations history for good agricultural practice and food traceability. Another major field is the training and education of both farming operators and farm managers. These applications fields of FVS are especially important in agricultural company as well as advanced family farm. In this paper, first, the NoshoNavi project, in which FVS has been developed, is outlined after explanation of background of the research. The objective of this national project is to visualize three types of the farming information mentioned above and extract know-how of farming skill using the integrated data. The project is expected to give useful tools for human resource development in agriculture. Second, design, structure and function of the latest version of the systems are described. Finally, the results of a trial run of the systems in real farms including 150ha rice farming company are given and implications of the application are discussed with future research topics in this research field. The smart phone system is simple to use with a low initial cost. On the other hand, the PC system can monitor many kinds of information with high accuracy. Both types of the systems have advantages and disadvantages. Suitable tasks for each type of system are clarified. A data exchange framework, called FarmXML, among related systems is also proposed.

Keywords: field monitoring, farming skill, GPS, RFID, FarmXML

1 INTRODUCTION

Japanese agriculture is facing structural changes. The number of family farms is decreasing and the number of agricultural company is increasing. These statistical observations imply that agricultural company as well as family farm is getting more important for Japanese agriculture. Increasing abilities of staff in agricultural company is crucial for success of the agro-business. Thus,
the human resources development for skill-up is one of the most important management issues for agricultural companies.

In modern farming, it is indispensable to monitor the field environment, crop conditions, and farming operations. These data could be big data. Visualization of the data is effective for human resources development for farming skill-up including operations and judgements. Applications fields of FVS for human resources development are especially important in farm companies as well as advanced family farm.

In the related research fields, Otuka and Sugahara (2003) developed a labor management system for farm by hand inputting data using handheld computers. Guan, Shikanai, Minami et al. (2006) develop a system for recording farming data by using a cellular phone equipped with GPS. Then, we have developed several kind of monitoring system of farming operation by using RFID tag (e.g. Nanseki, Sugahara & Fukatsu (2007), Sugahara, Nanseki & Fukatsu(2008), Fukatsu & Nanseki (2009), Fukatsu, Sugahara, Nanseki & Ninomiya (2009), Sugahara, Nanseki & Fukatsu(2009)).

Integrated use of RFID, GPS and camera is more effective to systematic monitor of farming operation. Thus Nanseki (2010) and Fukatsu & Nanseki (2011) have proposed a concept of farming visualization system FVS and demonstrated a system which consists of mobile PC, RFID readers and DGPS. This system is useful to systematic monitor of farming operation. However, equipments are heavy and not easy to wear in real farming operation. Therefore, we have developed new FVS consists of smart phone equipped with camera and GPS, and RFID readers. In this year, we will develop another new FVS consists of only smart phone equipped with camera and GPS, and RFID readers.

The objective of this paper is to propose a design of farming visualization system FVS and discuss necessity of the system for human resources development in agricultural sector and its usefulness. In this paper, first, the NoshoNavi project, in which FVS has been developed, is outlined after explanation of background of the research. Second, structure and function of the systems are described. Further, after explanation of background of the research. Second, structure and function of the systems are described. Finally, the results of trial run of the systems in 150ha of rice farming company are given and implications of the application are discussed with future research topics in this research field. A data exchange framework, called FarmXML, among related systems is also proposed.

2 STRUCTURAL CHANGES IN JAPANESE AGRICULTURE AND NEEDS FOR HUMAN RESOURCES DEVELOPMENT

There were 1,679,000 agricultural management entities including family farms and agricultural companies, which marked a decrease of 16.4% as compared to the five years ago (MAFF, 2012). 31,000 of agricultural management entities were organized management entities, which marked an increase of 10.4% in same period. There were 22,000 corporate entities including agricultural companies and 1,657,000 of non-corporate management entities, of which 1,644,000 were private family farms. The number of corporate management entities increased 13%, non-corporate management entities decreased 16.7% and private family farms decreased 16.8%.

The number of agricultural companies is 12,984, which is 60.0% of the total corporate agricultural management entities (Figure 1). Agricultural companies is increased by 2,002 in terms of the number, which marked an increase of 18.2%. The number of agricultural management entities with sales value more than or equal to 100 million yen (around 1.2 million USD) is increased and accounted for 9.5% in past 5 years. The number of agriculture management entities with sales value less than 100 million is decreased. Decreasing rate of the number of agriculture management entities is bigger with less sales value. Thus, Japanese agricultural sector is facing with structural changes.

As above mentioned, statistical observations imply that agricultural company as well as family farm is getting more important for Japanese agricultural sector. Our original nation-wide survey on agricultural company shows that 51.7% of agricultural companies in terms of the number
count sales value of more than or equal to 100 million yen (n=501). 69.1% of agricultural companies consist of more than or equal to 11 staffs including manager, full time employee and part time employee.

Increasing abilities of staff in the company is crucial for success of the agricultural business. The abilities include skills of farm machinery operation, skills of farming operation judgement and skills of farm management judgement. Good example of farm machinery operation is ploughing and irrigating paddy fields with tractor and special type of harrow. Good example of farming operation judgement is judgement of control of temperature and water in baby rice growing process in plastic house. Spraying of fertilizer and pesticide as well as water control in rice paddy fields are also good example of farming operation judgement. Another example of farm management judgement is making farm plan including combinations of crop and varieties as well as farm expanding and diversification strategy. The human resources development for these skill-up is one of the most important management issues for agricultural companies.

3 FARMING VISUALIZATION AND HUMAN RESOURCES DEVELOPMENT

In modern farming, it is indispensable to monitor the field environment, crop conditions, and farming operations. To support these activities at farm level, we have developed several types of farm operation monitoring systems based on various needs of farms. FVS (Farming Visualization System) is one of such systems and designed in order to record and replay all the information of farming operations based on combinations of data from several kinds of sensors including GPS, RFID readers and CCD cameras.

These systems can be applied for various application fields of agricultural sector. One of the major fields is to record precious and detailed farm operations history for good agricultural practice and food traceability. Another major field is the training and education of both farming operators and farm managers. Visualization of information of field environment, crop conditions, and farming operations is effective for human resources development for farming skill-up including operations and judgements. Applications fields of FVS for human resources development are especially important in farm companies as well as advanced family farm.

To promote the research in this field, the NoshoNavi project has been financially supported by Ministry of Agriculture, forestry and Fisheries of Japanese Government. The objective of this national project is to visualize three types of the farming information mentioned above and extract know-how of farming skill using the integrated data. The project is expected to give useful tools for human resource development in agricultural sector. In this national project, FVS has been developed as well as monitoring systems of the field environment and crop conditions.

Figure 1 shows a Road map of development of NoshoNavi system. At first stage, systems of continuous measurement and database of farming operation information, environmental information,
and crop bio information are developed. At second stage, systems of integration and visualization of farming operation information, environmental information, and crop bio information are developed. At third stage, methods and procedures of know-how extraction of skilled farming operation and its succession techniques are developed. This stage enables extraction of explicit knowledge from tacit knowledge and development of knowledge DB in farming.

Figure 2: Road map of development of NoshoNavi system

4 STRUCTURE AND FUNCTION OF FARMING VISUALIZATION SYSTEM

Figure 3 shows an overview of structure and function of NoshoNavi system in near future. NoshoNavi system provides a cloud computing service for farm manager and operator. Expected outputs from FVS include (1) integrated and visualized various information including farming operation, weather and crop growth, (2) visualized know-how of skilled farming operation, and so on. In the system, several systems connect to FVS cloud server with the Internet.

FVS gadgets on smart phone acquire information of farming operation and send it FVS cloud server. The gadgets are developed for Android smart phone equipped with RFID (FeliCa) reader, GPS sensor, camera, and acceleration sensor.

FVS virtual experience player synchronizes and visualizes farming operation information. This means that farm operator can see skilled operator of farming operation of with image data, sound, location and comment. The input data for the system can be obtained by FVS special data logger. Existing devices including wearable camera and GPS logger are also applicable to obtain the data. FVS special data logger is equipped with two RFID readers, differential GPS sensor, and two cameras. Therefore, the system can monitor detail information of farming operation. However, the system is not easy to use in daily farming and for monitoring skilled operation. FVS virtual experience player and FVS special data logger are for closed use in farm, which This means no connections to the Internet.

Several related existing systems for closed use in farm can also connect to FVS cloud server with FVS connection tools. One of them is PMS. The system is for planning and management support software for farm work in arable farming using a geographic information system-compatible field map (Yoshida, Takahashi & Teramoto, 2009). Another example is UECS for
greenhouse farming. The system is decentralized autonomous greenhouse environment control system in a ubiquitous computing and Internet environment (Hoshi, Hayashi & Uchino 2004, Hoshi, Hayashi and Shintani, 2008). To exchange information among systems, standardized data exchange format is needed. Therefore we propose FarmXML which is superset of BIX-pp and FIX. The former is proposed and implemented in UECS. The later is proposed in the NoshoNavi project and implemented in PMS.

In present version of the system, FVS cloud server is connected to virtual experience player. The server is also connected to PMS and UECS in the system of implementation. Present version of FVS gadgets use outside RFID reader with Bluetooth connection instead of inside RFID (FeliCa) reader. Present version of FVS cloud server dose not use the data of acceleration sensor yet.

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The results of trial run show that FVS and other NoshoNavi related systems are useful for acquisition, integration and visualization of information of farm operation, weather and rice growth. The visualized information is useful for making farm plans, better farming decision making, better machine operation which include temperature control of baby rice plant in plastic house and paddy harrowing by tractor.

Figure 2: Overview of structure and function of NoshoNavi system in near future

5 APPLICATION OF FARMING VISUALIZATION SYSTEM

Trial runs of the system are conducted in 150ha rice farming company in Shiga prefecture in 2011. The number of employs is more than 20 and the annual sells value is more than 200 million yen. The president of the company believes that the training of employees is important in sustainable development of the company. One of the major issues of the company is human resources development.

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FVS gadgets on smart phone are simple to use with a low initial cost. On the other hand, FVS special data logger can monitor many kinds of information with high accuracy. Both types of the systems have advantages and disadvantages. Suitable tasks for each type of system are deferent.

6 CONCLUSION

A design of FVS, farming visualization system, was proposed with applications to rice farming company in this paper. The necessity and usefulness of the system for human resources development in agricultural sector have been discussed and revealed. For the research topic in the future, further trial run of the system in real farms and full implementation of the NoshoNavi system are important.

REFERENCES