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네트워크 기반에서의 스마트 농업 표준 기준모델 분석

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Standard Reference Model Analysis for Smart Farming based on Networks

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요 약

IT 와 농업분야의 융합은 생산, 유통, 소비 분야에서의 효율과 질적 향상을 기대하게 되었고 특히 IT 영역의 정보 분석 기술과 자동제어 기술은 농산물 생산에 많은 장점을 제공하게 되었다. 네트워크 기반에서의 농업 분야 ICT확대는 기술적, 환경적인 측면에서의 어려움들을 해결하게 되었다. 본 논문에서는 IT와 접목한 스마트 농업 환경에서의 표준 기능 모델을 제안 분석하고 이를 바탕으로 한 스마트 농업에서의 기술적 서비스 요구조건 을 제시한다.

ABSTRACT

IT convergence with agriculture is expected to bring more efficiency and quality improvement in producing, distributing, consuming of agricultural products with the aid of information processing and autonomous control technologies of the IT area. Smart Farming based on network is a service which is capable of coping with environmental and technical problems with the actualized IT convergence case for agriculture. In this paper, it is required to consider the actualized IT convergence case for agriculture, namely Smart Farming as a solution to cope the presented problems. In addition, propose and suggest to standard model and standardization items requirement for the Smart Farming based on network.

키워드 : 스마트 농업, 표준기준모델분석, ICT 융합

Key word : Smart Farming, Standard Reference Model Analysis, ICT convergence

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Ⅰ. INTRODUCTION

IT convergence with agriculture is expected to bring more efficiency and quality improvement in producing, distributing, consuming of agricultural products with the aid of information processing and autonomous control technologies of the IT area.

However, there exist many difficulties to establish services and systems to actualize the IT convergence service in the agricultural field to cope with various objects such as time-varying weather changes, growth condition of farm products, and continual diseases or technical problems such as battery life, sensor malfunctions at severe conditions. In addition, the gap of viewpoints between the people engaged in farming and the IT engineers may cause more problems for accomplishing this mission[1,2,10].

Therefore, it is required to consider the actualized IT convergence case for agriculture, namely Smart Farming as a solution to cope with the presented problems[1]. The standardization process related with this issue is in progress in ITU-Y SG13 with the name of Y.ufn (Smart Farming based on networks)[4].

It looks meaningful to check each point by presenting an overview including the standard reference model, service requirements and network capabilities[3,4] for this purpose, though its standardization process is just at the initial stage[4,5].

Smart Farming can be run autonomously without human intervention when we apply the most advanced technologies such as sensors, computers, or control systems. However, there can be possibilities of unexpected events such as products theft, cost-down due to excess production, etc. Hence, we must confront these difficulties by any means. The network-aided support of the following services could solve such problems on the next generation or future network environment as follows:[7].

- farm products theft prevention service: a service that prevents the theft of agricultural products in farmlands, greenhouses, or warehouses by means of surveillance such as CCTV, infrared sensors, or other sensors which are connected to agricultural producers through networks.
- farm products traceability service: a service that provides the traceability information about farm products in the market to customers, through networks, including identity information about agricultural producers, food safety certification, etc.
- remote farm management service: a service that provides agricultural producers means to monitor and control farm conditions on the remote side through devices such as smartphones or other types of smart terminals connected to networks.
- farm production regulation service: a service that provides agricultural producers the information for deciding which farm products to sow, when to sow, or when to harvest, which are essential for farm production regulation considering at large[3].

In this paper, it is required to consider the actualized IT convergence case for agriculture, namely Smart Farming as a solution to cope the presented problems. In addition, propose and suggest to standard reference model and standardization items requirement for the smart farming based on network.

Ⅱ. Proposed standard reference model for Smart farming based on networks

To apply the Smart Farming based on networks shown in the Figure 1, a reference architecture showing the service roles, consumers, distributors, agricultural producers, service providers, is presented.

Service roles shown in the Figure 1, consumers, agricultural producers, distributors, service providers, play main roles of the Smart Farming based on networks as follows:

- Consumers: the service role that ultimately purchase the final agricultural product from distributors or agricultural producers and also request farm products

traceability service to the service provider;

- Agricultural producers: the service role that actually produces agricultural products to be supplied to distributors or consumers and is provided the Smart Farming services such as farm products protection service or remote farm management service;
- Distributors: the service role that distribute agricultural products supplied from agricultural producers through its own distribution network and is provided the farm production regulation service to maintain the break-even point;
- Service providers: the service role that provides the requested Smart Farming services to requesting users such as consumers, agricultural producers, distributors.

These service roles play their part according to the stage where they are positioned i.e., pre-production stage, production stage, post-production stage. In the pre-production and production stages, the agricultural producer can be advised on what to produce, when to produce, what to seed, and other matters from the service provider via the plan/production consulting. The distributors and consumers can also be advised from the service provider on market demands, food traceability, and prices. The network provider can provide the telecommunication network for interchanging information between the service roles for these purposes[4-6].

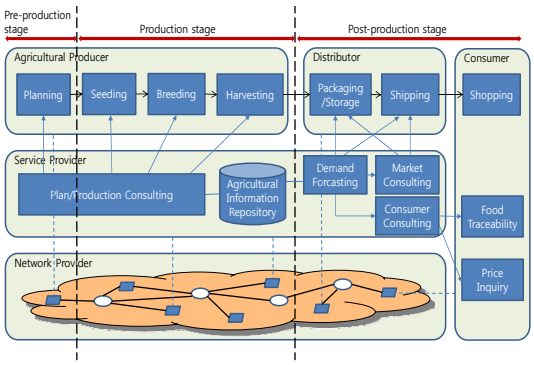

Fig. 1 Standard Reference model of the Smart Farming based on networks

2.1. Service requirements for pre-production stage

In the pre-production stage, it is expected to consider the following issues:

- Making business plan: To consider sales/production planning, it needs to simulate for profit-loss calculation of the overall business production enterprise and activities on marketing, management, and business interactions with personal communication communities;
- Operational review: For ensuring stable revenues, it is required to review globally on licenses, permits, regulations, patents, trademarks, risk management, environmental issues, production quality, timeline, etc.;
- Role of ICT in the Smart Farming: For defining the role of ICT in the Smart Farming, it is needed to consider how to apply ICT, such as sensing & monitoring system, network infrastructure, controlling system, information DB, farming management server, etc., to the Smart Farming;
- Business review: For the stable management of the Smart Farming business, it is needed to consider the size, type, and quality of facilities and facility equipments, real estate, farming equipments, ownership structure, etc.
- Financial estimate: For maintaining Smart Farming business and attaining more profits, it is very important to estimate a projected cash flow, income statement and balance sheet. It is also required to estimate a projected statement of income, expenses, and profitability;
- Decision making: This is the process on decisions such as produce selection and amounts, rationalized price policy and marketing policy at all levels of the marketing, etc.;
- Marketing plan: Before the production phase, it could be required to consider the market trends, customers service, marketing contracts, strategic partners, pricing, promotion, distribution. target markets, competitive advantage, etc. for a better decision;
- Understanding customers: For better understanding,

it is required to identify customer class for primary products and anticipating customer's changing characteristics[4,10].

2.2. Service requirements for production stage

Requirements for ICT convergence with greenhouse/plant-factory farming[5,8].

ICT convergence with greenhouse/plant-factory farming can be divided into several phases as follows:

- Monitoring any changes of facility environments in real-time basis;
- Offering the most suitable information on the quality of crops by analyzing synthetically the observation of crops status, growth condition, and environmental information;
- Organic controlling facility environments according to the growth level of crops and any changes of environments.

2.3. Service requirements for post-production stage

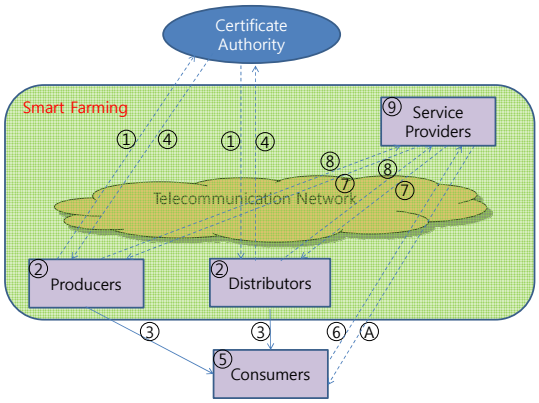

Fig. 2 Conceptual diagram of product traceability management considering roduction/shipping/distribution phases in the ubiquitous farming

The Figure 2 shows the traceability management which manages and records the information originated from farm products production, distribution and final consumption for maintaining the farm product distribution record[6]. For successful deployment of this feature, it is required to consider the following issues:

① Requests for traceability management registration to the certificate authority;
② Registration of the traceability information for maintaining the record;
③ Products with tags for maintaining the record;
④ Tracing of the record at each phase;
⑤ Checking of the record information on farm products by consumers;
⑥ Requesting for food safety checking;
⑦ Requesting for the traceability information;
⑧ Traceability information.
⑨ Checking of the food safety from the traceability information from producers or distributors;
⑩ A Checked safety results for the required food.

Ⅲ. service requirements for smart farming based on networks

3.1. Requirements for ICT convergence with outdoor farming

ICT convergence technology about raising outdoors crops can be divided into two stages based on an application concept in Figure 3 as follows:

- Cultivation/harvesting stage: A high functional and pro-environmental support technology is important like a growth management and damage prevention support, a productivity and quality prediction. And also, the standard technology development centralizing harvesting high-quality crops, prevention of damage;
- Processing/distribution stage: An integration control technology of production, processing and distribution is important like stability, pro-environment and freshness authentication and tracking.

And also, the standard technology development related in freshness, stability maintenance and value added improvement is in a process of processing and distribution[3,9].

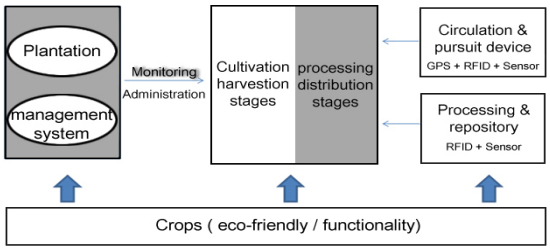

Fig. 3 Configuration of stages for ICT convergence with outdoors farming

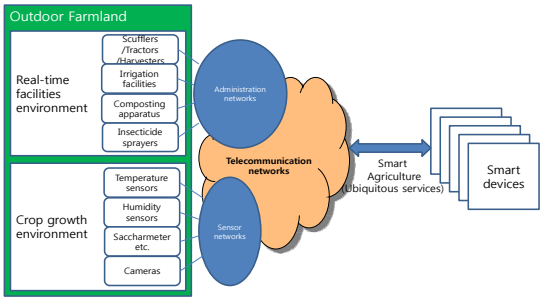

Fig. 4 ICT convergence with outdoors farming based on Networks

3.2. Requirements for ICT convergence with greenhouse farming

As an application concept of IT convergence technology about greenhouse farming, the Figure 5 offers technology as follows, through installed sensors and networks:[8,9].

- Monitoring a change of facility environment in real-time
- Offering the most suitable information of the quality of crops by analyzing synthetically the observation of crops change, growth condition, and environment information.
- Organically control facility environment according to a growth level of crops and a change of environment.

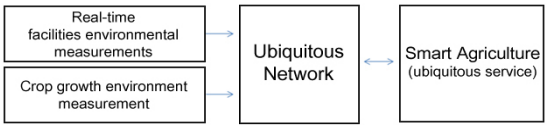

Fig. 5 Configuration for ICT convergence with greenhouse farming

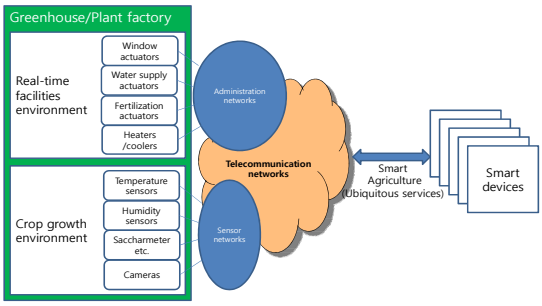

Fig. 6 ICT convergence with greenhouse farming based on Networks

3.3. Requirements for ICT convergence with plant factory

Required features in a plant factory consist of devices related in energy, harvesting device, a light source, environment control, and etc. for a plant factory interior, and a wide area of interfaces between database and a plant factory for related control information can be divided according to ICT fields. Requirement profile for environment control and monitoring system in plant factory are shown in the Figure 6[3].

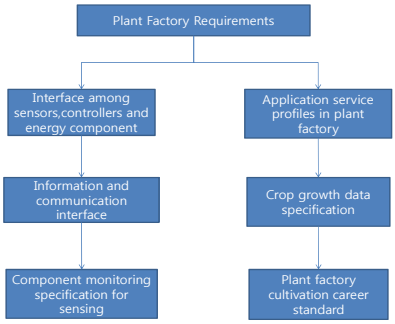

Fig. 7 Plant factory requirements according to ICT fields.

Ⅳ. Network capabilities for Smart farming based on networks

The high-level capabilities for the support of Smart Farming are listed as follows:[9,10].

- Connecting to anything capabilities: The capabilities of "connecting to anything" refer to the support of the

different ubiquitous networking communication types(person-to-person communication, person-to-object communication, and object-to-object communication) and include the support of tag-based devices (e.g., RFID) and sensor devices. Identification, naming, and addressing capabilities are essential for supporting "connecting to anything".

- Open web-based service environment capabilities: Emerging ubiquitous services/applications will be) rovided based upon an open web-based service environment as well as on legacy telecommunication and broadcasting services. In particular, application programming interface (API) and web with dynamics and interactivities will be supported. Such a web-based service environment will allow not only the creation of retail community-type services but also the building of an open service platform environment which third-party application developers can access to launch their own applications. Using interactive, collaborative and customizable features, the web can provide rich user experiences and new business opportunities for the provision of ubiquitous networking services and applications.
- Context-awareness and seamlessness capabilities: Context-aware means the ability to detect changes in the status of objects. Intelligence systems associated with this capability can help to provide the best service which meets the situation using user and environmental status recognition. Seamlessness is a key capability for "5Any" (i.e., anytime, anywhere, any service, any network, and any object).
- Multi-networking capabilities: Transport stratum needs multi-networking capabilities in order to simultaneously support unicast/multicast, multi-homing, and multi-path, etc. Because of high traffic volume and the number of receivers, ubiquitous networking requires multicast transport capability for resource efficiency. Multi-homing enables the device to be always best connected using multiple network interfaces including different fixed/mobile access technologies. These capabilities can improve network reliability and guarantee continuous connectivity with desirable QoS through redundancy and fault tolerance.
- End-to-end connectivity over interconnected networks: For Smart Farming, it is critical to develop the solution to provide end-to-end connectivity to all objects over interconnected heterogeneous networks such as NGN, other IP-based networks, broadcasting networks, mobile/wireless networks, PSTN/ISDN, etc. IPv6, with its large address space, can be considered a good candidate for providing globally unique addresses to objects.

Ⅴ. Conclusions

In this paper, we analyzed that standard reference model for Smart Farming based on networks. And also, described service requirements and network capabilities for Smart Farming infrastructure applications. A survey on the standardized points around Smart Farming based on networks is given in this paper. The standardization work for Smart Farming based on networks is just at the beginning stage. Hence, more studies on each point are required to finish the works including amendments and enhancements. More interests are expected to attain the successful results that ultimately contribute to innovate in the lifestyle.

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REFERENCES

[1] Dongbu IT Company, *Dongbu-Hannong Chemicals, UCT*. 2005. USN based Cultivation Environment Monitoring System for Improving Groceries Quality. pp.1-15.

[2] Yoo, N.H. 2009. Design and Implementation of the Management System of Cultivation and Tracking for Agricutural Products using USN. *J. KIISE: Computing Practices and Letters*. 15(9):661-6741.

[3] Se-Han Kim, et. al., Standardization Trend of - Technology in Korea, *IT Convergence and Services Lecture Notes in Electrical Engineering* Volume 107, 2011, pp 265-274.

[4] TD55-Y.ufnsc, ITU-T SG13, Revised text of the draft Recommendation "Overview of Smart Farming based on networks, Jun. 2013.

[5] TD345, WP1/13, Functional model for production service of Smart Farming. (Y.psf). 2015.

[6] Recommendation ITU-T Y.2201, Requirements and capabilities for ITU-T NGN, Sept. 2009.

[7] [ITU-T Y.2002] ITU-T Recommendation Y.2002 (2009), Overview of ubiquitous networking and of its support in NGN.

[8] [ITU-T Y.2011] ITU-T Recommendation Y.2011 (10/2004), General principles and general reference model for Next Generation Networks

[9] [ITU-T Y Supplement3] ITU-T Y.2000 series Series Y Supplement3(01/2008), Supplement on service scenarios for convergence services in a multiple network and application service provider environment.

[10] [ITU-T Y.2060(06/2012)] ITU-T Y.2060(06/2012), Overview of the Internet of things

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