Agricultural Knowledge Transfer Via Talking Planter

Yosei Isoe
Graduate School of Science and Engineering
Ritsumeikan University
Shiga, JAPAN
cc001071@ed.ritsumei.ac.jp

Yoshio Nakatani
College of Information Science and Engineering
Ritsumeikan University
Shiga, JAPAN
nakatani@is.ritsumei.ac.jp

***Abstract*—The succession of agricultural knowledge has recently grown in importance because of a decrease in the number of agricultural workers in Japan. To aid in solving that problem, this study suggests a framework for use in the succession of agricultural knowledge via a system. More concretely, it involves a method that planter communicates with users and other planters. The content of the communication includes failure information, which has been confirmed to be effective in a previous study.**

Keywords- Knowledge transfer; agriculture; tacit knowledge; explicit knowledge; SECI model.

I. INTRODUCTION

Knowledge Transfer is currently a very important theme and it has been gaining a great deal of attention. The transfer of knowledge issue is being tackled in a variety of scenes, for example, system engineering, artificial intelligence, and so on. However, these approaches involve a number of problems.

This particular research tackles the problem of transferring agricultural knowledge. Agriculture does not involve any corporatization and hence has typically been communicated from parents to their children or person to person over long periods of time. In recent years, however, the number of people who have been changing jobs from corporate employees to farmers has been increasing. As a result, the need for agricultural knowledge to be transferred to them has increased as well. In addition, with the increase of home gardens allowing crops to grow, gardening boom have taken place among young people, and the need for agricultural knowledge to be transferred to them is also increasing[3]. However, as lacking of experience, the transfer of newly increased agricultural knowledge has been taken place via the trial and error process until now. Recently, the possibility of knowledge being shared on a global scale through the new ubiquitous network society has also risen. This study suggests a framework by which novice agricultural workers can access to the knowledge of experienced agricultural workers via the network mentioned above. This study uses, in particular, knowledge gained from past failures and provided by the planters and novice agricultural workers can then share that knowledge. Through the conversation with planters, the novice agricultural workers can gain the knowledge while they are doing the agricultural work. There have been a number of studies and support systems on enabling objects to provide information to the user but this study suggests a new support system specifically concerning the transfer of agricultural knowledge.

Section 2 explains about associated concept of this study. Then, we introduce the previous study in Section 3. Finally, we explain the proposed system in Section 4, and present conclusion and future works in Section 5.

II. ASSOCIATED CONCEPT

A. *Tacit knowledge*

Nonaka defined tacit knowledge to be "knowledge gained from individual experiences or specific situations, which can include intangible elements such as beliefs, views, value systems, and so on" [4]. This concept was a refinement of Michael Polanyi's concept of tacit knowledge [5]. Agricultural knowledge regarding the necessary chores, know-how, and experience gained from failures could be classified as tacit knowledge.

B. *SECI model*

The SECI model was defined by Nonaka and Takeuchi as a knowledge acquisition process used to share tacit knowledge inside a company. This model repeats 4 processes, which are given below.

i . Tacit to Tacit (Socialization)
ii . Tacit to Explicit (Externalization)
iii . Explicit to Explicit (Combination)
iv . Explicit to Tacit (Internalization)

Figure 1 shows the flow of the SECI model.

 ISBN: 978-1-61208-163-2

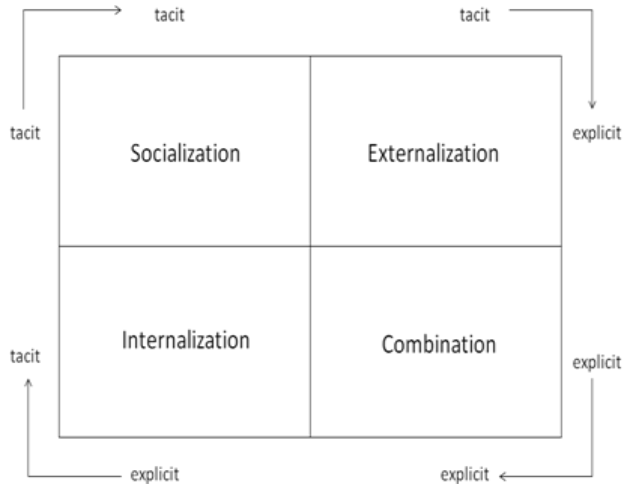

Fig.1 Flow of SECI model

These four processes lead to the creation of new knowledge. The succession of agricultural knowledge can also be classified into the four steps of the SECI model, with examples of each step being as follows.

i . Socialization

Novice agricultural workers work together with experienced agricultural workers. Novice agricultural workers can thus observe them, and then imitate them, learn the techniques of experienced agricultural workers.

ii . Externalization

Novice agricultural workers and experienced agricultural workers note down what they have noticed during agricultural work.

iii . Combination

Novice agricultural workers summarize what they have noted down. In addition, novice agricultural workers also transcribe what was noted down by experienced agricultural workers.

iv . Internalization

Novice agricultural workers work alone without the help of the experienced agricultural workers.

Several studies have been made on transferring knowledge using the SECI model, but have been inadequate. Examples include a "Knowledge Management Support System That Uses Fond Memories in Peer Support Communities of Universities" [6] and "Supporting Knowledge Transfers and Task Scheduling via Use of Ontology" [7]. Some research has also taken place on supporting agriculture. However, there has been almost none on support from the aspect of "Objects that can provide information to people".

III. PREVIOUS STUDY

A. Agricultural Knowledge Transfer

This research is based on the previous research called "Agricultural Knowledge Transfer Based on Experience from Failures" [8]. The previous study supports the transfer of the knowledge that should be transferred as the failure experience through the SECI model. The four processes of the SECI model were used in the system as follows.

STEP1: Socialization

Novice agricultural workers learn the experience gained in failure using the system.

STEP2: Externalization

Experienced agricultural workers or novice agricultural workers with experience gained from failures input the experience they gained from failures into the system.

STEP3: Combination

The rules are made according the failure experience and the time and stored in the system. The system then informs novice agricultural workers using those rules.

STEP4: Internalization

Novice agricultural workers carry out the actual work using the above rules or their own thinking.

The transfer of knowledge has been attempted by repeating the above 4 steps according to the SECI model.

B. System Construction of Previous Study

The flow of the system involves 5 main functions, with an explanation on each and the corresponding SECI model process being given below.

i. Retrieval Failure Experience function (Socialization)
ii. Recommendation of Relevant Failure Experience function (Socialization)
iii. Registration of Failure Experience function (Externalization)
iv. Make rules function (Combination)
v. Information function (Combination)

The system does not actually implement Internalization of the SECI model and instead, novice agricultural workers have to select the right choice before doing the actual work, which therefore plays the role of Internalization in the SECI model.

Figure 2 shows an image of the system and Figure 3 is the main screen of the previous system.

 ISBN: 978-1-61208-163-2

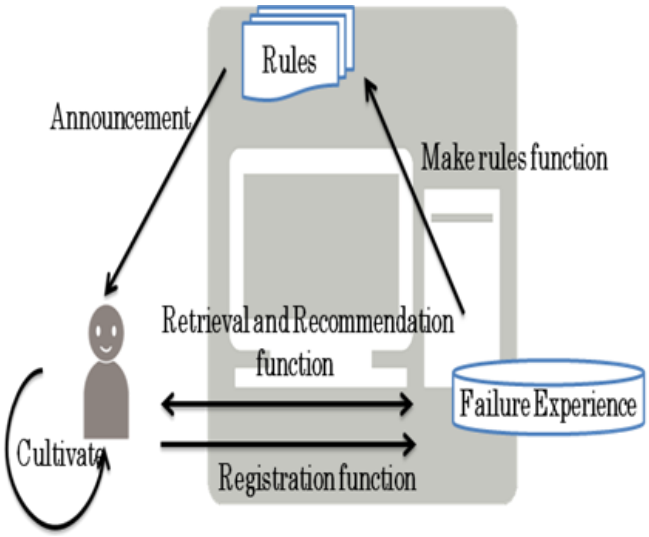

Fig. 2 Image of the previous system

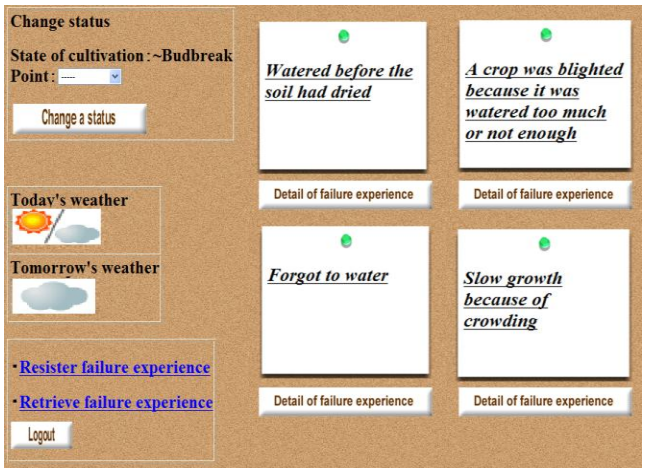

Fig.3 Main screen of the previous system

C. *Evaluation of Previous Study*

The previous study was evaluated using the system. The purpose is confirming whether the subjects did actually learn from experienced agriculture workers and their own experiences. In addition, the system also confirms whether or not the subjects were able to gain individual knowledge. The evaluation involved the method of cultivation being classified into 3 patterns, the results of which were then compared. The 3 patterns were as below.

i. Pattern where nothing was utilized
ii. Pattern where a manual was utilized
iii. Pattern where this system was utilized

The subjects cultivated Mizuna for a month, then they were interviewed, and the results of the 3 patterns were then compared.

D. *Experimental subjects*

Before the evaluation the subjects were provided with a questionnaire on their knowledge of agriculture, with 29 university students from the Social Communication Laboratory completing the questionnaire forms. 6 of the subjects that gave the same answers in the questionnaire were then selected as it was assumed that their knowledge of agriculture would be approximately the same. Table 1 shows the assignment of the method of cultivation.

TABLE I. ASSIGNMENT OF METHOD OF CULTIVATION

	Group A	Group B
Use nothing at all	Subject K	Subject T
Use a manual	Subject I	Subject H
Use the system	Subject O	Subject Y

E. *Results of interviews*

The results of interviews were classified into three different types of knowledge and experience as below.

i . Knowledge the subjects learned from the system or a manual
ii . Knowledge the subjects learned via experience
iii . Chores the subjects experienced

Some of the results of the interviews are given below, and are based on the above classification. Table 2 shows the results of "Pattern where nothing was utilized", Table 3 "Pattern where a manual was utilized", and Table 4 "Pattern where this system was utilized".

TABLE II. RESULT OF "PATTERN WHERE NOTHING WAS UTILIZED"

< Knowledge the subjects learned from the system or a manual>
Nothing in particular
< Knowledge the subjects learned via experience >
Don't plant too many seeds at one time
< Choices the subjects experienced >
Plant a little less seeds
Water the crop everyday
Water the crop using a glass container and tap

TABLE III. RESULT OF "PATTERN WHERE A MANUAL WAS UTILIZED"

< Knowledge the subjects learned from the system or a manual>
Water the crops carefully
Don't overwater
< Knowledge the subjects learned via experience >
Nothing in particular

 ISBN: 978-1-61208-163-2

< Choices the subjects experienced >
Plant seeds in a line
Water the crop carefully
Water the crop using the right amount

TABLE IV. RESULTS OF "PATTERN WHERE THIS SYSTEM WAS UTILIZED"

< Knowledge the subjects learned from the system or a manual>
Narrowly-spaced planting results in slow growth
The crop can be blighted because of being watered too many times or not watered enough
< Knowledge the subjects learned via experience >
Mizuna seeds are very small
Take care not to plant seeds too close to each other
Mizuna leaves are not very big
< Choices the subjects experienced >
Plant seeds with appropriate spacing
Don't plant one seed per space but instead two

The results led to the following discoveries:

<Pattern where nothing was utilized>
Subjects experienced gaining knowledge from experience.

<Pattern where a manual was utilized>
Subjects experienced gaining knowledge from the system or a manual.

<Pattern where the system was utilized>
Subjects gained knowledge not only from the system or a manual but also actual experience.

The traditional transfer of agricultural knowledge has involved the method that experienced agriculture workers provide novice agriculture workers with knowledge and experience, and the novice agriculture workers then gain individual knowledge via actual experience. These steps are typically used to transfer agricultural knowledge. The pattern that uses the system is thus fairly similar to these steps when compared to the other 2 patterns.

The system can therefore be used to efficiently transfer agricultural knowledge.

F. Problems

In the previous study, transferring agricultural knowledge has been proved to be effective through the use of failure experience and the SECI model. However, agricultural work is assumed to be done after referring the failure experience information in front of a computer. In the succession of agricultural knowledge, it is typical that the knowledge is shared and exchanged between people. Using the system via a computer therefore appears slightly unnatural and using the computer and doing the agricultural work will be recognized as two no-related things. Moreover, it will be difficult for users to relate knowledge acquired during agricultural work to knowledge acquired from the system because they would appear to be separated processes. This study therefore suggests a framework that users can use to help succeed agricultural knowledge face-to-face during actual agricultural work.

IV. PROPOSED SYSTEM

A. Media Equation

The Media Equation involves a "Person corresponding unconsciously and socially to the treatment of an object" [9]. This suggests that user can treat object in the same way as treating a person.

Example of study by using Media Equation include a "Clothes Which Propose Fashion Coordinate Based on the Previous Experience"[10]. This study uses that theory in aspiring to aid in knowledge transfers.

B. Approach of the system

This study attempts to rectify problems in the previous study through a "Media Equation". In addition, this study suggests a framework to help user gain knowledge with the same feeling as when the user work with a real person. The method "a planter provides information while talking to the user during agricultural work", in particular, is used. This results the user feeling that they are working together with another person, because, the planter provides a form of communication. In addition, the user can do according to the information provided by the planter. Thus, the user can learn know-how from the planter and do the agricultural work at the same time.

C. Summary of the system

In this study, the planter used grows crops while managing all the crops through communicating with the user. The user can thereby decide what to do in the next step by communicating with the manager planter.

This study mainly involves three conditions wherein the planter communicates.

i. The same work as the failure experience of another person.
ii. The same work as the failure experience of user.
iii. The different planter with the planter the user works with.

In pattern i, the planter tell user about the failure possibility according to the failure experience of the other worker. The same as pattern i, in pattern ii, the planter also talk to users about the possible failure. In pattern iii, the different planters communicate with each other, because, the agricultural work with each planter differs. In any other situation, the planter communicates if the content of the agricultural work is somewhat irregular, for example, the work of the day before and the work that the day greatly differs.

 ISBN: 978-1-61208-163-2

The system using various sensors to recognizes the type of agricultural work. For example, a sensor can be installed to measure the volume of water and another sensor to monitor the temperature.

Users can thereby obtain and share knowledge during agricultural work via communicating with the planters. Figure 4 shows an image of the system and Figure 5 shows the composition of the system.

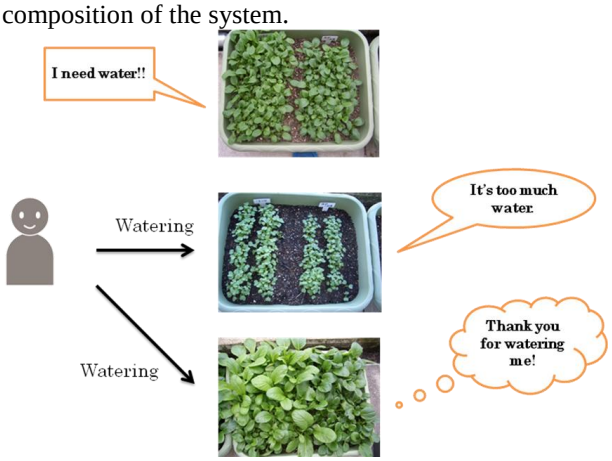

Fig. 4 Image of this system

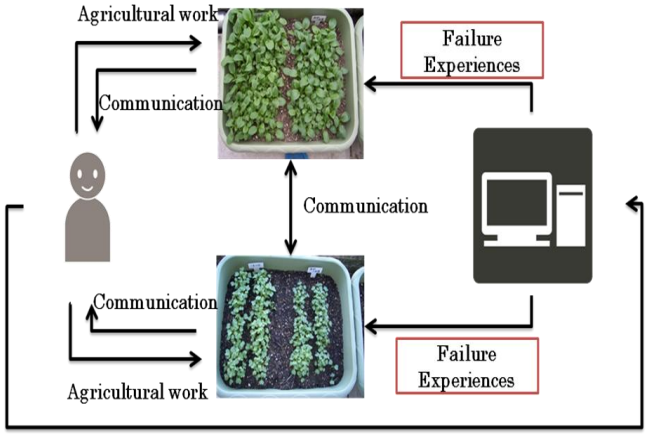

Fig. 5 Composition of this system

V. CONCLUSION AND FUTURE WORK

This paper suggested a framework to help the transfer of agricultural knowledge via communication with the planters. And a prototype is under development according the method mentioned in the study. Especially the "watering" is an essential part in agricultural work and this part will also be develop in this study. In the next step, add the possibility of choose a crop and state of cultivation and collect failure experiences. Moreover, the system will be evaluated and the efficiency of the method be confirmed.

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