Supporting ubiquitous language learning with RFID tags

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Abstract: Ubiquitous computing will help in the organization and mediation of social interactions wherever and whenever these situations might occur. With those technologies, learning environment can be embedded in real daily life. Especially, RFID (Radio Frequency Identification) tags are very useful and important technology to realize ubiquitous computing, because they are able to bridge real objects and information in a virtual world. RFID tags will be embedded in a lot of physical objects in the near future in order to trace products shipping, and so forth. Also, this paper proposes a computer-assisted language learning (CALL) using RFID tags, which is called TANGO (Tag Added learNinG Objects).TANGO detects the objects around the learner using RFID tags, and asks the learner appropriate questions for vocabulary learning in daily life with PDA. There are two different kinds of users of this system: one of them is an overseas University Student in Japan, who wants to learn Japanese Language; the other is a Japanese Student who is interested in English as a second language and plays an important role as a helper for the overseas student. They can share their knowledge through RFID tags and learn language with authentic and tangible objects. In the experiment conducted, the learners were very interested in this system.

Keywords: Computer Supported Ubiquitous Learning, Mobile Learning, Pervasive Learning, Computer Assisted Language Learning, Vocabulary Learning, and RFID tag.

1. INTRODUCTION

Ubiquitous computing (Abowd and Mynatt, 2000) will help organize and mediate social interactions wherever and whenever these situations might occur (Lyytinen and Yoo, 2002). Its evolution has recently been accelerated by improved wireless telecommunications capabilities, open networks, continued increases in computing power, improved battery technology, and the emergence of flexible software architectures. With those technologies, an individual learning environment can be embedded in real everyday life.

The main characteristics of CSUL are shown as follows (Chen et al., 2002; Curtis et al., 2002):

a) Permanency: Learners never lose their work unless it is purposefully deleted. In addition, all the learning processes are recorded continuously everyday.
b) Accessibility: Learners have access to their documents, data, or videos from anywhere. That information is provided based on their requests. Therefore, the learning involved is self-directed.
c) Immediacy: Wherever learners are, they can get any information immediately. Thus, learners can solve problems quickly. Otherwise, the learner can record the questions and look for the answer later.
d) Interactivity: Learners can interact with experts, teachers, or peers in the form of synchronous or asynchronous communication. Hence, the experts are more reachable and the knowledge becomes more available.
e) Situating of instructional activities: The learning could be embedded in our daily life. The problems encountered as well as the knowledge required are all presented in their natural and authentic forms. This helps learners notice the features of problem situations that make particular actions relevant.

Moreover, ubiquitous learning can be Computer Supported Collaborative Learning (CSCL) (O’Malley, 1994) environments that focus on the socio-cognitive process of social knowledge building and sharing.

One of the important ubiquitous computing technologies is RFID (radio frequency identification) tag, which is a rewritable IC memory with non-contact communication facility. This tag is going to replace the barcode. The features of RFID tag are as follows:

(1) Non line-of-sight reading: RFID is not necessary for line-of-sight reading like a bar code. In addition, the range of distance for RFID reader is longer than bar code scan. For example, the

(2) Multiple tag reading: Unlike a bar code reader, RFID unit can read multiple tags at the same time. This feature enables counting the number of objects in a second. That is the reason one of the key applications of RFID is supply-chain management.

(3) Data rewritable: RFID has a memory chip that can be rewritten using an RFID unit. In the mean time, the data of bar code is not changeable.

(4) High durability: Tags are very sturdy from vibrations, contamination (dust and dirt), and abrasion (wear). Hence, tags can be permanently used.

(5) Ease of maintenance: There are two types of RFID tags. One is passive, which is without any battery. The power comes from the reader unit. Therefore, passive tags can be used permanently. The other one is active, which contains batteries and has a longer range than passive ones.

We assume that almost all the products will be attached with RFID tags in the near future and that we will be able to learn at anytime at anyplace from every object by scanning its RFID tag. For example, we can get educational information on goods in stores and also on books in libraries.

This paper proposes TANGO (Tag Added learNinG Objects) System for vocabulary learning. At the beginner's class of language learning, a label that is written with the name of the object is stuck on the corresponding object in a room in order to remind learners about the word. The idea of this system is that the learner sticks RFID (Radio Frequency Identification) tags on real objects instead of sticky labels, annotate them (e.g., questions and answers), and share them among other learners. The tags bridge authentic objects and their information in the virtual world. TANGO system detects the objects around the learner using RFID tags, and provides the learner with the right information in that context.

2. CSUL: COMPUTER SUPPORTED UBIQUITOUS LEARNING

2.1 What is CSUL?

CSUL (Computer Supported Ubiquitous Learning) is defined as a ubiquitous learning environment that is supported by embedded and invisible computers in everyday life. Figure 1 shows the comparison of four learning environments according to(Lyytinen and Yoo, 2002). The CAL (computer assisted learning) systems using desktop computers are not embedded in the real world, and are difficult to move. Therefore, those systems hardly support learning at anytime and anywhere.

Compared with desktop computer assisted learning, mobile learning is fundamentally about increasing learners' capability to physically move their own learning environment with them. Mobile learning is implemented with lightweight devices such as PDA (Personal Digital Assistant), cellular mobile phones, and so on. Those mobile devices can connect to the Internet with wireless communication technologies, and enable the learning at anytime and anywhere. In this situation, however, computers are not embedded in the learner's surrounding environment, and they cannot seamlessly and flexibly obtain information about the context of his/her learning.

In pervasive learning, computers can obtain information about the context of learning from the learning environment where small devices such as sensors, pads, badges, and so on, are embedded and communicate mutually. Pervasive learning environments can be built either by embedding models of a specific environment into dedicated computers, or by building generic capabilities using computers to inquire, detect, explore, and dynamically build models of the environments. However, this makes availability and usefulness of pervasive learning limited and highly localized.

Finally, ubiquitous learning has integrated high mobility with pervasive learning environments. While the learner is moving with his/her mobile device, the system dynamically supports his/her learning by communicating with embedded computers in the environment. As for the broad definition of ubiquitous learning, both pervasive learning and mobile learning would be in the category of ubiquitous learning. RFID tags are often used to realize pervasive computing.

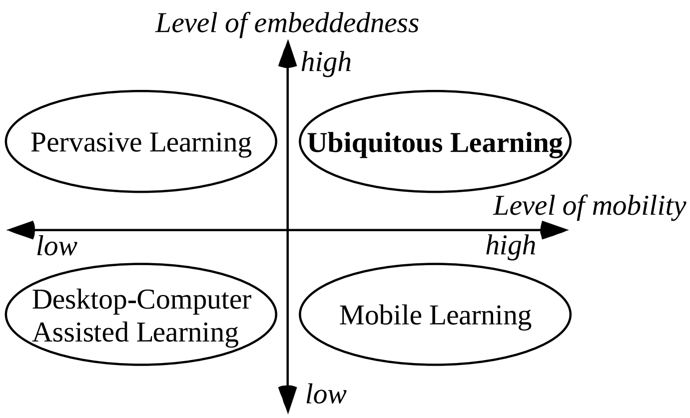

Figure 1: Ubiquitous learning. (Based on (Lyytinen and Yoo, 2002))

2.2 Learning Theories for CSUL

CSUL is advocated by pedagogical theories such as on-demand learning, hands-on or minds-on learning, and authentic learning (Ogata and Yano, 2003; 2004). CSUL system provides learners on-demand information such as advices from teachers or experts at the spot at the precise moment they want to know something. Brown, Collins, and Duguid (1989) define authentic learning as coherent, meaningful, and purposeful activities. When the classroom activities are related to the real world, students receive great academic delights. There are four types of learning to ensure authentic learning: action, situated, incidental, and experimental learning.

Miller and Gildea (1987) worked on vocabulary teaching, and described how children are taught words from dictionary definitions and a few exemplary sentences. They have compared this method with the way vocabulary is normally learned outside school. People generally learn words in the context of ordinary communication. Therefore, we believe that it is very important to support vocabulary learning in everyday life with ubiquitous computing technologies.

3. TANGO

We have developed the prototype system called TANGO, which works on a Toshiba Genio-e with Pocket PC 2002, RFID tag reader/writer (OMRON V720S-HMF01), and wireless LAN (IEEE 802.11b). RFID tag reader/writer is attached on a CF (Compact Flash) card slot of PDA as shown in Figure 2. The tag unit can read and write data into and from RFID tags within 5 cm distance, and it works with a wireless LAN at the same time. The TANGO program has been implemented with Embedded Visual Basic 3.0.

Figure 2: TANGO system.

3.1 Features

The features of TANGO system are:

(1) Vocabulary learning anyplace anytime: We assume that RFID tags will be attached with a lot of products in the future, e.g., food, closes, electronic appliance, and so forth. With those RFID tags, TANGO will enable people to learn vocabulary at anyplace at anytime.

(2) Authentic learning: TANGO uses real-world objects as learning materials and facilitates to link authentic objects to vocabulary. The system allows learners to feel and touch the real objects for better impact and increase in learning effectiveness.

(3) Collaborative learning through objects: TANGO facilitates to share knowledge about real-world objects with questions, answers and comments. This is a kind of collaborative learning because it is a meaning-making process for the objects.

(4) Media integrated learning: TANGO provides multi-media information such as text, voice, and video. The learners are able to confirm the pronunciation of the word object from the text written. Those data is linked to the real objects and enhances the understanding of the knowledge and the communication with other learners.

(5) Personalized learning: According to the learning records, TANGO asks suitable questions to the learner. For example, if the learner correctly answered a question about an object, TANGO will not ask him/her the same question. In addition, each question has different level of difficulties. TANGO provides questions according that level and the learner's level.

(6) Adaptive learning environment: Lerner's record will be created when the system is used. The questions asked will be based on 4 different levels according to the learner's history records.

(7) Game-based learning: TANGO is game-based where points are given when a questions are answered correctly and learners have to move around when using the system differentiates it from normal classroom learning.

3.2 System Configuration

TANGO has the following modules as shown in figure 3:

a) Learner model: This module has the learner's profile such as name, age, gender, occupation, interests, etc, and the comprehensive level of each word or each expression about an object. Before using TANGO, the learner does the examination, and enters the comprehensive level. In addition to this explicit method, TANGO detects learner's comprehension during the system use.

b) Environmental model: This module has the data of objects, rooms and buildings, and the link between objects and expressions in the learning materials database.

c) Educational model: This module manages words and expressions as learning materials. The teacher enters the fundamental expressions for each object. Then, both learners and teacher can add or modify them during system use.

d) Communication tool: This tool provides the users with a BBS (bulletin board system) and a chat tool, and stores their logs into a database.

e) Tag reader/writer: This module reads the ID from an RFID tag attached to an object. Referring to the ID in the object database, the system obtains the name of the object.

f) User interface: This module provides learner with questions and answers.

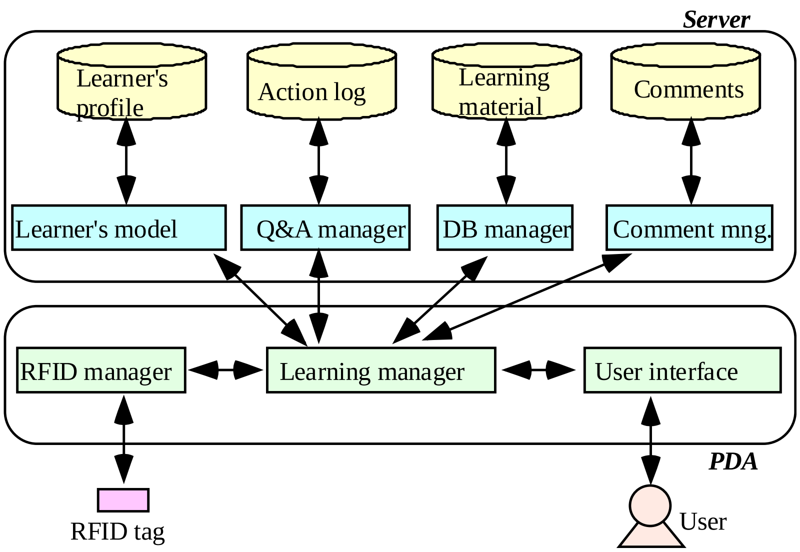

Figure 3: System configuration.

3.3 User Interface

There are 3 mains functions in the system. The interfaces of the learning environment TANGO are shown in Figure 4.

(1) Hint to questions: TANGO system asks the learner a question with voice. The adequate question is selected by scanning the RFID tags around the learner and using the learner model. If the learner cannot understand the question, the learner can listen again by clicking the button. Furthermore, if the learner cannot understand the question, the system can show the text of the question as a hint by clicking the “hint” button. By clicking the “read” button, the system begins to read a

tag. If the learner scans the correct tag, the answer is right. Then, the learner can move to the next question by pushing “next” button.

(2) Creation of new tags: As in Figure 4, anyone can create a new tag to an object. After the object is read into the system, its name, questions related to the object, level of difficulty can be registered into the system. Hence, items in daily life can be used directly as learning materials.

(3) Comments for objects: If the object has a comment, the “comment” button is active. The learner can also add comment by clicking the “add comment” button. The learner has RFID tags, can attach them on objects, and create a new question about the new object as shown in figure 3. In this way, learners can collaboratively learn language by sharing comments and tags.

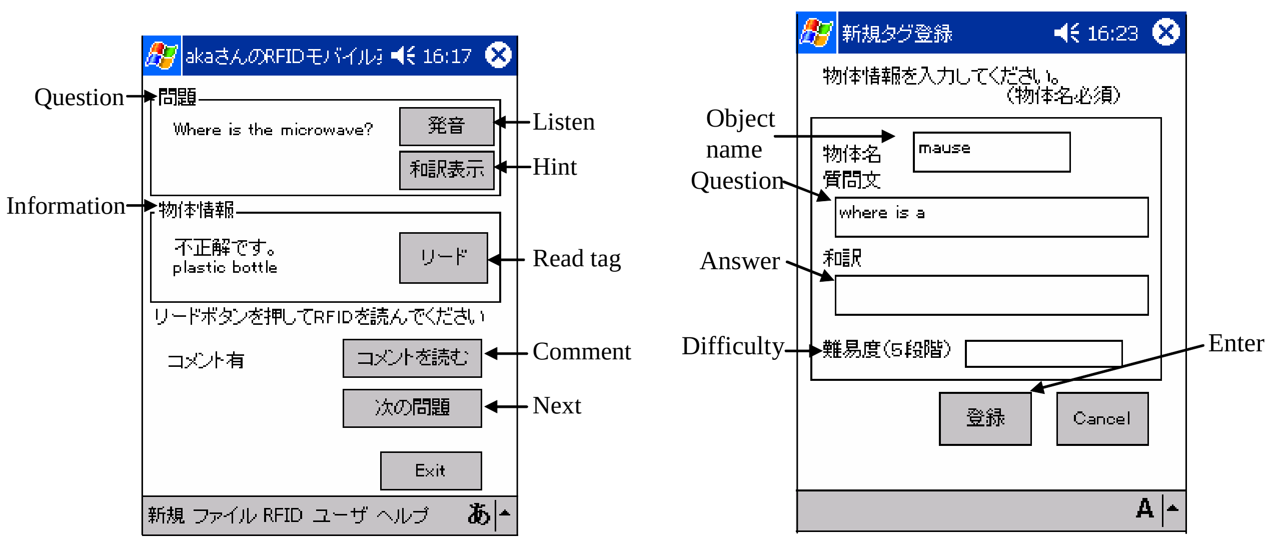

Figure 4: Main window and new-tag window of TANGO.

Figure 5 shows an example of a room where RFID tags were attached to some objects for TANGO. For example, when the learner enters a meeting room, the system asks him/her the question “Where is the remote control of the air conditioner?”. The learner can hear the question again if s/he wants. Moreover, the learner can see the text and hints. If the learner scans the tag labeled on the remote control, the answer is correct. Then the system will ask the learner to put it on the wooden desk. The interaction between the learner and the system goes on in this way.

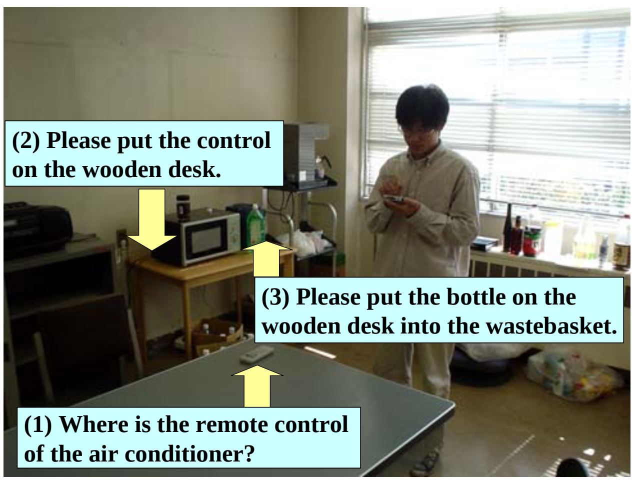

Figure 5: Usage example of TANGO.

4. EXPERIMENTATION

We had eight Japanese student and eight foreign students from our laboratory to evaluate the system. The Japanese students were arranged to use the system to learn English, while the foreign students were arranged to use the system to learn Japanese. The Japanese students consisted of six undergraduates and two masters students with an average age of 22.4 and average English education years of 9.8. As for the foreign students, they are four Dr Course students (one from Mexico, two from China, one from France) and four masters students (two from Mexico, two from China), with an average age of 26.1 and average Japanese education years of 2.2.

4.1 Method of Experimentation

The experiment was conducted over a period of two days. On the first day, the learners were asked to enter a room with 20 objects that are used in daily life such as heated plate, rice cooker, cardboard box, kettle, microwave etc, which they were usually using in their daily life. Twenty questions were prepared as shown in appendix 1. Each learner was given 20 minutes to use the system starting from reading the object's tag, answering the questions and giving comments. Due to unfamiliarity about the usage of PDA, learners were allowed to write their comments on post-it notes and stick it onto the objects (Figure 6). All comments and learning record was registered into the system.

On the second day of the experiment, from the record on the first day, the level of difficulty was determined. The learning was conducted by having the learners input additional comments and suggestions while repeating the same process as the first day.

4.2 Result and Observation

After the experiment, the users were asked to answer a questionnaire where a score between one and five to each of the nine questions is given, with one being the lowest, and five being the highest. Table 1 shows the results of the questionnaire. According to question (1), some of the users felt that the questions that the system asked were difficult. For question (2), the score was average for Japanese students but was more effective among foreign students. There were also comments that the revision that was conducted on the second day helped to increase their level of understanding. According to question (3), the comments were equally positive from both groups. There was also a comment to have the learners use a headphone when listening to the names of the objects for effectiveness. As in question (4), learners were able to identify the objects and its name using the system. According to question (5), the comment function was useful for the Japanese students but not that effective for foreign students due to some misunderstanding in terms of Japanese language related to English. From question (6), we also know that the system was effective to help learners to memorize names of objects. One of the learners commented that with this system, it was easy to understand the terms by corresponding with authentic objects. As for questions (7) and (8), we have comments stating that the system was interesting and they would like to use the system again. There were also comments that the system was built like a game that makes the learning enjoyable. Some learners commented that they had a feeling of achievement and excitement after using the system.

Besides the questions above, comments and feedback were also obtained from the learners. Some of the positive comments are as follow:

(1) Learning involving real objects was easily understood.

(2) Both the pronunciation and spelling of the object can be learned.

(3) Level of difficulty (pronunciation, text, meaning) created is useful for learning.

(4) Comment function is useful for interaction with other learners and convenient for asking questions.

From the above comments, we can say that the system was useful for learning language in real daily life. If the system is used frequently, the learners can spend lesser time to learn new words in classroom.

Some of the negative comments are as follow:

(1) There were only fixed pattern questions, so it would be better if questions were more application/ practical based.

(2) Only involved objects and names learning.

(3) Unable to see both English and Japanese at the same time.

(4) The answer was given immediately after the second hint was given.

(5) Foreign students have do not know the pronunciation of Kanji in Japanese language.

According to the first comment, the pattern of question is fixed as questions were only on "Where is …" and object names. Since both English and Japanese cannot be used at the same time, the interface will have to be changed. Some modifications will also have to be made to solve the problem in the fourth comment. As for the last comment, modifications will also have to be made when Kanji is used.

Table 1: The results of questionnaires (Ave (1) - for Japanese students; Ave (2)- foreign students).

No.	Questionnaire	Ave.(1)	Ave.(2)
Q1	Were the questions provided by this system difficult?	4.1	4.0
Q2	Do you think the level of difficulty was properly determined?	3.1	4.3
Q3	Was it easy to listen to the names of the objects using the PDA?	4.5	3.9
Q4	Were you able to identify the object and its names easily from the system?	4.4	3.8
Q5	Do you think the comment function is useful?	4.3	3.4
Q6	Do you think this system is useful for language learning?	4.4	4.1
Q7	Do you think that the system was easy to use?	4.5	4.8
Q8	Was the response speed of this system adequate for use?	4.8	4.5
Q9	Was the system interesting to be used?	4.4	4.5
Q10	Do you want to keep using this system?	4.3	4.4

Figure 6: Tango with PostIt (left), Tango without PostIt (right).

5. CONCLUSIONS

This paper described a computer-assisted language learning (CALL) in a ubiquitous computing environment. TANGO system detects the objects around the learner using RFID tags, and provides the learner with the educational information. In the experiment, the learner played the game of TANGO, and was very interested in this system. The implementation for TANGO is hoped to be spread not only to learn English or Japanese but also other languages such as Chinese or Spanish. The feedback from the evaluation will be used to improve the current system for ease of usability. RFID tag will be a very important element for the realization of a ubiquitous society especially with the advancement of memory storage, wireless technology and potential of programming languages and techniques. The TANGO system developed has utilized RFID because the future of RFID is unlimited and its usage will be embedded in various technologies and environments and is vital as a tool to aid in education and learning.

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Appendix 1:

Questions that were asked in the experimentation are follows:

1. Where is the cardboard box for bottles?
2. Where is the kettle made from metal?
3. Where is the microwave?
4. Where is the orange color shelf?
5. Where is the wet wipe?
6. Where is the bamboo chair?
7. Where is the remote control of the air conditioner?
8. Where is the black color CD boom box?
9. Where is the ladle?
10. Where is the lid for the pan?
11. Where is the crab-shaped chopping board?
12. Where is the wash stand (sink)?
13. Where is the copier?
14. Where is the heated plate?
15. Where is the plastic bottle of Chinese tea?
16. Where is the rice cooker?
17. Where is the barbeque sauce?
18. Where is the mirror?
19. Where is the wooden desk?
20. Where is the fabric chair?