Abstract

This paper describes the design and the use of computer supported ubiquitous learning environments. First, this paper mentions context-aware language-learning support systems for learning vocabularies, mimicry and onomatopoeia, polite expressions, and conversational expressions by leveraging PDA, GPS, RFID tags and sensor networks. Second, it describes a web-based video repository for sharing and retrieving learning experiences. This system was used in the scenarios of computer hardware assembling and cooking. Finally, the paper is ended with the discussions and future works.

1. Introduction

Context-aware computing [1] will help in the organization and mediation of social interactions wherever and whenever these contexts might occur. Its evolution has recently been accelerated by improved wireless telecommunications capabilities, open networks, continuous increase in computing power, improved battery technology, and the emergence of flexible software architectures. With those technologies, an individual learning environment can be embedded in daily real life.

Computer Supported Ubiquitous Learning (CSUL) has integrated high mobility with embedded computing environments [14] according to [11]. While the learner is moving with his/her mobile device, the system dynamically supports his/her learning by communicating with embedded computers and sensors in the real world.

The main characteristics of CSUL are shown as follows [14]:

1) Permanency: Learners never lose their work unless it is purposefully deleted. In addition, all the learning processes are recorded continuously every day.

2) 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.

3) 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.

4) Interactivity: Learners can interact with experts, teachers, or peers in the form of synchronies or asynchronous communication. Hence, the experts are more reachable and the knowledge becomes more available.

5) 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.

6) Authentic and learner-centered learning: CSUL is advocated by pedagogical theories such as on-demand learning, hands-on or minds-on learning, and authentic learning [3]. CSUL system provides learners on-demand information such as advice from teachers or experts at the spot at the precise moment they want to know something.

First, this paper focuses on CSCL for language learning because of the following reasons:

1) Language learning is life-long activity, and it needs to be supported by computers permanently.

2) Language learning takes place any time at any place. Therefore, learners need high accessibility to get information.

3) If learners have problems in conversations, they will need immediate help.

4) Learners need interactive support from experts or peers, because they have to explain the current situation.

5) Language learning is strongly influenced by situations.
We believe that language is mainly acquired through authentic learning. Miller and Gildea [12] worked on vocabulary teaching, and described how children are taught words from dictionary definitions and a few exemplary sentences. They learned lots of words outside school normally. Therefore, we believe that it is very important to support language learning in their everyday life with ubiquitous computing technologies.

Therefore, we have been investigating on computer supported ubiquitous language-learning environments. For example, we have developed

1. TANGO (Tag Added Learning Objects) [14] system to support vocabulary learning with RFID tags,
2. JAPELAS (Japanese Polite Expressions Learning Assisting System) [19] to support polite expressions,
3. JAMIOLAS (Japanese Mimicry and Onomatopoeia Learning Assisting System) [15] to support to learn mimicry and onomatopoeia with sensor networks.
4. LOCH (Language-learning Outside the Classroom with Handhelds) [5] system in order that overseas students can notify teachers their location and teachers can give location specific advice leveraging GPS, PDA and data communication card.

Second, this paper presents a video sharing system called LORAMS [16], which support to capture, share and retrieve learning experiences that happen at anytime and anyplace. Also PERKAM (Personalized Knowledge Awareness Map) [2] system is to support the learner with the Knowledge Awareness Map, which recommends peer helpers.

2. CSUL

CSUL (Computer Supported Ubiquitous Learning) is defined as a ubiquitous learning environment that is enhanced by embedded and mobile computers in everyday life. Figure 1 shows the comparison of four learning environments [14]. The CAL (Computer Assisted Learning) systems and ITSs (Intelligent Tutoring System) leveraging desktop computers are not embedded in the real world and difficult to move. Therefore, those systems hardly support learning at anytime and anywhere.

Compared with Desktop Computer Based Learning (DCBL), the concept of Computer Supported Mobile Learning (CSML) is to increase the learners’ capability to physically move their own learning environment. CSML uses lightweight devices such as PDA (Personal Digital Assistant), cellular mobile phones, and so on. Those mobile devices can connect to the Internet through wireless communication technologies that enable to learn at anytime and anywhere. For example, Houser and Thornton [7] developed an English text message system leveraging mobile phone. Uther et al [18] developed a mobile learning application for speech/audio language training. Also PhotoStudy [9] was developed in order to support vocabulary study with mobile phones. In addition, there are a lot of commercial products and Podcast contents to support mobile language learning. In this case, computers are not embedded in the learner’s surrounding environment, and they cannot seamlessly and automatically obtain information about the context of his learning. Therefore, they cannot provide suitable information for the learner’s context.

In Computer Supported Pervasive Learning (CSPL), computers can obtain information about the context of the learning from the learning environment where small devices such as sensors, pads, badges, RFID tags and so on, are embedded and communicate mutually. CSPL environments can be built either by embedding models of a specific environment into dedicated computers, or by building generic capabilities with computers to inquire, detect, explore, and dynamically build models of the environments. NIMES (Networked Interactive Media in Schools) project [10] is one of the examples of CSPL environments. The aim of this project is to support classroom activities by leveraging embedded computers in the classroom, e.g., on students’ desks and on black boards. However, the availability and the usefulness of CSPL are limited and highly localized.

Finally, CSUL has integrated high mobility with pervasive learning environments. While the learner is moving with his mobile device, the system dynamically supports his learning by communicating with embedded computers in the environment. TANGO is one of CSUL environments. This system allows learners to move with their PDAs and to communicate with the surrounding objects through RFID tags. Also RFID tags are used in museums[8]. As for the broad definition of CSUL, it includes both CSPL and CSML.

![Figure 1: Classification of the learning environments.](source)

In terms of human computer interaction, the challenge in an information-rich world is not only to
make information available to people at any time, at any place, and in any form, but specifically to say the right thing at the right time at the right place in the right way [4]. Therefore, CSUL environment should provide learners the right educational materials at the right time at the right place in the right way.

3. CSUL for language learning

3.1 LOCH

LOCH (Language-learning Outside the Classroom with Handhelds) system [5] has been developed in order that overseas students can notify teachers their location and teachers can give location specific advice using GPS, PDA and data communication card. This system is a specific application to support language learning and supports the following processes:

1. Enhancing the applicability of the sentences that students learnt during the course;
2. Learning on-site Japanese language in real life situations such as in a shopping market;
3. Learning local Japanese language and culture though the conversation with local Japanese people;
4. Sharing strategies and knowledge to solve problems when overseas students face.

Using the provided interfaces, the teacher assigns tasks to the students to go around the town, interact with native speakers and bring back their findings and/or questions.

Teachers give overseas students the following tasks in a meeting room at the beginning of the one day trip (figure 2 (1)):

1. Interview with a person: Students go to an office and make an interview with a person in Japanese for ten minutes or so. The mission is recording the interview and taking a picture of the person with PDA. For example, a student goes to the dean’s office and interview with him
2. Gather information: The mission is going to the specific location and getting information. For example, student goes to the bicycle-parking space at the station, and asks the staff about the fee, business hours, the number of the parking lots, etc.
3. Buy something local: For example, student goes to the super market, buy “fish sausage” and asks how to make it.
4. Have an experience: For example, the mission was going to the University health center and take blood pressure.

By carrying out those tasks, we expect overseas students to enhancing the communication skill in Japanese, and to perceive the local culture such as foods, activities, etc. Students can make use of their PDAs for writing down annotations, recording questions, taking pictures and reporting back to the teacher (figure 2 (2)). At anytime, the teacher is monitoring the position of the students on the map and can establish communication with them, either through instant messaging or BBS (bulletin board system) (figure 2 (3)). Then, the teacher guides the students through the task activities, giving suggestions or hints (such as “Ask somebody how to get there” or “You have to find the post office first”). After finishing the task, the teacher gives the student another task according to the student’s language skill, the location and the remaining time.

After all the students conclude their tasks, they meet together at the classroom, which is equipped with a smart board and where the teacher has been following their advances (figure 2 (4)). All the gathered information is displayed and discussed, and each student explains his/her strategies to the rest of the group. Similar situations are identified, and their solutions are shared under the guidance of the teacher. Also, the teachers link the problems and the knowledge that they taught during the course. This is a kind of “seamless learning”, where students can seamlessly learn Japanese language not only inside the classroom but also outside the classroom.

Certainly, this approach contributes with a better insight of the foreign students during their daily life in Japan. There are a myriad of expressions that students are unfamiliar with, and the purpose of the teacher is to give them the tools to respond and behave according to the situation. Furthermore, students are encouraged to go around because the usage of mobile devices seems new and interesting, and they have the assurance that the teacher can be immediately reached in case something goes wrong.
3.2 JAMIOLAS

Japanese language is very rich in mimicry and onomatopoeia (MIO) words. Mimicry words are imitating situations and body movements. For example, “uro uro suru” means walking around aimlessly. Onomatopoeia shows sounds of something, e.g., animals, natural phenomena, etc. For example, “gaya gaya suru” means a very noisy situation. Japanese language has over 2,000 MIO words in total. If students can use these expressions correctly, their conversation will be more rich, natural, and emotional. For example, MIO words are often used in word balloons in Japanese cartoons, “Manga.” In addition, those words are much related to Japanese culture itself. Therefore, learning MIO words are very useful not only to have rich communication with Japanese native speakers, but also to understand Japanese culture.

Generally, four skills (reading, writing, hearing, and speaking) are main objectives in language learning. Because time is limited in Japanese language learning course for overseas students, only a few onomatopoeia words could be taught. Therefore, students have to acquire more words in their daily life. However, it is very difficult to learn those words because the expressions vary according to the situation. If the expressions are not used properly, they might sound comical and strange. Moreover, it might lead to misunderstanding in conversation. Therefore, it is very important for foreigners to have the solid understanding of the situation.

The usage of MIO words depends on the situation where the speaker is. Therefore, JAMIOLAS[15] has been developed to support learning MIO words using sensors, which detects the speaker’s situation. Phidgets[9] sensors and ZigBee sensor network are used because it is easy to connect to PC and to control with program languages.

3.3 TANGO

TANGO (Tag Added Learning Objects) system helps a learner to memorize foreign language vocabularies, which detects the objects around the learner using RFID tags, and provides the learner with the right information in that context [14]. Figure 5 shows an example of an educational environment.
Where RFID tags are attached to almost all real objects. When the learner enters a room with his PDA, the TANGO system detects the learner’s location by reading the location RFID tag, and asks him some questions based on the available real objects and the learner’s model. For example, the system asks the following question “Where is the remote control of the air conditioner?” If the learner cannot recognize the voice, the system shows the question as a text. If the learner scans the tag attached to the remote control, the answer will be 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 scene of TANGO.**

### 3.4 JAPELAS

It is very difficult for overseas students to learn Japanese polite expressions because the expressions change in complicated way according to the context, e.g. hyponymy, social distance, and the formality of conversation scenes. Moreover, the feeling of social distance in Japan often varies from that in a learner's country. This difference may result in misunderstanding for the overseas students. Therefore, it is very important for the learners to learn the social situation in Japan, and to use polite expressions properly accordingly. We have implemented a PDA (Personal digital Assistant)-based language-learning support system for Japanese polite expressions learning, which is called JAPELAS (Japanese polite expressions learning assisting system)[19].

Figure 6 shows a scene of learning polite expressions with JAPELAS. Every user has a PDA and inputs his in-formation into the database, e.g., name, grade, age etc. When Mr. X talks to Mr. Z, the system tells Mr. X a casual expression. That is because Mr. X is older than Mr. Z. On the other hand, when Mr. X turns to Mr. Y in order to talk, the system tells Mr. X a formal expression. That is because the year of Mr. X is lower than the year of Mr. Y. The system detects the location by scanning a RFID tag. If the room is not a lab room but a formal meeting room, the system recommends the learner to use formal expressions for everyone.

**Figure 6: Usage scene of JAPELAS.**

### 4. Share and reuse learning experiences

The fundamental issues in ubiquitous learning are (1) how to capture and share learning experiences that happen at anytime and anyplace; and (2) how to retrieve and reuse them for learning. As for the first issue, video recording with handheld devices will allow us to capture learning experiences. Also consumer generated media (CGM) services helps to share those videos. The second issue will be solved, by identifying objects in a video with RFID so that the system can recommend the videos in similar situations to the situation where the learner has a problem.

We have developed LORAMS (Linking of RFID and Movie System) [16] to cope with those issues. There are two kinds of users in this system. One is a provider who records his/her experience into videos. The other is a user who has some problems and retrieves the videos. In this system, a user uses his/her own PDA with RFID tag reader and digital camera, and links real objects and the corresponding objects in a movie and shares it among other learners. Scanning RFID tags around the learner enables us to bridge the real objects and their information into the virtual world. LORAMS detects the objects around the user using RFID tags, and provides the user with the right information in that context.

Video recording process needs PDA as shown in figure 7 (1), RFID tag reader, video camera and wireless access to the Internet. First, a user has to start recording video at the beginning of the task. Before using objects, the user scans RFID tags and the system automatically sends the data and its time stamp to the
server. After completing the task, the user uploads the video file to the server and the server automatically generate SMIL (Synchronized Multimedia Integration Language) file to link the video and the RFID tags.

As shown in figure 7 (2), video search and reply processes need PDA, RFID tag reader, and real player. The user scans RFID tags around him/her and/or enters keywords of the objects, and then the system sends them to the server and shows the list of the videos that match the objects and keywords (figure 8). Moreover the system extracts a part of the video that matches with these objects. The video is replayed using FlashPlayer.

We conducted evaluations in the domains of PC assembling and cooking. Most of the subjected argued that it was so easy to record a video and find a target video using RFID tags.

Many teachers and learners believe that learning by doing is the best way for learning. In learning by doing model, the teachers identify a specific set of skills to teach, embed that skills in a task, activity, or a goal that the student will find it interesting or motivational, then the teachers can evaluate the learner’s understanding and skills according to how much the learner succeeds to reach to the goal. While the learner is practicing to reach to the goal, s/he usually looks for some knowledge. There are two logic ways to get the desired knowledge, one way is to refer to one or more of educational materials that match the learner’s needs like books, journals, or video lectures. The other way is to ask for an aid from other learners who have enough knowledge about the learner’s request. In last case, the learners can interact and exchange their knowledge in collaborative way. In a ubiquitous learning environment, it is difficult for a learner to know that another learner has this knowledge even that they are at the same location. In this case, the learner needs to be aware of the other learners’ interests that match his request.

The aim of PERKAM (Personalized Knowledge Awareness Map) system [2] is to support the learner with the Knowledge Awareness Map, which is personalized according to his current need and location. The system can recognize the environmental objects that surround the learner those he uses during his practice study. The system uses RFID tags to detect the surrounding physical space objects then it generates the learner’s digital space where each object in the physical space has its corresponding one in the digital space. The system matches between the learner’s current need and the other learners’ interests and locations, recommends the best peer helpers and visualizes the relative distance between the learner’s current need and the peer helpers’ interests and locations. The learner can contact with one or more peer helpers, forward to him/them his Environmental Objects Map, interact and collaborate.

While the learner is interacting with another learner remotely, trying to explain him his current environment and situation, it may be difficult or at least need long time to describe exactly the available objects that he uses during his practice. The role of Environmental Objects Map is to map the physical space to a digital space, where each object in the physical space is detected, recognized and presented graphically by this system (figure 9). The learner can forward this digital space to the peer helper in order to facilitate easy understanding of his environment that augments the collaboration between the learners.

This map displays a two dimensions knowledge space of the recommended learners who are using the system and have enough knowledge about the learner’s request (figure 10). This map represents the level of recommendation for each learner depending on his interests. The closer the recommended learner to the learner’s request in the vertical (y) dimension, the nearer his physical location to the learner.
5. Conclusions

This paper overviewed a context-aware language-learning support systems and web-based video sharing system that the author proposed. Those systems can augment learning experiences using ambient media. For further information, the authors web page is available at http://www-b4.is.tokushima-u.ac.jp/ogata/

The future works are shown below:
(1) Rich user interface: Everyone should be able to use CSUL easily. For example, voice input and output should be implemented in CSUL.
(2) Persistent learner model: The system should understand what the learner has learnt so far and what the learner has not learnt. Therefore, the learner’s activities should be recorded permanently and they should be accessed by other educational systems.
(3) Personalization: CSUL should be personalized to provide the right information at the right place at the right time in the right way to the right person.
(4) Learning support: CSUL should provide the right scaffolding and fading tool in terms of short and long term perspectives. Also CSUL should be supported seamlessly across the learning contexts.
(5) Evaluation: CSUL should be evaluated for short and long term. We need to investigate how to evaluate. Also, we should take account of privacy issue.

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References


