Submission to ICCE 2007.

LORAMS: Linking Physical Objects and Videos for Ubiquitous Learning

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Abstract: This paper proposes a personal learning assistant called LORAMS (Link of RFID and Movies System), which supports the learners with a system to share and reuse learning experience by linking movies and environmental objects. These movies are not only kind of classes' experiments but also daily experiences movies. Therefore, you can share these movies with other people. LORAMS can infer some contexts from objects around the learner, and search for shared movies that match with the contexts. We think that these movies are very useful to learn various kinds of subjects. We did evaluation experiments. The target of some experimenters is to record movies and link objects while the target of other experimenters is to learn using LORAMS and to try doing a task. We got the result that the learner's performance of doing a task using LORAMS is better than doing a task without its assistant.

Keywords: Ubiquitous Learning, RFID tag, multimedia

1. Introduction

Ubiquitous computing [1] will help organize and mediate social interactions wherever and whenever these situations might occur [9]. 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 [15]. With those technologies, CSUL (Computer Supported Ubiquitous Learning) is realized, where an individual and collaborative learning in our daily life can be seamlessly included.

One of the most important ubiquitous computing technologies is RFID (radio frequency identification) tag, which is a rewritable IC memory with non-contact communication facility [4]. This cheap, tiny RFID tag will make it possible to tag almost everything, replace the barcode, helps computers to be aware of their surrounding objects by themselves, and detect the user's context [3]. 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 distance range for RFID reader is longer than bar code scanning range.

(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. Therefore, 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, on the other hand, 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 does not use 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, where we will be able to learn at anytime at anyplace from every object by scanning its RFID tag.

The fundamental issues in CSUL are

(1) How to capture and share learning experiences that happen at anytime and anyplace.

(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 such as YouTube [http://www.youtube.com/] 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.

This paper proposes LORAMS (Linking of RFID and Movie System) for CSUL. 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.

As for related works, there are two kinds of educational applications using RFID tags. The first type is the applications that can identify the objects on a table and support face-to-face collaboration. For example, EDC (Envisionment and Discovery Collaboratory) [2] and Caretta [17] consist of a sensing board and objects with RFID tags such as house, school, etc. Detecting objects on the table enables the systems to show the simulation such as urban planning. Also TANGO (Tag Added learNinG Objects) system supports learning vocabularies [11][12][13][14]. The idea of this system is to stick RFID tags on real objects instead of sticky labels, annotate them (e.g., questions and answers), and share them among others. The tags bridge authentic objects and their information into the virtual world.

The second type is the applications that can detect the learner’s location using RFID tags that allows the system to track the learner’s positions and to send the right messages to the learner. eXspot [7] is an example of this type of application, which is designed for museum educators, it can capture the user’s experiences at a museum for later reflection. This system consists of a small RFID reader for mounting on museum exhibits, and RFID tag for each visitor. While using RFID, a visitor can bookmark the exhibit s/he is visiting, and then the system records the visitor’s conceptual pathway. After visiting the museum, the visitor can review additional science articles, explore online exhibits, and download hands on kits at home via a personalized web page.

In this way, RFID is very useful for identifying objects precisely. LORAMS system utilizes the full advantage of RFID to capture, share and reuse personal experiences for ubiquitous learning.

2. LORAMS

2.1 Features

The characteristics of LORAMS are as follows:

(1) Learner’s experience is recorded into a video and linked to RFID tags of real objects. The video can be shared with other learners.

(2) Learners can find suitable videos by scanning RFID tags and/or entering keywords of real objects around them.

(3) Based on the ratings by learners and the system, the results are listed.
There are three phases for LORAMS as follows:
(i) Video recording phase:
(ii) Video search phase:
(iii) Video replay phase:

Video recording process needs PDA, 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.

On the other hand, 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. Moreover the system extracts a part of the video that matches with these objects. The video is replayed using RealPlayer.

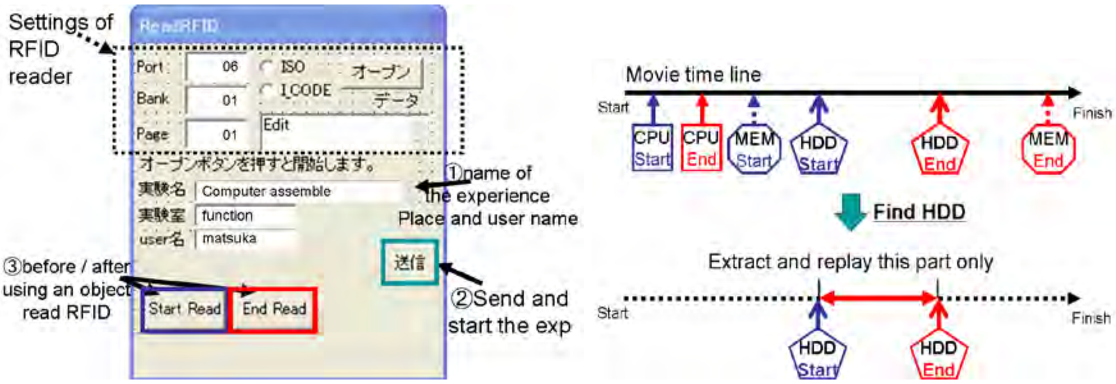

Figure 1: The interface of the recording phase (left) and video time line (right).

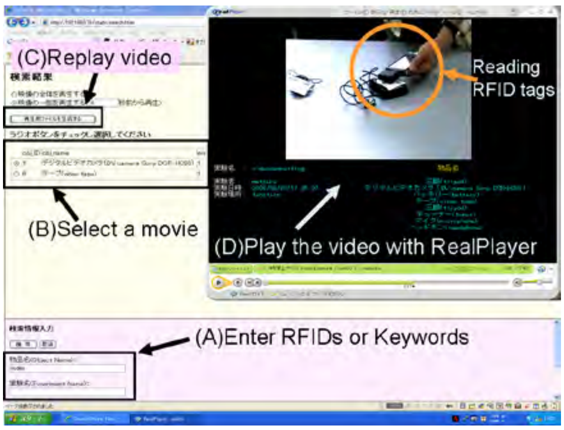

Figure2: The interface of the video search (left) and RealPlayer for video replay (right).

2.2 User Interface

In recoding phase, the user sets up the information on the RFID reader such as port number and code type, and enters the experiment name and user name. When the user uses an object, s/he pushes “start” button and scans the RFID of the object. Also, when the user finishes the work using the object, s/he pushes “end” button and scans RFID of the object. The RFIDs and the time stamps of the scans are sent to the server by pushing “send” button. As shown in the right of figure 1, the RFIDs are linked to the video.

First, the user scans RFIDs and/or enters keywords in (A) Then the system displays the result in (B) .The user can select one of the videos and by pushing the replay button (C), RealPlayer automatically appears and plays the selected video. The objects in the video are listed below the movie area in (D).

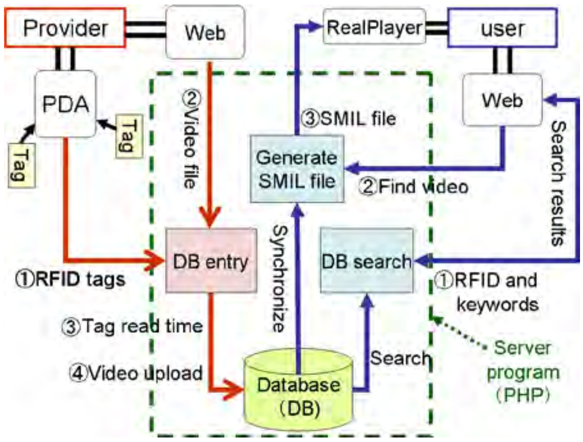

Figure 3: System configuration

2.3 System configuration

We have developed LORAMS, which works on a Fujitsu Pocket Loox v70 with Windows Mobile 2003 2nd Edition, RFID tag reader/writer (OMRON V720S-HMF01), and WiFi (IEEE 802.11b) access. 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 LORAMS program has been implemented using Embedded Visual C++ 4.0 and PHP 5.0.

The server application consists of the following modules:

(1) Database entry: It stores the RFID reading time stamp into the DB.
(2) Database: This system uses My SQL server as a database.
(3) Database search: This module matches videos with keywords and RFID tags.
(4) SMIL generation: After finding the segments that contain the keywords and RFID tags, this module generates SMIL files for each segment.

2.4 Ranking method

Ubiquitous computing environment enables people to learn at any time and any place. 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 in the right way [6]. This system employs the following equation to rank the search results in order to provide the right information

$$l = \sum_{i=1}^{5} w_i x_i \quad \text{Where,}$$

X1: subjective value given by the provider and 0<=X1<=1;
X2: objective value given by the user (learner), it is the average of the users' rates and 0<=X2<=1;
X3: # of the key-objects in the video / # of the key-objects given by the user;
X4: the period of at least one of the key-objects shown in the video / the length of the video;
X5: the period of all key-objects shown in the video at the same time / the length of the video;
Wi: the rating weight defined by the system administrator and $\sum(Wi) = 100$;
Key-object is the object that contains the keywords and/or RFID tags data given by the user.

3. Experimentation

We conducted the evaluation to measure how LORAMS can support ubiquitous learning. The tasks were installation some devices to personal computers as shown in Figure 4.

3.1 Experimentation design

Twenty students from the department of computer science in the University of Tokushima were involved in this experiment. Although they have already learnt theories of computer architectures at the classroom, they have never been taught how to assemble a computer in practice. Each of them was given 30 minutes to complete one of the following tasks:

Task 1- Plug a Hard Disk Drive 40 GB as a Master device and a CD-ROM as a Slave drive using one IDE cable.
Task 2- Plug a Hard Disk Drive 30.7 GB as a Master device and a CD-ROM as a Master drive.
Task 3- Plug an AGP VGA card 32 MB and 2x128 MB RAM.
Task 4- Plug an AGP VGA card 16 MB and 1x256 MB RAM.

Table 1: Objects and IDs used in the experiment.

Object ID	Object name
4F303032	SDDR RAM Hunix 256 MB
4F303034	SDDR RAM SEC 128 MB
4F303033	DDR RAM NANAYA 256 MB
4F303036	VGA SST MPF 39V512 -(16 MB)
4F303038	Hard Disk Drive Maxtor IDE 40 GB
4F303039	Hard Disk Drive IBM IDE 30.7 GB
4F303130	CD ROM Drive LG
4F303133	IDE Data Cable double
...	...

Before starting the task, it was explained to them the devices and how to use PDA and RFID tag reader. All devices were attached to different RFID tag as shown in Table 1. According to the pre-questionnaire, the students' experiences about PC assembling were evaluated and they were defined as expert or inexpert. Expert students were five students, who had the enough experience to complete the above tasks, and the inexpert students were fifteen students who had shortage of experience, then the students were divided into two groups as follows.

(1) Production group: which consists of eleven students (five expert and six inexpert)
(2) Learner group: which consists of six inexpert students.
(3) Video rating group: which consists of three inexpert students.

The experiment was based on the following evaluation methods:

(1) Evaluation method of video production group:

While doing the tasks, they recorded videos, shared and rated them using the system.

(2) Evaluation method of learners group

Each learner from the learner group was asked to do the following:

(i) Use the system and complete one task after watching the recommended video.
(ii) Do the same task again after one month without using system, in order to verify weather they have learnt during using the system.

(3) Evaluation method of ranking movies

The students of the video rating group were asked to rate all videos with a number that presented the objective value "X2".

After three months, six students from the learner group were asked to use the system, enter some keywords that describes the task's objects that each of them did before, watch the first three ranked videos by the system and re-rate them according to their opinions. The target of this step was to evaluate the system rating method. Moreover, the weight parameters were defined as follows.

(i) Weight parameter of subjective evaluation:

$$w_1 = 10, w_2 = 40$$

W2 was set a high value to increase the weight and the importance the learner's rating effect.

(ii) Weight parameter of objective evaluation:

$$w_3 = 20, w_4 = 10, w_5 = 20$$

w3 and w5 were set high values increase the weight and the importance of the videos that contain almost all the task objects.

Figure 4: Scene of the experimentation. (2 -recording no recoding)

3.2 Result

While using the system, the achievement rates (AR) and achievement time (AT) were calculated. After the experiment, all students filled in a questionnaire. They gave a rate from 1 (the worst) to 5 (the best) as an answer for each question. The result is shown in table 2. The average (Avg.) and standard deviation (SD) for the learners' answers are illustrated.

(1) Evaluation of the video production

First, all students belong to the production group executed tasks and produced videos using PDA and RFID. In this phase, the students could use a web search engine like Google to search for some information, while LORAMS system was not allowed to use. As a result, all the five expert students and two (out of 6) inexpert students could complete the task successfully. After that, the students of the learner group executed their tasks, while using LORAMS, as a result, five students (out of 6) could complete the task. One month later, the learner group was asked to do the same tasks again without getting any help, i.e., Internet connection, using LORAMS, or asking other people were not allowed, as a result, all the six students were completed successfully.

Table 2: Results of questionnaires.

No.	Questionnaire	Ave	SD
Q1	Is it so easy for you to read RFID tags, record a video and complete the task at the same time?	3.4	0.85
Q2	Is it so easy for you to make a link between RFID and movie?	3.5	1.71
Q3	Do you think that the recorded videos are very useful for the beginners to complete the task?	4.3	0.67
Q4	Do you think that the retrieved video is effective for learning?	4.5	1.21
Q7	Is it easy to find the suitable movie using this system?	4.0	1.10
Q8	Overall, is it easy for you to use this system?	3.7	0.52
Q9	Overall, do you think this system is useful for learning?	4.5	0.30
Q10	Do you want to use this system again?	4.3	0.67

According to Q1 and Q2 (as shown in table 2), the recording phase is accepted. However, they mentioned that, sometimes they forgot scanning tags and found it boring. On the other hand, there were two or more affirmative opinions, where some students commented that linking real objects to videos is easy and no need for typing, while the others comments that the linking process does not need any special video editing skills and it is considered as a good training for the producers. Therefore, an improvement of the user's interface is needed that decreases the button operations, and displays what objects have been read so far.

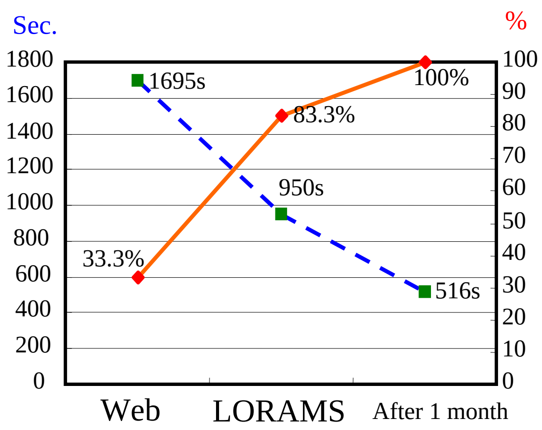

Figure 5: Achievement rate and time in each task

(2) Evaluation of the learning process

The achievement rates (AR) and achievement time (AT) for the learner group were shown in Figure 5. The AR increased by using LORAMS from 33.3 % to 83.3%, and the AT decreased. This means that LORAMS helps the students to learn how to install computer devices. Also the AR became 100.0% after one month. It indicates that the students have learnt and improved their skills while using LORAMS.

From Q2 (table 2), it is clear that the system can efficiently retrieve the matched videos and extract a part that includes the real object. Some students commented that only the part that I want to watch could be retrieved directly and no need to waste my time by searching for this part and watch unnecessary videos".

From these results, it is useful to watch the real experience into videos rater than to read related documents. Also it is confirmed that the learner could watch only the important part of the video that matches his need. Moreover the learners have gained new experiences and knowledge while using the system.

Table 3: video ranking

Student	1st	2nd	3rd
A	2	3	1
B	1	3	2
C	2	3	1
D	1	3	2
E	1	2	3
F	1	3	2
Average	1.3	2.8	1.8

(3) Evaluation the ranking method

As shown in table 3, for the first raked movies by the system, the average rating score for video rating group was 1.3. For the second and third ranked videos, the average rating score for video rating group was in opposite order. One of the main reasons that may cause this wrong order is the similarity between many computer components. Therefore, the ranking method needs more enhancements.

4. Related works

4.1 Adding annotation to video

It is necessary to make the annotation and the key word added to the video in order that the system may search the video for which the viewer hopes. Therefore, there is variously research of putting a detailed annotation to animation [5][10][16]. However a lot of human costs and time are necessary for these methods of producing videos. Then, there is a research, which the viewer puts the annotation of the video contents, and the production person's load is decreased. And, the accurate intelligence is added to contents by artificially giving the annotation [18].

4.2 Life log

"Life log" preserves contents that video, voice, position (GPS) of that time, and information from various sensors are combined in the data base. And, it puts up the key to search the video of own life log, and searches these videos. Moreover in Ubiquitous Memories [8], the RFID tag is used as a trigger that makes people recall their memories from their Life log.

5. Conclusion

This paper proposes a ubiquitous learning environment called LORAMS (Link of RFID and Movies System), which supports the learners with a system to share and reuse learning experience by linking movies and environmental objects. The evaluation showed that students acquired skills in computer assembling and LORAMS is useful for learning. In future work, we will enhance the user interface based on the learners' comments, improve the ranking method, and apply LORAMS to other learning domains, for example, cooking, chemical operations and bioreactor experimentations.

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