Use your mobile computing devices to learn
Contextual mobile learning system design and case studies

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Abstract—In recent years, with the rapid development of mobile computing technologies, a new learning style—mobile learning—has exploded everywhere in our society, which is considered as an essential learning style in the future. This paper presents a mobile learning system taking into account learning context, which is also called contextual mobile learning. With the help of this system, we can learn just in time in our daily lives whenever we need to learn, using mobile computing devices like Tablet PCs and PDAs. The main principles and the development process such as production of learning units and contextualization process are presented. Two case studies are introduced to apply the system in concrete scenarios.

Keywords—contextual mobile learning, context, augmented reality, RFID, just in time learning

I. INTRODUCTION

With the rapid developments in mobile computing technologies (like mobile devices and mobile networks) and new learning theories, mobile learning has exploded everywhere in our society, which is considered as an essential learning style in the future. It mainly refers to using mobile devices like PDAs, Tablet PCs, and smart phones in learning activities. People have started to take advantage of mobile learning in many aspects of their daily lives [1]. So far, there isn’t any complete definition for mobile learning, because it is still on developing. In our opinion, the most appropriate definition for today is “any kind of learning when the learner is not at a static or fixed location, or when the learner takes advantage of mobile technologies” [2]. Mobile learning compared with e-learning, wearable computing, mobile computing and ubiquitous computing is shown in Fig.1.

Mobile learning can be divided into many different categories, according to its main characteristics like devices, mobility, context and location [3]. In this paper we don’t talk about the precise classification of mobile learning. We only identify mobile learning according to its relation with the learning context. Some mobile learning activities are not relative to its context. Like a student using his smart phone to study English, there is no difference between on the bus or at home. The mobile learning which takes into account learning context is called contextual mobile learning or context-aware mobile learning [4]. For example, a visitor in a museum can get the introduction about the work of art that he is observing from his PDA.

Learning context is crucial in mobile learning, because for a learner, his activity and context are central in determining his learning objective and learning content. Reference [5] described learning context in three classes: learner context, physical context and computing context. Thanks to the development of wearable computers equipped with accessoril sensors, such as GPS receivers, RFID readers, digital cameras, etc, the learning context information as location, activity, network connectivity, etc, can be captured for improving and assisting learning activities [6]. The process of contextualization allows the adaptation and the delivery of learning units to mobile devices according to the learning context [7].

Figure 1. Mobile learning cartography

Figure 2. Help Me To Do principles in industrial scenario
What mainly interests us is to apply mobile learning technologies in our daily lives, like individual or professional learning and training activities. We designed a contextual mobile learning system, located as part of the HMTD (Help Me To Do) project, which aims to help users to master equipments in domestic, public, and professional situations (Fig. 2). But our interest points are not only limited to this. We try to apply the contextual mobile learning theories to all possible learning activities like HSHB project introduced in this paper.

The objective of our paper is to explain the process of design and the architecture of our contextual mobile learning system, which allows learners to access learning resources when learners carry out tasks and need to learn in mobile contexts. We will present the great principles on which our system is based, like MOCOCO definitions and IMERA platform, and the learning methods that we use, etc. The general architecture schema will explain how the system works. At the end, we introduce two case studies of our system, one for helping us repair computers and the other for helping us choose dishes according to nutritional requirements.

II. SYSTEM PRINCIPLES AND DESIGN

A. MOCOCO principles and IMERA platform

MOCOCO principles (Mobility, Cooperation, and Contextualization) are the central features of our system. It means that in an environment, the mobile learners, who can access to accurate, appropriate and contextualized resources, perform one or more tasks in collaboration with other users.

The system is designed on the basis of IMERA platform (French acronym of Mobile Interaction in Augmented Reality Environment) [8]. IMERA platform is set on wired and wireless networks. RFID technology is deployed in form of tags placed on some given areas, fixed readers, and mobile readers equipped to mobile actors. All mobile actors have wearable computers with Wi-Fi network connection and RFID readers. The actors then can identify the environment and communicate among them. On this platform the mobile actors can remove freely and carry out actions on the ground. Some other fixed individual or group actors can execute associated functions like the supervision or coordination works, using appropriate equipment, such as interactive supervision table.

B. Learning methods

The study of learning methods is very important in mobile learning. Compared to traditional classroom learning, the learning methods used in E-learning or mobile learning have many advantages for individual or professional lives, such as speed, efficiency, mobility, low cost, etc. We suggest that learning methods should be well thought out and chosen on the basis of learning activity, context, devices, etc. Taking into account the characteristics of contextual mobile learning and our predetermined application scenarios, we are most interested in just in time learning [9] and learning by doing [10].

In our case studies we propose a learning process on three steps:

- **Before** the activity: learn about coming actions
- **During** the activity: learn just in time actions to be carried out
- **After** the activity: review past actions

C. Contextualization with RFID

For a mobile learning system, the final objective is always to deliver the right resource to the right learner, on the right place, by right ways and at the right time. According to the contextual information, determine what learning resources to send and how to use them is the goal of contextualization. In our system we use RFID technologies to gather contextual information. Two phases of contextualization are thought about:

The first is learner contextualization. A learner must be identified to access the learning system and launch the application. Depending on his role and his predefined administrative level, a level of access right and appropriated functionalities will be distributed. To realize that an ID card with RFID tag owned by the learner is used to present to an RFID reader installed on all possible devices (fixed PC, Tablet PC, PDA, etc) in all possible contexts (fixed or mobile).

The second is object contextualization. RFID tags are placed on real objects or real areas. For example, an industrial machine has been placed a RFID tag which contains its important brief information like serial number, model, manufacturer, exit date of factory and so on. With an RFID reader, the learner call easily identify the object and get the relative resources stored on the database, such as repair history, electronic plan, user manuals, etc.

![Figure 3. Modeling of tasks with CTTE: appliance repairing](image)

![Figure 4. Production of learning units and SCROM xml schema](image)
D. Production of learning units.

When the learner carries out a task, he requires learning resource focused on the task to assist him. So the first work is to create learning units and to analyze the relationship between tasks and learning units, structure them and store them in database.

Firstly, we collect all the useful documentation of various formats, such as paper documents, electronic files (.doc, .pdf, .txt, .jpg ...). These documents are classified according to their usability. Some resources relative to tasks can be classified, structured and tagged according to the characteristics of tasks (objective, technical level, other relative tasks, etc.). We use CTTE (Concur Task Tree Environment) to help us analyze and model the tasks, as described in Fig.3.

Paper documents are scanned and transformed into electronic formats with technologies like OCR (Optical Character Recognition), which become learning fragments with other electronic files. Learning fragments are analyzed and segmented according to their usability, and then are structured and tagged according to the tasks involved. Finally, they are described with XML files and stored in database. The standard SCORM is used to make XML files, and IML-LOM is used to tag them by adding metadata. Fig. 4 shows the general process of learning units production and SCROM XML schema.

E. Configuration of mobile devices

According to the context, the choice of wearable computer and its input/output devices is also important.

Different actors in one particular scenario and actors in different scenarios need different configurations of mobile computers and associated peripherals (Fig.5). This step needs a study of all actors’ task, matching requirements concerning graphics information complexity (textual, graphic schemas or precise blueprints ...), interaction complexity (writing, observation, manipulation) and working conditions (seating, standing, hands availability ...), etc.

F. System organization.

Fig.6 describes the general organization of the system. The control engine works with the support of IMERA platform. It takes a role as a manager to organize learning activities. It collects contextual information and manages the database of learning units. The engine identifies the user (its role, its access level, preferences), and arranges interactions. Depending on learning contexts, different learning methods have to be adapted. In some scenarios, the communications between object appliances and wearable computers are also considered.)
III. CONTEXTUAL LEARNING CASE STUDIES.

A. Computer maintenance assistance

With our contextual mobile learning, we made an application to assist the computer maintenance. As computer has become an almost indispensable tool in all areas of our society, we usually meet computer technical problems. If it is a hardware problem, most employees don’t know how to fix it, some times even for a technician, it is also difficult. Based on the contextual mobile learning principles describes in the previous section, we propose a contextualized solution, using mobile devices (Tablet PC or PDA) and augmented reality accessories (semi-transparent glasses) to provide just in time learning solution when the user need a guide to maintain computers.

Through contextualization process, the user immediately gets the brief information of the computer to maintain and a list of all possible operations guides on his screen. This information will help him to initiate the maintenance work.

Here we take an example scenario of changing the hard disk of a computer. This work is composed of several steps such as: 1. Remove the screws on the case. 2. Remove the case. 3. Pull out the power connector…14. Fit on the case. If the user is not clear on one or several steps, he can launch the process of just in time learning and learn about how to carry out the actions. He chooses an “act” of guide in the index or by searching with keywords. On the screen of his device, the “act” begins to take place under the user’s commands. He can watch the sequence of action, listen to the voice guidance, etc… and step by step perform his task (Fig.7).

During this process of learning, the user can not only finish the job by following the guide, but also try to understand the whole sequence of actions. Moreover, some additional information is displayed for the user to learn more about the task. For example, when the user remove the hard disk, he is informed on the screen all the characteristics about the disk (Fig.7).

The system can also contain an interaction based on augmented reality: thanks to the semi-transparent glasses, the user can see the guide actions superposed on real objects (Fig.8).

If the user still have difficulties during the work after individual learning, a collaborative interaction can launch the communication with other remote experts via network, to guide the user by appropriate method (voice, text message, real gestures, etc).

Some first experimentations and evaluations of this case study have been done in our laboratory. The results were very positives and many useful suggestions were given. Further research will be focused on the collaborative interface development and the enrichment of learning units.

B. HSHB Project.

People start to pay more and more attention on dietary balance. At home, we can prepare and cook food according to our needed nutritional compositions, but in a restaurant, it is difficult to calculate the amount and percentage of different nutritional compositions. We always ask ourselves the questions like that: if I eat too much lipid this meal? What I should choose next?

The HSHB (Healthy Spirit in Healthy Body) [11] is an application of our contextual mobile learning system to teach us make dishes choice in university refectory or self-service restaurant, on using mobile device (Tablet PC or PDA), on respecting at the same time personal taste preferences and nutritious requirements (Fig.9).

RFID tags are placed on the menu sheets or on the front of various exposed dishes to identify a menu or a dish. All the nutritional compositions information of menus and dishes are edited by refectory clerks and nutritionists and stored in the data base, and to be retrieved during the dishes choice process.

The refectory clerk daily informs the system about the dishes offered today, and adjusts their instantaneous availability. Students receive on their mobile devices an appreciation of the adequacy of the choices compared to their nutritious profiles. The system can propose the most suitable configuration of dishes according to several characteristics: user’s preferences, offered dishes, nutritional constraints and so on. Students can make dishes choice by themselves according to the nutritional information offered by the system, and learn how to eat in a balanced way, like describe in Fig.10. After all dishes are chosen, a general nutritional analysis of the meal is given and stored in user logs, which is shown in Fig.11.
IV. CONCLUSIONS AND PERSPECTIVES

We have presented a contextual mobile learning system which is based on IMERA platform. MOCOCO principles are central in our approaches. Depending on learning context, the system allows users to acquire contextualized learning resources, according to different learning methods to help them carry out tasks. The production of learning units and the process of contextualization with IFID technologies were proposed and studied. Two case studies were introduced to apply the system to daily lives.

In the work of our laboratory, we are always open to collect new ideas that apply mobile learning theories into all possible areas of our society, especially in professional and industrial domains like the e-truck project [12].

REFERENCES