Context-Aware Model in a Ubiquitous Learning Environment

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Abstract

The idea of ubiquitous learning is to create a network of devices, people and situation that allows learning experiences to play out. This idea is attractive but it is not easily implemented. The GlobalEdu is a ubiquitous learning architecture integrated in ISAM, a software architecture that manages a large-scale pervasive environment. This paper presents a context-aware model implemented in GlobalEdu. Especially, we present the Context Management Educational Service and its interface with a Pedagogical Agent. A scenario application will be present too.

1. Introduction

In the mobile computing scenario, users carrying portable devices and have access to shared infrastructure independently from their physical location or displacement form. This scenario complements the Ubiquitous Computing [1] environments development, where the user is free to move anywhere, anytime. The essence is that the user’s applications are available in a suitable adapted form, wherever that user goes. This category includes location-aware applications [2], whose behavior is determined by the physical position of the user. The current location determines the current context; thus, location can be used to explore nearby opportunities (context-aware computing [3]).

In this scenario, new learning perspectives are possible. Ubiquitous Learning [4] can be built either by embedding models of specific environment into dedicated computers, or by building generic capabilities into computers to inquire, detect, explore, and dynamically build models of their environments. However, this makes availability and usefulness of ubiquitous learning limited and highly localized. Ubiquitous Computing is interesting for the development of ubiquitous learning applications because learning can occur anywhere, anytime, with continued computing support. Towards this scenario, some proposals are being developed [4, 5, 6, 7].

In our point of view, educational resources are distributed in the global network and the learning process connects them. Educational applications will allow all the context of the learner to be connected with the educational context, joining current information with educational objectives. The context aware is an important aspect for the learning process, but it is not easily implemented. GlobalEdu is a ubiquitous learning architecture proposal [8]. In it, a Pedagogical Agent (PA), a package of Educational Service (ES) and Support Services (SS) are used to support educational applications on ISAM [3]. It is a software architecture that manages a large-scale pervasive environment.

In this paper, we describe the context model in GlobalEdu, it is organized as it follows: Section 2 presents the definitions and standards associated with this work. Section 3 describes the GlobalEdu project. Section 4 details our context-awareness learning model. Section 5 describes a scenario for to evaluate the proposal. Section 6 presents the related works and section 7 presents the final remarks and presents the plans for future works.

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2. Background

Mobile learning [5,6] is fundamentally about increasing learner’s capability to carry their own learning environment along with them. M-learning has the potential to make learning even more widely accessible. However, considering the ubiquitous view, mobile computers are still not embedded in the learner’s surrounding environment and they cannot seamlessly obtain contextual information [4].

A ubiquitous learning system [4] can use several devices that communicate mutually to explore the context, and dynamically build models of their environments. It is considered that 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. The opportunities made available by the context can be used to improve the learning experience.

We assume that it is possible to development ubiquitous learning applications using ubiquitous computing support. With this, it is possible to implement distributed, mobile, context-aware, adapted and follow-me applications [3]. For us, joining high mobility with ubiquitous computing support makes possible to explore large-scale ubiquitous learning.

Considering a ubiquitous perspective and based on Ogata works [4], the characteristics of learning in this environment are: (1) Permanency: all the learning processes are recorded continuously; (2) Accessibility: learners have access to their documents, data, or videos from anywhere, according his/her requests; (3) Immediacy: wherever learners are, they can get any information immediately; (4) Interactivity: learners can interact with experts, teachers, or peers in the form of synchronous or asynchronous communication; (5) Situation of instructional activities: the learning could be embedded in our daily life. The daily context of the user can be connected with the local context, joining current information with educational objectives. For this work, local context is the information about persons, relations, places, and resources in the specific location. This information can be understood by software agents.

Ubiquitous learning scenario is attractive, but it is not easily to be implemented. We are investigating what subset of functionality is required on ubiquitous learning in order to achieve the benefits of large-scale ubiquitousness. Because this, we are considering a large-scale ubiquitous computing support. Through this, it is possible to join high mobility and ubiquitous learning. In this paper, we are going to concentrate the attention in the surrounding context learner. For us, context is any information (digital or no-digital) that makes possible the continuous learning in a large-scale and context-aware environment. Thus, it is important the adaptation learning process based on learner model. With this, it is possible the learning environment to relate learner and context.

According [9], the ongoing discussion about context features for learning has at least identified three main divisions: personal context, social context and organizational context. For this support, it is important to acquire the physical information that represents the resources accessed by the learner, such as network, locations and devices. Towards this scenario, some proposals are being developed [4, 5, 7]. In our research, we have developed a ubiquitous learning architecture proposal called GlobalEdu [8]. This architecture supports context-aware learning. Our context model uses personal, social and physical information about learner. GlobalEdu will be briefly presented in the next section.

3. GlobalEdu

GlobalEdu investigates how to expand the ISAM architecture to e-learning domain. The ISAM project [3] considers that “the computer” is the whole network. The computing environment (data, device, code, service, resource) is spread in composed cells. Users can move around, having both their applications and virtual environment following them.

The GlobalEdu model (Fig. 1) supports learning on ubiquitous computing environments. It is composed by PA (Pedagogical Agent), ES (Educational Services) and SS (Support Services). PA is an agent that runs in the device that the learner is using, assisting the educational process in the ubiquitous environment. The PA contains an interface to the ES and provides a ubiquitous vision through ISAM environment. The ES and SS provide the support to PA execution in the ubiquitous environment, through identification and adaptation of resources in agreement with the learner’s profile and learner’s context. As such, ES and SS are heavyweight execution units, and are executed in network servers. On the other hand, PA is a lightweight execution unit, so it can be executed in mobile devices.

The PA characteristics are: migration to the devices in use by the learner; communication with the ES to obtain environment’s information; control of access of the learning objects and context information, related to the location of the learner with learning goals.
ISAM to manage the mobility of the PA among several the migration and physical mobility support from pervasive execution environment (PE). Learning is that the user’s context can be connected with educational objectives. The ISAM environment. With this, it is possible to obtain ES manages the learner context in the each location. This service perceives changes of context elements in the different locations where the learner is. His/her Social Context and Physical Context compose the learner context.

The Social Context has the information about Location Context and Presence of other PAs in the currently context. Location Context is the information about People (name, e-mail, commitments, role), Events (type, description, location) and Resources (name, type, description, commitments) related to a specific location. The presence of other PAs presupposes the existence of other learners with the same goals, competencies and preferences whose information the learner may access for contact or not. This information can also be used for the creation of learner groups within the same context.

The Physical Context represents the resources accessed by the learner, such as network, locations and devices. We consider that the ubiquitous computational environment monitors Physical Context elements. Besides, any element state changes are informed to the Context Management ES.

Management context in GlobalEdu is the capacity to know how to locate the learner in an environment (cell) that he/she is currently, to identify a learner in the corresponding context and to provide interest information adapted to the device. In the same way, each location is modeled as a Geographic Region and has information about Location Context. These information is stored in a repository (Location Context Repositories) in each Geographic Region, represented as XML metadata. So, for GlobalEdu, the ubiquitous environment is composed by cells and these have different contexts (Fig. 2). For example, a University can be considered a cell and their buildings, different contexts.

4. Context-awareness model in GlobalEdu

For us, one of the characteristics of ubiquitous learning is that the user’s context can be connected with the learner’s local context, joining this information with educational objectives. The Context Management

**Figure 1. GlobalEdu architecture**

The GlobalEdu has ES and SS. The first one supports educational process in the ubiquitous environment. The second assists the ES process. The ES are:

- **Profile Management.** When the learner moves, his/her learner model can change. This service generates the learner model. It is represented by metadata, which uses categories of PAPI [10] and LIP [11] standards, Learning Styles [12] and Trail;
- **Content Management.** It is responsible for managing the learning objects (represented with IEEE LOM standards [13] learning object model) according to the learner model;
- **Context Management.** This service manages the learner context. Section 4 describe our model for this service.

The SS are the interface between ES and ISAM pervasive execution environment (middleware). SS use the migration and physical mobility support from ISAM to manage the mobility of the PA among several other devices used by learners. Besides, the SS manage the exchange of messages of ES with PA, and with the ISAM environment. With this, it is possible to obtain context information, to access available resources, to move the PA and to manage content and local Context repositories.

**Figure 2. GlobalEdu Ubiquitous environment**
The access to the environment by the learner is done with an authentication, and this event is noticed by the Context Management ES. With a new learner’s entrance in the environment the Social Context changed. In this case, the service takes two actions: (1) notifies other learners in the corresponding context (Location Context), and (2) sends to the new learner adapted information about that context that his/her is currently. A comparison is accomplished with the learner’s profile in order to define learners with the same goals, competencies and preferences whose information the learner may access for contact or not.

For the adaptation process, there is a relationship between Context Management ES and the others elements of the GlobalEdu Architecture (see Fig. 3).

Figure 3. Context Management relationship

With this, the learner can ask explicitly information about the Social Context that he/she is in, or still to extend the research for other contexts. For example, the search for learning objects becomes more productive if done in several different contexts.

5. Validation scenario

For evaluate the proposal, we have developed an application called U-inContext. Basically, this is a simplified version of the PA. U-inContext relates social context with learner, using his/her position and the learner profile. We have developed the Context Management ES and a prototype to the others SE and SS. With this is possible to validate the context learner proposal. The platform used by implementation is Java in the J2SE and J2ME versions.

For provide context-aware information to the learner the Context Management ES communicates with U-inContext and ISAM Environment. All this elements are executing in the same GlobalEdu Server machine (see Fig. 4).

Figure 4. GlobalEdu integrated in ISAM

In order to demonstrate a practical application using GlobalEdu context model, we presented a scenario that involves some of GlobalEdu functionalities. The case study is a University and the learners have in their devices an instance of U-inContext. The University is considered a cell, composed by different contexts, and the involved learners with different types of devices have access to a network where the GlobalEdu services are available.

As soon as the learner enters in the University, the system detected him/her and send a Social Context adapted information to U-inContext in to his/her device. Because the learner is physically moving in the University, he/she is passing by several contexts, and each one of these context has different information to him/her. Whenever there is some alteration in the context in which the learner is inserted, he/she is notified of this. For example, when the learner enters in a laboratory, the system notified him/her about the context. The learner becomes aware when there is somebody with similarities and/or complementarities relationship with him/her. Besides locating other learners that have relationship with his/her profile, the learner can communicate directly with them, by chat interface. With that, it is possible to provide an interaction among the learners that are in the same context.

With the purpose of validate the scenario, a test will be performed as soon as possible, involving three learners porting mobile devices (either notebook or iPaq hx4700). The test will be conducted in a specific building at Unilasalle University (Geographic Region). In this building we have mapped two contexts: the hall and the informatics laboratory (Location Context). The Figure 5 shows some steps of the scenario.
6. Related Work

Ogata [4] presents JAPELAS, a context-aware system for support learning of the Japanese language expressions. Learners, carrying PDAs, are assisted by the system to identify the adequate treatment expression of the other person, considering the context where they are. So, JAPELAS is directed for a specific content. GlobalEdu uses Learning Objects and does not specify a learning content. With the Content Management ES it is possible to learn about any content.

The project presented in [7] to design and build pervasive environments (WiFi and sensor-based technologies). The purpose is that digital augmentation offers a promising way for enhancing the learning process, especially encouraging the dovetailing of exploring and reflecting when indoors and outdoors. GlobalEdu supports indoors and outdoors learning application. Currently, we use WiFi technology and it is possible exploring only indoors learning application. Differently of [7], the context of GlobalEdu uses Social and Physical information.

7. Final Remarks

This paper presents a context-aware model implemented in GlobalEdu. Especially, we presented the Context Management ES and its interface with PA and ISAM environment. The GlobalEdu prototype has been developed and applied in ISAM. A scenario application was presented too. Differently from other researches [4,7], GlobalEdu considers the learner’s context of a general form, since that represented in the ubiquitous architecture. The proposal supports learner profile and learning objects. Moreover, the integration with ISAM platform is interesting because it supports a stabilized large-scale pervasive environment. It is expected that evaluation results of the prototype will be available at the time of this paper’s presentation.

8. References


