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Abstract

Mobile learning is an effective means of using mobile technologies to enhance traditional learning and expand the perspectives of the learning process itself. In a mobile learning environment, the main objective is to offer the learner the educational resource adapted to their profile and the context of the mobile device used. In the literature, several approaches have been proposed to address the limitations of mobile learning environments.

In addition, design pattern technology has shown its effectiveness in developing software for various fields. This software engineering technique allows for the definition or re-use of patterns while taking into account the principles and means of good design related to ergonomics and performances aspects. These design patterns provide the following features: Reusable, Consistent, Easy to Use and Reliable. So design patterns can be seen as a promising solution that can reduce the limitations of mobile learning environments.

In this paper we try to propose a design pattern engineering approach for the development of Mlearning applications.

Keywords: Design Patterns, Pattern Engineering, Reusability, Mobile Learning, Adaptive Learning.

1 Introduction

The rapid evolution of mobile and wireless technologies has created a new dimension of modern people's lives, it facilitates their daily activities and summarizes the distances between them, and it allows him to do many tasks anywhere and anytime. When these technologies began to be used in conjunction with learning, a new paradigm emerged, that of mobile learning. Since its appearance it has aroused much of attention by researchers whose attempt to propose approaches to address the limits of the mobile learning environment [1].

These limitations are related to mobile devices used by learners such as; reduced processing power, low memory capacity, limited battery and screen size, other limitations are related to wireless networks, as they are characterized by high latency, intermittent connectivity. In addition to the mobility of learners which results in a permanent change of context. Moreover, a mobile learning system must support the variety of learners who may have different competences and motivations to learn in different contexts. To this end, the need for personalized learning has been well recognized. Learning activities and course content would be adapted to the learner's needs, interests, preferences and abilities.

On the other part, the "reuse" dimension is becoming more and more important today, « it consists in taking advantage of the efforts made in previous work to reduce the effort to reduce a given work » [2]. Research on reuse has evolved gradually in recent years, moving from code reuse to the reuse of knowledge and reasoning approaches at different levels. Reuse can offer a promising solution that can reduce the limits of the mobile learning environment mentioned above; it also facilitates the introduction of adaptive, automatic and dynamic learning methods.

Design patterns are a particular form of reusable components [3]. They are, in this sense, one of the most relevant ways for reuse. They respond to this need while capitalizing on important knowledge acquired and approved by several MLearning developers. Such knowledge is reusable from the identification of needs phase to the implementation phase. First, an approach to the engineering of these specific reusable components for the modeling of mobile learning becomes more than necessary.

Our goal is to propose an approach based on the use of design patterns for modeling the main stages of MLearning development processes.

2 Structure of the approach

The mobile learning domain analysis allowed us to know the conditions necessary for a system to satisfy the adaptation of mobile learning content to the context. At the same time, the information of the service to be represented, the situations of the mobile learning environment and the profiles of the learners must be clearly identified and shared between the different entities of the system.

Our approach must therefore be well structured in order to deal with any such problem. In addition, we identify the following steps:

1. Acquisition of context; this consists of:
   - Acquire the profile of the learner from the questionnaires, tests.
   - Acquire information on mobile devices used by learners during their learning processes.
2. Use of the information collected for the specification of the set of rules used in the context adaptation process.
3. Execution of specified rules to provide content tailored to the context and profile of each learner,
4. Decomposition of contents to be exposed on the terminal into units. This decomposition must be generated automatically. This task will be established through a service-based approach;
5. Displaying content units to the learner.

We suggest an approach based on design patterns on the one hand and a rule-based interface suggestion system on the other, to solve the different facets of the problem.

In the following, we will outline the general structure of our approach by specifying the role of each component of the system.

2.1 Acquisition of context

We identified two sources of context:

- Information related to the learner profile.
- Information related to the mobile learning environment.

The *OBSERVER* pattern offers a better solution to this type of problem. By observing a subject (observable), 1l determines the presence of a new context and notifies its observer who records its information. In addition, in order to acquire the learner's contextual information, we placed an observer on the terminal (learner's mobile). The latter will play the same role as the subject. Sensors built into the mobile device can detect different variations in the learner's context such as temperature, noise level, brightness, humidity, geographical position, etc. They also detect variations related to platforms such as operating system version, screen size, language. However, after each detection of change, a notification will be sent to the observer so that he can perform the appropriate behavior while acting on all the information extracted.

The idea behind using the Observer pattern is not limited to observing a single subject. The latter, expressing any context of use, can undergo various changes. In fact, the Perception entity of the Observer model is able to listen to events applied on all subjects at the same time. In this regard, we are reapplying the Observer design model to observe learner-related changes.
In our case, the learner profile represents our second observation subject, while the observer will be the same already applied to the terminal.

The following figure shows the two cases of using the Observer pattern to identify both the context of mobile learning and the information related to the learner profile.

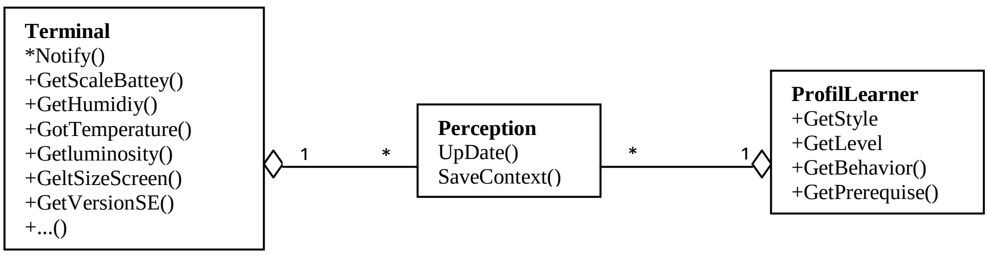

Figure 1: Acquiring context with the *Observer pattern*.

In the next part, we will detail the behavior to take place according to the Information retrieved. This is a reasoning on the information gathered to train the content of mobile learning.

2.2 Specification of adaptation rules

The observer we will name Perception will act as an intermediary between the entity responsible for the Subject notification and the rest of the entities forming the adaptation process.
However, once notified by a contextual change, the Perception pattern retrieves the acquired information from the terminal and the learner profile and transmits it to the rules engine to make the reasoning. This reasoning is managed through business rules to return the content

of the mobile learning to be represented. A rule engine “Is a system that can define rules and apply them to facts” [4].

We chose to use the Specification design template [5]. It provides a lightweight, reusable solution for business rule management and complex problem handling.

The figure 3 models the merging of the context identification step seen in the previous section (Observer pattern) and reasoning with the Rule-based Specification pattern.

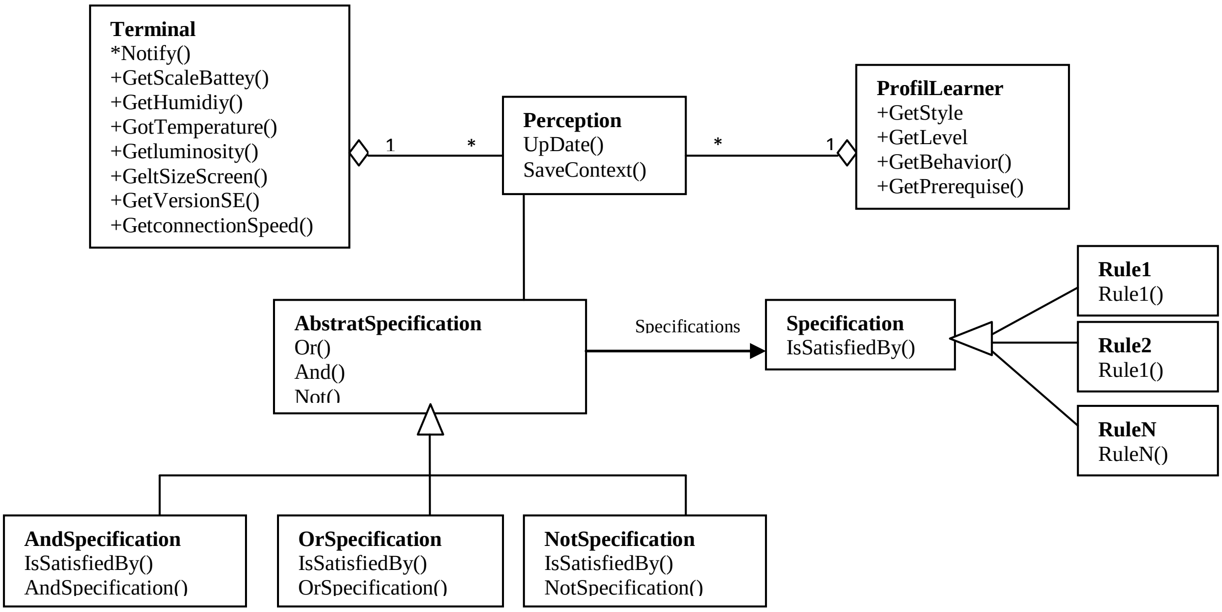

Figure 3: Context Observation and Captured Data Specification.

The Perception entity retrieves the information once notified by the existence of a change and transmits it to the *AbstractSpecification* entity. The latter combines, using the «OR, AND and NOT » methods, between the various rules already predefined by the designer in the form "If (condition) then (conclusion)". The latter express a set of explicit statements to describe how the application should compare its facts (data). All rules with a valid condition will be accepted. This allows only the data forming the content of the learning to be exposed to the learner to be returned to the end of the process. Our model supports the acquisition of context with the Observer pattern and the specification of adaptation rules according to the context and the learner profile. In the next section, we will discuss the content composition portion to be exposed.

2.3 Content Composition

The Observer and Specification design patterns are essential for the smooth routing of the adaptation process. However, they are insufficient to satisfy everything, since they do not allow the content to be presented to the learner.

The content model used by mobile learning contains the different learning concepts. Each concept represents a way of presenting content, i.e. that the same content has multiple presentations. The content is exposed to the learner in a format appropriate to their profile and the context of the mobile device used. For example, for a learner with a visual learning style (according to the Fleming model [6]), the most appropriate presentation for his style must contain images and videos.

However, if the battery level of the mobile device is low, the appropriate presentation in the context of the device should not contain videos, as they consume a lot of energy. So the construction of mobile learning content exposed goes through two stages. And as the design pattern Editor tends to build complex objects step by step. It allows producing different variations or representations of an object using the same construction code. We used this pattern for the construction of content suitable for mobile learning.

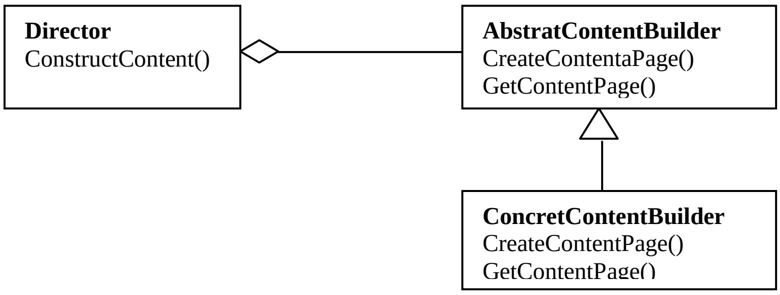

Figure 4: Content build by *Builder pattern.*

The Director entity is used to build content. The *ConcretContentBuilder* entity builds and assembles the various elements of content presentations. The content can be of a single type of a combination of different types of elements. For example, a definition of such a concept can be in text form, or can be in text form with explanatory images. In general, four types of learning content are identified: Text, image, video and audio. We used the composite pattern to model mobile learning content with their different types. Figure 5 models the merging of the Builder pattern used to build mobile learning content with the Composite pattern used to model different types of content.

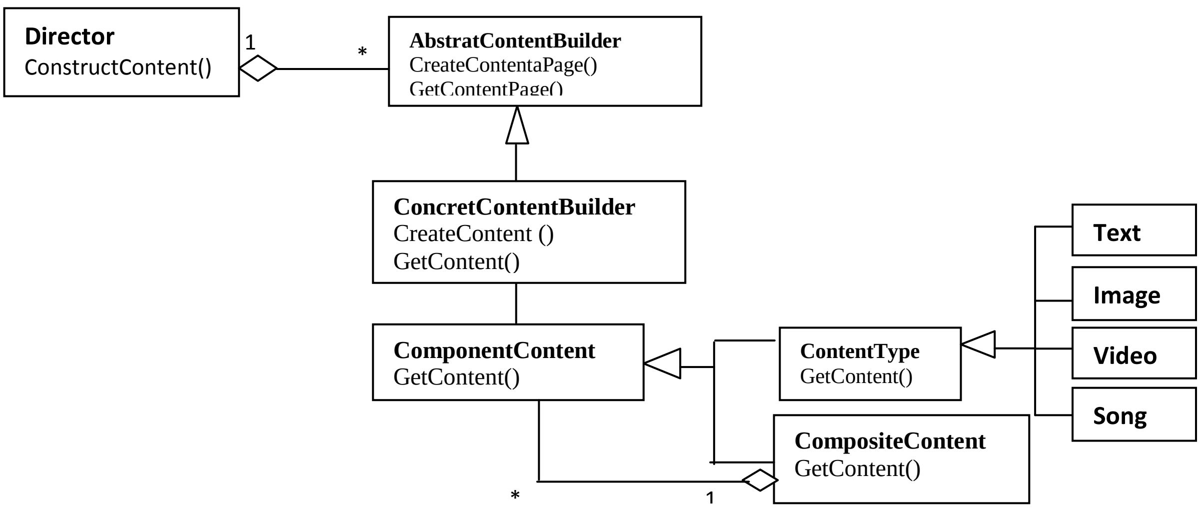

Figure 5: The Builder pattern with the *Composite pattern*.

The *ComponentContent* entity declares the interface of the incoming elements in the mobile learning content composition and implements its default behavior. This entity also defines an interface for accessing and managing *ContentType* components.

The *CompositeContent* entity defines the behavior of content composed of multiple types, stores components, and implements operations related to them. Thus the *CompositeContent* contains several other components, which makes it a kind of container.

The *ConcretContentBuilder* manipulates content elements using the interface. It can group these elements to build several types of presentations.

Conclusion

The field of Mlearning has recently attracted the attention of a large number of researchers. Despite the existence of various approaches to adapting learning content to the context of use, particularly for mobile applications, they have several limitations. Based on this finding, we have used these deficiencies as our research focus. We have focused our efforts on the problems of these systems, such as the consideration of a limited range of context and the lack of an adaptation process.

Adapting mobile learning content to the context of use requires a good approach to acquiring context, reasoning, constructing learning content to represent and managing adaptation to each context change. The proposed architecture, based on design patterns, covers these different functional needs. In the next work, we are trying to implement a case study from our lives. We take one example as proof of concept of the proposed architecture for adapting mobile learning content.

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