Supporting Content Contextualization in Web based Applications on Mobile Devices

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Abstract: Mobile devices, in the form of smartphones, are endowed with rich capabilities in terms of multimedia, sensors and connectivity. The wide adoption of these devices allows using them across different settings and situations. One area in which mobile devices become more and more prominent is within the field of mobile learning. Here, mobile devices provide rich possibilities for the contextualization of the learner, by using the set of sensors available in the device. On the one hand, the usage of mobile devices enables participation in learning activities independent of time and space. Nevertheless, developing mobile learning applications for the heterogeneity of mobile devices available in the market becomes a challenge. Not only this is a problem related to form factor aspects, but also the large number of different operating systems, platforms and app infrastructures (app stores) are aspects to be considered. In this paper we present our initial efforts with regard to the development of cross-platform mobile applications to support the contextualization of learning content.

1 INTRODUCTION

In recent years, the use of mobile devices to support teaching and learning has gained increasing attention. These devices have become important components of modern learning environments and they allow learners to get engaged in different learning activities independent of time and space (Sharples et al., 2009). Mobile devices, in the form of smartphones or tablets, provide rich functionalities with respect to the contextualization of the learner as they incorporate a rich set of sensors that provide data that can be used to gather information about the current context of a user. Determining the current geo-position of the learner does provide a first step towards gathering the entire set of contextual information of a learner. Other kind of contextual information might include acceleration sensor data that allows to track whether the learner is currently on the move (e.g., in a public transport system) or in a stable position (e.g., sitting in a café). Furthermore, the digital compass available in smartphones can be used to calculate the current viewpoint of the learner. Additionally, the camera can be used for capturing photos, and therefore create additional learning materials or scan, e.g., barcodes providing access to certain learning materials. Once the context is determined, the different learning resources can be made available and tailored to the learner´s situation through access to standard learning management systems (LMS).

A major challenge on developing and scaling up m-learning application addressing some of the issues mention above is how to cope with the wide range of mobile devices and operating systems available. We agree with Thomas et al., (2012) in the sense that we couldn’t follow an app-based strategy for core services, at scale, with the uncertainty of all the time having around a large number of different platforms and changing markets. The development of mobile applications aiming at providing a rich contextualization for the learners is difficult because it requires a large number of different platforms and devices with different specifications (computational power, screen-size, available memory, etc.) (Tan et al., 2009). Kauninef et al., (2012) suggested a m-learning approach that contextualize the learning content by using multimedia capabilities of the devices independently from the time and place. Learning content becomes instead adaptable to the device screen size and battery life. Other approaches, such the one proposed by Giemza and

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Jansen (2011) suggest the use of a flexible architecture adaptable to the device screen, input methods, etc. and provide different representation views for the same content on different device types in the learning scenarios.

One way to overcome some of the mentioned above problems is the implementation of platform independent mobile applications for retrieving content and contextual information about the learner. In this paper we describe our initial efforts while exploring how to develop and implement different mechanisms to support the contextualization of the learner. The paper is organized as follows. Section two introduces in details the problem description and the motivation for this work. The last two sections describe technical and implementations aspects and the first implementation of a prototype. The paper concludes with a short outlook and plans for future work are presented.

2 PROBLEM DESCRIPTION AND MOTIVATION

One of the challenges we are addressing is how learning content in the form of learning objects, materials, resources or services can be available and retrieved in a way that they are relevant to the user in his/her current context. Contextual information about the environment (location, time, lightning, noise, etc.) or communication resources (network connectivity, communication costs, etc.) could be used to determine some features of the user´s current context (Anastasios, 2008). There are two main problems associated to this situation; one of them is how to provide the convenient access to the content available at a LMS while the other one is taking into account the wide range of mobile devices that learners may have, so to provide the right features of the user´s current context as discussed above.

According to the first problem, mobile devices can be used to access learning material available at different LMS (such as Moodle) via a mobile web browser or by downloading native apps, which usually do not take the current context of the learner into account. Jordi et al., (2012) have recently developed web service extensions to already existing Moodle 2.0 web services that allow mobile interactions with course content and management of user's personal content, viewing and uploading assignments, etc. Unfortunately, this extension does not provide the possibility to download learning materials (in formats such .pdf, .rtf, etc.) to the mobile client. Therefore, to our knowledge there are not many implementations able to provide the suitable content depending on the user´s current context. If it was possible to derive the user´s contextual information combined with a set of rules and behaviours, then we can offer and provide the appropriate content and format of learning materials. For example, students travelling on the train or bus can use audio materials instead of text documents due to poor lighting conditions. Contextualization of the learning content in a variety of settings can make the learning process more convenient.

One of the approaches to solve the second problem related to software implementation issues is to rely on web-based solutions. Using only JavaScript, HTML and CSS provide us with limited possibilities respect to taking advantage of the device capabilities, mainly due to security restrictions that do not allow access to device specific hardware such as the camera, the accelerometer, etc. In order to overcome this kind of restrictions, solutions such as the PhoneGap framework have been developed. With the help of this framework, HTML5 and JavaScript applications have the ability to use device specific resources on mobile devices in a platform independent way. In this paper we propose an approach that provides convenient and flexible access to the content from different LMS with the corresponding user´s current context for different mobile devices. Since the learners can have different types of mobile devices there is a need for platform independent development of such applications. In our case, this purpose is achieved by the development of a hybrid cross-platform mobile application that addresses the issues discussed earlier in this section.

3 TECHNICAL APPROACH AND IMPLEMENTATION ISSUES

This section describes the technical approach we have chosen to implement the cross-platform mobile application to support the contextualization of the learner. In order to get the content (learning materials) from a specific LMS (Moodle in our case), we implemented a Web Service that directly provides access to the learning resources (Fig. 1). Therefore, single resources stored in the LMS can easily be accessed by a learner by just scanning a QR code. The idea behind using a QR code image is for determining the current context (position, time and so on) of the learner, as additional information about the learning material.

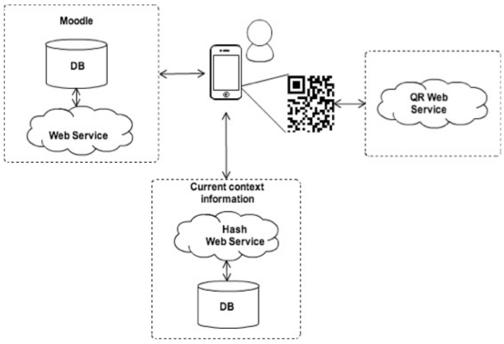

Figure 1: The different components of our proposed approach.

On the server side, as shown in Fig.1, we have implemented a Web Service that is capable of transferring/interpreting images of scanned QR codes taken by the camera of a mobile device. Afterwards, the Web Service is capable of analysing the images of the scanned QR code and it returns a hash code. We decided not to directly store the URL to the according resource in the QR code to increase the flexibility of the provided solution. We have implemented an additional Web Service that maps the hash code to the relevant resource in the LMS.

By providing the necessary information gathered by the sensors in the mobile device, the Web Service can determine the current context in which the user tries to access a certain learning material. For example, with the help of the geo-position of the user and the values measured by the acceleration sensor, it could be possible to determine where the learner is currently located and if he/she is moving or not. Furthermore, the selection of learning materials might be influenced by the contextual information about the learner. If the learner is currently moving or located on a nearly fixed position, e.g., a podcast of the corresponding learning material might be more appropriate than a presentation on slides since we might assume that the learner is currently driving in his car or on a public transportation system. The other way round, if the learner is in a geographically fixed position, it might be assumed that he/she is currently sitting in a particular location where consuming visual materials (slides or video presentation) might be appropriate. Therefore, learning materials can be selected (based on a set of recommendations) for supporting content contextualization. For instance, for each set of possible defined scenarios we could provide a set of recommendations about learning material (e.g. format type) with respect to current context/position. As described above, all major functionalities are implemented as Web Services that allows rapid and flexible development of new applications that make use of the provided functionality.

There are several approaches for developing cross-platform mobile application. One of them is to use specific development frameworks that provide a platform-independent API where the code, using a cross-compiler, is transformed into platform-specific native app targeted at the different platforms that the application will run on. The advantages of this approach are the access of platform dependent resources of the mobile device and an increased performance, as the application works natively on the device. On the other hand, the disadvantage of this approach is the complexity of writing the cross compiler. There is another approach to develop mobile web applications that will run in a browser-view embedded into a native app as hybrid apps. PhoneGap is a framework that utilizes this approach and provides a cloud service that easy can compile and build mobile apps with the latest version of the SDK for the target platforms. One of the main advantages of this approach is related to performance, as it runs on the mobile device not in the browser and processes the JavaScript locally.

4 IMPLEMENTATION OF THE FIRST PROTOTYPE

This section describes the implementation of the first prototype and the functions and interactions between the Web Services and the mobile application.

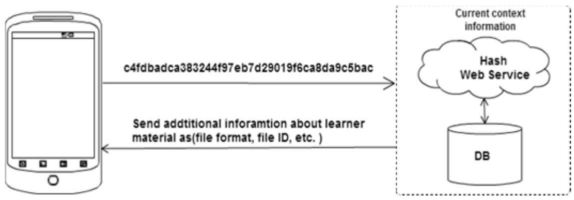

Figure 2: The operation of retrieving information about the resources from the LMS.

A learner can take a picture of the QR code image as described in the previous section. After this the Web Service that translates the hash code into information about the resources of the LMS is called. For instance, information about different format types of learning material, path to those in the LMS, as well as name, size, etc., could be retrieved from this service. After getting additional information about the learning material, this content can be retrieved from the LMS by using the Web Service implemented for providing the suitable resources from the LMS (see Figure 2 above).

For the implementation of the client side, we used the Vaadin TouchKit framework that allows creating the mobile user interface similar to native mobile apps. This framework gives the opportunity to create the mobile application on Java without using any scripting languages. This framework doesn't provide the creation of hybrid applications for that we used the PhoneGap Build service for building the native app for the target platforms. To get access to the specific hardware of the mobile device (e.g., the camera) we used the PhoneGap library, made for using it in Google Web Toolkit (GWT) applications) that provides access to almost all mobile features. Furthermore, new features are flexibly added to this API so that the integration is possible seamlessly.

5 CONCLUSIONS

This paper described an approach for receiving contextualized learning materials from a learning management system on mobile devices with gathering additional information about the learner's current context. One of the major benefits of the presented approach is the platform independent implementation of the mobile application by using PhoneGap build service that allows customized user interfaces best suited for the different platforms we wanted to support. Furthermore, the proposed approach provides a great deal of flexibility by implementing the major features as stand-alone Web Services that can easily be consumed also by other applications.

Future plans for the development of our work do include on the one hand, a heuristic evaluation focussing on the model and software engineering approach used for retrieving the contextual information and defining the set of recommendations according to this information. Particularly identify the main context dimensions, design and explore multi-dimensional vector-space model for contextualization of learner. This will include using not only the camera on the mobile device but also additional sensors as GPS, accelerometer, etc. On the other hand, a comparison evaluating the advantages and drawbacks of the different frameworks used for the implementation of cross platform mobile apps, as presented earlier is also planned. We are currently deploying the mobile application using IBM´s mobile development platform called IBM worklight studio.

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