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A Conceptual Framework of the Use of Mobile Augmented Reality in Peer Assessment

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Abstract: This study presents a conceptual framework of applying mobile augmented reality technology on peer assessment to reduce the bounds of work reviews and assessment. According to mobile technology and augmented reality, students can show their design in various ways at different places or in different situations. This paper proposes a novel mobile peer-assessment system which combines augmented reality with the reviewing and assessing processes. This framework enables students to enhance work interpretation, frequently interact with peers, represent their thinking and reflect upon their own works. Furthermore, the mobile AR technique provides personalized and location-based adaptive contents that enable individual students to interact with the mixed reality environment and to observe how works are possibly applied to the real world in the future. The whole process assists students in reviewing works based on various dimensions, gaining proper knowledge, cultivating critical thinking skills and reflection as well as promoting meaningful learning.

Keywords: Augmented reality, peer assessment, mobile learning

1. Introduction

Peer assessment has been widely recognized as an educational arrangement and a learning tool for enhancing student's participation and improving student's performance (Topping, Smith, Swanson and Elliot, 2000; Van den Berg, Admiraal and Pilot, 2006). Previous studies related to education, business, health and science on self and peer assessment in higher education have indicated that students who involve in the interactive assessment process can enhance their interpretation and reflection (Searby and Ewers, 1997; Ballantyne, Hughes and Mylonas, 2002; Prins, Sluijsmans, Kirschner and Strijbos, 2005; Price and O'Donovan, 2006). In recent years, mobile technology provides the potential of creating innovation learning experiences. In order to eliminate the limitation of space and time, mobile peer assessment positively influences the assessment methods and outcomes and enables students to submit their own work, review peers' work, mark and provide feedback conveniently by using their own handheld devices. However, during the peer assessment process, providing students with sufficient information to review peers' work is preferable. Augmented reality (AR) is the technology that provides the right contents at the right place at the right time. The mobile AR technique is able to overlay virtual objects on the real work to present rich information to students and construct meaningful presentation by combining location-awareness and contextual learning. In order to provide full insight into effective peer assessment processes, this study presents a conceptual framework for providing intelligent and mobile supports through incorporating the AR technique to enhance work presentation and the effectiveness of peer assessment. In this framework, the difficulty of reviewing peers' work and understanding peers' thinking can be resolved

and sufficient information representation enables accurate assessment. Most importantly, appropriate assessment criteria and rich feedback facilitate students to reflect upon their own work and improve the quality of their work. Through reviewing peers' work in various situations, students are able to acquire more knowledge.

2. Applying Mobile Augmented Reality in Peer Assessment

Regarding how to effectively involve students in peer assessment, these processes including exploration of assessment criteria, presentation of works, assessment methods, coordination of assessment and feedback are very critical (Chen, 2010; Lan, Lai, Chou and Chao, 2012). Appropriate technologies applied in peer assessment can assist the reviewing and assessing activities. In recent years, students attempt to learn in various locations, and therefore some studies have proposed the critical issue of how to use handheld devices to enhance assessment (Penuel, Lynn and Berger, 2007; Shin, Norris and Soloway, 2007). Students can use handheld devices to flexibly do self- and peer-assessment inside and outside classrooms (Chen, 2010). Chen indicated that combining mobile technology with the concept of round-table presentations, the mobile self- and peer-assessment system can assist teachers to arrange assessment activities more flexibly and make students more attentive to presentation, interaction and feedback in the assessment process. However, most of these studies emphasize the exploration of assessment criteria, marking process and the promotion of feedback to enhance the effectiveness and reflection of peer and self- assessment. Actually, it is a very critical issue that students' work can be presented in detailed during the assessing process. Through reviewing peers' work, students can understand how to mark and reflect upon their own work.

In order to present students' work and ideas sufficiently during the assessment process, augmented reality (AR) is the technology that shows the right contents for the right device to the proper person at the right place and at the right time (Chang and Tan, 2010; Chang, Tan and Tao, 2010). AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. AR supplements reality, rather than completely replacing it (Azuma, 1997; Azuma et al., 2001). It can overlay virtual objects on the real world to fulfill the feeling of immersion and therefore supplements user's everyday life with information, images, sounds, and other sensory information from their devices. Shortly to say, through putting a virtual layer of information over the real world, AR pretends that virtual objects are real and presented at the right place. In recent years, significant advancements related to wireless and mobile technologies make handheld devices which combine several utilities to be the most convenient platform for the AR technique. The camera on the handheld device can capture images of real world, a compass can detect the direction of user's face, the GPS receiver can locate the position of users, and the monitor can show the images of the outcome that the mobile AR technique create, which can be text, table, image, video and their combination. Even more, extra components such as buttons or tables can be included for interaction. The mobile AR technique provides pliable mobility and a location independent service without constraining the individual to a specific area. According to the NMC Horizon Report 2012 K-12 Edition, AR supports visual and highly interactive forms of learning in education. Students can use it to construct new understanding based on interactions with virtual objects that bring underlying data to life as it responds to user input (NMC Horizon Report, 2012). Numerous researches has proposed how the AR technique helps students to learn, such as serious games, language learning, e-books, storytelling, driving guidance, and so on (Azuma, 1997; Van Krevelen and Poelman, 2010; Chen and Tsai, 2012). By this way, AR holds the possibility to revolutionize the way in which information is demonstrated to people and has great potential for on-demand, context-aware, and collaborative training (Hollerer, 2001). Moreover, the mobile AR technique provides personalized and location-based adaptive contents for individual students to interact with the mobile viewing environment, and see how works are applied to the real environment in the future at the current place.

According to the above mentioned, the mobile AR technique can obviously support students to review peers' work during the peer assessment process. Formerly, in a design course, students only review the work based on assessment criteria such as originality, produce skill, colour scheme and so on but cannot view the usability of the work in the future in this environment where the assessor located. However, the most important functionality of a location-based mobile AR technique is to

provide the proper contents according to students' current location. The relevant contents in students' vicinity can be presented by the mobile AR technique automatically while students walk in the area. For example, in the design course, while students stand in a specific environment, they can observe how a painting can be hanged on the wall or becomes a fresco or how a handiwork can be rebuilt to a sculpture putting in the environment. The mobile AR technique can fuse digital media with the physical world to create the proper conditions for locative, contextual and situation-based demo scenarios. In this study, during the peer assessment process, assessors not only assess the work presented in front of them but also image the future application of the work. Therefore, assessors can know the design skills and ideas of designers as well as the usability of the work in the future.

3. System Architecture

In the educational field, there are many situations cannot be experienced in the classroom. Augmented reality is the latest technology that can accommodate or modify their learning experience to their specific needs. Augmented reality is defined as a real-world environment whose elements are built upon computer-generated sensory input such as sound, video, graphics or GPS data. In this study, AR allows students to see virtual objects about peers' works or contents in a real world environment with the aid of camera during the assessment process. The overall framework of the use of mobile AR technique in peer assessment is described in Figure 1.

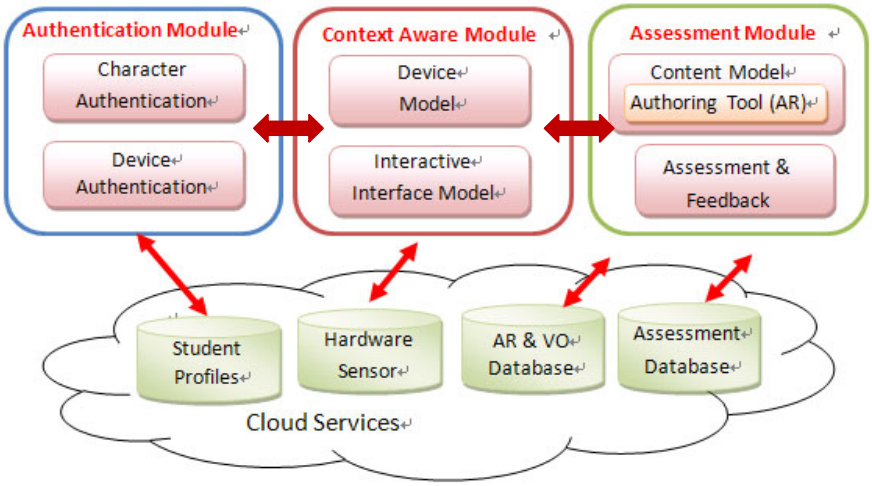
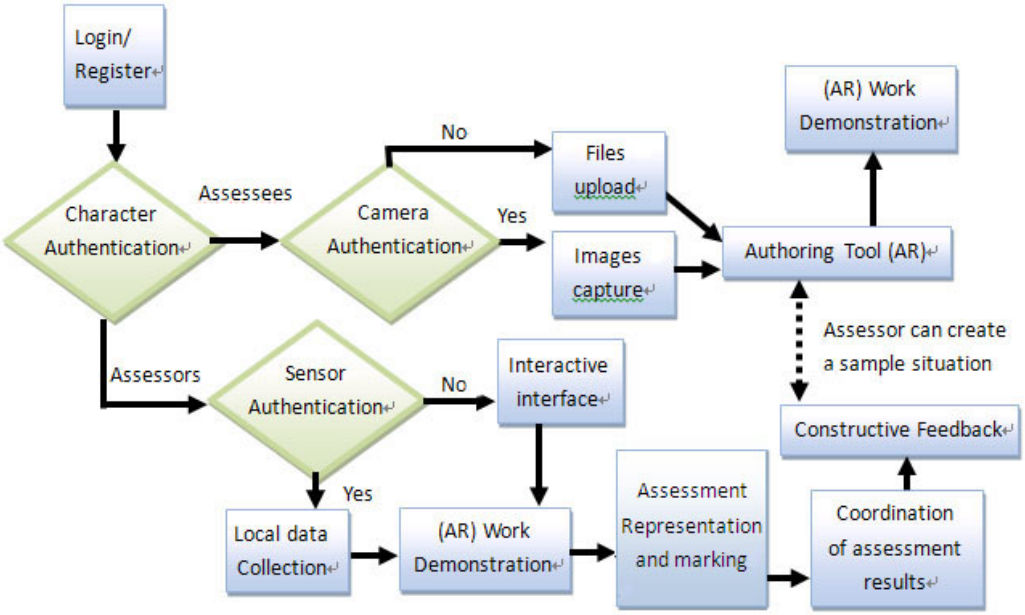


Figure 1. The architecture of the mobile augmented reality peer assessment system

During the whole learning and assess process, all procedures are parted into three modules including the authentication module, the context aware module, and the interactive assessment module. There are four databases in the cloud, including the student profiles, hardware sensor, the AR and virtual object database and the assessment database. The authentication module enables right people to get right information to assess right works. The context aware module enables assessors to use proper device to receive right context for assessment. In the context aware module, the device model detects students' devices and collects local data in order to choose a proper context list in the content model. The content model provides right materials to assessors from the virtual object database. Students can use an authoring tool to create AR tag, work introduction, and even AR situations. When the uploading work is done, the proper content can be overlaid on the real world image through the AR technique, and thus assessors mark these works more conveniently and accurately. According to the application of the AR technique on work demonstration, the assessment module enables assessors to review peers' works conveniently and intuitively. Assessors can give feedback to assessees and create new AR situations for the work that can assist assessees to reflect upon their work design. For teachers, they can know how students review peers' work from the AR situations and give more feedback to assessors and assessees. Moreover, teachers can create integrated AR situations for further applications.

Figure 2 indicates the process of the use of the AR technique in peer assessment. At the beginning of the assessment activities, students must login to authenticate their identities. There are two kinds of characters including assessors and assessees who need to upload works. All data related to students have been built in the student profiles. Next, the system detects how many kinds of sensors the student's handheld device has. Camera is the most important function for assessees. An assessee should create a demonstration situation for his own work by using the AR authoring tool. If there is no camera in the assesse's handheld device, he/she should upload some images or video files. For an assessor, if the sensors in demand do not exist in the assessor's device, the interactive interface model will be activated to ask the assessor some questions to check the right situation. Subsequently,



assessors have to involve in assessment activities including assessment representation, marking, coordination of assessment result and constructive feedback.

Figure 2. The process of the mobile augmented reality peer assessment system

4. Illustrative Example

In this study, some undergraduates majoring in visual communication design enrolled a fundamental design course and were arranged in small groups. The teacher assigned a painting work and then students could receive the notification on their own mobile phone or tablet. Students had three weeks to prepare their drafts and the exposition of their design ideas after which these were uploaded onto a mobile augmented reality peer assessment system. Subsequently, during the assessment process, the teacher designed two activities in which students had to mark peers' work in an indoor environment as well as in an outdoor environment. The assessment situations in indoor and outdoor environments and the interfaces of the system were presented in Figure 3.

In the indoor situation, assessors go to the exhibition to capture the tag through their own camera on handheld devices. Then, they can see the work that can be constructed as a physical produce in the real world. The introduction of assessees' work and the assessment criteria can be shown on the device at the same time. In the outdoor situation, assessors go to outside to capture the tag on the wall, and then the visual work is presented on the wall in the real world. Assessors can review the assessees' information and assessment criteria as well. However, assessment criteria are different based on the varied situations. For example, assessment criteria including suitable, originality and colour scheme have to be considered in the indoor assessment, and assessors mark the dimensions of suitable, exquisite level and usability in the outdoor assessment according to the features of outdoor situation. By this way assessors can mark the usability of the work at the current

location. In addition, all assessment related to the work can be presented simultaneously on the device as shown as the right side of Figure 3.

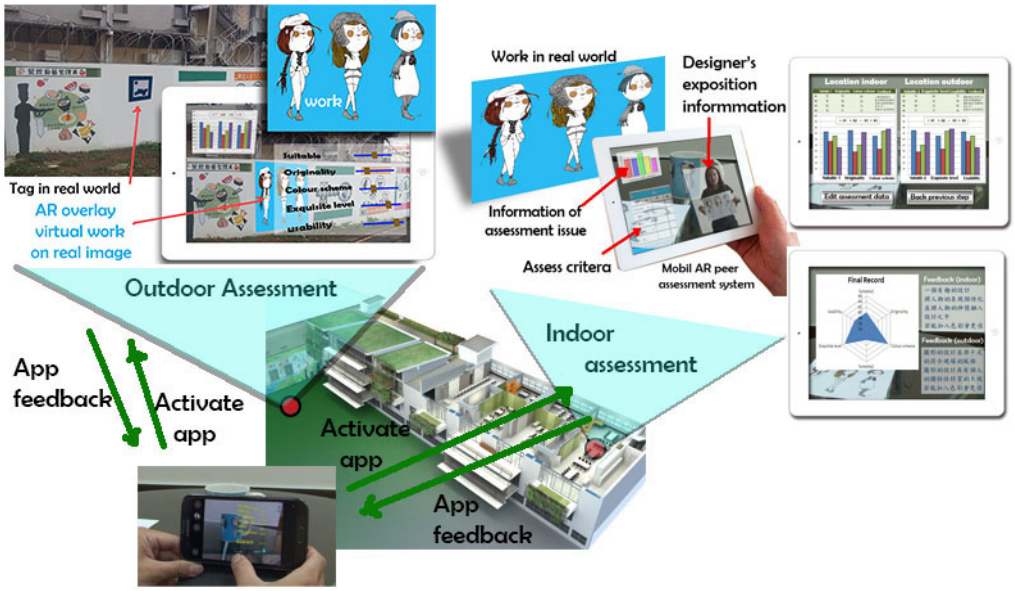


Figure 3. The demonstration of the mobile augmented reality peer assessment system

According to the different surroundings, students are not only able to acquire the relative explanation and representation of work but also apply appropriate assessment criteria that produce sufficient assessment results to mark peers' work. The system facilitates students to observe other assessors' marking as well as receive assessment feedback. Therefore, students can reflect upon their work according to the various and meaningful feedback received.

5. Conclusions

This study proposes a novel framework which incorporates augmented reality into the reviewing and assessing process to enrich peer assessment. The mechanism enables students to review and assess peers' work represented with the AR technique through combining virtual objects with the real world. Students can use their own handheld devices to capture and acquire appropriate information at the right time in the right situation. The mobile AR technique provides flexible mobility and location-based adaptive contents to interact with the assessing work and the real world for individual students. By incorporating the AR technique, the proposed framework enhances work interpretation, frequently interact with peers, represent their thinking and reflect upon their work. The overall process facilitates students in fostering critical thinking skills and improving the quality of their work as well as promoting meaningful learning. Although the proposed framework has indicated the assistance of incorporating AR in peer assessment, considerable work remains to be done, including further large-scale classroom experiments and system adaptability.

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