A Collaborative Augmented Campus Based on Location-Aware Mobile Technology

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ABSTRACT

Mobile devices are changing the way people work and communicate. Most of the innovative devices offer the opportunity to integrate augmented reality in mobile applications, permitting the combination of the real world with virtual information. This feature can be particularly useful to enhance informal and formal didactic actions based on student collaboration. This paper describes a “collaborative campus”, originated in the physical architectural space, but exposing learning contents and social information structured as augmented virtual areas. ACCampus, a mobile augmented reality system, supporting the sharing of contextualized information is proposed. This system combines the world perceived by the phone camera with information concerning student location and community, enabling users to share multimedia information in location-based content areas. User localization is initially detected through QR codes. The successive positions of the user are determined using the mobile device sensors. Each augmented area is univocally spatially associated to a representative real wall area. Selective content sharing and collaboration are supported, enabling a user to distribute his/her augmented contents to specific users or groups. An evaluation of the proposed environment is also conducted, which considers that learning in collaborative environments is related to perceived member contribution, enjoinment, motivation, and student participation.

Keywords: Augmented Reality, E-Learning 2.0, Collaborative Learning, Location-Aware Learning, Mobile Learning

INTRODUCTION

Together with social software, also mobile devices are producing a deep transformation on the way people communicate and can be adopted together with Internet to motivate learners (Georgiev et al., 2004; Sharples & Roschelle, 2010).

The user interaction scenarios implemented on mobile phones for accessing Internet is generally limited to traditional API, button-based interfaces. Top-of-the-range mobile devices al-
low us to adopt Augmented Reality (AR) based technologies to involve users in a mixed reality, made up of real world, observed towards a the device camera, and of overlapped informative contents (Doswell et al., 2010; Henrysson et al., 2005; Liu & Chu, 2008; Liu et al., 2010). In particular, the usage of AR is facilitated because of the innovative characteristics of the last device generation (on-board camera, accelerometers, compass, GPS etc.), combining instantly the preview made by the video camera with the AR information. Using this approach, mobile devices expand the users’ perceptions and interaction styles by providing context and location awareness: the real world perceived through the phone camera is always visible to users and is augmented with information associated to the user location.

Exploiting AR context-awareness, this paper goes in the direction of the creation of a “collaborative campus”, named ACCampus, which extends the metaphor of “cooperative building”, i.e., room elements with integrated information technology (Streitz et al., 2001). The augmented campus is set in the physical architectural space, it exposes AR learning contents to users’ interaction, allowing students to create and share social information, according to the needs expressed in Garaj (2010). User localization is initially detected through “Quick Response” (QR) codes (Wikipedia, n.d.). The successive positions of the user are determined using the mobile device sensors. An ad-hoc developed group presenter tool supports synchronous context-based group discussions inside the campus environment.

The proposed approach has the following objectives:

- Creating a mixed reality “place” (Fitzmaurice, 1993) where formal and informal discussions might arise to support collaboration and group activities. In this communication place, the world observed through the phone camera is augmented by information concerning the user location, his profile and his community, enabling students to share multimedia contents in location-based areas;
- Supporting m-learning processes, improving student collaboration and motivation;
- Evaluating how the proposed learning environment and its related learning model influence students’ feelings toward collaborative learning, as well as to assess the degree of system acceptance by proposing a questionnaire survey and by analyzing the student participation to a collaborative session.

The rest of the paper is organized as follows: First, we present a review of the literature and of researches related to the system; next we present the main features offered by ACCampus, and describe some usage scenarios. We present an example of collaborative learning process supported by the proposed system, illustrate the evaluation phase, and discuss the results of the experience. Finally, we conclude the paper.

**BACKGROUND**

To get the objectives of location-based and immersive collaborative learning, this paper presents an AR-supported location-based environment adopting handheld phones for facilitating the sharing of contents. The mixed reality surrounding the user actively involves her/him in interesting collaborative activities, thus enhancing her/his collaboration skills.

Considering the objectives of the proposed work, the background information is organized in two different sections, strictly related among them.

**M-Learning and Augmented Reality**

In the last few years, the amount of various mobile devices and their computational power are dramatically increasing (Sharples & Roschelle, 2010). The variety of computer-like functionalities available on the top-of-the-range devices and their diffusion enable to consider them as a pervasive learning platform. The application of
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