

An Augmented Reality Application to support Learning and to get Participant Feedback

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Abstract

Mobile devices are radically changing the way in which we 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 and on traditional lecture. This paper describes a “collaborative campus”, originated in the physical architectural space, but exposing learning contents and social information structured as augmented virtual areas. To this aim, ACCampus, a mobile augmented reality system, supporting the sharing of contextualized information has been proposed. This system combines the world perceived by the phone camera with information concerning the student location and his 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 also supported enabling a user to distribute his/her augmented contents to specific users or groups. The application also supports the teacher during Face-to-Face lecture in receiving feedback from the audience concerning their agreement with and the clarity of the presentation.

Categories and Subject Descriptors (according to ACM CCS): H.5.3 Group and Organization Interfaces

1. 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 [GGS04] [SR2010].

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 allow 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 [DBB06] [HBO05] [LC08][LTC10]. 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 [STM*01]. 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 [Gar10]. User localization is initially detected through “Quick Response” (QR) codes. The successive positions of the user are determined using the mobile device sensors.

The proposed approach has the following objectives:

- creating a mixed reality “place” 0 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/her community, ena-

bling students to share multimedia contents in location-based areas;

- supporting m-learning processes, improving student collaboration and motivation;
- provide feedback to the teacher on the student perception during a lecture.

The rest of the paper is organized as follows: Section 2 is a review of the literature and of researches related to the system; Section 3 presents the main features offered by ACCampus, while Section 4 concludes.

2. Related Work

In the last few years, the amount of various mobile devices and their computational power are dramatically increasing [SR10]. 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 mobile technologies to the learning process is named mobile learning or m-learning [GGS04].

Generally, mobile systems support learning “anytime, anywhere”, but, with the empowering of the devices, they can be effectively adopted to support students’ face-to-face interactions as well as their coordination in collaborative learning activities. Examples of these technologies are student response systems and classroom presenters [RT*07].

In [LL08] [RT*07] tablet PCs have been adopted to support Group Scribbles, basing on the Scribble Sheet, a small square of virtual paper where a single concept can be expressed, whether via a quick sketch or a few words. Scribble Sheets can be posted to public boards, visible to all participants of a group activity. The approach we propose, similarly, enables to publish contents on virtual public boards, also during a group activity.

In [Gar10] the students of a course in Multimedia Technology provided the user requirements for mobile learning applications. This study, among others, puts in evidence the importance of learning across contexts (i.e., to take pictures on location when students perform a visual design activity), of uploading several content types and of combining individual and group uses in a way similar to Youtube, Flickr or blog. The system we propose goes in this direction and seems to satisfy these expectations.

In [TK*09] a location-based dynamic grouping algorithm has been proposed. Learning groups are created identifying the learner geographic locations and other learning factors, generating a Mobile Virtual Campus.

CAARS [DBB06] is a context-aware mobile augmented reality instructional system. The supporting technology is based on a wearable see-through heads-up display. Image recognition and analysis are applied to facilitate accurate

real-world object recognition, also improved with landmark decoding. An example of usage for off line training automotive manufacturing production workers and for providing decision-support on the line is also briefly described. Differently from this approach, the work we propose is mainly based on the sharing of contents and does not require specific hardware, except mobile devices.

In [LTC10] the authors presented a system aiming at supporting English learning integrating the usage of 2D barcodes and Augmented Reality as follows: when approaching a zone, a student used the PDA phone to decrypt a 2D code and then obtained context-aware contents from server. The students then practiced conversation with a virtual learning partner. Differently from them, our approach adopts a single QR code in each environment. In the same environment, the user moves the phone as a window on the mixed realities (augmented and place) and shares with his/her colleagues several content areas. Our approach simplifies the interaction with the environment and proposes the augmented information without requiring the recognition of a bar code for each area in the same room. In addition, learning occurs in a Web 2.0 way: the students collaboratively upload and share contents, disposing also of content presentation facilities.

3. The ACCampus system

The system proposed in this paper supports the creation of communities that can spontaneously occur, or collaborative work of student groups explicitly created for accomplishing specific tasks inside a course.

3.1 The augmented board

The aim of this research is the creation of a “collaborative campus”, which is more than an augmented space: it is a “place” where formal and informal communications occur and new knowledge is built. As described in [HD96], to let the informative space become a place, it is necessary to provide support for adaptation and appropriation of the technology by the campus communities. In particular, people transform a space into a place if they feel to be “at home”, putting their pictures on the walls, disposing the furniture or placing personal objects around their rooms. Similarly, in the augmented campus, students can create their artifacts and attach them on the augmented walls.

During the initial phases of this research, we noticed that the user tends to follow the reality, through the camera preview, by remaining in axe with the cellular phone. This phenomenon is due to the directionality of the device screen, which offers the best vision when the phone is lined up with the user eyes. In addition, users are also typically accustomed to using their mobile device as a photographic camera, and, therefore, the mobile screen as a camera viewfinder. Thus, the device is naturally used as a hand held AR lens giving a moving view on the AR scene. It is important to point out that the user needs to hold the device and, consequently, his/her maneuverability is quite limited.

Basing on these observations, the Azimuth orientation sensor has been adopted for creating a 360-degrees space. This space constitutes a cylinder surrounding the user and ideally laying near the walls of his/her room. While the Azimuth provides the main dimension of the ACCampus augmented reality, the Pitch orientation sensor is combined with the accelerometer to detect how the camera is oriented in the space vertical dimension. This kind of information allows us to implement a natural scrolling mechanism for AR areas and to provide feedback to user by prospectively deforming the projected objects according to the device vertical orientation.



Figure 1. An example of augmented board

Figure 1 shows an augmented wall, associated with the classroom board, as seen by a student. He/she can select with a touch a post in the augmented wall associated to a real blackboard. This image has been obtained mounting a screenshot taken by the phone on the laboratory background image, taken by a regular camera. It is important to point out that although the interface focuses the user interest on the augmented content, the information concerning the surrounding environment is always present.

3.2 The Augmented Campus features

The AR informative places created by using ACCampus organize formal and informal contents presenting them on virtual boards.

Each board can contain several content types: Finger Notes (short messages painted directly on the screen with fingers and stored as images), Text Notes, video and pictures that are directly supported by the system. It is, however, possible to share all other kind of content supported by the available applications.

As in each community, the number of entries can be relevant and it is necessary to adopt some filtering mecha-

nisms. In particular, the system makes use of content ranking, group/user filtering, number of views and newest first.

The augmented campus aims at facilitating communication between students within both the same degree program and the same course. Thus, for each program an AR announcement wall where students can post their messages is available. Similarly, a course wall is located inside each classroom or into a laboratory, as shown in Figure 1, where the board related to the Software Engineering course is shown.

The augmented board can have different usages depending on the set of permissions assigned to the users, considering their roles:

- administration boards, representing the official bulletin board (locked), where contents are provided by the university staff, such as time tables, or teacher news on specific courses;
- student boards, enabling the students to communicate by uploading and commenting contents. They correspond to bulletin boards open to the student community and adopted for not strictly didactic announcements;
- group project boards, specific for group learning approaches. During a project activity, the teacher can create an area for each group. At the end of the collaborative activity, the area can be closed and its content is mirrored on a supporting web site, to free the wall space for other activities; the support provided to student collaboration is described in the next section;
- augmented projector, the system enables a user to surround him/herself with an augmented slide projection visible on the other participant devices. To this aim, he/she uses the specific presenter control to navigate contents and update the objects shown to the others.
- learner feedback, the systems provide a visual feedback in augmented modality to the teacher, resuming the learner impressions on the in presence lecture.

3.3 Lecture support

Lecturing is one of widely used methods of instruction. Nowadays, lectures may adopt many different forms, but regardless the philosophies adopted to strengthen the educational process, a lecturing is oratory, and the lecturer must first successfully communicate with his/her students [DW84]. Consequently, when covering the syllabus over a scheduled period of time, the lecturer will make use of his/her oratory and communication skills by explaining concepts, providing examples, and maybe trying to foster students' active learning by questioning them and proposing exercises. However, in order to successfully achieve the objective of imparting knowledge, it is important that the lecturer obtains continuous feedback from learners' understanding of the lecture. "Are the students following the lecture? Did they correctly understand this explanation?"

Am I explaining the lesson at the adequate pace?”, these are some usual questions that lecturers may ask themselves during a lecture and the answer to which is usually inferred from the students’ expressions and attitudes, the questions they raise, or just by asking them directly. Unfortunately, these methods are not totally reliable. Sometimes students are shy and feel reluctant to communicate their difficulties when trying to understand a concept or following a lecture. Correctly interpreting a student’s expressions is by no means an exact art which can easily lead to misinterpretation and error. Moreover, due to their different profiles and degree of understanding of the course subjects, the questions raised by one or two students may not be representative of the knowledge acquired by most of the classroom. Also, the communication flow from student to lecturer is not as free as it would need to be in order to facilitate learning, as it is usually hampered by the student fear of ‘showing him/herself up’ in front of the rest of the classroom. This problem usually limits student participation during the lecture, and it becomes greater the bigger the lecture hall is. In these cases participation is very often reduced to a small group of enthusiastic students.

The idea consists of providing lecturers with an AR instrument capable of reporting feedbacks on the learners’ opinions and feelings.

Figure 2 shows the proposed AR interface highlighting a participant from whom the feedback would be obtained. As depicted in the picture a triangular view is superimposed on the image of the participant. The feedback information is represented via the well recognized and frequently used smile icons metaphor. In addition, above the viewfinder triangle, the user name is reported. Furthermore, a bridge between the ACCampus system and the social world of Facebook, the well known and popular social network, is also provided. This way, by touching the “f” logo icon on the top right hand side of Figure 2, the user of the interface can access the profile of the participant being observed.

With regard to the feedback communication functionality, the system is able to represent the following feelings and sensations:

With regard to the feedback communication functionality, the application interface allows participants to communicate the following feelings and sensations:

- Learner Comprehension;
- Learner Involvement and Interest;
- Learner Agreement.

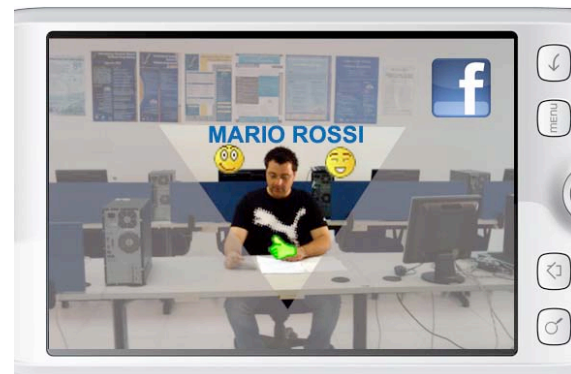


Figure 2. The proposed AR interface provides feedback to the Lecturer

Each piece of feedback information is shown in a different position of the AR interface via the corresponding iconic image. As shown in Figure 2, the upper rightmost side of the triangular area depicts an icon which represents the participant’s level of interest and involvement in the subject of discussion, while on the upper leftmost side the indicator of the participant’s comprehension level is depicted. The lowest corner of the informative triangle depicts the Agreement indicator, which should be triggered by the speaker through a voting request. Let us point out that if the user does not provide a piece of feedback on one or more feelings and sensations the associated space in the interface does not show any symbol.

Figure 3 depicts the icons adopted as visual metaphors for the feedback information. The first five symbols on the left hand side are used to represent the level of Interest and Involvement, in an increasing order. The next five are the ones used for representing the participant’s level of comprehension. Both indicators range in the set {Very Low, Low, Medium, High and Very High}. The rightmost side of Figure 3 shows the binary User Agreement status (respectively no/yes). In accordance with this representation, the participant depicted in Figure 2 reports a Very High level of Interest and Involvement, a High level of Comprehension of the covered subjects, and a positive response to the last voting session requested by the speaker.



Figure 3. The proposed AR metaphors

The proposed AR interface will be connected with the ACCampus user localization sub-system, and the orienteer and accelerometer sensors, embedded in the devices, will provide the necessary information to identify the framed

participant and the shooting angle adopted for increasing the perceived quality of AR objects.

4. Conclusion

In this paper we presenting a system, names ACCampus aiming at support learning at different levels exploiting Augmented Reality and mobile devices. In particular, the system provides context-aware features to support asynchronous group content sharing and to support the teacher during in presence lectures to collect the participant feedbacks.

At the present we are evaluating the usability of the tool and we are developing a version of the system using glasses interface to create a less invasive support during the lectures.

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