

# Designing to Enhance Student Participation in Campus Heritage Using Augmented Reality

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**Abstract**—This paper presents Capsule, a design prototype using augmented reality to encourage students to learn the cultural heritage on campus. Based on a pilot study with prospective and current students, Capsule not only provides students the cultural histories of campus but strengthens the connection between students and heritage by adding features of improving the interaction between students and the heritage. The performance of the prototype was evaluated in a user study with 10 students, which provides design implications for future cultural heritage.

**Index Terms**—Cultural heritage, augmented reality, AR, digital heritage, heritage, mobile, campus heritage

## I. INTRODUCTION

As culture provides people the connection to certain values and communities, cultural heritage provides an automatic sense of unity and belonging to certain groups and communities and allows people to better understand previous generations and the history of where they are and what they are seeing. Specifically, campus heritage provides students with the bonding and attachment to university communities and through a broad and comprehensive understanding of the historical development of the campus. When people start to understand and value the culture, they will learn to care for it and eventually enjoy it. The enjoyment will increase people's thirst to further understand the culture, which makes the whole process a virtuous circle. As for students, learning about the campus culture and heritage could increase the bonding with their universities and strengthen the individual identity to the universities. However, students have limited access to campus culture and heritage. Before the widespread of Internet, students could only gain heritage information from traditional campus tours and heritage archives. Therefore, it is hard to lead students to the start of the heritage cycle.

However, the emergence of internet and social media has enabled the digitization and management of the archived heritage content as well as the user-generated content [3]. These features form the digital cultural heritage that augments the interaction between users and heritage. Internet archives and virtual heritage provide students more convenient and realistic experiences to learn about campus heritage. Digital cultural heritage together with the mobility of mobile devices allow people to access either static or location-based information

more quickly than traditional ways such as online searching and physical archives searching. Furthermore, mobile digital cultural heritage enables documenting, creating, and sharing diverse formats of heritage information such as texts, photos, and videos. These features have also been well applied to mobile tourism [1], [2]. Though current technologies bring people new access to cultural heritage, more efforts should be made to motivate people to learn about cultural heritage. Thus, we aim to apply new technologies to the current mobile platforms for better interactions between students and heritage. Augmented reality (AR) as an interesting and innovative technology could be used here to enrich students' perceptual experiences with the campus heritage in a real world context. In this paper, we present a design prototype called Capsule that applies the AR technology into the interaction process, in which students could learn about the campus heritage in a real-world environment as well as having the opportunity to manipulate and interact with the digital heritage freely.

## II. METHODS

In order to come up with a useful and practical design prototype, we performed a pilot study exploring the needs and obstacles students are facing while they learn the campus heritage. We then conducted a user study to assess our design prototype and to gain useful insights for future prototype design. As the target user groups are students, the participants for pilot study include two groups of prospective students and their parents found from a campus tour of the university, and 5 current full-time students at the university by online recruitment from October to November 2017. All participants were over 18 years old, and were presented with consent form before the interviews. Each pilot study included a 20-minute semi-structured interview. Specifically, for prospective students, the interviews aim at understanding their motivations and expectations from the campus tour by asking questions such as why they participate in the campus tour, what is the most interesting story they've heard from the tour, and whether there is any information provided from the tour that is not enough/clear. For current students, the interviews were about understanding their perceptions on the campus heritage and their connections with the university. The interview questions include what kind of campus heritage they know, if they are

interested in learning the campus heritage, and how they learn about the campus heritage.

As a result of the pilot study, we came up with a design prototype, Capsule. Specifically, we used the most identical heritage of the university as an example in our prototype. The information provided in our prototype was about the identical heritage site and was collected from university archives. We then conducted an audio-recorded user study with 10 current students at the university. Demographics of participants were collected, including age, gender, major, and whether they had experiences of using an AR app. Detailed demographics are presented in Table I. In the study, participants were given a mobile phone with the prototype installed, and were asked to think aloud while we perform specific tasks such as taking pictures with the AR objects and comparing the heritage pictures with current objects. An short interview was followed up to collect their feedback on the prototype. The overall study lasted about 15 minutes. We originally conducted our user studies at the heritage site; however, participants reported their hands felt cold when holding the mobile phone, and the noisy environment made the recording out of quality, so we moved our study to a lab environment. In the lab, we used a picture of the heritage site to represent the real heritage. The prototype then used image recognition function to activate the AR features. Moreover, as the lab environment limited the possibility of taking pictures with AR objects, we provided sample pictures for participants to perceive.

TABLE I  
PARTICIPANT DEMOGRAPHICS

Table	Demographics			
	Gender	Age	Major	Exp in AR
P1	M	28	Culture and Society	Yes
P2	M	28	Human Computer Interaction	Yes
P3	F	27	Information System	Yes
P4	M	25	Computer Science	Yes
P5	F	24	Music	Yes
P6	F	22	International Studies	Yes
P7	F	20	Marketing	No
P8	F	22	Security	No
P9	M	22	Finance	No
P10	F	25	Human Computer Interaction	Yes

### III. PROTOTYPE DESIGN

In this section, we introduce the prototype design generated from the results of our pilot study.

#### A. Pilot Study Findings

Here are the findings from our pilot study to help us build up the prototype. First, our participants showed great interests in learning the campus heritage. Specifically, prospective students and their parents wanted to learn about the campus culture and the heritage from a campus tour to decide which university the kids would go. They showed their love to the introduction and funny stories behind the campus heritage from the tour guide. However, all the participants mentioned that it was very hard to hear the tour guide talking outside especially when there

were many other visitors walking between the tour guide and them. Second, the outdoor noise such as wind blowing and car driving sound would hinder them from listening clearly to the tour guide. Additionally, as we also participated into the campus tour, we observed that most people in the tour took pictures with the heritage, which not only indicated they used their phones frequently during the tour but they wanted to keep a memory of the tour through pictures. As for current students, some students showed their interests about learning the campus heritage but felt there were few resources they could access. Other students demonstrated the main reason they were not interested in was that they didn't feel they were connected with the heritage and have not realized that they were also a part of the history. To address these problems, we see great potentials in mobile AR technology that could connect people with cultural heritage in the real world through an interactive way using mobile devices. AR enables users to have direct interactions with the cultural heritage and historical figures, and also to leave their own footprints on the heritage. Therefore, we designed and implemented the Capsule, a campus heritage prototype using AR, to solve the problems above. Detailed design descriptions are presented below.

#### B. System Requirements of Prototype

The application prototype is based on a mobile device using Android 4.4+ or iOS 9+ as the operating system and is equipped with a camera and touch screen. The AR function requires network access to work and the Global Positioning System (GPS) requires access to GPS function in the mobile device. The prototype is developed using the game engine Unity and Vuforia 7 plugin. Thus, no physical learning materials are needed.

#### C. System Design

Our application prototype contains several features categorized into two major contributions: an education component and a sense of belonging (see Fig. 1).

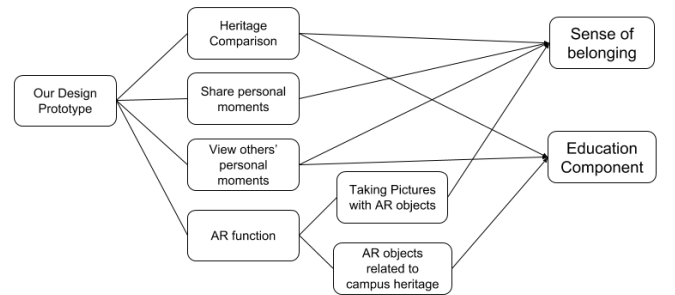


Fig. 1. System design of the prototype

1) *Education component*: Our prototype provides the basic heritage information in a storytelling way. Students could learn about the cultural heritage by interacting with the AR figures related to the heritage. Detailed interfaces are described in the next section.

2) *Sense of belonging*: Since students had less connection to the campus heritage, our design stresses the connection between students and the heritage by adding features such as taking pictures with AR objects related to the heritage, sharing personal moments, and viewing others' personal moments with the heritage.

#### D. Interface Design

The ideal augmented reality feature in this mobile app utilized image/object recognition technology and the GPS. A user can use a phone to scan the cultural heritage building. GPS together with image/object recognition will process the data and response according to cellphone position. Accordingly, the user can adjust its angle and stand in the right position based on the instructions (see Fig. 2(a)). We didn't include GPS function in our current prototype.

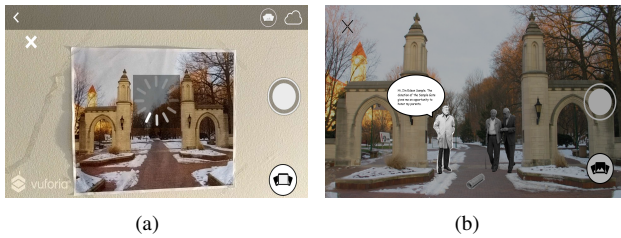


Fig. 2. (a) heritage scanning; (b) AR figures with heritage stories.

AR figures appear after scanning. Each AR figure is dynamic and interactive. By tapping a AR figure, a chat bubble that contains historical story will appear. All information in the chat bubbles came from newspaper and old documents at University archives (see Fig. 2(b)).

Capsule provides users ancient pictures about the identical heritage site of universities. Users could learn about the heritage by seeing pictures and their descriptions. Besides, Capsule also provides users the feature to compare ancient pictures with current heritage buildings by pressing the bottom right button on the screen (see Fig. 3). Once users release their fingers, the old pictures will show again.

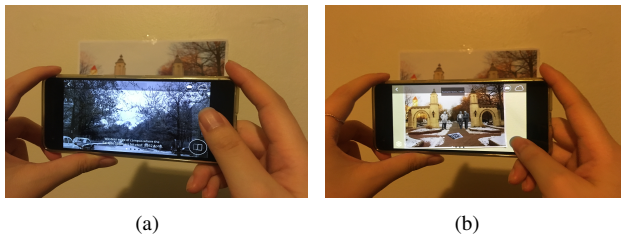


Fig. 3. (a) see old heritage pictures of the heritage; (b) press the bottom right button to see the current real heritage and AR objects.

Capsule also encourages users to interact with the historical AR figures. Users can choose a specific AR figure and take pictures with it. They could choose to share their pictures with proper texts as their moments in the app. These moments become the new history and are part of the cultural heritage.

Thus, users would have more connections with the campus heritage. Moreover, by tapping on the bottom right button, past moments left by previous visitors are displayed in a random order (see Fig. 4(b)). These moments could be personal stories or school events happened previously, which help users learn more about cultural heritage and feel themselves more related to the campus.

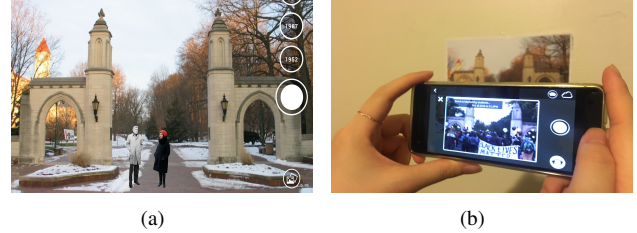


Fig. 4. (a) taking pictures with AR figure; (b) viewing a previous moment of a student protest event.

## IV. FINDINGS

In this section, we report the main findings from our prototype evaluation.

#### A. Interacting with AR heritage arouses users' curiosity

All participants showed their positive attitudes towards our prototype. Specifically, some participants expressed their curiosities about the heritage after reading the stories from AR figures and comparing past with present.

P2: "Oh. I want to know if he (the historic figure) is still alive!"

P4: "I'm very interested in the tuition part (from the story), and curious about if the stories are true."

P5: "I think the historical pictures are good to see more shots of what it looks like before and I want to see the pictures of the times when it is under construction. It will be fun to compare that with current heritage."

From above we could see that AR as an interactive technology brings the existed effective ways, such as digital storytelling and place-making, to the user's perception of the real world in order to further increase his/her curiosity about campus heritage. Therefore, future design for cultural heritage should continue considering AR as an effective approach to enhance student engagement in learning campus heritage.

#### B. Taking pictures with AR figures facilitates social interaction of people

Eight out of ten participants stated that they would definitely take pictures with the AR figures. The other two participants said they didn't like taking pictures at all. Noticeably, all eight participants mentioned that they would like to post their moments both in the app and on their own social media, which formed both in-community social interaction and the social interaction in personal network.

1) *Taking pictures with AR figures facilitates in-community social interaction:* Capsule enables users to share their moments within the app, and also view others' moments randomly. Thus, all users would form a heritage community. Within the community, users could share with each other their unique moments with the same heritage. Some participants even found their connections to the heritage via the in-community social interaction.

*P1: "I like these wedding pictures and I will comment something like 'can't wait to see me and Jamie do that!' "*

*P6: "Oh... It reminds me of my past... I joined this protest after work as well thought I couldn't remember the details."*

Therefore, future cultural heritage design should put efforts into encouraging in-community social interaction to enable the connection between heritage and individual.

2) *Taking pictures with AR figures facilitates social interaction in personal network:* All participants demonstrated their willing to share the pictures with AR figures on their personal social media. This action actually activates further social interaction within the personal network. Some participants even mentioned they want to take pictures with AR figures together with their family or friends.

*P3: "I prefer to take pictures with my friends and send them to my family."*

*P6: "I will take pictures with old figures, and share it on Facebook or Instagram because my family and friends can see."*

This personal social interaction is likely to involve more people into learning campus heritage, which forms a good heritage learning environment as one of the participants P2 mentioned:

*"I really want to share this experience with my friends who go with me. It would be so great to sync my screen on other phones."*

3) *Informational social interaction is preferred in the in-community social interaction:* In our user evaluation, we asked participants if they would like to comment on these AR figures or others' moments they see in the app. Noticeably, most of the participants said they would rather see the comments and give a like than leaving comments. Some participants explained why they prefer to see comments:

*P7: "I don't tend to leave comments on pics, but I would probably like them. Also I would like to see others' comments to know when did it happen if it was an event. Someone might know from the comment..."*

*P8: "I would like to see comments, and I think if there's information such as 'The place close at 9' will be helpful."*

Some participants felt the comments were not necessary, which is originate from what information they could get.

*P1: "I don't think it is necessary but if they do have comments, I want the comments to be sorted as pros and cons."*

*P6: "I don't think comments are necessary for historical pictures because there's already enough information for me about the heritage."*

There are many possibilities about this situation. One could be in the heritage learning context, users dedicate to learn more about heritage than normal social interaction. Another possibility could be even in the same heritage community, people are still strangers and with weak relationships. Therefore, making comments might be a too closed interaction for them to use. Thus, future design should try to include features that enable useful information and social features with proper interaction, such as heart or thumb up.

## V. CONCLUSION

AR as a trending new technology provides immersive and interesting experience for students to learn and interact with the campus heritage. Capsule incorporates digital storytelling, place-making, and user generated contents with AR technology to enhance user participation in learning campus heritage. Our participants showed their positive feedback on our prototype. Besides, our study also found that improving the in-community social interactions and personal social interaction could enhance user engagement in learning campus heritage. However, there are some limitations in our study. First, participants reported the issue of using AR function in cold weather. Our study was conducted in winter, so their hands felt cold when holding the cellphone and interacting with the prototype. This is not only a limitation of the current study, but a general problem that should be considered for all studies involving AR function. Therefore, future research could focus on exploring useful AR design to solve this problem. Second, our study was not conducted in a real outside environment. Participants might have different experiences and perceptions on certain features of our prototype in different environments. For example, participants could take pictures with AR objects outdoor instead of seeing sample pictures to better perceive the function. Third, our user study lacked of user studies with prospective students and their parents as well as quantitative data for evaluation. In the future, We would continue working on our prototype and would conduct more outdoor user studies with a broader population which involve quantitative evaluation.

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