I was here: a system for creating augmented reality digital graffiti in public place

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ABSTRACT

Since ancient times travelers and tourists try to leave their marks in places they visit. However, carving or writing on historic landmarks can cause irreversible damage on such sites. One possible solution are digital graffiti. These can for example be created through projection mapping where beams of light wrap the object with the digital graffiti created by users so everyone at the site can see them. However this may disturb other visitors being there at the same time. In this paper we explore an alternative solution for creating digital graffiti by utilizing Mobile Augmented Reality (MAR) technology. We developed a mobile application which allows users to: (i) select an object or a building, (ii) map a 3D mesh onto it in order to prepare its 2D plane , and (iii) draw a graffiti on this plane. After completing the drawing the application wraps the object or the building with a modified 2D texture creating an illusion of digital graffiti. In order to (i) evaluate the social acceptance of placing digital graffiti onto historic landmarks and to (ii) evaluate if the use of our prototype is socially acceptable in public spaces, we carried out a small reflective user study. We created a couple of simple graffiti on different historic buildings and posted them on social networking site Facebook. Despite amateur appearance, posted photos received attention and generated some positive responses and questions.

Categories and Subject Descriptors

H.5.1 [**Information interfaces and presentation**]: Multimedia Information Systems—*Artificial, augmented, and virtual realities*

Keywords

augmented reality, digital graffiti, public spaces, mobile interactions, handheld augmented reality

1. INTRODUCTION

Graffiti are a form of visual expression that can be carved or painted on walls or other surfaces. They can take many forms from simple written messages to elaborate drawings and are considered either as acts of vandalism [5] or admired as an art form [12]. They exist since ancient times [1, 2] and can carry political, social, artistic or any other message. Graffiti are primarily associated with different subcultures such as hip-hop youth or street art movements. However, there is a group of graffiti makers that is often forgotten – tourists.

Since ancient times travelers and tourist leave marks and writings on sites they visit. This is manifested across cultures and covers simple inuksuit built by Inuit peoples marking routes or sites for navigation and as a point of reference, to scribbled messages on the walls of ancient buildings denoting ones presence and appreciation of the site. The later form can be seen for example (i) on the walls of the Church of the Holy Sepulchre in Jerusalem scribbled by the crusaders and pilgrims, (ii) on the Mirror wall in an ancient village of Sigiriya in Sri Lanka featuring over 1800 pieces of prose, poetry and commentary written by ancient tourists between 600AD and 1400AD [2], or (iii) scribbled names of Greek and later Roman soldiers, merchants, and travelers in Egypt [8].

In a similar way, today's tourists also exhibit the tendency to leave their mark in places they visit. For example the breast of the statue of Juliet in Verona is showing prominent signs of wear by years of groping, or the Blarney Stone in Ireland that gets kissed by visitors. Even more personal example of expression is leaving a chewing gum (e.g. the Market Theatre Gum Wall in Seattle) or a D lock with declarations and messages on bridges in cities all over the globe (e.g. the Butcher's bridge in Ljubljana). While these are "socially accepted" marks and often become (together with local graffiti) tourist attractions themselves, some tourists also carry out unacceptable acts by today's standards. For example scribbling ones initials on a brick of the Roman Colosseum [9] or signing one's name on an ancient Egyptian's statue [13]. Both acts resulted in an outrage of masses on social media.

While ancient tourists' graffiti are a source for history research and debate such as searching for Herodotus signature [8], the majority of today's graffiti are not seen as art or valuable (except for studying them as a social phenomena [11]). One possible solution to prevent permanent marks on

Figure 1: *This is screenshot of the mobile application projecting digital graffiti onto the wall of fortress in Split.*

historic landmarks is to allow tourists to leave their footprints in a digital form and project it on a desired location of the historic site [7]. However, this approach can disturb other visitors being there at the same time. Our idea includes placing a graffiti on a particular object or a building by Augmented Reality (AR) paradigm where only the user owning a device can see their graffiti when looking through the camera lens of their mobile devices, which can bee seen in Figure 1. This opens up interesting questions such as: is the process of making digital graffiti in public places and the end result placed on historic landmarks socially acceptable? To answer this questions we carried out a preliminary user study. Within the study we created a couple of simple graffiti on different historic buildings and posted them on social networking site Facebook to harvest the feedback.

In the next section a description of the prototype developed is presented, followed by a method section describing the process of the evaluation. Section 3 presents the results and includes the discussion of these. The paper finishes with conclusions and future work.

2. PROTOTYPE DESCRIPTION

Our prototype uses a mobile platform as a medium for Augmented Reality visualisation (AR) – the concept better known as Mobile Augmented Reality (MAR). Mobile devices have become ubiquitous in the last two decades and with the ascent of powerful smart phones coupled with quality cameras, AR for the first time emerged as consumer product. This development also enabled researchers to explore AR in various domains [4]. One of the advantages of MAR is that it can be visible to device owner only. We have used this fact in developing our prototype as digital graffiti visible to everyone (e.g. projection mapping of user generated digital graffiti on walls) may not be appreciated by everyone at the site.

We have built a mobile application prototype as a means to explore the feasibility of our idea. We have used the Metaio SDK[1] for tracking and rendering 3D objects. The interaction with the prototype can bee see in Figure 2 and 3 as a

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[1]http://www.metaio.eu/

series of screenshots. Users are presented with four options as seen in the left most screenshot: three geometric bodies and a building. When selecting any of the three geometric bodies the applications expects markers to be placed under the objects for (i) marker based tracking (see Figure 2), and when selecting the building a (ii) markerless tracking (see Figure 3) also known as instant tracking is used. Marker based tracking was designed for drawing on smaller objects, whereas markerless solution was used for outdoor scenarios. Whilst markerless solution is obviously more flexible, due to the fact that it works in unprepared environments, it is prone to tracking failures, especially in cases when tracking surfaces are not optimal (varying illumination, no hard edges, low contrast, etc.)

After selecting a body (and consequently the marker based tracking method) users are presented with the view of the camera and the virtual mesh of the selected body on previous screen. This virtual mesh needs to be adjusted to the surface of the selected physical object placed on the paper with markers. This is visible on the second screenshot from the right in Figure 2. Users have the possibility to expand or shrink the selected mesh in all directions by selecting the direction of size adjustment and pinch gestures (marked by two fingers on the screen in Figure 2). In our example we are adjusting the size of the cuboid mesh to the white cardbox placed in the centre of the paper with markers. All sides of the cuboid are marked with numbers, which becomes useful in the next step.

When the virtual mesh is wrapped around the physical object users can press the colour palette icon in the bottom left corner of the screen to start drawing. The drawing surface, visible on the second screenshot from the right in Figure 2, is a 2D texture that represents a 3D virtual object. The numbers on the sides of the virtual object are also visible in the 2D texture. This enables users to know where the graffiti will be drawn on the physical object. In our example the sides 1 and 2 are facing us, hence we decided to draw on these. However, we can draw on any side, although these might not be possible to visualise (e.g. the bottom side of the cuboid). The 2D texture features a simple drawing application where colours and the size of the brush can be selected. In addition, there are predefined drawings that can be placed on the surface.

When tapping on the green check mark on the screen, users get back to the AR view where the drawing made on previous screen is placed on the physical object. It is possible to take a picture of the graffiti or to return to the drawing screen. The markerless tracking can be seen in Figure 3. The sequence of screens is similar to the one with the marker. However, we do not need to place a paper with markers under selected physical object in order to track it.

3. METHOD

To answer our research questions (social acceptance of creating and created digital graffiti at/on historic landmarks) we run a reflective user study with the lead author. Such approach is often used to reflect upon the prototype developed, shed light on interactions details, provide a glimpse into the subtle affordances the prototype can offer [6], or when developing for a peak experience for a small number
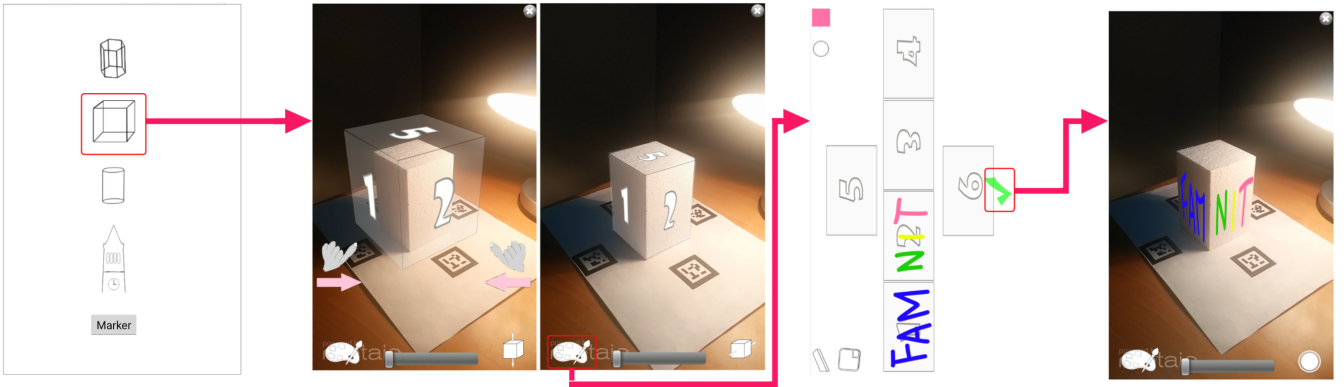
Figure 2: *Prototype interface with marker-based tracking.*
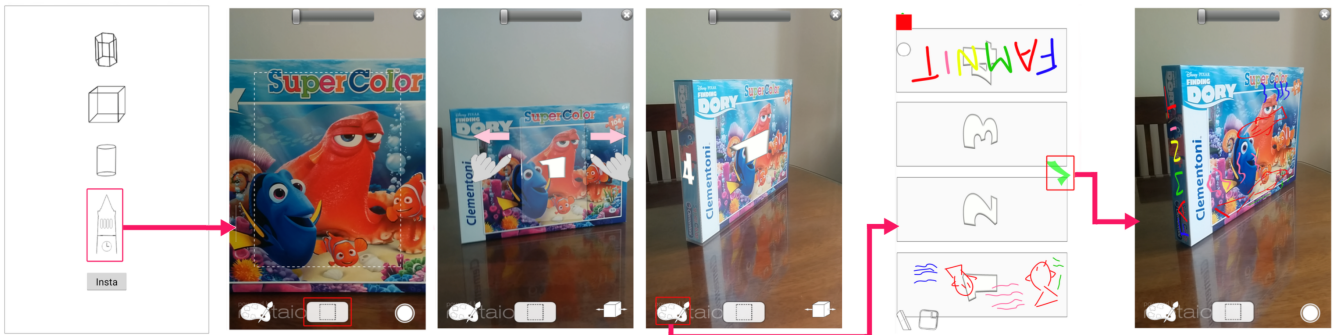

Figure 3: *Prototype interface and interaction process with markerless tracking.*

of users (even a single user) [3]. Using the developed prototype the author created 10 digital graffiti on various historic sites in historic city of Split during high season when many tourists are visiting these attractions. He then posted some of his creations captured from various angles on his Facebook timeline. We chose social networking service site to reach a wider audience compared to sharing graffiti with (individual) contacts.

4. RESULTS AND DISCUSSION

The picture editor we used in our application allowed us to create simple drawings and captions only. Drawing on a 2D plane on a small screen proved difficult, especially as the developed prototype did not provide zooming functionality. In addition to this, currently implemented drawing tools are primitive and did not allow for drawing in multiple layers as all draw actions are fully opaque. As a result, only a couple of attempts ended with desirable results. However, to our surprise, the alignment of virtual mash to the 3D object was not as difficult as initially expected. The author quickly got a feel for it and managed to precisely map the virtual mesh to the real object as can be observed on third screenshot from the left on Figure2 and forth screenshot from the left on Figure3.

Another issue we wanted to look at was social acceptance of using the prototype in public. There are a couple of promi-

nent examples of technology failures such as GoogleGlass[2], which may partly be blamed also on social acceptance . The key problem with GoogleGlass was caused by the visibility of the camera placed on the frame of glasses, which posed an obvious danger of intrusion into privacy of passers by or people being talked to. However, there are examples of successful camera based products, which continuously record users' surroundings. One such example are life-logging cameras usually worn around one's neck, such as Microsoft SenseCam [10], Vicon Autorgapher[3], and Narrative Clip[4] . Similar to mentioned products, in order to create digital graffiti one needs to point the phone's camera at historic landmarks, which may unintentionally record passersby or people in the vicinity. Our observations confirmed that despite the prolonged use of the phone's camera, during which the author created digital graffiti, none of the passersby or people in the vicinity seemed to be bothered by author's actions. This is probably due to the fact that so many people nowadays use their phones and tablet computers to take photos and film their undertakings on holidays, that holding up the phone for a prolonged amounts of time does not seem unusual.

The last part of our evaluation focused on exploring if placing digital graffiti on historic landmarks is socially accept-

able. The author posted three curated digital graffiti images (such as seen on Figure 1) on his Facebook's timeline. Even if graffiti were of primitive nature (e.g. the graffiti were mainly composed of text and simple shapes) the published pictures attracted attention from author's social network. Comments were ranging from questions about the technology used, questions about the source of the pictures, to comments on the appeal of particular digital graffiti. Based on the fact that none of the comments in our pilot study highlighted that placing digital graffiti on historic landmarks is controversial or disrespectful, our preliminary study suggests that digital graffiti using MAR technology are socially acceptable. However, to make this conclusion final, a more comprehensive study including quantitative data capture would need to take place. Due to the fact that posted pictures did not cause a massive hype, we were not able to collect other statistically significant metrics such as number of likes, shares etc.

5. CONCLUSION

Whilst ancient graffiti are seen as a valuable window into the lives of past generations, many current graffiti made by tourists or travellers are considered as acts of vandalism. However, digital graffiti concept we presented in this paper may be able to provide sustainable means of fulfilling tourists' wish for marking a place they have visited. The concept is based on MAR technology as a method of generating and viewing digital graffiti. We implemented this concept into a prototype by building a mobile application that enables users to create digital graffiti on arbitrary objects of a predefined shape. By mapping a virtual mesh onto objects, the application can generate an appropriate 2D plane of the mesh on which users can draw digital graffiti.

In order to evaluate the feasibility and social acceptance of creating and placing digital graffiti on historic landmarks, the paper presents a preliminary self reflecting study. The study was based on creating digital graffiti of various historic landmarks, which we published on the authors Facebook timeline. The results show that: (i) due to primitive drawing functionality of the prototype only basic graffiti could be created, (ii) contrary to expectations author quickly became very skilled in mapping the virtual mesh to real objects, (iii) even after prolonged use in public space the application did not provoke unwanted attention or reactions from passersby, and (iv) despite amateur appearance, posted photos received attention and generated some positive responses and questions from author's social network. The results of preliminary study suggests that digital graffiti and the proposed concept are socially acceptable. Based on the results of the presented short self-reflecting study we are planning a more comprehensive study in order to confirm our findings. This will include more in-depth measuring of acceptance of digital graffiti through social reach (number of likes, shares on social networking sites, etc) and through downloads of the app in the app repository (Google Play). Before embarking this route, the current prototype also needs to be improved. For example the drawing interface needs to be expanded with zooming functionality, transparent layers, wider range of brushes, etc. Finally, transferring the graffiti in the digital

domain allows for easy sharing which may provide indirect advertisement for local communities and promote touristic places to a wider public. How effective are such practices in this context should also be further studied in the future.

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