DigiGraff: Considering Graffiti as a Location Based Social Network

David McGookin, Stephen Brewster and Georgi Christov
Glasgow Interactive Systems Group
School of Computing Science
University of Glasgow
Glasgow, G12 8QQ
firstname.lastname@glasgow.ac.uk

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Abstract
We introduce DigiGraff: a technique to allow lightweight and unconstrained digital annotation of the physical environment via mobile digital projection. Using graffiti as a design meme, DigiGraff provides a way to study the role of location in the creation and browsing of social media, and introduces concepts of temporality, ageing and wear into message presentation. As the volume of geo-tagged social media increases, we outline why such consideration is relevant and important, and how DigiGraff will support deeper understanding of location data in social media.

Author Keywords
Graffiti; Digital Projection; Temporality; Geo-Social Media; Mobile Devices

ACM Classification Keywords
H.5.2. [Information Interfaces and Presentation]: User Interfaces - Interaction Styles;

Introduction
Graffiti is largely seen as an indicator of urban decay and deprivation. The 'tagging' of property (usually illegally) with spray paint grew to prominence with hip-hop culture in the 1980's, and has evolved into a complex urban sub-culture [9]. However, the role

Figure 1. Examples of everyday graffiti. The use of paint to illustrate the location of subsurface utilities (Top). High-pressure washers are used to create advertising (Middle). Artistic expression in chalk (Bottom).

graffiti has played as a means of marking and annotating the physical environment is much older and more varied. Social communication, memory aids and blogging have all been identified as reasons for the creation of graffiti in the Roman city of Pompeii [3]. This has led to the much wider definition of graffiti, beyond the legality of its creation, as: "images engraved on a space that did not primarily serve this function" [3]. When considering graffiti in such a way we can clearly see modern examples of these uses.

Contractors often graffiti roads and pavements; spraying in paint the locations of utilities as a way to communicate with later engineers (Figure 1 top). Decorators will chalk signs on the pavement to warn pedestrians that a nearby fence or door has recently been painted. Chalk graffiti is used in a similar way to indicate directions to local events, such as bake sales, garage sales or festivals; making visible local knowledge in the environment. Advertisers have also used graffiti as a means of promotion. Figure 1 (middle) illustrates "inverse" graffiti, where templates and high-pressure washers are used to "clean" graffiti into surfaces. Finally, a variety of media are used for artistic self-expression and communication of thoughts and feelings (Figure 1 bottom).

The varied roles that graffiti plays in society, and the varied media used for its creation, illustrate its use as a creative and lightweight annotation of the physical environment, similar to the ways in which paper books are marked and annotated by readers. There are also parallels between these uses of graffiti and online social networks, where we can consider graffiti as a social network with a strong location based component. Indeed, most of the mentioned examples only make sense when the user, graffiti and what that graffiti refers to are spatially co-located. Consideration of graffiti in such a way is highly relevant when we consider the increasing amounts of user generated content (UGC) created on mobile devices and tagged with a physical location [8].

However, current social networks treat location as a secondary feature. When users create messages the current location of the device used is automatically appended to the media. The relationship and relevance between the message and location is unclear. For example, the user may just happen to be in a location when posting a message, rather than creating a message because of his or her location. By requiring users to more explicitly consider location during both creation and browsing of UGC, we aim to better understand the role it can play.

To investigate these issues we have developed DigiGraff – a location-first social network tool. Its design has been strongly influenced by the affordances of graffiti; allowing a tight focus on location, whilst making few other constraining design assumptions.

Related Work

The role of virtually attaching social media to a physical location was first investigated in the GeoNotes system [6]. It used a sticky note metaphor to attach messages to nameable physical locations using Wi-Fi triangulation. In many respects, GeoNotes was a precursor to today's mainstream social networks such as Foursquare (www.foursquare.com) or Facebook places (facebook.com). Here, users "check in" to a building, business or named place and leave comments about it. Whilst these networks have a strong location-

Figure 2. DigiGraff uses an iPhone 4 connected to a pico digital projector to create and display annotations.

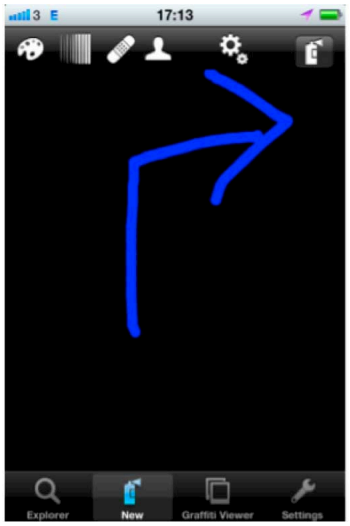

Figure 3. Users create annotations by sketching onscreen. Various colours and materials are available. Users determine the visible lifetime of the annotations via the material used.

based component, as messages are required to be associated with a location, those locations must be already named or nameable. This severely constrains the role of location. Arbitrary locations, such as the side of a building or half way along a road, cannot be used. Users cannot leave a drawing in the corner of a park that means something to them, or tag the correct path to assist friends finding their new home for the first time. In addition, as the pages users check-in on are often controlled by the owner of the physical location, this restricts the comments about the location that can be posted. Uncomplimentary comments may be removed or blocked. Therefore, whilst useful, existing networks constrain the use of location, making them unsuitable to fully understand the role it can play.

An additional issue is the observability of digital annotations in the physical world. Existing approaches linking physical and digital spaces employ QR codes (2D barcodes with embedded urls) in the physical environment that allow users to access appropriate pages online (e.g. Facebook places) [1]. However, there is no reflection in the physical environment of the comments made: users must login to the networking site to see them. Posch and Hoier [10] have begun to investigate tangible technologies to link low-level, on-line features to the real world. They developed a physical "like" button and display linked to a business' Facebook page showing the number of people who "like" it. Other approaches, such as the use of *in situ* digital displays [2,7], can also fulfil this role. However, these suffer from the same issues. Only predefined locations can be annotated (the physicality of the devices placed in the environment enforce this), and again these are under the control of the owners of the physical locations.

A final issue is the nature of the messages themselves. Work by Cowan *et al.* [4] investigated making sketching easy to integrate with Facebook through the use of digital pens. They found sketched updates created a deeper social engagement between participants, and were more often commented upon by others. This is unlike the common approach of text-based updates in existing networks (although these can be appended with other multimedia content), but is much closer to the drawing and sketching behaviour prevalent with real-world graffiti (see Figure 1).

With the increasing prevalence of geo-tagged social media, there is a clear need to understand the role of location in both its creation and browsing. However, whilst useful, prior work places constraints on location, limiting our understanding of its role.

DigiGraff

To allow us to better investigate the role of location in social networks we have developed the DigiGraff system. DigiGraff is designed based on our prior discussion of the roles graffiti plays, and allows unconstrained annotation of the environment. DigiGraph runs on an iPhone 4 coupled to a pico projector (see Figure 2). This communicates with a central server used to store and retrieve user created graffiti annotations. Using DigiGraff users can both create annotations to be displayed in the environment, and browse the annotations of any other user.

Creating Annotations

As with traditional graffiti, and informed by the work of Cowan *et al.* [4], users generate annotations by sketching them on the touchscreen of the device (see Figure 3). Various stoke thicknesses and colours are

Figure 4. Users create their annotations by pointing the device at the location they wish to annotate and "spraying" it onto the environment. Similar to real graffiti, the annotation is geo-fixed and cannot be updated.

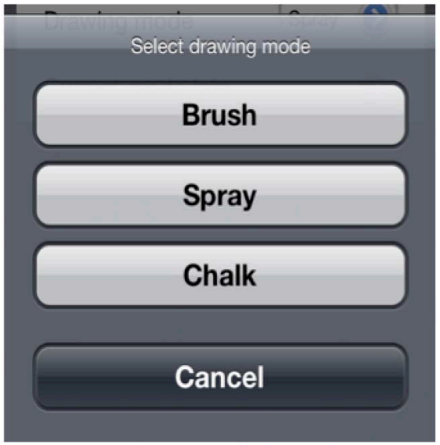

Figure 5. When committing annotations users must select the medium used. The medium used determines the temporal life of the annotation in the environment. These increase from Chalk to Brush (paint).

provided to allow the generation of rich sketches. We use a template model, where the annotations made can be freely changed during creation. When the user is happy with the annotation, he or she must transfer it onto a surface in the physical environment. To allow this we project the annotation via the attached pico projector. Using the inbuilt gyroscope and magnetometer, the user can orientate and align the annotation to whichever surface he or she wishes to attach it to (see Figure 4). The user then presses a button to commit the annotation. Once committed the annotation can be seen by all other users, but cannot be directly manipulated. However, the user and other users are free to add new annotations on top or in relation to existing ones. The new annotation may be collaborative with the first; such as drawing the directions of nearby coffee shops next to an annotation indicating dislike of the particular shop the annotation is attached to. Alternately, it may be competitive, such as being created directly on top of, and obscuring, an existing annotation.

A number of different media are used to generate graffiti. Whilst the choice of medium may be artistic, it is also informed by the period of time the creator assumes the graffiti will be relevant. The medium used to create graffiti embodies its obsolescence. For example, a decorator may write "wet paint" in chalk on the pavement to warn passers-by of painted railings, although writing in paint would be more convenient. As the paint on the railings will not be wet for more than a few hours the graffiti will soon be redundant. As the graffiti is written in chalk, it will be washed away by rain or eroded as pedestrians walk over it. A road worker however, would write in paint the location of electricity and gas pipes for future repairs to be completed. The graffiti is relevant until the repair has started, so should only be removed when the road is dug up. In both cases the authors of the graffiti have a notion of the temporal span: the period of time over which the annotations made are important. We also incorporate this temporal aspect of graffiti. When committing an annotation a user must also provide a notion of the medium that the annotation should be rendered with (see Figure 5). This is loosely coupled to a time-scale, beyond which the annotation will no longer be visible in the environment. This ranges from a few hours with chalk, to several months with paint.

Viewing and Browsing Annotations

To re-enforce the connection between the annotation and the environment, the annotations are projected onto the physical location they were originally attached to using the pico projector. Pico projectors have already been used in other forms of augmented reality, such as augmenting paper maps with directions [11] and enabling platform games that merge the digital and physical worlds [12]. Although using standard digital (rather than hand-held pico) projectors, Dalsgaard and Halskov [5] have investigated projecting multimedia content onto historical artefacts (e.g. projecting an animation of an historical story onto the rune stone that describes it). Whilst their installations required significant calibration of the digital projection to closely match the physical artefact, their work clearly shows the greater sense of co-presence that can be achieved between the augmentation and the environment. Graffiti artists have also used projection as an artistic medium. Static laser projection (see Figure 6) has been used to project graffiti onto the sides of buildings. Such close coupling between the digital and physical is a key advantage in comparison to standard AR

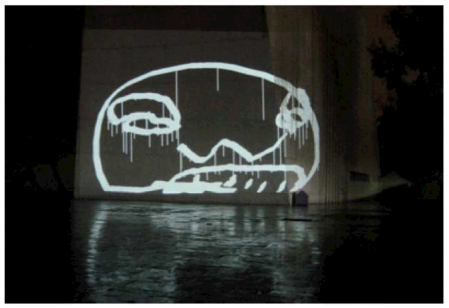

Figure 6. An illustration of Laser Tag graffiti using a static laser projector to apply large scale graffiti to the sides of buildings. Image courtesy of `Bennet 4 Senate' @ flickr.com. Licensed under Creative Commons Attribution-ShareAlike.

Figure 7. Using the iPhone's orientation sensors, the projector acts as a flashlight, progressively "illuminating" the fixed graffiti annotations as it is passed in front of them. Insert: the graffiti annotation once it has been fully uncovered.

approaches where coupling is mediated by the visual display of the device, with virtual data overlaid on a live video feed from the device camera [13].

With DigiGraff, we exploit this advantage of projection, creating a greater sense that the annotations are co-present in the environment. The pico projector is used as a "flashlight", progressively illuminating the geo-fixed annotations as the user moves the device across them (see Figure 7). The same onboard sensors (GPS, magnetometer and gyroscopes) used when creating annotations are employed to determine device position and orientation. To further reinforce the notion that annotations are fixed to the environment, we impose a high-pass filter on GPS readings when the user is actively browsing an annotation. This means that a larger change in the determined GPS location is required, such as the user walking several meters away, before we assume that the user has moved. Without this there is a strong likelihood (due to small changes in GPS readings) of an annotation disappearing or "jittering" whilst the user is attending to it.

Although the GPS units in modern smartphones are very accurate, there is an inevitable error in the determined device position. Our initial tests indicate the iPhone 4 has a regular horizontal accuracy within 10m. Therefore, when browsing the environment only annotations within 10m of the determined user location are visible to the user. Although annotations may not be projected in the *exact* same physical location of their creation, they will be projected very close by. E.g. an annotation on a wall may have moved, but is still shown on the same wall. However, this does restrict the fidelity of the coupling between the real and virtual environment, and its impact needs to be determined.

We map the opacity of the projected image to the previously discussed temporal lifetime of the message. Users must determine, through the rendering medium, how long the graffiti should be visible for. Rather than ceasing to display an annotation after it has "expired", we linearly fade the annotation: from 100% opacity when created, to 0% when expired. This allows the annotation to "wear" appropriately for its medium of creation, providing an indication of the annotation's age and its continued relevance in the environment.

Discussion

Whilst DigiGraff presents a novel way to embed social media into the environment, our goal is to understand the role of location as a primary, rather than secondary, aspect of social media creation and browsing. The increasing amounts of UGC tagged with a location make it important to more fully understand location in both the consumption and creation of this content. DigiGraff provides a platform to do that.

That we use a projector during both creation and consumption of content is a key point. Users must explicitly consider where the annotation will be placed, and when browsing, how the annotation relates to its surroundings. This avoids the "happens to be" relationship between location and data that exists in many existing social networks (e.g. twitter). Using Graffiti as a design meme has also allowed us to reduce other implicit constraints that exist in current location-based social networks. Graffiti is democratic, can be created anywhere, on any surface and can take any form. We do not constrain users to text, require they create annotations in specific places or provide greater control to a subset of users. No user can exert more control than another over any annotation, including

their own. We do not argue that these will all be found to be important, or as important as they clearly are in existing graffiti. However, by using the lightweight techniques of graffiti we can identify if, and in what way, more dedicated support (such as following, "like" buttons etc.) is relevant, without assuming that it is. Graffiti has also allowed us to incorporate new ideas that are not currently supported by existing networks. The use of different mediums to create annotations allows a straightforward way to remove annotation once their usefulness has ceased.

Our current work is considering these issues by providing a number of users with DigiGraff devices for several weeks and studying their use. The results of this will allow a deeper understanding of location in social media and the uses to which it can be put.

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