The Mobile Phone as a Digital SprayCan

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ABSTRACT
Since the first appearance of modern man, one trait of human behavior in our interaction with the physical environment appears to be an inherent desire to leave our mark on a particular object or space. ‘SprayCan’ graffiti that appeared in the 1970s is but a modern extension of this phenomenon, yet it divides communities and generations in terms of how it should be dealt with in terms of either complete acceptance or punitive action. In this paper we present a system that tries to bridge the divide as it both provides writers with a means of tagging their environment, using mobile phones and RFID tags, whilst minimizing the physical effects to the landscape for the communities where it resides.

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1. INTRODUCTION
If applications are to become pervasive then they must become part of our everyday fabric of our lives and existence [1] and will often require us to provide users with the ability to interact with objects and places within both real and virtual worlds. One trait of human behavior in the interaction with objects appears to be an inherent passion for leaving our mark on these objects. Whilst we often perceive this as a modern phenomenon, most notably through graffiti sprayed in public places, this is not a new trend and marking our surroundings is evident from ancient times most notably cave paintings. Modern spraycan graffiti divides opinion; some view it as blight on the landscape, while others view it as an art form. As a consequence this has led to very polarized approaches of how authorities should deal with its perpetrators. Some authorities and communities take a very hard line of treating all graffiti art as vandalism; the Berkeley Police Department of California even go so far as to issue guidelines on their website to enable parents to spot if their children are likely to be engaged in graffiti, whilst others have tried to incorporate it into the mainstream with the acceptance and exhibition of the work of artists such as the Keith Haring [2]. In either case, judging by its continued proliferation, neither approach appears to be providing a solution acceptable to both the authorities/communities and the perpetrators.

In this paper we draw inspiration from the book ‘Banksy’s Wall and Piece’ by one of the most innovative graffiti artists of the current era, which states:

‘Imagine a city where graffiti wasn’t illegal, a city where everybody could draw wherever they liked. Where every street was awash with a million colours and little phrases. Where standing at a bus stop was never boring. A city that felt like a living breathing thing which belonged to everybody not just estate agents and barons of big business. Imagine a city like that and stop leaning against that wall – its wet.’

Whilst we do not advocate the implementation of this graffiti utopia, and given Australia’s recent banning of the Playstation 2 game ‘Marc Ecko’s Getting Up: Contents Under Pressure’ for allegedly promoting graffiti[3] this would appear unwise, we do believe that there are aspects of this vision which could produce a system that may offer benefits to both sides of the debate and produce a richer urban landscape. To this end we do explore a system utilizing the already pervasive consumer device, the mobile phone, coupled with the emerging pervasive technology of Radio Frequency Identification (RFID).

To enable an understanding of the design of the system, which we will describe in section 4, we first explore the nature of modern graffiti and more particularly the practice of ‘tagging’[2] in section two. In section 3 we discuss the emergence of RFID and its close relative Near Field Communications (NFC) in relation to their growing synergy with the mobile phone before describing a means of using this technology to create a system that could well address the social needs of the perpetrators whilst minimizing the physical impact on the environment in which they operate. Finally, we shall draw conclusions on the system developed thus far and define enhancements that could extend its impact in the emergent technological landscape.

2. TAGGING
As with any cultural phenomenon there is some dispute over where tagging began, whilst many cite ‘Julio 204’ who began

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1. Banksy is a graffiti artist from Bristol, UK, whose artwork has appeared throughout the world. Despite this he carefully manages to keep his real name from the mainstream media.

2. It is interesting to note that the board who took the decision were not concerned with the random acts of violence that also form part of the game.

3. The act of writing graffiti tags most commonly using spray paint.
writing his tag\(^4\) in New York during the late 1960s closely followed by his contemporary ‘Taki 183’ they essentially popularized what first began in Philadelphia by ‘Cornbread’ and ‘Top Cat’ [3]. However, it was an Interview with Taki 183 in the New York Times in 1971 that seemed to spawn a whole generation of writers\(^5\) who gave rise to what is now one of the images synonymous with New York, the graffiti-strewn subway car. As the abundance of tagging grew, partially fuelled by the emergence of the Hip-Hop, a whole new sub-culture formed with writers forming alliances or ‘crews’ (crews differed from the gang cultures that also emerged at this time as they spanned ethnic and social divides [4]) engaged in particular styles of graffiti and producing increasingly complex designs. New members of a crew are often sought out by the more experienced writers to whom they then pass their knowledge about techniques and style. The actual crew style differentiates one crew from another and often crews compete against each other through their expertise in implementing their style. Within this competition there are certain ‘rules of engagement’ in that it is considered unacceptable to write over another writer’s tag or ‘bite’\(^6\) another writers style [5].

An individual writer’s skill is shown through the evolution of the images synonymous with New York, the graffiti-strewn subway car. As the abundance of tagging grew, partially fuelled by the emergence of the Hip-Hop, a whole new sub-culture formed with writers forming alliances or ‘crews’ (crews differed from the gang cultures that also emerged at this time as they spanned ethnic and social divides [4]) engaged in particular styles of graffiti and producing increasingly complex designs. New members of a crew are often sought out by the more experienced writers to whom they then pass their knowledge about techniques and style. The actual crew style differentiates one crew from another and often crews compete against each other through their expertise in implementing their style. Within this competition there are certain ‘rules of engagement’ in that it is considered unacceptable to write over another writer’s tag or ‘bite’\(^6\) another writers style [5].

An individual writer’s skill is shown through the evolution of the simple tags through to ‘throw-ups’\(^7\) and ‘pieces’\(^8\) (sometimes called ‘burners’) which raises their position within the graffiti hierarchy. A later metamorphosis of the tag was the stamp, which is a pre-tagged sticker\(^9\) and as we shall see has parallels to the mobile system presented in this paper.

It appears that for many engaged in tagging it is a way of gaining recognition and a sense of belonging both in their local landscape and amongst their peers [6] and has little to do with gaining a thrill from engaging unlawful acts as Banksy observes

‘Graffiti writers are not real villains. I’m always reminded of this by real villains who consider the idea of breaking in somewhere, not stealing anything and then leaving a painting of your name in four foot high letters as the most retarded thing that they have ever heard of.’

Many sociologists would agree and advocate that tagging should not be simply dismissed as an act of vandalism\(^10\), but as a reflection of the society that produced them. This view is perhaps endorsed by the fact that despite the large amounts of resources expended on preventing tagging it continues to flourish.

With the birth of the internet we have seen graffiti evolve its communities through sites such ‘Art Crimes The Writing on the Wall’ (www.graffiti.org) and WataRush (www.watarush.com) although for many it does not satisfy a desire for the belonging to a physical space [3] and is why we believe a more innovative solution could be achieved through pervasive computing.

3. RFID AND NFC ON MOBILE PHONES
With over 643 million devices sold in 2004, and forecasts predicting that global mobile subscriptions will reach 3 billion users by the end of 2010, [7] there is little doubt that the mobile phone has become the pervasive consumer device. RFID is being hailed as the next big evolution in computing as it enables everyday objects to be connected to the internet. RFID tags, a simple microchip and antenna, interact with radio waves from a receiver to transfer the information held on the microchip. These RFID tags are classified as either active or passive, with active RFID tags having their own transmitter and associated power supply. Passive RFID tags do not have their own transmitter; they reflect energy from the radio wave sent from the reader. Active RFID tags can be read from a range of 20 to 100m, whilst passive RFID tags range from a few centimeters to around 5m (dependent on operating frequency range).

NFC is an interface and protocol targeted in particular at consumer electronic devices, providing them with a secure means of communicating without having to exert any intellectual effort in configuring the network [8]. To connect two devices together, one simply brings them very close together, a few centimeters, or make them touch. The NFC protocol then automatically configures them for communication in a peer to peer network. Once the configuration data has been exchanged using NFC the devices can be set up to continue communication over a longer range technology. The other advantage with NFC comes in terms of power saving, and it achieves this by having an Active Mode (AM) and Passive Mode (PM) for communication. In AM both devices generate an RF field over which they can transmit the data. In PM, only one device generates the RF field, the other device uses load modulation to transfer the data. The data rates available are relatively low, 106, 212, or 424 kbits/s, although for the applications envisaged this should be more than sufficient [8].

Nokia has recently introduced clip-on RFID and NFC shells (Nokia Xpress-on Mobile RFID/NFC Kits) for the 5140 and 5140i Series 40 phones respectively. The RFID/NFC shells can be accessed via J2ME applications running on the phone to trigger defined actions within the application. For this particular project we have RFID shells on 5140 phones. These phones are likely to be the first of many as RFID/NFC enabled devices are predicted to be present on 50% of phones by 2009 [9] giving the technology enormous potential for the creation of pervasive applications.

4. MOBILE GRAFFITI SYSTEM
The system described here is not the first to propose mobile digital graffiti. Siemens have recently described a system where users can save virtual post-its [10], in the form of SMS messages, in a virtual world at a physical location defined by a latitude and longitude obtained from a Global Positioning System (GPS) enabled mobile phone. Although this system could be used for
graffiti it only exists in the virtual world and as such would require users to permanently monitor their position with GPS switched on their phone which would place a high power burden on the device. A conceptually similar development is the Place-Its project developed by Sohn et al. [11] which uses a location-aware system on a mobile device to leave messages for people depending upon their position in the physical space.

A system currently operating in the UK called TagandScan (www.tagandscan.com) allows users to tag physical locations with information or pictures through a Java application operating on their mobile phone which connects to a central server. The actual location is identified by GSM cell-id and is therefore highly variable in its accuracy. The Grafedia project (www.grafedia.com) allows users to access rich media content on their mobile phone by entering a word, written by hand onto physical surfaces e.g. walls, appended with the suffix @grafedia.com. Whilst this system offers a new experience to the writers it appears to offer no benefit to the authorities/communities concerned with graffiti as the physical defacement is still taking place.

The system proposed here, known as ‘Mobile SprayCan or Mobspray’, addresses the limitations of the two systems previously described and is akin to stamps only in that we use stick-on 13.5 MHz RFID tags rather than traditional stickers. However, unlike stamps, the RFID tags are not a repository for the actual writers tag but represent a physical location where digital writers can “get-up”11 using the application on their mobile phone. The particular RFID tags being used are Mifare Ultralight13 with a memory area of 64 bytes only. The Ultralight tag’s memory is divided into pages of 4 bytes, giving it a total of 16 pages. The first 16 bytes of a Ultralight tag contain the unique identifier of the tag, one-time programmable area (OTP), lock bytes and checksum bytes. The rest of the memory is assigned for user data which amount to 48 bytes (pages 4-15). The 48 bytes of tag memory is comprised as follows:

- 15 bytes for tag location as a text string
- 25 bytes holding 5 writer tag names each 5 characters

Ultralight tags support both MifareUL features and NFC Transfer Interface Packet (NTIP) records for data transfer ‘to and from’ the tag. NTIP has record types, and by knowing the types an application can understand the binary structure of the record. The particular type of NTIP record is defined by fully qualified name (FQN) which can then be used to auto launch a midlet once a tag is touched. Mobspray uses MifareUL features to read and write data as the RFID shells made available for this project do not support target or NTIP record type definition while registerising for auto launch.

MifareUL uses either a logical or physical structure to access the memory on an Ultralight tag with the logical addressing range being 0-47 and physical range being 0-63. The contents of a typical mobspray tag are shown in figure 1.

For this project we produced postcards with the Mobile SprayCan logo and RFID tags attached, as shown in Figure 2, to make tag sites easily identifiable for our test crew.

Writers first register on the project website, www.mobspray.com, with a unique tag name of up to five characters and then upload their own custom mobtag14 to the database operating on this central server. Writers’ are then able to use their own mobtags, or view other writers’ mobtags, by accessing this database using a GPRS connection initiated by the J2ME application on the phone when an RFID tag is read as shown in Figure 3.

11 Get-up or getting-up is the term used by writers for the physical act of writing their tag at a particular location.
12 To avoid confusion between RFID tags and graffiti tags we have coined the term ‘mobtag’ to describe the images created in this project.
13 http://www.semiconductors.philips.com
14 The use of pre-prepared custom images is already established among writers through stickers and sketch pads of designs (often referred to as ‘Bibles’ or ‘Black Books’).
Once a writer reads an RFID tag, the client application, shown in figure 4, displays the contents of the RFID tag which consists of a tag location string and the names of last writers to have visited that particular RFID tag.

The application then connects to the database which returns the time and date at which those writers tagged that location. The writer can then choose to view any of the writers’ mobtag images or place their own mobtag at that location and these details are stored within the database.

If the user chooses to write his tag, the application creates a new list of the last 5 writers by dropping the last writer from the previous list and shifting the remaining by one position. This list is then written on the RFID tag. The writing event triggers an update on the database as shown in Figure 5.

It would be possible to achieve the same functionality without storing any data on RFID tags, with writers’ interactions and the tag location stored server-side. However, the design outlined was chosen in order to demonstrate the potential for future systems where tag storage is not as severely constrained and also because of graffiti’s inherent nature of physical interaction with a particular location. Figure 6 shows the actual screenshots of the application highlighting the reading and writing functions outlined earlier in figure 4 and 5 respectively.
and then a list of last 5 writers who wrote to that tag. The writers are displayed as a selectable list on the mobile phone and the current writer can then select from the list to view the mobtags by initiating a connection to the server over GPRS. The current writer can write his/her mobtag to the location at any time after the initial tag read. To avoid entry errors into the system the application checks before every write if the user is attempting to write at the location he initiated the read action upon. This is done by checking the unique identifier of the RFID tag before initiating write process against the identifier obtained by the RFID read process earlier on.

The images for this particular system are 128x128 pixels, 16 bit colour. This mobtag size was chosen to match the maximum resolution on the test mobile devices. In Figure 5 we show the six tags of our test crew.

5. WRITERS EXPERIENCE

Whether it is the work of an individual or a group, the context of Graffiti is always social in nature. A piece of writing or a tag can represent social disintegration or group dynamics; it can just be a representation of an individual’s creativity or motivation; it can emerge through boredom or revenge; but what is common to all these is a social relationship, mutual encouragement, competition, anonymity amongst peers and socialization. We have attempted to retain this social relationship in Mobspray through a website that links the tags to a map of the local area which marks all Mobspray sites together with a history of mobtags submitted by different writers. The sense of competition is kept alive by displaying the latest mobtag as a site marker on the map. Writers can choose to keep their identities anonymous or just be known within a certain group of peers. This, in our view, not only keeps the essence of graffiti but also creates a whole new breed of community where members interact in both physical and virtual worlds whilst interacting physically with their environment. Figure 8 shows a screenshot of an interactive map of Lancaster University where the authors are testing the system. Visitors hover over the image and each mobspray site shows the last tag submitted to it.

![Figure 8. Interactive map from mobspray website](image)

Although, only a small proportion of our test crew of writers had a specific interest in graffiti, their experiences do highlight some interesting experiences of utilizing this technology and produce aspects akin to the tagging behavior of ‘real’ writing crews and indeed behavior often associated with gaming.

Firstly, as we had linked the website to the mobtags a competitive aspect of tagging did emerge as writers tried to get their tag on as many locations as possible which is referred to as bombing amongst conventional writers. There is an obvious ludic parallel of trying to win the game and indeed a game based around this premise could prove popular.

Secondly, the mobtags started out as very simple one color signatures in the majority of cases but a competitive element emerged where the mobtags became much more elaborate in a similar vein to traditional spraycan tags as discussed in section two. This is also akin to the ludic desire of identifying yourself as an experienced player rather than a novice.

Finally, the storage of a list of the last writers to tag a particular location gave a sense of community and belonging to a space which appears an important attribute for most writers.

In terms of the tagging process, it was perceived to be extremely easy and most of the crew commented that the act of actually touching the object you wished to communicate with seemed very obvious and natural. The major criticism was related to not having the ability to create the mobtags using the mobile phone directly which was a limitation of the devices themselves and is something we are trying to address with a future evolution.

6. FUTURE ENHANCEMENTS

The system as described in Figures 3, 4, and 5 is limited due to relatively low resolution images, constrained by network bandwidth, device display limitations and the storage capability of low-cost RFID tags. However, the system can be extended in several appealing ways. The natural progression is to enable the system to support rich media, including sound, video and hyperlinks in a similar vein to the Grafedia project. With modern mobile devices now equipped with an array of multimedia capabilities including sound recording, up to two cameras capable of taking full motion video and the ability to store such creations

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15 In this project the writers were recruited from the colleagues and friends of principal researchers.
on capacious flash memory, the opportunity for an innovative application co-existing in real and online worlds is clear. Such a development would enable tagging to evolve into something akin to performance art, with writers creating short videos for the consumption by their peers or others in the locality.

Improvements in the Human Computer Interface (HCI) present in mobile devices will make the development of street art on much easier. Already we see phones with stylus to aid user input; it is conceivable artistically complex works could be produced on-device for display on a system described herein. Further, the incorporation of 3D sensors into mobile phones would allow writers to create virtual art pieces by moving the mobile phone in the same way as an actual spraycan.

Viewing of mobtags on a constrained mobile phone makes it unlikely that Mobile SprayCan would replace or even reduce graffiti in a given area and indeed it would need trials within a real writing community to truly ascertain its applicability and acceptability. However, by utilizing NFC access points the system could be extended to allow mobtags to be downloaded from phones and then projected onto walls or displayed on large screens, as shown in Figure 9.

Here, a writer’s creations could be viewed by a large number of urban dwellers, reflecting the effects of traditional graffiti with a number of drawbacks removed. Projecting graffiti onto buildings has already been seen in New York through the work of the writer Fi5e, who has captured the motion from real writers creating their tags and produced small movies which he projects onto buildings from a projector mounted in a car [12] as shown in figure 10.

7. DISCUSSION AND CONCLUSIONS
As we stated at the start of this paper if we are to truly attain an environment of pervasive computing technology then we must utilize technologies available to all sectors of our society and provide systems that will engage groups whose activities are out of the mainstream. Graffiti is a cross cultural phenomenon that is part of every single society. Within the variable contexts of their production, graffiti allows personalized and de-personalized space, the construction of landscapes of identity, the ability to make public space into private space, and act as a promoters of ethnic unity as well as diversity. Graffiti can be understood as concrete manifestations of personal and communal ideologies which are visually striking, insistent, and provocative; as such, they are worthy of the continued attention of art historians, social scientists, and policy makers alike [13]. The Mobile Spray Can project is but our first step towards providing a system that will allow writers to continue to express themselves through graffiti tagging but without producing the physical impact that many members of the community find objectionable.

Further, this project also highlights the potential for mobile phones equipped with RFID/NFC capabilities enabling many other applications, such as games. Combining these technologies takes advantage of the synergy between two pervasive computing domains, and indeed the ever-evolving feature sets on mobile phones paving the way for many innovative applications.

8. ACKNOWLEDGMENTS
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9. REFERENCES

16 This project is detailed at the website ni9e.com and more images are available on that site.


