drawnTogether – a collaborative approach to virtual graffiti

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ABSTRACT
In this paper, we propose and implement a new application enabling ubiquitous creation of virtual graffiti, intended to support location awareness and interaction amongst mobile people despite their lack of temporal co-location. In particular, we developed a mobile application using the GPS and compass within the iPhone 3G S to allow participants to create sketches attached to real world geographic locations and others to view them and contribute at a later time. We intend to show user interaction rates among participants increasing when they can contribute to something permanently, even in the digital sense.

Author Keywords
sketch, collaboration, interaction, location awareness

ACM Classification Keywords
H.5.2 Information Interfaces and Presentation: Miscellaneous—*Optional sub-category*

INTRODUCTION
People are intended to do funny things together. Sometimes, they also want others' help to finish their jobs. But what if they cannot turn up in the same place at the same time, but they are still eager to know what others are seeing or think about at this position? Our collaborative artistic application is intended to group people in the same location but not necessarily at the same time to work together. The work is drawing. They make sketches collaboratively. For example, Alice and Bob can make a sketch of a building in different time and view the sketch together.

The purpose of this application is to help users collaborate and communicate better with others in the same network, or let users be more aware of what happened around based on context information and more involved in social activities.

APPROACH
We develop a collaborative artistic application for the iPhone 3GS. This application allows users draw sketches on their iPhone 3GS and upload the sketch as well as their global position and orientation at that moment, to a server. The sketch can be anything the user wants to draw. It can be the view he/she is seeing, or the idea he/she is thinking about, or his mood and feeling. The context information accompanied by the sketch uploaded to server together contains both temporal and spatial information. Each sketch is timestamped at the point it is uploaded to the server.

The spatial data has

1. the current position the user locates, indicated by x (latitude), y (longitude) and z (altitude) available via GPS in the device.

2. the current orientation the user faces available via the magnetic compass within the device. The orientation is important because view would be affected given different orientation.

Just like common social networks, users have his/her own networks in our system. i.e., one may only interested in his/her friends' sketches or sketches based on their tagged metadata. It is expected that the amount of created sketches could quickly overload our small interface. For this reason, we are initially allowing sketches to be filtered based on tags and their creator, as seen in Figure 1.

The specific activities users conduct using our system include:

1. Hold iphone in hand, stay at any location GPS can track.

2. On the iphone screen, make some sketch as seen in Figure 2. Users can select color (red, yellow, green, blue) from the palette at the bottom of the screen.

3. For sketch, users can have that creation tagged in setting page.

4. As the sketch is created, it will be uploaded to the server at small increments (every n seconds)

5. Users can retrieve entries based on a simple query interface. Thus conditions involve: social relations, tag, time, and present location.

6. Users can view which sketches are near them via a map interface, as seen in Figure 3

Submitted for review to CHI 2009.

Figure 1. A mockup of the proposed settings interface

Figure 2. A mockup of the proposed drawing interface

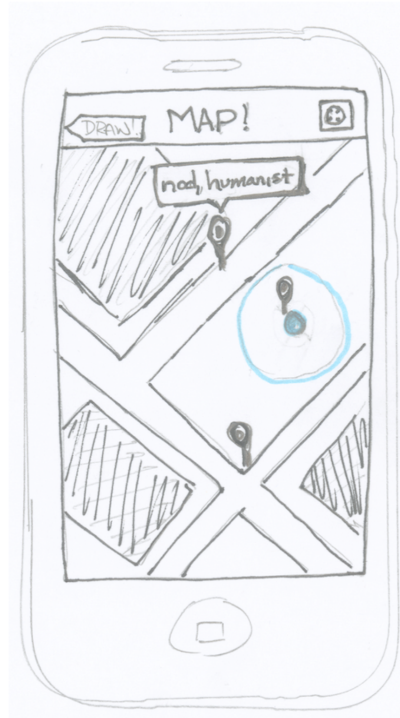

Figure 3. A mockup of the proposed map interface

DESIGN PROCESS

Ethnographic data gathering

We conducted three semi-structured interviews and carried out at least five other free form conversations around the goals of the project. Since graphics creation on mobile devices is very infantile, we instead chose to focus on "normal users" that may have used graphics programs and the intersection with their mobile usage.

The three researchers in this project were to each speak with individuals and gather information concerning artistic leanings and computer based tools used in these endeavors. In hindsight, we should have either had one individual conduct all interviews, or provided a more rigid script for each interviewer to use. The questions started from the following set, but would often stray into other tangents concerning the topic:

- Can you list any devices you have used for drawing besides paper?
- Have you used any drawing software before?
  - If yes, which tool have you used and how often have you used it?
  - Would you choose to use Paint or Photoshop if familiar with both?
- Do you prefer art creation on paper or via digital means? Why?
- Have you ever considered collaborating with others when creating artistic works?

- Imagine you are able to draw on a screen and have that work appear on a building. What would you draw?

These questions, although not rigidly adhered to, provided for interesting conversation starters and were definitely useful in showing a definite interest in our eventual application.

One of the interviewees came from China and is a student at Texas A&M University. He mentioned he usually uses Paint application and sometimes uses Photoshop and that, overall, he uses graphics applications about once a month. His responses indicated that the MS Paint application is simple and easy to use, and that Photoshop has too many functions and is quite sophisticated to use. Additionally, after he heard about our application, he said it would be helpful to provide a function to search a sketch drawn by friends without going to a certain location.

One of a the respondents, an economics student of Chinese origins, has never used an iPhone before. Yet, she is very interested in drawing and painting. She mentioned highly enjoying drawing on a small toy board which has an eraser as a child. She randomly uses the Windows Paint application, as well. Most often though, she uses analysis software, such as SPSS to draw professional diagrams. When questioned about pure artistic endeavors, she expressed a high preference pen and a paper drawing and a complete disdain for using a mouse to draw strokes when sketching. Her response concerning this area was “If I can have a pen to draw on the computer screen, I would definitely draw a good picture.” Concerning collaboration, she definitely showed some excitable interest but her biggest concern was the ability to tell her strokes apart from others. When the question about drawing on a screen and appearing on a building was broached, she replied that she would like to draw something related to her surroundings and that she would care about others sketches. In particular, she remarked, “That’s one aspect of collaboration, right? First, I care about my friends’ drawing. Then people who share the same interests with me.” When our intended application was finally revealed, she said she would care more about what people around her were drawing.

Another interviewee, a technology worker from Houston, TX, mentioned being highly proficient in multiple graphics applications, including Photoshop. Throughout the interview, his mind raced with different ways to collaborate on different projects even at one point asking “Would it be possible to really project what others were drawing onto an external wall for live events and concerts?” This was an idea previously not considered by the researchers and one that is being heavily considered as a way of involving passersby who may not have a device but could still be considered consumers of collaborative creations.

Storyboards

We can apply our application to various scenarios. In this section, we show two of them.

Scenario 1: collaborative drawing

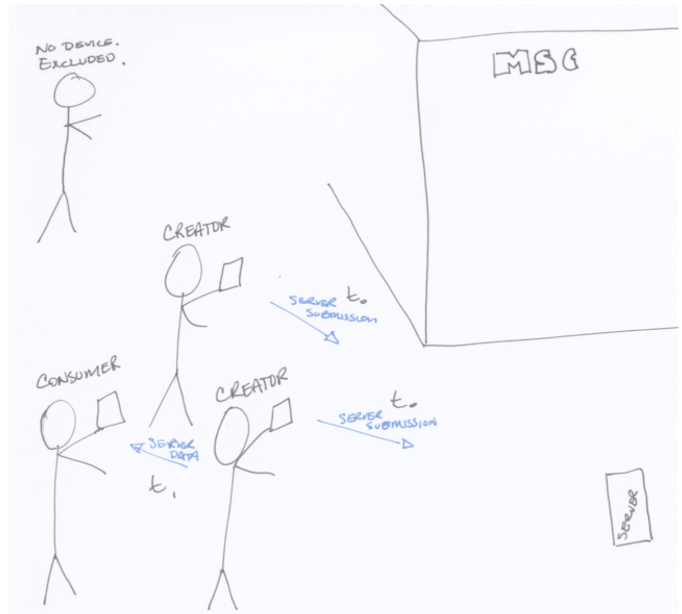

Figure 4. Scenario 1

Alice and Bob are students at Texas A&M University and are friends. Alice wanted to draw the MSC building before it is remodeled, so she went near to the building and sketched it using our application. She did not finish the drawing because of a class. While she is going to a classroom, she sends a SMS message to Bob. The message is “Could you finish the sketch for the MSC building in location X?” Fortunately, he is passing in front of the building and starts to add some sketch into the figure, which Alice drew. Sometimes later, he finishes to draw the building and sends a SMS message to her. The message is “I’m done!” After the class is finished, she goes to the location in which she drew the building. She can view what they drew and is satisfied about what they did. This can be weakly seen in Figure 4.

scenario 2: event impressions

Alice and Bob can attend a public event, such as a conference or a concert. While at the event, each user contributes small sketches to the location. On a whim, Alice decides to draw the standing position of each speaker during their talk or show and tags these creations as “position”. Likewise, Bob decides that each time a question is asked from the audience, he will annotate that by creating a mark on the screen and tagging it “question”. At the end of the conference, they each view the other’s visual notes and deduce several anecdotal observations related to audience participation and performer position. This can be weakly seen in Figure 5.

USER STUDY

Interviewees

We conducted eight people:

- (A) male, an iphone 3G S user
- (B) male, a computer science graduate student

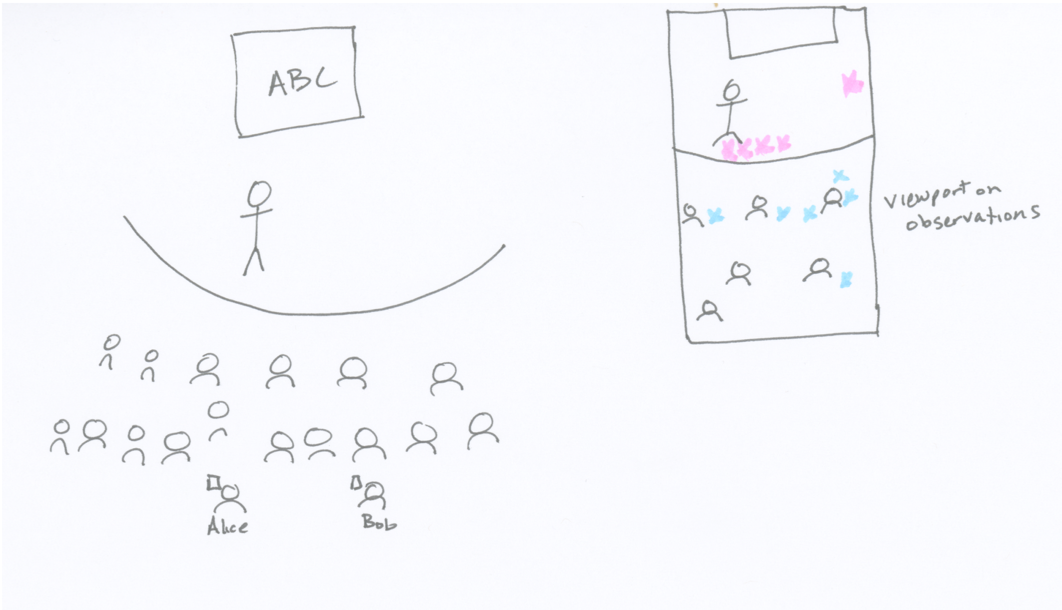

Figure 5. Scenario 2

- (C) female, a person who enjoys drawing
- (D) male, an iPhone 3G S user
- (E) male, a computer science graduate student
- (F) male, a computer science graduate student
- (G) male, professional graphic artist and iPhone 3G S user
- (H) female, non-technical profession, non-iPhone user

conducting user study

Conducting the user study can involve multiple methods. For our study, we took an informal, guided conversational approach to gather the information. We provided a semi-structured questionnaire that our interviewers were to follow.

This questionnaire was divided up into multiple phases.

Introduction

This phase consists of multiple steps:

- welcome and greetings
- gather consent and completion of form
- introduce the system in conversational form
- communicate goals for this study

This phase is general housekeeping and provides for a welcoming and customization period between the interviewer and interviewee. Any general questions are encouraged at this point about the general concept, but the system has not been officially "placed in their hands" yet.

Facilitation

In order gather information about usage, we physically hand the users a lo-fi representation of the drawnTogether interface in the form of a tangible, translucent enclosure with cards that can swap out to represent the varying views of the application. When the user "navigates" between the views, the interviewer acts as the computer and move the cards for the user. The benefits of this are numerous, but primarily, it allows us to iteratively improve the interface and pilot new versions in a much faster way than implementing the changes in software first.

We interviewed multiple individuals (eight total) over a period of three days. The first six individuals used the same version of our interface. The last two used a modified version based on feedback gained from earlier interviews. The second version of our application views were very well received, as will be seen in the following commentary.

For each interview, we began our questions with handing them the device, then asking the following:

> Is there anything particularly interesting about the concept of the application?

Most respondents actually felt the application to be quite interesting. Respondent B, however, felt that it's merely a "funny application", and doubted if there would be enough situations for the system to be used. He did provide one possible scenario. Imagine a group of architecture students enter into one building to make a sketch of the inside structure of this building. Each student can find whether the viewer around him or her has been drawn or not. If not, he can add his sketch on the screen of the application. If yes, he may ignore it and go to other places to draw or make some correction based on others' drawings. It was interesting to the researchers that even a skeptic began to imagine practical, unforeseen collaborative uses.

Following the initial question, we followed with providing four erasable markers of differing colors to the interviewee. We had them "navigate" to the drawing screen if he or she were on a different screen. At this point, we asked the following:

> Can you draw a simple picture using multiple colors on the screen?

With this question, we wanted to gauge the intuitiveness of the interface and the user's ability to recognize visual affordances and their mapping to intended tasks. Person A asked "Can I draw now? What's the status of my pen?". Several users touched the settings button before ever trying to draw, with the purpose of exploring their options and tools before actually beginning any sketch creation. Person C immediately picked up a random pen (blue) and began drawing on the screen. When asked how they would change colors in the application, the response was "Oh. . . the settings page", to which she instantly and easily navigated to the page and chose the blue color. Again, with each navigation, the interviewer acted as the computer and moved the cards as requested to transfer the user to different views. Once in the setting page, all users had an apparently clear understanding of how to manipulate the current drawing color or erasure.

Multiple users asked about the tagging features visible on the settings page. With minimal instruction from our facilitator, users understood the nature. One thing was made clear to the developers with these questions, though. The ability to create tags and filter tags on the same view was a little confusing and needs to be revisited. The later revision used by the last two interviewees provided a much clearer mapping and helped to eradicate most of the confusion.

There were several questions about the appropriate time to tag a drawing or as to the origin of the tags used for filtering. These questions were quite helpful in illuminating deficiencies with some of the feedback mechanisms around the affordances related to tagging.

One interesting suggestion from multiple users was to add a voting feature for a given location's sketches. This way, a ranking per location could be used to sort each location and be communicated on the map also.

Our next question was one which encouraged them to examine the map view, if they had already not seen it:

> Please navigate to the map view. *[pause for navigation]* What pieces of information do you gather from this view?

Once on the map, Person G mentioned "Oh, I can see where other users sketches are. Cool". This was very satisfying to the researcher that the primary and immediate purpose of the map was summed up so well. User A asked, "Can you show the sketches actual sketches from different locations on the map? In a pop-up window?"

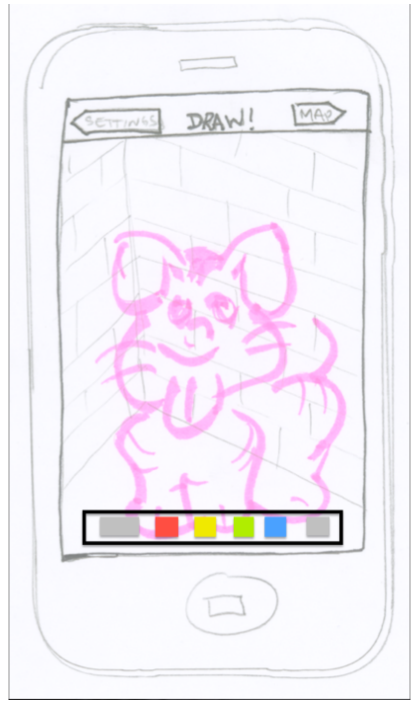

Figure 6. A mockup of the modifed drawing interface

Interview Completion
In this phase, we attempted to provide a summary of each person's response and to gather further clarification if needed.

We also ended with one final question, intended to spark a free form conversation:

> Are there any recommendations you would make to improve your experience?

Two individuals suggested moving the color palette from the setting page to the bottom of the drawing view. This would have the effect of drastically reducing the interaction required for a meta task of changing the drawing color. Several users changed colors at least twice, so the benefits of this change seem beneficial. For the final two interviews, this change was adopted, as seen in Figure 6, and proven to be a valid enhancement immediately. Person G used the modified drawing view and changed colors five times while creating a sketch. Person H changed colors four times. This was a definite, measurable improvement and allowed for a more refined workflow for task completion.

The sacrifice of reduced drawing area was mitigated by removing the top bar completely in the drawing view and adding navigational elements to the bottom toolbar to allow for access to settings and the map. This had no visible, negative effect on the latter participants in the study on their ability to navigate between views.

Another suggestion, offered by Person A, was to launch the application with the map page initially. Further conversation with the participant on this consideration showed several potential benefits of adopting this.

- Participation feedback is immediately communicated by this macro approach to making visible the locations containing sketches. Each sketch becomes just one minor data point on the geographical plot.
- Users can immediately choose to change their location in order to either add to an existing drawing or to create something new and unique
- Community involvement is augmented by seeing participation. If each map pin is somehow annotated with the sketch age, a visual component could easily communicate a temporal nature for each sketch showing which areas could benefit from a "fresh creation".

In closing, almost all participants expressed an interest in getting this application for their personal use.

DEVELOPMENT

System Architecture

The heart of the mobile application is the integration of a live video feed from the device's camera overlaid by user contributed sketches for the current location of the device. The application relies on Apple's CoreLocation service to provide the location and orientation information in order to retrieve user content from the web service. We run an NSTimer that creates NSInvocationOperations at regular intervals to submit any user created content in the background during viewing and to retrieve any new content for the user's current geographic area.

We incorporate a simple user identity component using Twitter. This allows us to attach a user to a sketch without having to manage the identity infrastructure. By having identity information attached to each contribution, we also have the ability to allow users to filter based upon the user.

There is a tagging component, although it is limited in this initial prototype. The user is able to create a set of tags that is applied to sketches created after tag assignment.

Finally, a map view is provided. It indicates to the user sketches near to them, to allow for "sketch tours" or other artistic discoveries.

Figure 7 presents our proposed system architecture. Mobile users can draw sketches together despite their lack of temporal co-location. For example, user A drew sketch in a certain location (point$_0$) at t$_0$ and left the location. The user A's drawing has been stored into database through web service (web server). Sometime later, user B came to the location (point$_0$) and adds some sketches into the previous sketch drawn by user A at t$_1$. Web users can view what people has drawn by their web browser which accesses to our web service (web server). Each marker in our map page indicates there are sketches in the location.

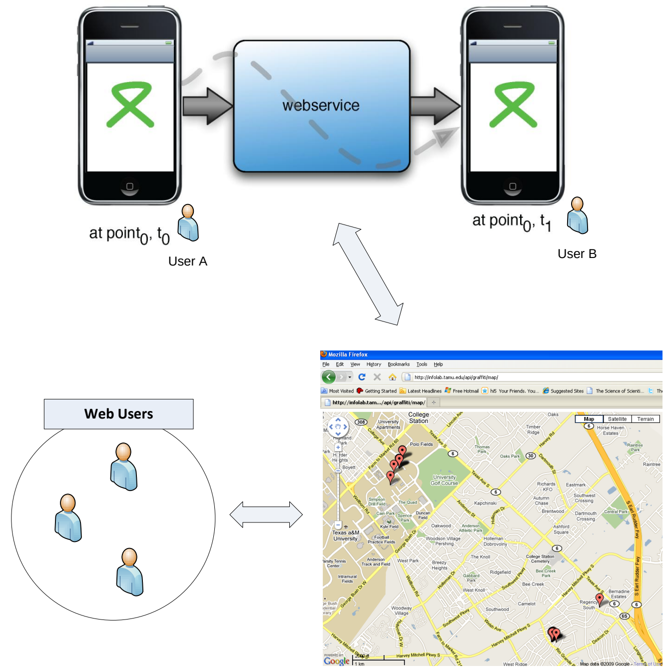

Figure 7. The proposed system architecture

Application Environment and Development Tools

Mobile Client

Since the application is intended for the iPhone OS, there are few options for development environments. The path of least resistance (and greatest productivity) is for the application to be written in Objective C, and built using Apple's iPhone SDK toolchain integrated into the Xcode IDE. It is possible to develop iPhone applications outside of Xcode, using other text editors and foregoing the builtin debugging integration that Xcode offers, but to compile and link, one is still required to use the provided tools by Apple. For this reason, we focused on the Xcode environment and the full stack that it has to offer. In particular, we has used the following:

- development workstations will run OSX
- Xcode
- iPhone 3G S
- iPhone Simulator

Web Service

In order for the applications on the client devices to share content, a centralized web service is required. This web service was built using the following:

- Python scripting language
- Django Web Framework
- Lighttpd HTTP Server
- MySQL Database
- JSON for data transport

We built up a google map with markers of sketches on a web page. This enables users view sketches globally and have a sense of the sketch distribution directly.

- google map api
- javascript

Version Control & Source Code Management
In order to facilitate sharing our work, we have created a repository at GitHub[1]. This allows us to use Git, a distributed version control system, for all of our created content. Our source code, scripts, and even our papers (written in LaTeX) has been stored in this shared repository. This allows us, as a distributed team working in disparate locations, to share all content and stay up-to-date with others contributions.

Git also provides issue tracking that we have begun using in an effort to track progress and discussion on multiple concurrent items.

EVALUATION

PRIOR WORK

Zurita et al. [7] presents MCSketcher, a mobile collaborative sketching system, using handheld devices in an ad-hoc network. People can draw sketches with collaborators in the same page in the system. They can take a picture and use it in the background of the drawing. The system supports gesture recognition for basic navigation gestures, and selecting and resizing items. Collaborative work is only available in an ad-hoc network. In other words, friends or collaborator can only work together in close distance. Our application connects to a server to store what users draw and to retrieve what they drew in the past using cellular networks. One can collaborate with not only friends, but also any people.

Kim and Dey [2] presents displaying augmented reality based car navigation information on windshield. Augmented reality helps elder people can concentrate to drive a car and easily follow directions from a navigation system. Augmented reality is one of ways to display various information in a view. Likewise, overlapping sketches in our application can help for users to know what has happened in a certain location.

Bastéa-Forte and Yen [1] presents a collaborative sketching tool. Each user has a Tablet PC to draw some sketches and to view shared sketches. Each user's drawling is synchronized, so that users can view the same drawling. The collaborative sketching tool helps each user's contribution is equalized although it reduces total number of sketches. Our application enables users to collaborate drawing no matter what their relationship is.

The authors in [6] are trying to combine various context-aware applications. They want to retrieve data from different sources and services, thus design a general purpose client software that can be used to access a variety of context-aware services. In their paper, they proposed an architecture of their system model. They use messenger protocols. If a service has new information, it sends a short notification message via the servers to the client. The client can then decide whether it wants to retrieve the full data. Therefore, the client can directly connect to the service. A discovery service is used to find services which are relevant for a client in its current context. It uses the messenger protocol to inform the client software about new services.

The authors in [3] tested a few hardware and software technologies in real-time collaborative system, basically raised two fundamental principles - collaboration and persistence. The two principles refer to the ability to communicate ideas with other interested parties in real-time and the ability to store the results of those interactions for long-term reference, respectively. The softwares include NetMeeting, OneNote, DyKnow. Their work is mainly to help students share class materiel and simultaneously edit presentation text or sketch.

Scheible and Ojala [4] proposed MobiLenin system which allows users to use their mobile devices to interact simultaneously with a multi-track music video shown on a large public display. It is built on a server-client based architecture. Our work can be inspired by their interface which combines the private GUI of a personal mobile device with the public GUI of a public display. In their system, a group of people can share the authorship of the multimedia art piece in real time. The users are aware of what others in the co-located group do and make a good contact with each other.

Scheible, Ojala and Coulton [5] also implement MobiToss application which allows gesture control, for creating and sharing mobile multimedia art. The directions are also considered in their system. By tilting the phone in different directions, the clip taken by the phone will be transferred to public display. The clip is also uploaded to a website for sharing the created multimedia art with others. It is somehow like our google map viewer for sketches.

CONCLUSION AND FUTURE WORK

The evaluation results show people can draw sketches on their device smoothly and effectively. They felt excited when they can make sketch together with others on a small device individually despite their lack of temporal co-location. As it is an almost real-time application, the device will show the newly strokes almost immediately after the strokes are created. One can also view the entire map with sketches in multiply places in google map, from where by clicking a marker, a window with sketch will pop up. In the future, we will add search function on the customized Google map to search sketches in certain locations. Also, we will focus on ways to display this potentially large dataset in a way optimized for small devices.

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APPENDIX

WEB SERVER APIS

Login

This method is to authenticate a users Twitter credential.

URL:

http://infolab.tamu.edu/api/graffiti/login

HTTP Method(s):

GET, POST

Parameters:

- u: Twitter username
- p: Twitter password
- d: device id of mobile phone

Example:

http://infolab.tamu.edu/api/graffiti/login?u=user&p=pass

&d=2123456

Insert sketches to DB

This method is to insert sketches to DB.

URL:

http://infolab.tamu.edu/api/graffiti/put/*deviceid*

Device id:

Unique device id of mobile phone

HTTP Method(s):

GET, POST

Parameters:

- lat: latitude
- lon: longitude
- s: stroke points
- c: color

Example:

http://infolab.tamu.edu/api/graffiti/put/2123456?

lat=12.22&lon=22.44&s=[[44,34],[80,33]]&c=aabbccdd

Get sketches from DB

Return sketch information in a location using json format

URL:

http://infolab.tamu.edu/api/graffiti/strokes/*lat*/*lon*

Lat:

latitude

Lon:

longitude

HTTP Method(s):

GET, POST

Parameters:

- c: creator name

Example:

http://infolab.tamu.edu/api/graffiti/strokes/12.22/22.44?

c=nod

Get map information

Return sketch information to display on the map

URL:

http://infolab.tamu.edu/api/graffiti/map