Wigglestick: An Urban Pedestrian Mobile Social Navigation System

David Jimison
Mobile Technologies Group
Georgia Institute of Technology
686 Cherry Street, N.W.,
Atlanta, GA 30332-0165
1- 404-894-2730
gtg961u@mail.gatech.edu

Nithya Sambasivan
Mobile Technologies Group
Georgia Institute of Technology
686 Cherry Street, N.W.,
Atlanta, GA 30332-0165
1- 404-894-2730
gth658b@mail.gatech.edu

Sugandha Pahwa
Mobile Technologies Group
Georgia Institute of Technology
686 Cherry Street, N.W.,
Atlanta, GA 30332-0165
1- 404-894-2730
gth811p@mail.gatech.edu

ABSTRACT
The following paper examines ongoing work on Wigglestick, a mobile way-finding service for the urban pedestrian. It enables users to tag media at specific spots, make their location visible to approved friends, and find their way to desired places. Its usage of the divining rod as a metaphor for the development of the mobile application has encouraged a minimal abstracted visualization approach and a social navigation system based on user-generated location tags.

Categories and Subject Descriptors
H.5 [**Information Interfaces and presentation**]: User Interfaces – *User-centered Design*

General Terms
Design, Human Factors.

Keywords
Urban pedestrian, social navigation, way-finding, mobile interfaces, smart phones, tagging.

1. INTRODUCTION
As urban dwellers become increasingly mobile, they encounter various unfamiliar environments. Many challenges are encountered in finding places of interest in such environments and finding directions to them, often resulting in alienation and/or boredom in the person. Often maps, location-aware mobile devices, online way-finding mechanisms and word-of-mouth are used to help acquaint oneself with the place; however, these methods are somewhat deficient in providing insider information on shortcuts, services and establishments, such as finding an arts theater or a decent Chinese restaurant. There are other problems encountered while faring through an unfamiliar territory, such as language barriers, not knowing the quality of the place. In such a situation, it would be advantageous if the user were informed of his/her friends present in vicinity. Studies have shown that additional context is viewed favourably by the public, agreeing that gadgets could provide contextual information in addition to way-finding services [7][8].

In this paper we present Wigglestick, a mobile phone application, which addresses these difficulties to help the urban pedestrian enjoy the walking experience. Wigglestick, a colloquial term for a divining rod, was conceived by imagining one's mobile phone as such a device, capable of leading the user to any physical location or object desired. While Wigglestick is similar to other mobile way finding services [1][2], it allows the user to tag various locations, search and display nearby places of interest such as cafes, theaters, associate media items (text, audio, video, images) with particular locations into an online service, such as a picture of a library. Wigglestick differs from Geocaching, an outdoor treasure-hunting game, in that it allows users to mark locations without using physical containers or trinkets. Wigglestick allows users to In addition, Wigglestick provides socializing capabilities by allowing the user to make his/her location visible to approved friends, view locations of friends and view various trails left by other users to get to a particular location.

The use of the divining rod metaphor has informed several distinct features and design choices in its User Interface. The map has a legacy in the plotting of land and the laying of roads, in short, for pre-planning movement between destinations. In contrast, a typical stroll through the urban landscape involves frequent unplanned detours: through the park, around construction, to explore. Previous studies have explored various forms of presentation of information in navigation, showing that 2D information is similar to verbal presentations and 3D information is realistic yet demanding in technical resources [9]. Wigglestick attempts to provide a different interface for these experiences by providing an abstract radial visualization, which depicts distance and direction to the desired locations. Comparing this to Google Maps [6], we have lost street names, buildings, and all other representations of the physical environment. Instead, Wigglestick places the onus of navigating the physical world, looking around for cars and street lamps, upon the user. By remaining minimal, it is Wigglestick's aim to make no pretensions of providing accurate information about the users physical environs, other than the proximity to their desired location. Wigglestick provides a minimally intrusive interface encouraging the user to remain present and engaged with their physical world, by intentionally diffusing representation of the physical world. Thereby it disables the user from becoming engaged with their virtual representation moving through the virtual street.

Previous studies have shown that landmarks are the most popular and effective forms of cues in navigation [10][11]. The navigation information must be flexible enough to handle the organic evolution, and at times dramatic changes, that occur in the structure of cities. Social tagging systems allow the user to create labels for places of interest. They allow multiple benefits in discovery as well as retrieval [4]. Previous research has explored tagging of physical objects [3] and multimedia objects [5]. Our approach combines tagging, ability to drop media, socializing, contextual information and way-finding with a minimalist interface.

2. SYSTEM DESIGN

2.1 User Interface

Wigglestick's main mapping visualization represents the distance and direction between the user and a number of locational objects, or tags, ranging between one and thirty five. As shown in Figure 1, two outer rings, each listing a distance in feet at the top center, reside at the edge of the mobile screen. The out most ring contains tags from its distance up to 5 miles, the inner ring depicts tags from its distance up to that of the outer ring, while the space encircled by the inner ring represents tags of any lesser distance. The user always remains at the center of the inner sphere. Each tag resides either locked to one of the rings, or placed proportionally based on distance and direction, within the inner sphere.

The user toggles the distances of both rings simultaneously by pressing up and down on their phone's joystick., thus zooming in/out, and changing the placement of objects between the freeform inner sphere and the locked outer rings. Distance is informed by relating visual difference between a tag and the listed difference of a ring. By zooming the size of area which the inner sphere is representing from 15 feet up to 3 miles, at increasing intervals, the user is able to refine their understanding of a desired tags proximity, while maintaining general knowledge of any similar tags in the surrounding area.

At center screen, the red dot represents the user, the size of which depends on the resolution of the system's location technology, and the transparency based upon its current accuracy. Wigglestick is designed to operate using a range of location awareness devices, particularly GPS, WiFi triangulation, or cell tower IDs. GPS typically provides 10 foot accuracy, while cell towers are closer to 150 foot. By depicting the user's dot as the size of their navigational accuracy, Wigglestick provides visual feedback on how dependable their system is. For instance, with cell tower IDs, the Wigglestick user would know when they are within a block radius of their desired destination, at which point they can read its street address and find it. GPS accuracy fluctuates due to environment. By tracking unexpected variations in the GPS coordinates, Wigglestick is able to determine the GPS unit's approximate variance in accuracy. This information is used to create a semi-transparent extension to the user's dot, sized by the unit's inaccuracy. This approach provides the user feedback on how well Wigglestick believes it is functioning, and therefore how reliable its current information is.

Tags are textual terms associated with a specific latitude and longitude, and optionally linking to additional photographic, audio, textual, and or video media. Users determine which tags are viewable by querying combinatorial terms to the Wigglestick server. For instance the query "restaurant Mexican" would return up to 35 tags listed with both of these terms, within a 5 mile radius of the user. Users further filter which tags are viewable by selecting the sources of these tags by other users or available online resources, such as Wikimapia.com

As user generated content, there are discrepancies not only in nomenclature, but also in precision of location. Nearly all physical objects encompass space greater than a singular point of latitude and longitude, and this is reflected in the input of the user. Wigglestick accommodates both of these issues in its interface design. Users can add terms to a tag, thereby generating additional definitions for the space. They may also claim their tag to be marking the same physical object as a proximate tag. Tags are typically depicted as dots on the screen; however, in this case, and if both sources are selected by the user, the dot will instead be drawn to cover both locations.

The Wigglestick background displays thin lines called trails, and which represent previous user's movement through the space, as shown in the last segment of Figure 1. Wigglestick uses its knowledge of where users are to compile a time stamped listing of space which is navigable by foot. This data is anonymized, and only captured by users with location resolution of better than 15 feet. The more frequent a space is occupied by a user, and the more recent, the brighter its depiction on the background, thereby making commonly used pedestrian pathways more visible than the occasional one.

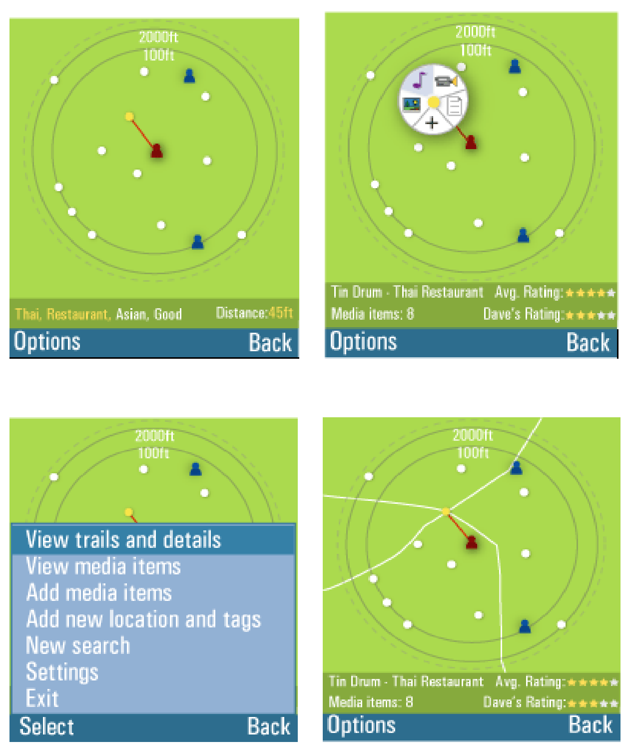

Figure 1: *Stages involved in searching for a destination*

Reducing the complexity of the visualization enables organically evolving maps, with current information. As an example, the satellite images shown on Google Maps are over three years old and do not depict buildings or roads changed since then. Aside from the exorbitant costs, to provide up-to-date satellite imagery would require both a loss of privacy and constant clear skies. By drawing imagery based upon live web data, Wigglestick creates a mapping system which evolves organically. The user generated locations can be as recent as 2 seconds prior. The background trails depict other users movement.

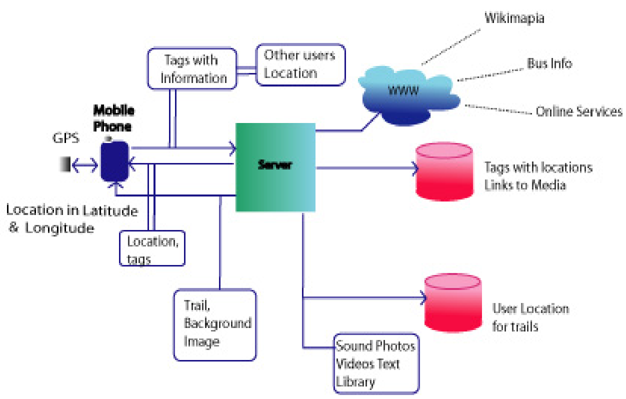

Figure 2: *Architecture diagram of WiggleStick*

2.2 Architecture and Implementation

The Wigglestick architecture involves a Java ME application on the mobile phone which connects to web services, as shown in Figure 2.

Determining Location and Movement When a user launches Wigglestick, the mobile first connects to the GPS unit over Bluetooth, and establishes its latitudinal and longitudinal coordinates as can be seen in Figure 2. These coordinates, refreshed every two seconds, are stored in-system and monitored for fluctuations of position. Changes of coordinates over time, greater than variable *resolution*, are averaged into cardinal and ordinal direction. If the shifts are consistently a single direction over a period of 10 seconds, then it is assumed that the user is moving in this direction; however, if the fluctuations continually jump between directions, the system decides that the GPS unit is exhibiting inaccuracy, and increases *resolution*. This results in the user's icon becoming larger on screen, and the system not recognizing changes of position as frequently, and thus being more certain when they are actually occurring.

Positioning Tags After determining the coordinates, as can be seen in the Figure 2, the application attempts to send them to the server, which in turn, performs a database query, and returns a list of links to a generated images, the coordinates of any nearby *friends*, and up to 35 tags within a 5 mile proximity to the user, ordered by most recently added. The images, offload the processor intensive work of depict trails created by users (explained later) to the server. The degree that the user's interface is zoomed in, determines which images are placed as the background. Tags and *friends* are drawn on the mobile screen, as proximate to the user, every two seconds. As the user moves towards the physical location of a tag, it is drawn closer to them.

Tag Structure Tags are written in an XML base format, and consist of latitude, longitude, time added, and at least one textual descriptor. Tags can contain links to media, additional text, or a web link.

Generating Tags Selecting on 'Add Tag' brings up a text box to enter descriptive terms for the location. The use of commas enable multiple terms to be defined for a single location. The user has the option to browse for video, sound or images, to upload to the server and associate with the tags. In addition to this, the user's coordinates, and user name are uploaded to the database.

Searching for Tags Selecting 'Search' enables the user to query the database for tags by any term. Queries are reductive, and allow searching by tag descriptors and users.

Customization Within the user customization panel of Wigglestick, users are able to list the phone number of a friend they wish to add. This person receives notification, and if accepts, both people will be able to see each other's locations when within 5 miles of each other. Users are also able to select external services which provide location information, such as Wikimapia.com. If selected, Wigglestick will return those locations as tags to the user.

Trails When a user starts their application, if their location *resolution*, is less than 3 meters, a new timestamped trail is created for them in the database (as can be seen in Figure 2), and their initial coordinates are stored. Every time that the user's direction is changed, the application send their current coordinates to the trail server. The server then assumes that a straight line between each point was traveled. All locations are averaged to a resolution of 2 meters, and any previously stored location in the trail database is assumed to be the same, as the current, and the older coordinates are used. This method enables the abstracted tracking of a users movement. When a new user enters into an area, the server checks for previous trails, and draws them with the most recent being white, and older trails being faded based on age.

3. EVALUATION

The aim of this prototype is to facilitate urban navigation in unfamiliar environments. In order to evaluate the application at this stage, we used two types of evaluations – Heuristic Evaluation on expert users and the Think Aloud protocol on non-expert users. The evaluations were conducted among seven users in the Spring of 2007 at the Georgia Tech campus.

For the Heuristic evaluation, we chose the following heuristics which we felt were most relevant and useful for our prototype: ***Visibility of system status*** **-**Since the system would be used across multiple locations and serve various purposes, we choose this heuristic to ensure that the system provides adequate feedback to let the users be aware of their actions. ***Consistency and standards*** - Since our platform would require its users to have extensive interactions within active surroundings (which may be distracting), we wanted to keep the interface friendly, as well as consistent within its conversational/interactive language. We wanted our prototype to be clear and not confusing, with common standards across the various situations a user might encounter. ***User control and freedom -*** We chose this Heuristic because our prototype includes a wide variety of functions, and an operational version of our system would provide many pathways for a user to follow. Should she change his/her mind or make a mistake during the interaction, we wanted to be sure that the user could easily recover or backtrack. ***Flexibility and ease of use -*** We chose this heuristic so that the system would allow both novice and experienced users to easily access the system. ***Recognition rather than recall -*** The heuristic was important in order to assess our attempts at placing all necessary information options in front of the user on each screen, so the user would know where s/he was in the interaction process. We also wished that users would not have to rely on memory during their interaction. For the ThinkAloud, we chose users with no familiarity of the system. With brand new users who have never engaged with our system, we felt that the feedback, verbal and non-verbal, would be very descriptive, and would most closely mirror a potential user scenario in the real world.

Overall, our evaluation results have been positive on the sociability and clutter-free visualization aspects. Most users were happy to not be bothered with too much information in a mobile application. The tagging feature was received very positively. It was also noted that the interface was novel and very intuitive. We also learned that after an initial learning process, the user masters the use of the application. We uncovered a few interface issues such as on first glance of the screen, the user would see the white circles used to denote tags and may not find a relationship between the tag descriptor and white circle used to denote the tag.

4. FUTURE WORK

As a next step, we hope to integrate a strip of textual directions in the system, such as ‘Turn left on Peachtree St’. In the realm of user interaction, our pilot studies showed that being proximate to the location is not always the necessary condition for people to tag a place. Rather users sometimes tag larger locations when in their site, despite being significantly distant. We would also like to explore the nature and ontology of keywords used as tags. There are other issues of scaling such as handling locations in the hundreds and also visualizing multiple paths without clutter on the screen. We would also like to explore the use of a radar-like visualization for navigation as used in video games.

5. CONCLUSION

We have presented a mobile way-finding social navigation system based on a minimalist visualization. Preliminary testing indicates that this approach offers a rich and intuitive user experience. By combining tagging, sociability and contextual information with location data, we have provided a novel user-centered mobile way-finding experience.

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