Touch Me wɛər: Getting Physical with Social Networks

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***Abstract*—This project explores possibilities of association between existing social network information and real-world physical interaction. These possibilities are explored through the integration of wearables technology with mobile social network technology. We use the term "mobile social networking" to refer to those advanced interactions which integrate complex real world actions with online social network information. This project focuses particularly on the physical aspects of mobile social networks as basic as human touch. Touch Me wɛər is able to associate social network identities with real world physical contact and in turn advertise that information online or use it real-time within the physical world. As a proof of concept, the Touch Me wɛər application was implemented. Touch Me wɛər changes the color of one's shirt depending on who they have hugged. Also the details of who was hugged and when are advertised on the user's social network profile. One can imagine many other interesting uses for this technology. The possibilities and implications of this technology are discussed.**

I. Introduction

This work builds on the "WhozThat" system [1], which supports the exchange of social network identifiers via bluetooth and then supports accessing social networking information via the users mobile device using the social network identifiers. To briefly describe how Touch Me wɛər uses the WhozThat system, consider the following:

> "A man walks into a bar and seeing an old schoolmate he proceeds to hug her. It just so happens that his wife is browsing facebook at that moment and notices an update to her "Touch Me wɛər" application, apparently her husband has just hugged someone named "Monica." Interesting..."

A story like this is possible, and that is what this project is all about. This paper discusses how such interactions are made possible by using mobile social networks and integrating it with wearables. This paper discusses a system which drives real-world interactions supported through the sharing of social network identity between wireless mobile devices such as cellphones or in this case, a Bluetooth enabled shirt. The shirt is not only capable of communicating wirelessly through Bluetooth but it also has sensors and lights connected to a microprocessor. The novelty of this project is that we can connect those sensors and the particular actions they detect all the way back to someone's social networking profile (in this case a Facebook profile). As well, we are able to then take information from the social network and connect it with lights on the shirt, completing the cycle: physical action to social network to physical action.

Touch Me wɛər is built on concepts and technologies from many different fields and areas of computer science. For instance, the end points of the system or interfaces consist of a shirt (lights, sensors) and a web browser (accessing a facebook application). However, the infrastructure to support Touch Me wɛər requires mobile computing devices using wireless communication. A background and summary of each of these technologies is given in section II.

The implementation of Touch Me wɛər consists of a few interacting pieces. The shirt contains sensors, LEDs, a microcontroller, power source, and bluetooth chip. An access point talks to the shirt using bluetooth and then talks to facebook over an internet connection. A facebook application is updated with information from the access point, which in turn can access social network information and relay this information to the microcontroller in the shirt using bluetooth. The details involved in implementing this system and how the different parts of system work are discussed in section III.

II. Background & Related Work

The excitement generated by new social networks and mobile devices such as the IPhone has lead to dense populations of highly connected individuals and information. The possibility of connecting individuals' existing social network information through mobile devices makes many physical interactions and activities associable with the wealth of existing social network information. The integration of these worlds (the physical and internet) through ubiquitous mobile devices using wireless technology creates a new multi-dimensional space for all new types of interactions. The technologies that make this all possible are discussed in this section.

A. Mobile Computing

Advances in cell-phone connectivity and the ever-more ubiquitous "smart phone" have brought the internet into the pockets of individuals anywhere, anytime. Along with the ability to always be "connected", social networks have developed resulting in very high penetration rates within certain communities (in particular college campuses). This means that within many social contexts there is a high number of social network users with mobile computing devices.

B. Social Networks

Online social networks have been exploding in popularity over the last few years. According to Facebook.com's statistics page, the site has over 200 million active users [2], meaning that 1 in 5 people using the internet uses Facebook(according to comScore). Existing social networks already allow users to share a rich set of contextual data online. The amount of data and the type of data stored on these sites is growing daily. Remarkably, Facebook alone gets over 850 million new photos uploaded to it every month. Also, the way in which user access that data is expanding. Facebook applications allow developers to provide users with new ways of accessing data. Common types of information shared on these networks include contact information, gender, relationship status/interests, activity, music, literature interests, group or cause association, and of course information concerning user/friendship interconnections. This rich source of information is a recent development, without which this paper's work would have much less applicability. However, the existence of such data and access to it through the Facebook API allow for a simple touch sensor and LED to become a gateway to an entire world of applications and information. In effect, the wearable and its use become a part of a users digital identity.

C. Mobile Social Networks & WhozThat

This paper uses the term mobile social network to refer to those advanced interactions which integrate complex real world actions with online social network information. mobile social network are motivated by the desire to enrich a person's interaction with his/her physical environment, including interactions with other people as well as nearby wireless devices devices through sharing of information applicable to a user's social network identity, effectively creating a mobile social network. Given access to someone's social networking information the entire user environment can be enriched. Previous systems such as WhozThat [1] and Serendipity [3] achieve this integration of mobile computing and social networks through combining internet connectivity to the social network along with local wireless communication.

The key piece of information is the social network ID. Given this ID, a mobile computing device such as a cell-phone can access an online social network API and share information. Also, for phones that do not yet support an internet connection, a base station has been used to relay Bluetooth messages to the social networking site. This physical hardware, or wearable (in this case a shirt) can gather information about user actions and environment. This contextual and environmental information can be shared with the social network or used to obtain pertinent information from the social network.

Some existing work in mobile social networks has merged social networks with mobile devices. Most current integrations of these social networks with mobile devices have consisted of simply extending the social network interface to the mobile device, i.e. just browse Facebook using the mobile device. However this approach does not manage to exploit the richness of information existing both in the social network and integrate this with the physical actions of the user. In particular, the interplay between these two worlds is most novel. Other work such as a dating application on mobile phones [4] and a Bluetooth-based presence sharing system called Serendipity [3] have explored the combining of local and social information, but the outcomes are fairly closed systems that are forced to create their own lightly populated social networks, which are cut off from the wider online social networking phenomenon. Research in context-aware smart spaces [5], [6], [7], [8] and context-aware UIs [9] [10] [11] hint at some of the possibilities of mobile social networks, but are largely disconnected from the phenomenon of online social networks.

D. Wearable Sensing and Actuation

A large body of work has explored wearable sensing platforms that detect information about a wearer's movements, physiological state and location, primarily to support context aware applications. See for example [12] for a recent investigation along these lines. Though social interactions are often a part of the context that these projects are interested in sensing—since engagement in a social interaction is a good predictor of "interruptability"—few have really focused on detecting or monitoring social interactions. A noteworthy standout is the work of Pentland et al., who developed a mobile-phone-based system that can detect a wealth of social information from audio recorded during conversations [13] [14].

Another class of projects have investigated how communicating wearable devices can augment real-world interactions and experiences. For example, Borovoy et al. developed communicating name tags that tracked wearer's face to face interactions and allowed wearers to easily exchange virtual business cards [15]. Cutecircuit's "hug shirt" is a Bluetooth enabled shirt that uses and assortment of actuators to simulate the sensation of a real life hug. Users of the hug shirt system can send each other these simulated hugs like SMS messages [16].

A final class of relevant devices has employed wearable and, particularly relevant for our discussion, textile-based actuators for a variety of purposes. Several designers have used LEDs in wearables displays. See for example Phillips' lumalive, Buechley et al [17], and Nyx [18]. Examples of other wearable actuators include the use of vibrating motors to create "subtle" haptic feedback devices [19] and shape memory metals to create shape changing clothing [20].

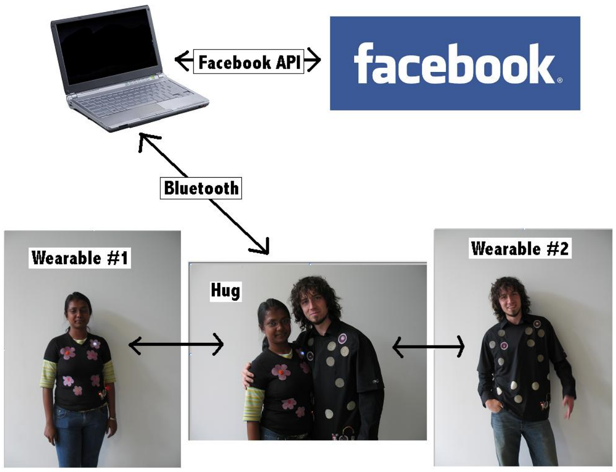

Fig. 1. Overview of Touch Me wɛər

Our system differs from previous ones in its integration of wearable, socially relevant sensing and actuation with a social networking system. It is worth noting that many previous wearable sensing projects, like the ones cited in this section, could be similarly linked to social networking sites.

III. Design & Architecture

The architecture of Touch Me wɛər consists of three components: wearables, an access point, and a social network. This particular implementation uses shirts as the wearables, a laptop as the access point, and Facebook as the social network. The shirts and laptop communicate with each other wirelessley via Bluetooth and the laptop communicates with Facebook via an internet connection. As we will describe in more detail in section III-B, the access point could also be a mobile device that communicates with Facebook (or another social network) via a cellular network. The rest of this section will describe the shirts, the access point, and the communication that happens both between the shirts and the access point and between the access point and Facebook. This overall structure is shown in figure 1.

A. The Shirts

The shirts in our application scenario are used to sense real-world/physical interactions between people and, conversely, to display facebook information in a real-world/physical setting. Each shirt contains an embedded microcontroller, a Bluetooth radio, an RGB LED and two “hug sensors” that enable it to accomplish these tasks.

The shirts were constructed using commercially available sewable LilyPad Arduino modules [21]. Each shirt includes a LilyPad Arduino microcontroller (that contains an ATmega168V chip), a LilyPad power supply that has been modified slightly to run off of a lithium ion rechargeable battery, and a LilyPad RGB LED module. The modules were stitched to the shirt and each other with conductive thread using a sewing machine. We used a silver plated nylon thread, with an approximate diameter of 170 microns and an approximate resistance of 270 Ωs/meter as a top thread in the machine and a 100% stainless steel thread, with an approximate diameter of 280 microns and approximate resistance of 15 Ωs/meter as bobbin thread. A photograph and diagram of a shirt is shown in Figure 2.

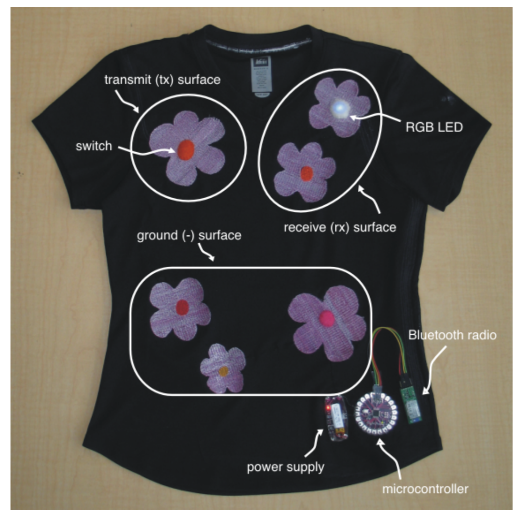

Fig. 2. A Touch Me wɛər shirt

The RGB LED in each shirt functions as an ambient display that conveys information about the user’s facebook profile. In particular, when the user is not actively engaged in hugging another person, the light’s color indicates how many of fellow Facebook users are in the vicinity of the local access point. A blue color indicates no people and a red color indicates 10 or more people. The color of the light changes gradually from blue to cyan to green to yellow to red as the number of people increases. Whenever a new person enters the vicinity of the access point, an update message is sent to all shirts in the vicinity of the access point.

Each shirt also contains two hug sensors. One sensor is a simple switch that is activated when a user hugs any another person —whether or not that person is wearing a Touch Me wɛər shirt. The other sensor enables Touch Me wɛər shirts to communicate with each other whenever two people wearing the shirts give each other a hug. The shirts of two huggers can thus exchange IDs — or other user-specific information. The shirt keeps a running tally of how many people in total the wearer has hugged, and also keeps track of which other Touch Me wɛər enabled users the wearer has hugged. Whenever a wearer hugs another person, information about the interaction is relayed back to the access point, which in turn sends that data to the wearer’s Facebook profile.

The more complex hug sensor consists of three exposed conductive surfaces. In the shirt shown in Figure 2, each of these surfaces consist of one or more decorative flowers that were embroidered onto the shirt with conductive thread. One surface is tied to ground, one functions as a transmit (tx) bus and one functions as a receive (rx) bus. When two wearers hug one another, the ground surfaces on the shirts should contact one another and the tx surface of one shirt should contact the rx surface of the other and vice versa. As long as the surfaces are in approximately the same area of each shirt (rx on the right hand side of the chest, tx on the left and ground across the bottom of the shirt), this pattern of contact occurs naturally during a hug.

B. The Access Point

The access point serves the function of relaying data from the Touch Me wεər shirts to the social network, Facebook.com. The access point can consist of any computing device that supports both Bluetooth communication and an internet connection. Obviously, these functionalities need to also be available through some set of drivers and APIs. The access point must be able to detect and receive data from the Touch Me wεər shirts. Also, the access point must be able to run code which accesses the Facebook API. We have implemented the access point functionality on phones and on a laptop. For simplicity of the internet connection we used in a laptop for the testing of this application, however, we have achieved running a working access point of similar functionality on a Nokia N80 cellphone.

The possibility for turning a cellphone into an access point allows for the Touch Me wεərapplication to follow the user as they move from place to place. The user effectively carries the access point with him and anybody else in close proximity can use the cellphone access point to relay information to Facebook. We used the Java 2ME Wireless Toolkit to program the cellphone. On the laptop we can use regular J2SE. The use of java on both platforms allows for most of the code to be shared between the two implementations.

C. Wireless Communication

Wireless communication between the Touch Me wεər shirts and the access point was accomplished through Bluetooth. Bluetooth was chosen for wireless communication due to it's limited distance and low power usage. It was important that a wireless radio could be battery powered and run on the wearables. Also, it seemed appropriate for wireless range to be restricted to local interactions to avoid interference and detect only local information (such as hugs within a single room).

1) The Hardware: The RN-41 Bluetooth Module from Roving Networks accepts simple commands from the Atmel ATMega168 chip allowing for the Bluetooth radio to be set to "discoverable". Once this has taken place the access point can find the Bluetooth radio on the shirt. To achieve wireless communication at the access point, an integrated Bluetooth radio or USB Bluetooth dongle was used. The laptop interfaced with its Bluetooth radio using a Java API. This API supported device discovery, service discovery, etc... The laptop would then open a data stream to the shirt with which data can be sent and received.

The FBML

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<h2> Who You've Hugged! </h2>

 <p>You hugged <fb:name uid="50027562"/> at 6:53 PM<br><br>
 <fb:profile-pic uid="50027562" size="square" linked="true" />
<br><br>
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Your Profile Hug Item

Fig. 3. An Example Hug Item in FBML

2) Bluetooth Details: The 1.1 Bluetooth Specification defines three communication layers or protocols accessible through the Java Bluetooth API: Service Discovery Protocol (SDP), Radio Frequency Communications Protocol (RFCOMM), and Logical Link Control and Adaptation Protocol (L2CAP). By polling the SDP all shirts within the local area can be discovered and added to the list of devices. The Touch Me wεər radios have the same Bluetooth service UUID, using this ID we can discover the service using the SDP. Once the devices are discovered, data streams are then opened to each of these devices listening for updates of any hugging activity from the Touch Me wεər shirts.

D. Talking to Facebook

Facebook.com has opened up its information to external applications through the Facebook API. This API has officially supported libraries in many different languages such as Perl, PHP, Java, and even Lisp. We chose to use their Java client library which supports logging in to Facebook and all major queries for different types of data on Facebook. Many tutorials and examples of using Java to access the Facebook API can be accessed on the Facebook developers site [22].

In particular this project accessed the name and picture of those involved in the hugging. The Touch Me wεər application shows a history of the user's "hugs" on their Facebook profile. The history consists of a list of hug items. Each hug items consists of the name and picture of who the user hugged along with the time the hug took place (or when the accesspoint was notified of the hug). Our project took advantage of the Facebook Markup Language FBML to display this information to the user. FBML makes it very easy to display Facebook information through simple tags. An example of how this data is written in FBML is shown in figure 3.

IV. Implications for The Future

Research on the intersection of mobile computing and social networks is still rather immature. Many of the research challenges and questions are still very fresh and many more issues are possibly still unknown. The integration of wearables into a mobile social network demonstrate the extent to which these new technologies may be integrated in users' physical interactions. This section identifies key research questions which are brought about by Touch Me wɛər. These are questions that the authors feel should be kept in mind as new technologies in wearables integrate mobile social networks into the physical interactions of the social network user.

A. Privacy Implications

While mobile social networks offer the promise of bringing people closer together, they also pose a threat to security and privacy by bringing malicious users closer to people (in this case within hugging distance). As the fear of Internet cyber-stalking became more and more apparent in the 1990's and 2000's, many law researchers considered the fears to be unfounded because online fears did not often translate into physical dangers or interaction [23]. While this is a debatable issue concerning online dangers – obviously the extension of online identity into real-world interactions and local information will make existing cyber-stalking dangers all that more "real". As a result, an important and pressing set of research challenges facing the design and implementation of mobile social networks is posed by security and privacy issues.

It is important to consider security and privacy at the outset of bringing wearables into mobile social networks before the technology is diffused into society [24], [25]. New threats need to be understood and countermeasures developed now, when the technology is still being developed; timing is important [26]. These countermeasures must be integrated into the architecture of systems for mobile social networks, and utilized by mobile social network applications. Users must also be aware of the threats and how they can achieve safety and privacy within these new systems, which has not always been in the case with many recent technologies [27], [28].

While classic security issues such as confidentiality and availability are certainly important, some of the most interesting research issues relate to preserving privacy in a mobile social network setting. Consider just the case of identity theft. Our current implementations do not protect against spoofing a social network ID. Spoofing an ID is as simple as reading a publicly available Facebook ID off of the browser's navagation toolbar and then hardcoding that ID into your mobile computing device (in this case, your shirt). Anybody you hugged would be reported to have hugged the person you are spoofing. Take this example beyond hugging and you can imagine the very serious implications of such identity theft.

Privacy is a concern in the modern world, and any technology that opens up a new world of information is bound to be considered suspect, and well should be. Our current work is limited in its consideration of privacy in that it has relied on existing privacy control mechanisms that already exist in the social network communities. Such privacy mechanisms include allowing only certain communities (say a user's fellow college students on facebook.com) to access your information. Also, Facebook currently enables users to set options for a limited profile that will be seen only by the users they select. The privacy issues most unique to this work are concerned with the physical environment interactions that take place (physical contact).

While classic security issues such as confidentiality and availability are certainly important, some of the most interesting research issues relate to preserving privacy in a mobile social network setting. This project serves as a justification for exploring mobile social network technologies further to understand the challenges and dangers that may face a society in which one's physical environment and even clothes are integrated into a vast network of social interaction information.

B. Social Implications

The range of possible impact by mobile social networks is broad and deep. Social networks and mobile technology have already penetrated deep into society and greater interaction between the two will increase this role. The important role such a technology plays in society will also increase the need for educational resources to be available to all segments of society. New curricula, classes, and general awareness must generated to meet the requirements imposed by mobile social networks. A new awareness and education about mobile social networks must be spread quickly and equally to ensure that mobile social networks help society equitably without creating too large a burden. The results from this work, including user studies, surveys, software, and design principles will be shared openly with the public and other researchers in order to foster cooperation and further mobile social network understanding for all.

The diverse range of possible impacts of this mobile social network technology brings up unique social issues. Social Networks and use of mobile computing technology is already taking a strong hold within certain sectors of society and the role these technologies play within society can only be expected to increase. The ubiquitous nature of these technologies will require a greater emphasis on general education about the technology. Without general awareness and access to information on the technology, educational gaps could widen, putting certain segments of society at an every greater disadvantage. While the spread of mobile computing technology connects more people to a greater degree, it can also impose itself upon segments of society that do not understand or desire the new technology. For instance, someone does not need be a participant or even aware of social networking for information about them to be spread through the network. Pictures, stories, and now records of physical contact could be spread through legitimate or even dishonest actions causing a new misunderstood technology to affect innocent people, unaware of its existence.

To summarize, it is important to understand that a technology capable of relating daily activities including diet, salary, social tendencies, political affiliation (in fact any type of preference), and even who you touch with a digital (ubiquitous) identity, may pose an equally broad range of significant implications for areas of social interaction, as of yet, not understood.

C. Bringing People Closer Together

Many people ($\sim 300,000$ as of April 21^{st} 2008) have already installed "Hug Me" applications on their Facebook profiles. These applications allow users to send their friends virtual hugs. However, by taking advantage of mobile computing and wireless technologies Touch Me wɛər extends this functionality to actually record a person's physical hug history. Now a user can give someone a real hug and display a history of their hugging activity on their Facebook profile.

Social Networks allow for people to know more about each other and to interact easily and often over the internet. However, this does not necessarily promote face-to-face interaction between friends. In fact, it provides yet another example of how technology can make people more connected while also alienating them from real personal interaction. However, when integrated with a wearable or clothing item, the inter-connectivity of social networks could promote more real interaction between people. Who wants a virtual hug when you can have a real hug? This goes for all the other virtual activities that take place on social networks. As new developments in wireless and mobile computing technology allow for greater integration of social networks and the user's physical environment, more and more virtual activities may be extended into the physical world. In this way, applications like Touch Me wɛər may, in fact, bring people closer together.

V. Conclusion

The mobile social networking and wearables technologies presented in this paper demonstrate a potential to transform the way that people interact in many physical environments. Driven by the staggering rise of social networks online as well as the incredible ubiquity and increasing openness of mobile computing devices and platforms, applications such as Touch Me wɛər could become commonplace very soon. This could result in revolutionizing societal interactions, while also creating many new dangers to society. This paper serves as a proof-of-concept meant to demonstrate how such applications can be implemented and also to propose new questions and concerns brought about by the possibilities of the new technology.

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