Enhancing Organizational Communication using Sociometric Badges

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Abstract

We present applications to enhance communication for an organization using Sociometric badges. The badge collects the voice, motion, and location data of the wearer. We use this data to determine the amount of face-to-face interaction, conversational time, physical activity levels, and physical proximity to other people.

With the data collected from each individual we analyze the collective behavior of the organization and provide individual feedback to encourage increased efficiency in communication. To visualize the feedback we have implemented three sample applications on multiple platforms: the Meeting Mediator, the Presence Book, and Follow the Star, a socially intelligent, location-aware visualization tool.

1 Introduction

Social scientists have always been interested in enhancing organizational effectiveness and individual well-being in the workplace. Organizational behavior is a multidisciplinary field that seeks knowledge of human behavior in organizational settings by systematically studying individual, group, and organizational processes. Some of the questions it tries to answer are: How can individuals get regular feedback on their communication habits? How can leaders enhance the effectiveness of their teams? What can be done to improve the quality of organizational communication? [6].

In this paper we present sample applications that work in tandem with developing technology to provide communication feedback to users of our system. The *Sociometric* badge developed by the *Human Dynamics* Group at the MIT Media Lab automatically measures individual and collective patterns of behavior, and predicts human behavior from unconscious social signals [10]. Utilizing this information, we have implemented three applications across multiple platforms to provide some solutions to the questions posed by the field of organizational behavior.

We can enhance organizational communication by supplying personalized, real-time feedback to individuals through mobile applications. By examining the aggregate data collected from individual badges, we can determine where there exists an opportunity for improvement in the group's communication pattern. For example, when we discover inefficiencies and imbalances in the organization's communication network, applications can step in and offer suggestions to reduce the load at the bottlenecks, or urge greater participation from under-contributing nodes [12].

This paper presents the design and implementation of three applications on different platforms: the *Meeting Mediator*, the *Presence Book*, and *Follow the Star*. Each application uses the information gathered from the *Sociometric* badge to provide individual feedback to enhance efficiency in organizational communication.

2 Related Works

2.1 Electronic Badges

Today wearable badges are common in large organizations. Employees use them to identify themselves to others or to gain access to certain locations or information. The *Active Badge* developed at Xerox PARC in 1992, was one of the first attempts to augment inanimate name tags with electronics. Using an infrared (IR) transmitter, this badge could broadcast the identity of its wearer and trigger automatic doors, automatic telephone call forwarding, and computer displays [13]. This form of IR-enabled badges is commonly used today.

The Vocera Communication System [4] is a commercially available badge system based on 802.11 technology. Users interact through wearable badges that can be clipped to coat pockets, worn as pendants, or carried in holsters. The Vocera badge provides a voice-controlled user interface and enables instant, hands-free conversations among people throughout the workplace. The main server provides basic

speech recognition and manages communication through voice dialing, e-mail, and telephone systems.

2.2 Context-aware Applications

Much work has been done in the area of context awareness. Hinckley and Horvitz [7] suggested sensing techniques that would allow mobile phones to change phone alerts according to the user's context. Siewiorek et al. [11] extended this and proposed context-aware mobile phones that adapt to dynamically changing environmental and physiological states of the user.

Many of these systems focus only on the individual's context; however, context is often determined socially, dependent on group membership and the activity the group is engaged in.

Our group has developed several socially aware applications. Eagle and Pentland presented the *Reality mining* system [5] which recognizes the social patterns in daily user activity to identify socially significant locations and model organizational rhythms. It presented a mobile-phone-base system that uses Bluetooth addresses and a database of user profiles to cue informal, face-to-face interactions between nearby users. The VibeFone application [8] is mobile social software that uses location, proximity and tone of voice to gain a sophisticated understanding of people's social lives by mining their face-to-face and phone interactions.

3 The Sociometric Badge

The *Sociometric* badge (figure 1) can collect and analyze behavioral data from hundreds of individuals over extended periods of time [10]. Its current capabilities include:

- Measuring human movement using a single 3-axis accelerometer. This can detect activities such as walking, sitting, nodding, and hand movement.
- Extracting speech features in real time to measure non-linguistic social signals. This does not record any content, but is capable of identifying social signals such as enthusiasm, interest level and persuasiveness [5].
- Sending and receiving information over 2.4 GHz radio to and from different users and base stations.
- Performing indoor user localization by measuring received signal strength from fixed base stations.
- Capturing face-to-face interaction time using an IR sensor. When badge wearers have a direct line of sight to each other, an IR signal will be received.
- Capturing proximity data by using Bluetooth and the radio transceiver.
- Communicating with Bluetooth enabled mobile devices to provide feedback to the user.

Figure 1. The *Sociometric* badge

4 Sample Applications

Mobile phones and the environment around the user can be used as platforms to display feedback information derived from the badge. We propose two sample applications on mobile phones and one application on the ceiling to improve interpersonal interaction in an organization.

For mobile platforms we used the Motorola A1000 [1] and Nokia N80 [2], both commercially-available smart phones with JSR-82 [3], the Java APIs for Bluetooth. The smart phone applications were developed as a client-server Java MIDlet on the Wireless Toolkit 2.5 published by Sun Microsystems, using MIDP 2.0 and CLDC 1.0 [3]. We developed a generic API portable to both phone platforms.

4.1 Meeting Mediator

4.1.1 Design

When *Sociometric* badges are used in a meeting, it can help the user better understand the flow of the meeting and possibly improve their participation. For example, it can detect the turn-taking pattern of the conversation. Often people do not realize that they are dominating a conversation while other people might need reminders to participate more in the conversation [9]. Many people are also interested in their speaking style in meetings. If one's speech always leads to boredom or an emotionally negative response, a recommendation for a change in the manner of speech can be helpful. Mobile phones can be a non-intrusive display, gently urging a change in the participant's pattern of behavior.

Figure 2 shows the visualization of our prototype. Each circle indicates a participant in a meeting. The size of the circle denotes the amount of speaking time. The arrows indicate the flow of conversation, showing who is most likely to respond to a comment from another person. The colors of the circles can indicate different characteristics of the participants such as interest level or persuasiveness. In out current version, the colors denote the movement of people: darker color indicates higher activity.

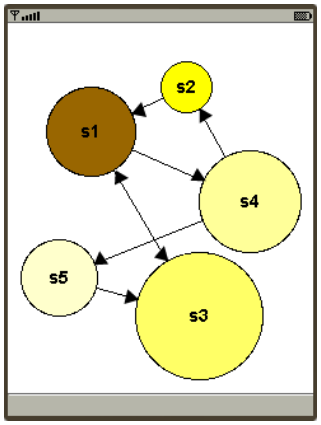

Figure 2. *Meeting Mediator*: **circles denote individuals, size denotes speaking time, arrows denote flow of conversation, and colors denote movement level**

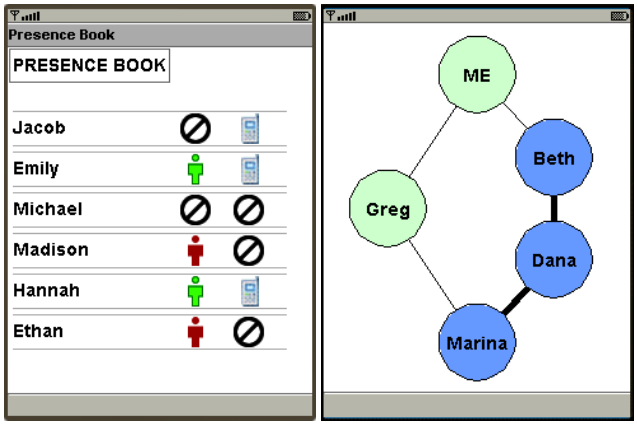

Figure 3. *Presence Book*: **(left) Human icon denotes presence at their office and its color denotes current availability. Phone icon denotes availability over their mobile phone. (right) Links that connect the user to an entry. Colors denote teams within an organization, thickness of arrows denote strength of tie**

4.1.2 Implementation

The *Sociometric* badge provides real-time voice analysis on whether a user is speaking or not and the longitudinal aggregation of the data will allow us to know who are the dominant speakers and who are in the periphery. The badge can also give real-time feedback to the user based on their speaking behavior. The accelerometer data can further improve the quality of the feedback; for example, it can recognize fidgeting behavior and quantify boredom levels.

In our experimental scenario, each person in the meeting wears a badge and carries a mobile phone. Every 5 seconds, the badge broadcasts its unique identifier number and a Boolean variable of whether or not the wearer is speaking. The movement data is transferred in a similar manner. To verify significant user movement, we average 5 seconds of accelerometer data and compare it to a threshold learned through training. Each badge broadcasts their own information over the 2.4GHz radio, while simultaneously receiving the radio broadcast of other badges in the meeting. The badge forwards this aggregated information via Bluetooth to the paired mobile phone of its wearer. The phone application then determines the speaker(s) during the 5 second time segment, and refreshes its display.

4.2 The Presence Book

4.2.1 Design

The *Presence Book* (figure 3) expands the function of a traditional address book by updating real-time social information such as availability, accessibility, and the egocentric social network. We will use the term *entry* to refer to the person of interest.

Availability denotes whether an *entry* is able to accept the user's communication request. A user may look at their address book to answer questions like: "Would I be interrupting a conversation if I call now?" or "Are they too busy to meet me now?". In our prototype, speech and movement data is used to detect the availability of an *entry*.

Accessibility indicates how easy it is for the user to access an *entry*. If the *entry* is sitting in their office, we can say that the *entry* is accessible for face-to-face communication. If the *entry* is walking down the hallway then they might be accessible through e-mail or phone. We use the location data of an *entry* to detect their accessibility.

We display the egocentric social network by showing the links that connect a user to an *entry* (figure 3, right). Answers to questions such as "Who do I know that knows Bob?" or "Who in the development department hangs out a lot with the marketing department?" can be helpful in initiating social ties. We use the history of online and offline interactions to determine the strength of social ties [12].

4.2.2 Implementation

For the implementation of the *Presence Book* we have used the same phone models and programming platforms as the *Meeting Mediator* application. The badge analyzes the voice frequency to detect if the person is in a conversation or not. This information along with the badge identifier number and movement data will be broadcasted over the 2.4GHz radio.

Figure 4. *Follow the Star*: **An environment with two star stations. The color light bulbs illuminate when the target is underneath: green when the target is available and red when they are not.**

4.3 Follow the Star

4.3.1 Design

The *Sociometric* badge can be used not only within an organization but also at the interface between an organization and its customers. *Follow the Star* is a location-aware visualization tool that uses the ceiling as a display. Ceiling displays are ideal for stores and offices because it is unobstructed by tall shelves and walls. Moreover, it can mark the absolute position of the target of interest by displaying a *star* directly above.

Attributes of the *star* can relay additional information about the target. For example, we can use the size of the *star* to display the target's level of expertise. In the current version of our prototype, we use color to represent the target's availability: red indicates that the target is currently occupied while green indicates that the target is available.

4.3.2 Implementation

The target's badge broadcasts location and availability data over the 2.4GHz radio. Our current implementation employs fixed *star* stations, each comprised of a badge and multiple color light bulbs. When a *star* station receives data from a target badge, it turns on the appropriate light bulb to display a *star*. We can imagine that by densely positioning a large enough number of *star* stations, it will appear as if the star is following the target in real-time.

5 Discussion and Conclusion

We have presented a few applications as examples of how the *Sociometric* badge can be used to enhance communication in an organization. The biggest challenge of our approach is privacy concerns. This paper has been limited to applications where the privacy concern is minimal. For example, speaking information collected during working hours might be less controversial than collecting the same information after work. Also location of a store employee is something that should be published as publicly as possible. Privacy concerns can be reduced by reporting the data anonymously; however, this is not possible in applications such as the *Presence Book* where the purpose is to provide the individual information of other users. One solution can be to allow users to have individualized control over their privacy level.

Our applications provide social information on platforms that are in the periphery of user's attention, allowing real-time feedback in a non-disruptive manner. We believe that using the *Sociometric* badge together with our applications can have a strong impact in increasing the efficiency of organizational communication.

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