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Sociometric Badges: State of the Art and Future Applications

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Abstract

Sociometric badges are wearable electronic badges capable of automatically measuring the amount of face-to-face interaction, conversational time, prosodic style, physical proximity to other people, and physical activity levels, using social signals derived from vocal features, body motion, and relative location. We present the prior and current state-of-the art in this area of wearable computing and propose several applications that haven't been fully exploited.

1 Introduction

It is not uncommon that employees wear name tags inside large organizations to identify themselves to others or gain access to certain locations. The first attempt to augment inanimate name tags with electronics was the *Active Badge* developed at Olivetti Research in the early 1990's [14]. Containing only a small microprocessor and an infrared transmitter, this badge could broadcast the identity of its wearer and trigger automatic doors, automatic telephone call forwarding, and computer displays [15]. The initial application of this system was as an aid for a telephone receptionist and was mainly used for tracking people indoors.

More complex badge platforms have been developed after the *Active Badge*. In 1996, the *Thinking Tags* [4] were the first computationally augmented name tags that were capable of displaying how much two people at a conference or meeting had in common, simply by lighting LEDs of different colors depending on how many questions the participants had previously answered the same. Two years later they evolved into the *Meme Tags* [3], allowing conference participants to electronically share brief ideas or opinions through a large LCD screen. This system further evolved into the *nTAG System*, a commercial solution to improve, measure, and automate meetings and events [1].

The *Wearable Sensor Badge* developed at Philips Research Labs in 1999 [6] was capable of detecting simple pre-ambulatory activities using an accelerometer. The *iBadge* [10] was designed to be worn by children to capture interactions with teachers and common classroom objects.

The *SocioMeter* was a wearable sensor package designed to measure face-to-face interactions between people with an infrared (IR) transceiver, a microphone, and two accelerometers [5]. It was used to learn social interactions from sensory data and model the structure and dynamics of social networks. However, due to its size and weight, users reported feeling somewhat uncomfortable while wearing it.

The *UbER Badge* [7], developed at the MIT Media Laboratory, is a research platform for facilitating interaction in large groups of people. This badge has both RF and IR communication, an LED display capable of presenting graphics and scrolling text that users in the vicinity can read, an on-board microphone for audio sampling, audio output available at a headphone jack, a pager motor for vibratory feedback, three on-board processors, flash memory capacity, provisions for connecting LCD displays, and connectors that allow a variety of different sensors to be integrated.

The best known commercially available badge system is the 802.11-based *Vocera Communications System* [2]. Users interact through wearable badges that can be clipped to coat pockets, worn as pendants, or carried in holsters. The system centers on a server that maintains voice dialing phrases, badge session identifiers, e-mail addresses, telephone numbers, and names. The Vocera badge provides a voice-controlled user interface and enables instant, hands-free conversations among people throughout the workplace.

2 Current State of the Art

There is a need for automatic tools to measure individual and group behavior in the social sciences. Researchers often rely on surveys and human observers to study human behavior. This is often expensive and time consuming. Therefore, we have decided to build an experimental research platform

that could prove useful and effective in the assessment of human behavior. We predict there will be a large demand for such tools in different research communities and later on in the consumer market for self-monitoring devices.

In [9] we presented the design of a wearable *communicator* badge, a push-to-talk system capable of playing audio messages and reminders through a speaker. Since then, the *communicator* badge has evolved into what we call a *sociometric* badge, a device which main purpose is to automatically capture individual and collective patterns of behavior. We have manufactured three hundred *sociometric* badges and used them in real organizations to automatically measure individual and collective patterns of behavior, predict human behavior from unconscious social signals, identify social affinity among individuals working in the same team, and enhance social interactions by providing feedback to the users of our system [8].

Our proposed approach to capture social signals and measure human behavior has several advantages over existing methods such as direct observation by humans, the use of pervasive cameras to videotape social interactions, or the use of surveys. Direct observation of humans by humans is expensive and limited to a few people per observer, and observers do not always agree. Deploying pervasive cameras is extremely expensive and their range of measurement is constrained to a particular place. The use of surveys is subjective, inaccurate and time consuming. In contrast, the ability to automatically capture not only visible characteristics of human behavior such as face-to-face interactions, relative location, and motion but also the underlying psychological processes that occur during social interactions in hundreds of people, at the same time and with a single unobtrusive tool, represents a great advantage.

3 Applications

Sensible organizations. Organizations will become truly *sensible* when they start deploying hundreds or thousands of wireless environmental and wearable sensors capable of monitoring human behavior, extracting meaningful information, and providing managers with group performance metrics and employees with self-performance evaluations and recommendations. *Sensible organizations* is a new concept of social sensor network technologies that will help improve organizational practices. A sociometric badge could potentially measure, analyze, and reveal organizational dynamics by closely looking at interactions and social behavior among employees of an organization. Companies using this research platform could have a better understanding of how they work and how they can improve their daily routines in order to increase productivity, innovation, and job satisfaction.

Knowledge management and collaboration tools. Employees working in large organizations often find it difficult to discover colleagues working on similar projects or with similar interests or expertise. A knowledge management system consisting of environmental and wearable sensors, computers, and software that continuously and automatically monitors an organization's social network and its different areas of knowledge and expertise would facilitate information transfer and promote collaboration. Data mining of digital documents, face-to-face interaction, e-mail, instant messaging, and other forms of communication will provide new information on how complex social structures work, how to optimize human interaction, and how to engineer organizations.

The future of healthcare. Carrying an un-obtrusive device that continuously monitors one's health and prevents the most common diseases before they even occur has the potential to revolutionize the healthcare domain. Patients usually go to a doctor once symptoms become apparent. A self-monitoring device that can detect the earliest symptoms of illness and alert its user could prevent some of the most prevalent diseases. Sung et al. [13] showed that non-invasive behavioral measures such as voice features and body motion are correlated with depression state and can be used to classify emotional state and track the effects of treatment over time. A *sociometric* badge could be used as a self-monitoring device that alerts the user or their family members of early symptoms of depression. It could also be used to monitor the daily activities of the elderly, detect falls and behavioral changes, and automatically alert a family member or a doctor of a potentially dangerous situation. Another major disease for which a self-monitoring device does not currently exist is obesity. A *sociometric* badge and a mobile phone could be used to keep track of energy expenditure, food intake, daily routines, and provide feedback and suggestions to their users.

Intelligent hospitals. Wearable communicator badges are already used in hospitals [11]. Doctors and nurses need to be in continuous communication. A *sociometric* badge that knows the exact location and context of each person could provide information at the right place and the right moment. The technology used in the *sociometric* badge could augment the capabilities of existing commercial devices. Oftentimes errors occur during nurse time-shifts. A wearable device that monitors the interaction among nurses and alerts them in a timely fashion when and what information should be transferred would reduce the amount of errors incurred. *Sociometric* badges could also be used during

triage in the emergency room to provide doctors with a more in-depth analysis of the patient's psychological state, to track patients as they move from one hospital section to another, and to wirelessly transfer and store physiological data captured during the entire patient's stay in the hospital.

Personal sales coach. Recent experiments in the *Human Dynamics* group at the MIT Media Laboratory have shown that it is possible to measure how persuasive a person is being when talking to others, how interested a person is in a conversation, how much attention a person is paying to someone, and how effective someone is at negotiating by measuring different voice features and body motion [12]. *Sociometric* badges could be used to track individual and global sales performance in retail stores and give advice on how to interact with clients more effectively. Sales representatives today lack sufficient feedback on their selling capability. Top performing sales representatives usually have good communication skills, exhibit a lot of enthusiasm and energy, and form a personal bond with their clients. *Sociometric* badges could serve as personal sales coach devices that allow sales representatives and managers to reflect about their own performance and improve their sales skills.

Virtual worlds and social networking sites. Millions of users have online profiles in social networking sites (such as *Facebook*, *MySpace*, *hi5*, etc.) or characters in virtual worlds and multiplayer games (such as *Second Life*, *The Sims*, *World of Warcraft*, etc.). Interaction often requires that the user be seated in front of a computer and is currently limited to instant messaging, direct manipulation of virtual characters, and voice or video over IP. Combining the current features of social networking sites and virtual worlds with the capabilities of the *sociometric* badges would enhance the users experience by adding mobility and information from the real world gathered by sensors.

4 Conclusions

Social signaling seems to provide an independent channel of communication, one that is quantifiable and which can provide an important new dimension of communication support. The implications of a system that can measure social context are important in a mobile, geographically dispersed society. Propagating social context could transform distance collaboration, for example, letting users become better integrated into ongoing projects and discussions, and thus improve social interaction, teamwork, and social networking. Our long-term goal is to develop a set of interventions and recommendations that can lead to better individual and group performance. All sensors and electronic components contained in the MIT Media Laboratory *sociometric* badges will eventually become smaller. A truly unobtrusive version should be extremely light-weight and almost imperceptible for the user. Future work includes validating the automatic measurements performed by the badges and implementing the applications proposed in this paper.

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