THE UBER-BADGE - A VERSATILE PLATFORM AT THE JUNCTURE BETWEEN WEARABLE AND SOCIAL COMPUTING

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Abstract

We present the design of a new badge platform for facilitating interaction in large groups of people. We have built this device to be very flexible in order to host a wide variety of interactions in the areas where wearable and social computing converge, from game environments to meetings and conventions. This badge has both RF and IR communication, a 5x9 LED display capable of presenting graphics and scrolling text that users in the vicinity can read, an onboard microphone for 12-bit audio sampling, a 12-bit audio output, a pager motor vibrator for vibratory feedback, 3 onboard processors, capacity for up to 256 MB of flash memory, provisions for connecting LCD displays, and connectors that mate into the Responsive Environments Group's Stack Sensor platform, allowing a variety of different sensors to be integrated. We describe several applications now being developed for this badge at the MIT Media Laboratory, and touch on how it was used in a multiplayer, augmented reality urban adventure hunt game in Manhattan in the summer of 2003.

1. Introduction and Prior Work

Electronic badges are fundamental to the history of Ubiquitous Computing. As canonical "nametag" badges tend to be pinned on the chest or hung about one's neck, they are able to display simple messages to nearby people; tending to face along the direction where the wearer's attention is focused, they are well suited to broadcasting a line-of-sight ID code that enables proximate devices (including other badges) to be aware of individual presence. The first electronic badges pioneered over a decade ago by Olivetti Research [1] were very simple platforms, as they periodically transmitted a modulated InfraRed (IR) ID to the vicinity, enabling people to be located by networked photosensitive readers as they moved about a facility. Another approach is to use the badge as a dynamic display and as a facilitator for person-person interaction at large events. This is the direction taken by two mid-90's projects at the MIT Media Lab, the "Thinking Tag" [2], that flashed LED's according to agreement of proximate wearers on a series of provocative questions and the "Meme Tag" [3], which featured a large LCD display that enabled users to selectively exchange brief catch phrases.

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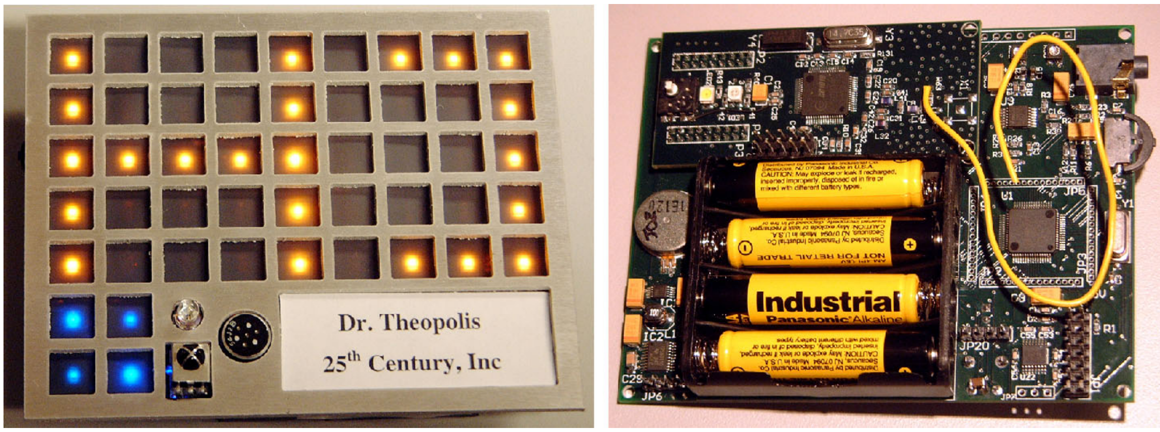

Figure 1: Production UbER-Badge: Front with faceplate and rear with RF card & batteries

Badge platforms have subsequently moved into the commercial world, with systems like the Matchstick and the Japanese Lovegetty [4] designed as matchmakers for nightclub environments. In contrast, the nTAG [5], designed to facilitate business meetings and conferences, features a 128x64 pixel, back-lit LCD display, a trio of navigation buttons, and both IR and quasipassive radio frequency (RF) backscatter communication – the IR is for line-of-sight communication with other badges and fixed beacons, while the backscatter system allows the badge to upload data to microwave beacons when it is less than 20 feet from them. The IntelliBadge [6] is also intended for conferences, but as it is only essentially only a hybrid inductive (for close range) and RF (for longer range) passive ID tag, it is unable to display information or store state – the responsibility of tracking the tags is moved off the badge and onto the networked infrastructure of fixed readers. These products target applications such as tracking people through a convention hall, detecting what booths they visited or were most interested in, and (in the case of the nTAG), exchanging virtual business cards and encouraging inter-attendee interaction.

2. The UbER-Badge Hardware Design

Although the UbER (Ubiquitous Experimental Research) badge was originally designed to augment the experience of attendees at large Media Lab events, many features have been added to enable it to act as an experimental platform for groups doing research in interpersonal interaction and mobile social computing. Accordingly, it encompasses an extreme mix of capabilities not available in prior badge platforms, as surveyed above.

A production badge is shown in Fig. 1, and its block diagram is given in Fig. 2. A UbER-badge measures 8.25 x 10.5 cm, and weighs 0.1 kg with all four AAA batteries installed. At an average current of about 100 mA, badges last for roughly 15 hours of continuous use. In quantities of 300, the cost of an assembled badge is US $65, not including the case or front panel.

To maximize longevity, this device needs to consume low power, and since this platform is being made to support many different research programs, it must be extremely agile. The Texas Instruments' MSP430F149 fits these requirements. It is an 8MHz 16-bit microcontroller optimized for Gnu C, with 60kB of flash for program memory, 2kB of

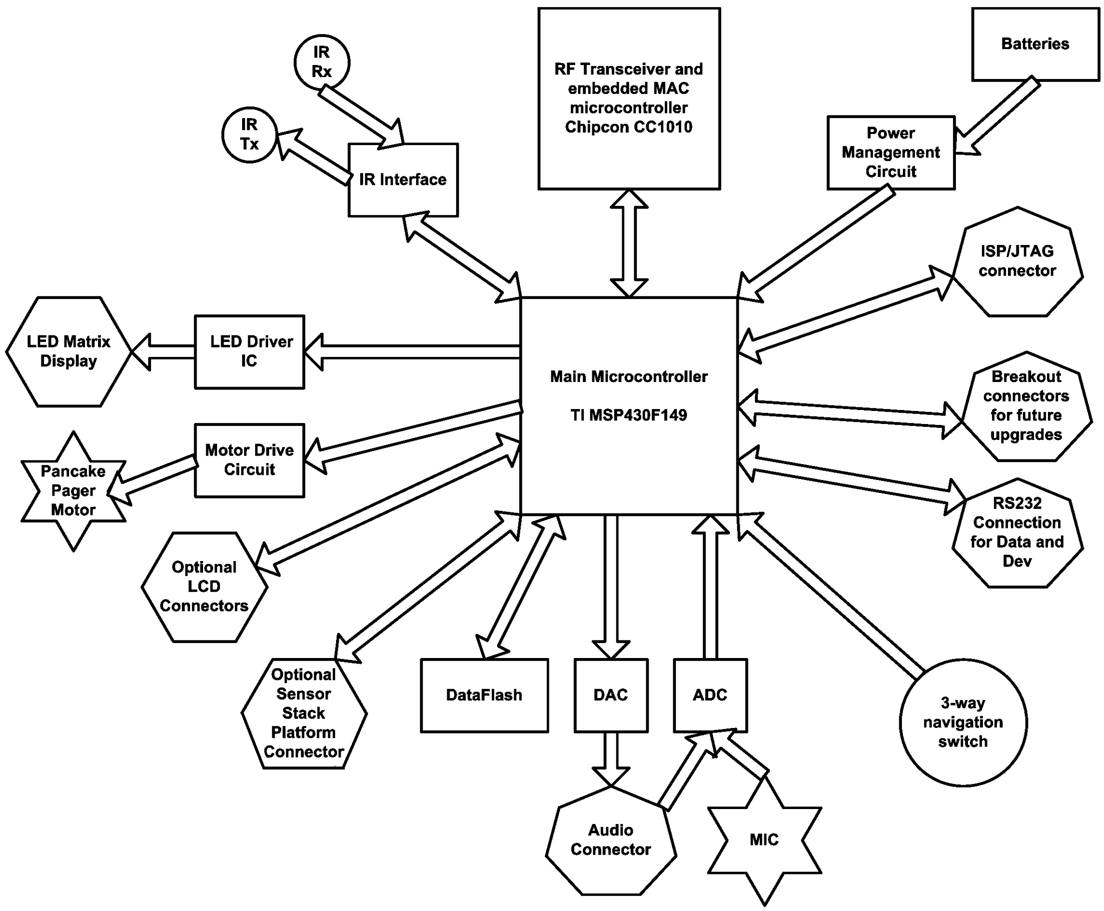

Figure 2: Block Diagram of the UBeR-Badge

RAM, SPI, a UART, a 12-bit ADC, and a Pulse-Width-Modulation controller. The display on the badge was designed to show simple iconographic animations and scrolling text that can be easily read in any lighting condition across several meters (it's hard to read the LCD panels used with existing badges at any significant distance or outdoors). Accordingly, the badge was equipped with a 5x9 LED matrix driven by a dedicated controller that conserves the battery's power and provides a fast SPI interface to the main application processor. In addition, 4 brightness-controllable blue LEDs below the matrix are managed directly by the MSP430s PWM to provide additional visual output. An aluminum faceplate with a grid surrounding the LED matrix is skinned with a diffusive material, making the display less coarse. To support applications that require larger messages or more data to be shown on the badge, it was equipped with circuitry and connections to drive a large backlit alphanumeric LCD display that can be mounted beside or atop the LED matrix. Another connector is provided to support a narrow LCD that can be mounted on the top of the badge, allowing the viewer to see personal messages without rotating the badge to inspect the front.

In addition, the badge provides tactile feedback with a pager-style vibrating motor, with force controlled by a PWM channel on the MSP430. A side mounted switch, providing up, down, and push-to-select, is used for user input. An onboard microphone is connected to a12-bit audio input, and a 12-bit audio output is available at a headphone jack. This capability can be used to record, detect, process, generate, or transmit audio events. The headphone output, for example, can be used to provide contextual audio prompts that relate to the badge's location in social or geographic space. In addition to the program memory within the main microcontroller, the badge can access up to 256MB of data flash for storing audio or user data. To support applications requiring sensing, compact cards from our Stack Sensor architecture [7] can be plugged into the badge at a set of dedicated headers; these cards currently include circuits that incorporate multiple modes of tactile sensing, 6-axis inertial measurement, and sonar proximity.

The badge is equipped both with an IR communication channel to support face-to-face and local communication and a RF communication channel to support larger distance and wider bandwidth communication. The IR system consists of a composite IR LED lamp with a 17-degree spread, an IR receiver with integrated demodulator, photodiode, photodiode amp, and a Cygnal C8051F301 processor, which acts as a dedicated IR communication controller to buffer incoming and outgoing IR messages. A slightly quicker version of the Sony-IR protocol is used on the badges, with the IR modulated at 40kHz. In addition to controlling the IR communication, the Cygnal chip also manages a RS232 port on the badge, allowing connection to a PC. The badge's IR communication is sensitive out to 3 meters.

The badge also features a RF section [8] based around the Chipcon CC1010, which contains a processor and RF transceiver with programmable transmission strength and programmable frequency within the range of 300MHz to 1000MHz. Similarly to the IR system, by using the Chipcon’s integrated microcontroller, all of the communication processing and protocol is offloaded from the main application processor. The software that runs in the CC1010 implements a peer-to-peer random access network supporting up to 64,000 nodes using a carrier-sense method of media sharing and collision avoidance. Using a simple wire monopole antenna, easily tucked behind the badge in its case, the RF range has been tested out to 100 meters.

3. Applications

The first demo application that was developed performed several functions that could be used in a large group setting. At distribution, all badges are programmed with the identification of their wearers. Upon meeting another badge-user, the badge displays greeted each other by name and the badges exchanged contact information, which could be later retrieved at a computer-based kiosk. Furthermore, a badge-user can enter in the name of another person that he or she would like to find. As the badge-user moves around the event, each person’s badge that they face would show a graphic indicating how long ago the individual being sought was last seen (note that the RF is not line-of-sight, so simple proximity is enough to register presence). The badge-user can then follow this visual trail to find the person he or she is looking for. A system of broadcast messaging was also added to this demo application allowing a message to be sent to all conference attendees telling them of a certain upcoming event. The demo application was augmented with small IR beacons located at points of interest. When a person views one of these points, it is registered in their badge. This information is passed from badge to badge, enabling people to see which locations are being heralded the most. When a

Figure 3: Participants using a UbER-Badge to explore clues triggered by IR beacons at the Manhattan waterfront while playing Midnight Madness during summer 2003

person sees all of the points of interest, a message is sent to everyone else, telling them that he or she has seen them all, and their badge plays a musical song of victory.

Other applications are being developed that focus on “viral communication” [9], where messages are passed badge-badge, propagating without a fixed infrastructure. Other researchers are exploring how selective audio can be recorded by the badge, and analyzed later to reconstruct social context in face-face meetings [10].

A set of UbER-badges have been used last summer in an augmented reality urban adventure hunt in Manhattan called "Midnight Madness"[2], an annual game based upon a movie from the 80s of the same name [11]. The basic idea is simple. Teams are assembled and given a puzzle that, when solved, leads them to the location of the next puzzle. At the end of the trail is a secret finish line, and the first team to reach it is declared the winner. In the past years, the game has been very linear in structure and the teams all followed the same path. But this year, close to 40 teams registered, so a slightly different plan that would scatter the teams was designed. The UbER-badges and beacons were used to enable this new game plan, as well as to add some new features to the game. Accordingly, each team was given a badge. When one team was within RF communication distance of another, their badge told them which team was nearby and which pieces of the puzzle that team had acquired, promoting inter-team trading and communication.

The first half of the game was designed so that the teams were given different clues at the outset, which they could solve in many different orders. IR beacons were scattered about the city, triggering clues presented via the badge's audio output or LED display. The clues were laid out in small chains that connected where a beacon was located. When a team got to a beacon, their badge was given a piece of a puzzle, and a display pattern started to fill in. For example, one of the beacons was embedded into a Buddhist shrine, located by deciphering a riddle found in a fortune cookie. When the player stood before Buddha, the badge vibrated and a piece of the puzzle appeared on the display. Players

[2] See: http://www.midnight-madness.org

were brought through Chinatown, following a trail of iconographic representations of landmarks, leading them to another beacon located in a newspaper box on Mott Street.

The final use of the badge during the Midnight Madness game was for an interactive music puzzle that was integrated into the environment. The last clue led players to the waterfront in Brooklyn, where they started to discover hidden beacons. When they found the first, their badges told them to plug in headphones. With each beacon discovered, the badge played a different tone. When all beacons were discovered, the badges played a melody. The players would then have to manually play the tune by returning to each of the beacons in the proper order. If they played it correctly, they were given the location of the finish line. In general, the badges added tremendously to the game, providing an interface between the city and the players, as well as adding to inter-team communication and competition.

4. Conclusions

As the UbER-Badge integrates an unprecedented number of features into a compact, wearable badge platform, it enables many different applications to be explored for mobile social computing - we've barely begun to harness its potential. Accordingly, we are planning to fabricate and use several hundred UbER-Badges to facilitate interaction and collect data at large upcoming Media Lab sponsor meetings.

5. Acknowledgements

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6. References

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