Whole Body Interaction – Position Paper
Personal Sensor Networks Enriching Personal Digital Memories

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1 Introduction

During a lifetime, a person will accumulate a vast amount of personal data, information and memories. When we talk about memories, often it invokes suggestions of images, conversations, emotions and experiences. However an even greater diversity of information about a person can be found by also considering their documents, emails, creative works and so on. All of these things can go towards providing a picture of a person and their life. Our own minds have an astonishing ability to store and retrieve these large quantities of data. They are not perfect though, and with the relentless pace of technological change and ever increasing availability of cheap storage, the question arises as to whether we can augment our own memories using digital means.

The potential for a computer-type device to aid in the storage and indexing of the vast quantities of digital data that we accumulate over our lifetimes is something that was recognised as long ago as 1945, when Vannevar Bush wrote about the possibility of recording 100 photos on a head-mounted stereoscopic camera, and the need to store the sum of human knowledge in a coherent form [2]. Closer to the present, it is increasingly recognised that while the technology exists, the automatic capture of memories is not so straightforward. Photographs can be automatically captured, but their context is immediately lost to the computer without additional annotation.

While digital photographs and video remain the mainstay of many personal digital memory projects, the trend has been to assign them context primarily using time and location (GPS) data. Body sensor networks provide a potentially much richer source of context information with which to annotate other digital memories. These could provide a variety of additional environmental details such as temperature, motion, gestures and physiological readings amongst others, which could perhaps be used to determine activity and emotion. Including wireless capabilities as part of the body sensor network allows this to be taken a step further. A memory exists not just within the context of the environment, but also within the context of the memories of those around them.

Figure 1: Sun SPOTS sending acceleration readings to a base station.

Through the sharing of data between body sensor networks, a system could determine the other individuals present and their interdependent roles in the creation of the memory.

In this position paper we present an initial overview of a project to allow network collaboration between body sensor networks in close proximity. Information from the body sensors is shared and can be used to enrich a personal memory database, allowing a more detailed interpretation of user activities through relation of both digital memories and sensor readings.

2 Related Work

Body-mounted sensors are commonly used by personal digital memory projects to improve the relevance of data stored by the system. The well established *MyLifeBits* project [4] developed the *SenseCam*, a digital camera worn around the neck and designed to automatically take photographs based on sensor responses. The device includes light-colour, light-sensitivity, body heat, temperature and accelerometer sensors, which trigger photographs following significant changes to the sensor readings. The readings are processed directly on the device, rather than being recorded for inclusion in the personal digital memory store.

This work was extended by Byrne et al. [3], most notably to include Bluetooth readings to allow the determination of more significant event changes using details of any other devices present. Bluetooth device presence is recorded, allowing similarity between photographed events to be established, as well as the importance of the device's owner to the event based on the duration a given device was present.

The *Cityware* project undertaken at Bath University also utilises Bluetooth signatures in an effort to detect 'familiar strangers'. The motivation for the project is premised on the principles of social networking, with the intent that an individual might discover others that they pass every day, but are not otherwise aware of [5].

Various other projects have also considered body sensor networks and context awareness for providing information to be recorded in a personal digital memory, or similar

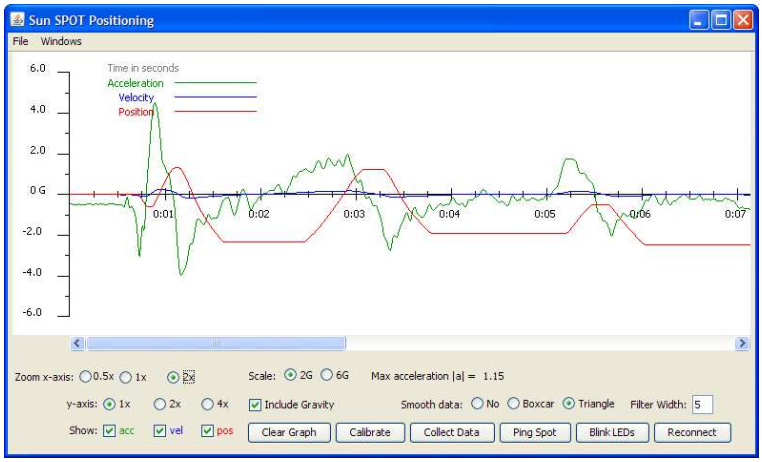

Figure 2: Acceleration, velocity and relative position data readings (based on software created by Ron Goldman [1]).

system [7, 6]. Our belief is that these can be extended further by allowing the sensor networks not only to broadcast presence information, but also some of the sensed data itself to be used by other nearby body sensor networks. Our memories are inevitably built not only on our own actions and emotions, but as a reaction to those of others. Combining the networks of body sensor networks in proximity to each other can allow the collaborative nature of events to be incorporated into a digital memory record.

3 Design

Our existing design, currently at an early stage of development, is based on Small Programmable Object Technology (SPOT) hardware created by Sun Microsystems [1]. These 'Sun SPOTS' are small, self-contained devices as can be seen in Figure 1, that incorporate temperature, light and 3D accelerometer sensors, as well as networking capabilities. Each user of a personal digital memory system wears a single SPOT that is able to measure and record sensor readings. This data is stored on the SPOT until it comes into range of a base station, at which point the data is downloaded for incorporation into the personal digital memory store.

Should a device come into radio range (reported to be up to 100 metres [1]) of another device worn by another user, recorded sensor readings can be exchanged between the devices. The SPOT is also able to record identity information, and proximity information based on radio strength. In a situation where several SPOT-enabled people are present, group data can then be shared, collated and stored along with other more direct memory-related information such as photographs and videos.

At present we are able to record and transmit data to the base station using the standard Sun SPOT functionality. Figure 2 shows acceleration, velocity and relative position readings being transmitted and recorded directly from the SPOT sensor board. Based on the 512k available volatile memory on the device, approximately 1 hour of 3D

accelerometer readings can be recorded given a storage frequency of 0.1 seconds.

The devices also have broadcast transmit and listen capabilities, allowing us to locate other nearby sensors. Sensors discovered in this way will be notified and recorded, after which a direct link can be established to share data between the devices.

Although recording such data is not new, we believe interesting results may derive from this ability to share this data with nearby sensors in real-time. However, our present goal is to develop the full hardware and software functionality needed before undertaking limited trials as a data-gathering exercise. It is hoped that analysis of this data will yield interesting correlations between users, allowing us to determine additional information about activities and events.

4 Conclusion

As the development of personal digital memory databases continues, the importance of the metadata associated with audio-visual content is becoming increasingly clear. A person's movement, and their interaction with others, can play an important role in understanding the underlying meaning behind any given situation. For example, when two people are running, the context of whether they are running with, towards or away from one another is critical for a true appreciation of the nature of the situation. Without sensor data correlation, such distinctions would be almost impossible for a personal digital memory system to determine independently. Our aim is to develop a simple solution built using Sun SPOTs to establish and record additional data about a person's movement that can then be shared in order to understand activity and intentions.

References

[1] E. Arseneau, R. Goldman, A. Poursohi, R. B. Smith, and J. Daniels. Simplifying the development of sensor applications. In *OOPSLA '06 Workshop on Building Software for Sensor Networks (BSSN @ OOPSLA 06)*, Portland, Oregon, USA, 2006.

[2] V. Bush. As we may think. *The Atlantic Monthly*, July 1945 1945.

[3] D. Byrne, B. Lavelle, A. R. Doherty, G. J. Jones, and A. F. Smeaton. Using Bluetooth and GPS metadata to measure event similarity in SenseCam images. In *5th International Conference on Intelligent Multimedia and Ambient Intelligence (IMAI'07)*, Salt Lake City, Utah, USA, 2007.

[4] J. Gemmell, G. Bell, and R. Lueder. Mylifebits: A personal database for everything. *Communications of the ACM*, 49(1):88–95, 2006.

[5] V. Kostakos and E. ONeill. Cityware: Urban computing to bridge online and real-world social networks. In M. Foth, editor, *Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City*. Information Science Reference, IGI Global, Hershey, PA, USA, 2008.

[6] Y. Sumi and K. Mase. Supporting the awareness of shared interests and experiences in communities. *International Journal of Human Computer Studies*, 56(1):127–146, 2002.

[7] W. Wahlster, A. Kroner, and D. Heckmann. Sharedlife: towards selective sharing of augmented personal memories. In *Reasoning Action and Interaction in AI Theories and Systems*, pages 327–42. Springer, 2006.