Memory Rich Garments: Body-Based Displays

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ABSTRACT
This paper describes conceptual and technical prototypes of reactive body-worn artifacts that display their history of use and communicate physical (or embodied) memory. This work concentrates on garments that reflect more subtle, playful, or poetic aspects of our identity and history.

The pieces described here are part of a larger research project called Memory Rich Clothing. A variety of input and output methodologies are explored to sense and display traces of physical memory, raising the question: What exactly do we want to remember.

Author Keywords
Reactive garments, wearable computing, electronic textiles, history of use, physical memory.

Introduction
The miniaturization and reduction in cost of digital memory input devices and other digital accessories enable us to capture and store a constantly growing amount of personal data. The term "life caching" describes the process of compulsively photographing, annotating, and saving photos to document moments in everyday life.[1] The term "memory industry" is being used to describe our growing interest in various gadgets that help commit to computerized memory all of the things that we otherwise might forget, such as appointments, commitments, and other important life details.
The more traditional research in wearable technology deals with memory under a framework of efficiency and productivity enhancement. Although these technologies are portable/wearable, they often overlook the presence of the body when registering memories. The data make their way through physically intimate personal devices, but these devices only capture a very objective sort of user experience. The technology mediates people's relationships without taking into account corporeal or embodied ideas of intimacy, and ignores the body as an instrument for communication.

The garments we wear, on the other hand, are some of the most physically intimate things that we interact with in our daily lives. As we wear them, they become worn and start to carry the evidence of our identity and history. Digital technologies, through the form of reactive displays integrated into the garments, allow us to shape and edit that evidence to reflect more subtle, or more poetic, aspects of our identity and history. Gestures and personal history can in this way be perceived, manipulated, and represented on displays integrated into the fabric. Collectively, these digitally augmented garments change and modulate social interactions.

Memory Rich Clothing
Memory Rich Clothing is an ongoing project that focuses on research and development of reactive garments that display their physical memory, or "history of use." Our primary objective is to produce garments that show personal data, such as where and when they have last been touched, including subtle evidence of intimate contact.

The secondary objective in this work is to raise several questions relating to the ubiquity of digital memory accessories and wearable/portable electronics. These questions relate to the narrow definition of memory as it is used in the consumer-electronics market, issues of privacy and surveillance, and explorations of visualization of physical memory.

The term "physical memory" is used to describe spatial and tactile memory inherent in experiencing things through the body in activities such as playing an instrument. Here, we refer to the fact that the garments build up physical memory insofar as they retain some traces of presence of the user, through the ability to sense and record a history of interaction that can be communicated visually.

Computer memory refers to the saving of data, whereas human memory describes a more personal, interpretive process. By placing these memories directly on the body, we question assumptions about the ways that the body remembers. If the way that the body is perceived or used changes, the way we build our memories can also change.

Intimate Memory
Intimate Memory was our first experiment in Memory Rich Clothing. The garment consists of a shirt and a skirt, which employ two different input and output methodologies to record acts of physical intimacy and indicate the time elapsed since those "intimacy events" have occurred.

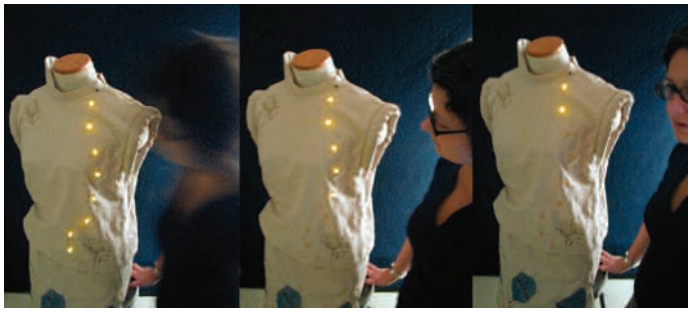

Figure 1 Indication of time in the Intimate Memory Shirt.

The shirt deploys a microphone in the collar and a series of LEDs stitched in a curved line across the front. When someone whispers something into your ear, or blows on your neck, the shirt lights up, showing that an "intimacy event" has occurred. The number of lights represents the intensity of the intimacy event, similar to the volume indicator on a stereo. Over time, the lights turn off, one by one, to show time elapsed since the event took place.

The skirt incorporates soft switches, sewn out of conductive metallic silk organza, and connected with conductive threads to a stitched analog circuit. When they are groped, LEDs illuminate in the embroidery to register the intimacy event. In a similar fashion to how our skin registers touch, the illumination fades over time to indicate the time elapsed since the event. The light not only registers intensity but also how the event unfolds over time. Do things that mark us intensely last longer in our memories?

The circuit design becomes an aesthetic component of the garment design. The shapes created can be decorative as well as functional, especially when using highly conductive yarns. Together with the use of traditional materials and components for garment making (integrating snaps, rivets, zippers, beading techniques, etc.), we can create simple circuits that fit into the aesthetics of fashion and that can be manufactured in similar ways.

Invasion of Privacy

Because of the sexual aspects of groping someone's skirt, this garment highlights the fact that many memory technologies (and wearable technologies) are potentially invasive. Most people who view this piece remark that in general, they would not want other people to see that they had been groped. They claim that this information, and this physical memory, is a private one. It is a memory that they might not want to share with others.

This piece visualizes ways in which our actions and our personal histories can be recorded, stored, and displayed. It highlights issues of surveillance and loss of privacy implicit in the deployment of many wearable technologies.

Figure 2 The Intimate Memory Skirt illuminates when someone touches, or gropes, the leaf patterns.

A more recent experiment in memory-rich garments consists of two sets of three dresses that explore touch, embodied intimacy, and the technical implementation and construction of visually reactive substrates for displaying use data on textiles.

The conceptual framework consists of gathering and displaying intimate touch events but also explores social choreographies that emerge when three bodies actively inhabit three identical reactive costumes.

Spotty Dresses

The first set of three dresses is called Spotty. The dresses are constructed out of thin, light cotton, overprinted with an irregular pattern of thermochromic spots, based on animal camouflage patterns. These dresses remember traces of presence, similar to the idea of hit counters on web pages, to show when and where the users have been touched.

The direct touch memory is displayed when one user touches another and affects the color of the spots using body heat. Since the dresses display a camouflage pattern, body contact – whether touching, rubbing, pressing the fabric against their bodies, or the bodies of other – makes the inks change color and effectively disappear.

Figure 3 The color of the spots in the Spotty dresses changes when they are touched.

Increased physical intimacy makes their spots blend into the skin, it erases the camouflage patterns. Because of physical intimacy, the wearer comes out of hiding. The wearer becomes nude, revealed, exposed. This simple interaction paradigm highlights the dichotomy between privacy and intimacy and how we happily relinquish one in exchange for the other.

Feathery Dresses

The feathery dresses deploy similar technology to that used in the Intimate Memory skirt, but replace the analog circuit with a microcontroller, so as to better control the illumination of the feathers embroidered onto the front of the dresses.

The touch memory is based on the idea of intimacy maps on the body. There are three touch sensors (soft, conductive textile switches) that record touch events. These events act as input into the simple program running on the microcontroller and affect the pattern of illuminated feathers embroidered on the dress. Each "sensitive" area on the dress is directly mapped to illuminate a different intimacy area of feathers. The microcontroller allows us to use much less conductive material in the body of the dresses and reduces failure rates due to broken connection. It also allows us to experiment with different representations, behaviors, and timing.

Figure 4 The feathery dresses illuminate to display site-specific touch events.

Body-Worn Interactive Modules

While the Feathery Dresses and Intimate Memory garment allowed explorations of intimacy and interactivity, their physical configuration was fixed as components were embroidered, stitched, or woven directly into the garments. To allow more flexibility in our investigations, we developed the "Octopus" modules: compact, body-worn displays that support a range of possible interactions. Several devices, approximately five to 15, are affixed to a single person, using magnetic snaps that can be attached and rearranged on a reconfigurable garment substrate.

Octopus Modules

Each palm-sized device has a flash-programmable microcontroller and a 20-LED display. Each has its own rechargeable battery, so the garment need not carry power or data wires. The devices can communicate with each other and can detect movement of the wearer.

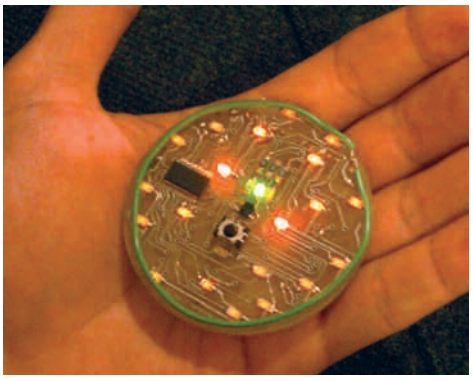

Figure 5 Octopus module.

In designing the modules, we aimed for compactness and power efficiency. By using model-aircraft batteries and surface-mount components, we kept the weight to 18g (0.6 oz.). The current battery provides up to three hours of operation, depending on display usage.

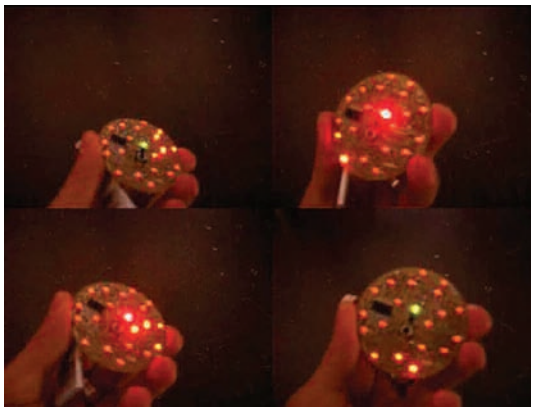

Figure 6 Octopus modules distributed on the body, in two different configurations: a representation of contact (on the left) and body movement, or acceleration (on the right).

Sensing Activity

Three types of events can be sensed using the Octopus modules. Body movement (an accelerometer detects shaking and tilting; thus simple changes in posture or gait can be detected). contact (a capacitive sensor and an IR reflectance sensor detect the contact of hands or objects with the front surface), and communications (the devices can interact over line-of-sight using an IR remote-control protocol.

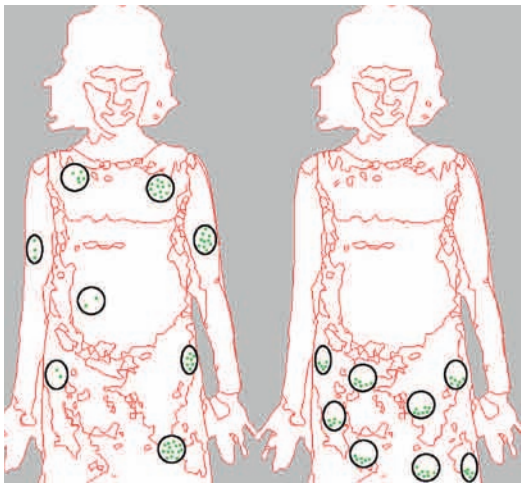

Figure 7 Representing motion and acceleration on the Octopus module.

Interaction Concepts

"Suntanning" – portraying exposure to IR beacons or to incandescent lamps.

"Viral infection" – visualizing transmission of a code between parts of the body and between people.

"Body usage history" – display which parts of the body have been moved or touched recently

"Movement representation" – visualizing the movement and acceleration of the body over time and through space.

Prior Work: TouchCounters, FishFace, and Shakepad II

Several projects from the Tangible Media Group at the MIT Media Lab were a source of inspiration for the development of the modular and reconfigurable Octopus system.

The TouchCounters are an integrated system of electronic modules that, through physical sensors and local displays, record and display usage history information, allowing access to this information during the performance of real-world tasks. A distributed communications network allows this data to be accessed remotely. TouchCounters incorporate techniques that include usage history tracking for physical objects and multi-display visualization.[4]

Figure 8 TouchCounters showing correlation of usage of multiple containers.

The FishFace modules are a set of independent but connectable gestural input devices with proximal visual feedback, with integrated motion detection through electric-field sensing and a graphics display on an array of LEDs that allow representation of abstract information.

Figure 9 FishFace electric field sensing modules for non-contact, gestural input.

The Shakepad II deploys an embedded accelerometer as a gestural interface for an extremely small computer. This tilt- and shake-sensitive interface captures the expressive nuances of continuously varying spatio-temporal input.[5]

Recoding Use Data

Human use has an impact on the integrity of digitally-augmented objects. Drawing upon previous work in "history enriched digital objects,"[2] the memory-rich experiments layer a history of use on a variety of digitally augmented clothing. The primary purpose of these augmented layers of information is to inform, involve, and unite, to create a feeling of social presence in textured history and assign value and identity.[3] Collecting use data interests computer scientists who see possibilities in leveraging people's simple behaviors in order to assist others and develop more collaborative practices.

Figure 10 Drawing on the Shakepad II.

Many traditional human-computer-interaction (HCI) or ubiquitous-omputing (UbiComp) research projects that record history of use are predicated on data analysis and user modeling. The assumption is that use data is recorded in order to provide useful information. How we define this is an interesting question. These dresses could be theorized as such use-history artifacts that show how often the wearer has come into contact with other people or objects. In the evening, the dresses could display a history of their daily physical contact. But they do not: none of this data is saved. This is meaningful because it creates a different kind of paradigm where context and evanescence both contribute to emergent meanings as they evolve between people. As the illumination fades, so do the memories; as the body carries marks of time, so do these garments. In this paradigm, data are impermanent and perpetually contextualized within interpersonal relationships.

Conclusion

In closing, we have noted the limitations of current memory-recording devices to address embodied interaction between people. By recording and visualizing the "history of use" of garments and the bodies that inhabit them, we create garments that show personal data, such as how they move through space or where and when they have last been touched. These representations reflect more abstract, subtle, and possibly more poetic aspects of our identity and our history.

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The Octopus Modules were designed and produced at Blackdust Design.

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