HUGBUG
A WEARABLE INTERFACE FOR FACILITATING DIGITAL DESIGN FOR CHILDREN

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ABSTRACT

Wearable interfaces allow computational components to be woven into fabric. The potential of wearable interfaces to stimulate design thinking in diverse populations has been explored in recent years. Our development, which we have called the HugBug is a fun wearable interface in the shape of a hat supplemented with programmable LED lights and a touch sensor used as an example to demonstrate an Input-Process-Output model to children and stimulate design thinking. The interface was used in two workshops in Canada and Mexico.

KEYWORDS: *Wearable computing; tangible design; Children; digital media; intercultural collaboration.*

INTRODUCTION

Novel computational components allow for the incorporation of diverse materials, from paper and clothing (Qiu et al., 2013) to anything that is conductive (e.g., fruit or water), into digital user interfaces. The educational and inspirational potential of these approaches provide fertile ground for exploration. We are pleased to present the HugBug, a wearable interface used as a teaching tool. We used HugBug to introduce digital design to children and youths and to illustrate the application of a simple Input-Process-Output (IPO) model (IBM Corporation, 1974) to inspire physical computing interface design.

HugBug is meant to elevate the experience of hugging by adding light and sound. It consists in a large hat supplemented with a programmable bright RGB LED strip and a glove with touch sensors (Figure 1). Technically, when the wearer hugs someone, the touch sensors send a signal to the microcontroller that triggers a light show on the hat and gradually increases the volume of the music played. When the hugging stops, so does the light show and the volume of the music begins to decrease. The LED strip is controlled by a Flora microcontroller that uses it to start a light show when touch is detected by the sensor. A backpack contains a source of music (e.g., laptop and speakers) that is activated in time with the light show.

HugBug was originally developed as a fun interface to engage people in emotionally expressive behavior (e.g., hugging) in public spaces. It adds digital media to the already performative act of hugging, making it potentially more appealing. The design was inspired by the observation that there is a lack of physical contact between people in public urban environments, which can contribute to a sense of isolation and alienation. Similar to public performance acts such as Improv Everywhere (http://improveverywhere.com) and theatre and technological social probes such as the coMotion (Kinch et al., 2014) project, HugBug, as a fun interactive piece, aims to raise awareness of this issue and to promote communication in public spaces. HugBug encourages friends and strangers to initiate physical contact and thus promotes expression, performance and a stronger sense of community.

We first demoed HugBug at the Toronto Mini Maker Faire, a social event for makers, technology enthusiasts and amateur inventors (Figure 1). The invention was well received with over 30 people (both adults and children) hugging the second author who wore the hug-enhancing device. We made several observations during the demo: initially most people found the HugBug interesting but were reluctant to engage with it through hugging. Because of its public and physical nature, hugging between strangers usually requires verbal or non-

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Figure 1. *HugBug* showcased at the Toronto Mini Maker Faire

verbal (e.g., inviting gesture) permission before initiation. Once permission was given, about one third of the people encountered engaged in hugging. The rest preferred to observe the hug and accompanying lights and music. Those who did take part in the hugging enjoyed the experience and many encouraged their friends to try it. Because of the position of the lights (i.e., on top of the hat), they were perceived more by the audience than the huggers. In contrast, because of the location of the speakers, the huggers, rather than the audience, heard the music. Most hugs lasted from 3 to 8 seconds, which was shorter than expected. In future, we plan to perform more public space experiments with the HugBug to explore the effect of the social and cultural context in which it is used and the effect produced by the person wearing the device.

USING HUGBUG TO FACILITATE DESIGN THINKING

HugBug can be thought of as an interface that turns its wearer into a cyborg, in the sense of a human augmented with digital technology (Gray et al., 1995). In this way, it can offer a good illustration of how we can extend human capabilities and expressive power with technology. In our labs in Toronto, we have been using a simple Input-Process-Output (IPO) model to teach digital design to youths and children in workshops (Figure 2). IPO and similar models were developed in the 1970s by the computer industry to capture and express software and hardware design (IBM Corporation, 1974). To have concrete and tangible examples is important for conveying abstract ideas, especially for children and youths, which is why we decided to use the HugBug as an example illustrating the use of the IPO model in concrete terms. We used the device in two physical computing and digital design workshops: one in Canada and one in Mexico.

The Canadian workshop was organized as part of a one-day event for 100 high school students (grades 9 and 10) who attended with their teachers (82 boys, 18 girls). We used the HugBug as part of a presentation to introduce the students to digital design (See Figure 3). The workshop was intended as a general overview of emerging technologies and included a discussion of rapid prototyping methods and open-source hardware, as well as, wearable computing. After introducing the IPO model, we showed a short video of how HugBug worked and described its design and underlying technology to the students. During informal interviews after the workshops with students and their teachers, they expressed that both IPO and HugBug were intuitive and inspiring. They were intrigued with the possibility that they could also design and implement their own wearable interfaces and use lights in their clothing. Despite the good feedback, HugBug was used as just one example in this workshop and it was hard to assess its usefulness.

In the second workshop, in Mexico, we worked with a group of 25 children between the ages of 3 and 15 (10 girls, 15 boys). The aim of the workshop was to introduce the children to digital design, to enable them to incorporate digital components into their own designs (Hamidi et al., 2014). We introduced the children to the IPO model and used HugBug as an example of how technology can be used to expand human expression. While we showed several examples of fun tangible

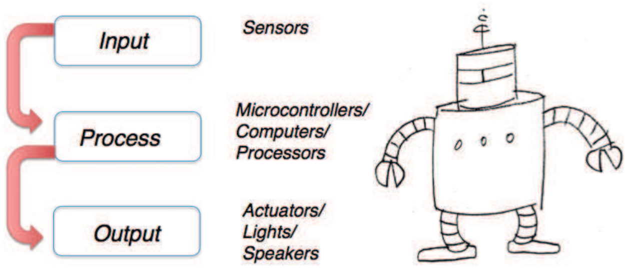

Figure 2. The simplified IPO model

Figure 3. *HugBug* described in a workshop for high school students

Figure 4. In a workshop for children, participants drew their designs on paper and added glitter and LED lights.

designs, we focused on HugBug, describing its design and implementation. When we were using it to demonstrate the IPO model, a couple of the children made the observation that if (as we suggested) sensors could be thought of as technological equivalents of human senses and microcontrollers as the human brain, then, wires would be equivalent to nerves in the body. This observation shows a deep understanding of the model. The children then tried on the interface, asked numerous questions and cracked jokes (mainly about the size of the hat). This generated a generally happy mood, which we believe is conducive to creativity and learning. As designers, it was important that we were present and could answer questions directly. This interaction made digital design seem more accessible and within reach.

After seeing the examples, the children drew Mexican folk art creatures, first indicating where touch sensors and lights would be and then embedding them there. The main idea was to extend the creatures' sensory powers by planting touch sensors on their bodies and extending their expressive powers through electric lights. The outcome of the workshop was more than 30 drawings, 18 of which were of detailed creatures that were enhanced with blinking LED lights and touch sensitive batteries (e.g., see Figure 4). The rest of the drawings were of things other than creatures or were unfinished. The children were proud of their work and showed them to the adults in the center and to each other. Through their drawings, the children showed a useful understanding of the IPO model and an ability to apply it to new contexts (Hamidi et al., 2014).

RELATED WORK: WEARABLES AND LEARNING

The potential of wearable computing (and more generally, *computational textile or e-textile*) as a teaching tool that can reach a diverse population of users is explored by many research projects such as the LilyPad ProtoSnap (Qiu et al., 2013) and EduWear (Katterfeldt et al. 2009), kits specifically developed for education. Qiu et al. have proposed the design of a computer science education curriculum using computational textile and wearable interfaces (Qiu et al., 2013). The researchers suggest that computational textiles allow for the engagement of diverse users, including users more interested in design and aesthetics rather than implementation and coding, with computational concepts and methodologies. Additionally, Katterfeldt et al. (2009) argue that the "'soft', not initially technical-looking character" of fabric as a material is more inviting to diverse groups of children and allows for novel artistic expression. In our approach, the focus is not on wearables as an implementation platform but as tools for inspiration that can facilitate different forms of digital design.

Katterfeldt et al. identify the potential of computational textiles for implementing personally meaningful and relevant designs (2009). According to constructionism (Papert, 1980), an influential development theory, this characteristic is a prerequisite for deep engagement in the activity of meaning construction that, in turn, facilitates learning and empowerment. Historically, we have a long and intimate relationship with our clothing. Clothing textiles and cloth are among humanity's earliest and most effective technologies that, according to Marshall McLuhan, "extend" our ability to adapt to different environments (McLuhan, 1994).

Another aspect of wearables is that through connecting to our physical body directly, they can sense our internal physical characteristics and externalize them. This characteristic is used to teach physical education through sensing and communicating characteristics such as heartbeat, speed (Dittert & Schelhowe, 2010), anatomy and physiology through externalizing internal body organ representations and processes (Norooz and Froehlich, 2013). Several previous projects have explored hugging as a mode of interaction. Huggy Pajama (Teh et al., 2008) is a wearable interface that allows parents to hug their children remotely, and the Huggable (Stiehl et al., 2006) is a robotic companion that has "sensitive skin" and can be interacted with through touch and hugging. The HugBug is different from these systems in that it does not simulate or replicate human hugs but rather enhances and promotes them.

CONCLUSION

We have introduced HugBug, a fun wearable interface, to enhance and promote hugging. We used it to illustrate the application of an Input-Process-Output model in two workshops for youths and children. We found the model useful in inspiring design thinking and illustrating the model.

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