Bod-IDE: An Augmented Reality Sandbox for eFashion Garments

Figure 1: Bod-IDE with a designer standing in front of the 'mirror' display with some tags fastened to their body and a prop.

Kevin Ta
University of Calgary
Calgary, Alberta, Canada
kta@ucalgary.ca

Ehud Sharlin
University of Calgary
Calgary, Alberta, Canada
ehud@cpsc.ucalgary.ca

Lora Oehlberg
University of Calgary
Calgary, Alberta, Canada
lora.oehlberg@ucalgary.ca

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Abstract

Electronic fashion (eFashion) garments use technology to augment the human body with wearable interaction. In developing ideas, eFashion designers need to prototype the role and behavior of the interactive garment in context; however, current wearable prototyping toolkits require semi-permanent construction with physical materials that cannot easily be altered. We present Bod-IDE, an augmented reality 'mirror' that allows eFashion designers to create virtual interactive garment prototypes. Designers can quickly build, refine, and test on-the-body interactions without the need to connect or program electronics. By envisioning interaction with the body in mind, eFashion designers can focus more on reimagining the relationship between bodies, clothing, and technology.

Author Keywords

Creativity support tool; electronic fashion; augmented reality

ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces; *Prototyping*

Introduction

Electronic Fashion (eFashion) combines clothing design with interactive technology. Example garments include

Figure 2: The mirror display (zoomed for clarity) with a designer wearing multiple tags and an augmented prop. Virtual components are rendered in real-time.

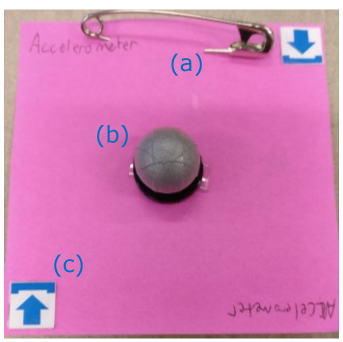

Figure 3: An example wearable accelerometer tag. The tag has a (a) safety pin, (b) reflective marker, and (c) tag type icon. When viewed in front of the mirror it has a virtual representation and can be

a shape-changing scarf that senses how it is tied [7] or a data-driven dress that visualizes brain activity [5]. To create garments, eFashion designers must translate imaginative conceptual designs into a pragmatic and implementable plan. This includes soldering and programming, which are time consuming, require expertise, and are semi-permanent and thus, difficult to iterate on or modify. Before committing to a full implementation of an interactive prototype, designers have few means to investigate their garment's behavior in response to its wearer's movement, activities, and context. Currently, eFashion designers communicate through sketches, conversations, and physical gestures. As designers, we ask: *What if eFashion designers could explore the role and behavior of an interactive garment in the context of the body, to refine an artistically potent, yet physically feasible eFashion vision?*

We present Bod-IDE, an augmented reality (AR) 'mirror' that allows eFashion designers to experiment with virtual interactive wearables. We envision Bod-IDE as a compliment to conceptual sketching, where designers can prototype embodied interactivity using an AR representation of their garment. This frees eFashion designers from the need to solder or sew physical materials and instead focus on experimenting with wearable interactivity – exploring alternate behaviors that arise from on-the-body prototyping.

Related Work

Prototypes can address three kinds of design questions: *implementation, look & feel*, or *role* [3]. While most toolkits and prototyping tools for wearable technology facilitate *implementation* and *look & feel*, we emphasize the *role* of interactive garments – prototyping its response to the wearer's actions and context.

Wearable Toolkits. Past researchers have developed wearable-specific hardware toolkits for eFashion design. For example, Arduino Lilypad [1] – intended for final runway-ready garments – allows designers to integrate sewing-compatible microcontrollers and electronic components onto clothing. However, designers need to make semi-permanent connections and hide or integrate the components into the garment's aesthetic limits alterations. MakerWear [4] uses reconfigurable magnetic hexagonal pieces that form a wearable physical programming language; this kid-friendly platform offers a non-permanent way to define behavior of wearable technologies. However, it aesthetically constrains eFashion designers to its hexagonal grid. Our goal in Bod-IDE is to allow designers to refine an existing fashion vision's fashion and interaction aesthetic by quickly exploring alternative input and output mappings.

Augmented Reality Toolkits. Augmented reality (AR) has been used as physical stand-ins for electronic components when developing prototypes. Polymorphic Cubes [9] is an AR system that allows virtual stand-in components that can interact, behave, and integrate in place of the physical electronic component and addresses *implementation*. Mirror Mirror [8] is a virtual fitting room mirror that allows a designer to create their own shirt prints on top of their bodies. Designers create an aesthetic with Mirror Mirror (*look & feel)*, but the system does not yet allow a designer to explore what role their garment's behavior plays in the context of the intended wearer's activities (e.g., dancer's outfit on stage). Bod-IDE builds on these two approaches by combining interactive AR components with real-time on-the-body prototyping via an AR mirror.

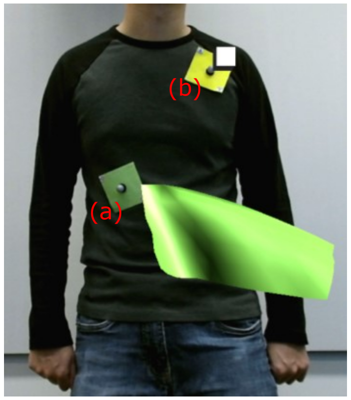

Figure 4: (a) Virtual cloth tag fluttering in the wind when activated by (b) a button.

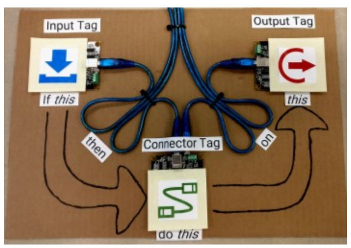

Figure 5: The program board using Phidget RFID readers to register program behaviors. Designers place tags on top of the bins (icons).

Scenario

Katie, an eFashion designer, wants to create a steam punk styled jacket that represents her client Sasha's Twitter feed activity. Katie creates concept sketches that capture the aesthetic and basic behavior of the jacket. With her vision in mind, she uses her augmented reality mirror (Bod-IDE) starting with the Twitter feed module. She creates one of her jacket's envisioned behaviors – animating the jacket on a retweet – using the program board (Figure 5) to link the Twitter tag to various output components that could communicate 'aliveness', settling on LEDs and fans. She physically attaches the tags on top of an existing jacket that she plans to modify for the project using safety pins with the LED tags placed on the side of her shoulders and fans along the inside of her forearms.

To test this implementation, she wears the jacket and sits on a chair in front of a coffee table to simulate a café space. The mirror animates the tags with virtual components by blinking the LED on every retweet. She notices that the LEDs flickers too often because Sasha's Twitter feed is popular and that it would draw too much public attention. She taps alternative Connector Tags on the program board to explore different mappings between the Twitter tag and the LED's, settling on a Connector Tag that blinks the LED after a certain threshold and tries again in front of the mirror. After some refinement, she invites her client Sasha to try on the jacket in the mirror. Sasha mentions that she would like the fans to the side of her arms since it had a clockwork automaton aesthetic. Katie quickly swaps the locations of the LED's and fans. Katie eagerly asks Sasha to try her jacket again, as they explore more interactive behaviors together.

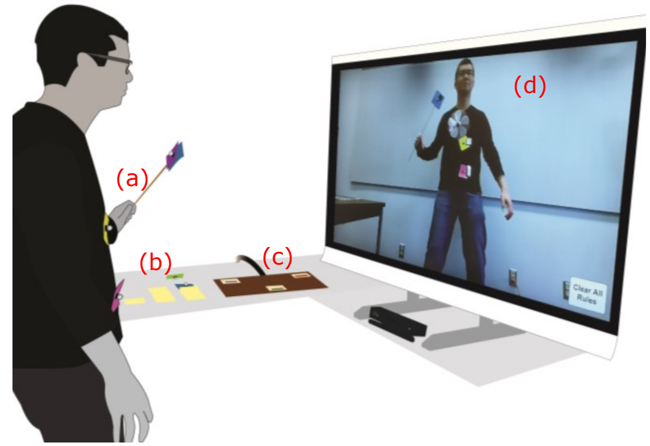

Figure 6: Using Bod-IDE (photo traced for clarity), (a) designer holding a marker augmented prop and wearing tags, (b) programmable tags, (c) programming board, and (d) 'mirror' with component renderings and behaviors.

Initial Implementation

Bod-IDE allows designers to physically place, program, and test virtual interactive components (tags) on their body. We use simple paper tags (Figure 3) with reflective markers and RFID tags that attach to the user's body with tape or a safety pin and are easily repositioned. When in front of the mirror, each wearable tag is rendered on top of the designer's body or a mannequin.

Our initial implementation uses Unity, Kinect v2, and Phidget RFIDs. Our initial component tag set includes a button, accelerometer, simulated tweet events, LEDs, motors (fan), sound effects, and virtual cloth. We also included connectors for toggling on/off components, 1-to-1 analog control, and a threshold-activated toggle.

Button
wearable
input

New Tweet
non-wearable
input

LED
wearable
output

Sound Effect
non-wearable
output

Toggle on/off
non-wearable
connector

Figure 7: Types of tags. Tags that are wearable feature a reflective marker and a safety pin.

Authoring Interactivity
Programming uses a modified if-this-then-that programming pattern similar to IFTTT [11]. Designers must combine three types of tags to form an if-*this* (input) then do-*this* (connector) on *that* (output) statement. Each statement is registered by physically placing the tags in each bin on the program board (Figure 5). For example, an accelerometer's velocity can be mapped 1-to-1 to the speed of a motor (accelerometer + analog + motor) or toggle the motor on when it has been shaken hard enough (accelerometer + toggle + motor). A designer can go between former and latter examples by changing the connector tag from the analog tag to the toggle tag.

Once the designer has defined a set of rules, they can fasten the wearable tags to their body using tape or safety pins. The designer can also attach tags to props (Figure 6a) to create accessories or build larger structures (e.g., wings).

Discussion & Future Work
The next step in this project is to use Bod-IDE as a design probe to interview with eFashion designers. As a design probe, Bod-IDE can initiate discussion of how eFashion designers might use technology to: (1) encourage exploration, (2) support discussion, and (3) bridge physical and virtual materiality in prototyping.

Encouraging Exploration. We intend to extend Bod-IDE with additional interactive wearable components and environmental simulations. Some work has been done to create actuating dynamic clothing using pneumatic origami [6] and memory shape alloys [7]. These operations may include scaling, actuating, stiffening, or multiplying forms on-the-body. These concepts could easily be prototyped in augmented reality without the constraints of real world mechanics or materials. Furthermore, designers could test their garments in various virtual enviroments – such as train stations, funeral processions, or weddings – to communicate how the garment's visual and behaviorial aesthetic might address social expectations. These designs and other explorations could be recorded and revisited for further refinement.

Supporting Discussion. eFashion designers rarely work in isolation, and often work alongside technologists. Bod-IDE designs can act as boundary objects [10] facilitating interdisciplinary communication across eFashion designers, engineers, or clients. For example, designers may also want to work more directly with models or clients (e.g., dancers) to tailor interaction to the wearer's unique physical abilities, while simultaneously supporting design input from all stakeholders (participatory design). We also would like to consider how Bod-IDE might be used as a remote collaboration tool – exporting designs to send to remote engineers or clients for feedback, before the designer has committed to physical prototyping.

Bridging Physical and Virtual Materiality. The current implementation still cannot explore how real-world materials interact with virtual components. For example, many eFashion designers examine how different materials or fabrics will diffuse light. A future version of Bod-IDE could potentially communicate across physical and virtual representations of materiality. This could be used in tandem with existing fashion design practices – such as draping textiles on a mannequin or using a swatchbook [2] library of both virtual and physical interactive textiles.

References

1. Leah Buechley, Mike Eisenberg, Jaime Catchen, and Ali Crockett. 2008. The LilyPad Arduino: using computational textiles to investigate engagement, aesthetics, and diversity in computer science education. *CHI 2008*. ACM, New York, NY, USA, 423-432.
2. Scott Gilliland, Nicholas Komor, Thad Starner, and Clint Zeagler. The Textile Interface Swatchbook: Creating Graphical User Interface-like Widgets with Conductive Emroidery. *ISWC 2010*. IEEE, 1-8.
3. Stephanie Houde and Charles Hill. (1997). What do prototypes prototype. *Handbook of human-computer interaction*, 2, 367-381.
4. Majeed Kazemitabaar, Jason McPeak, Alexander Jiao, Liang He, Thomas Outing, and Jon E. Froehlich. 2017. MakerWear: A Tangible Approach to Interactive Wearable Creation for Children. *CHI 2017*. ACM, New York, NY, USA, 133-145.
5. Chelsea Klukas. 2014. MakeFashion Spotlight: Common Experience. (March 2014). Retrieved March 11, 2018 from http://www.makefashion.ca/make-fashion-spotlight-common-experience/
6. Laura Perovich, Philippa Mothersill, and Jennifer Broutin Farah. 2014. Awakened apparel: embedded soft actuators for expressive fashion and functional garments. *TEI 2014*. ACM, New York, NY, USA, 77-80.
7. Luisa von Radziewsky, Antonio Krüger, and Markus Löchtefeld. 2015. Scarfy: Augmenting Human Fashion Behaviour with Self-Actuated Clothes. *TEI 2015*. ACM, New York, NY, USA, 313-316.
8. Daniel Saakes, Hui-Shyong Yeo, Seung-Tak Noh, Gyeol Han, and Woontack Woo. 2016. Mirror Mirror: An On-Body T-shirt Design System. *CHI 2016*. ACM, New York, NY, USA, 6058-6063
9. Sowmya Somanath, Lora Oehlberg, Ehud Sharlin. 2017. Making despite Material Constraints with Augmented Reality-Mediated Prototyping. *Science Research & Publications Technical Report*. University of Calgary, Calgary, AB.
10. Martin Stacey and Claudia Eckert. 2003. Against Ambiguity. *Comput. Supported Coop. Work* 12, 2 (May 2003), 153-183.
11. Blase Ur, Melwyn Pak Yong Ho, Stephen Brawner, Jiyun Lee, Sarah Mennicken, Noah Picard, Diane Schulze, and Michael L. Littman. 2016. Trigger-Action Programming in the Wild: An Analysis of 200,000 IFTTT Recipes. *CHI 2016*. ACM, New York, NY, USA, 3227-3231.