Exploring Interactions and Perceptions of Kinetic Wearables

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ABSTRACT

Jewelry and accessories have long been objects for decorating the human body; however they remain static and non-interactive. This work explores opportunities for accessory-like kinetic wearables and their association with individual style. We developed Kino, a kinetic accessory system which enables both aesthetic and functional clothing-specific design possibilities. We engaged both fashion designers and everyday users to unpack envisioned use cases and perceptions of the system. Participants viewed the devices not as gadgets but as companions due to their close proximity to the body. They envisioned a wide range of usage scenarios, highlighting the complexity of mobility in relation to personal style. We observe how mobility offers opportunities for fluid representations of self, which is unachievable though static clothing and accessories. We also outline how personalized aesthetics is important for the meaning making of novel on-body devices.

ACM Classification Keywords

H.5.m. Information Interfaces&Presentation (e.g.HCI): Misc.

Author Keywords

Fashion; Wearable Technology; Robotics.

INTRODUCTION

Jewelry and accessories have long been objects encoded with social, cultural, and personal meaning for ornamenting the body. While there have been numerous explorations with the aesthetic form of jewelry, they largely remain analog and non-interactive. Recently, there has been a rise in computational jewelry [25], i.e., adornment artifacts that function both as jewelry and as a computational device. However, they are often limited to output in the form of alpha-numerical displays or LEDs. In this work, we incorporate movement into static accessories so they become mobile objects on the body. They reconfigure location and complete functions beyond decoration. Movement opens the design space for dynamic interactions between device, clothing, and the body. Through mobility, the device can alter the appearance of one's outfit for increased fluidity in self-expression. It can also configure between location-specific roles, shifting between technical gadget and object of ornamentation according to location.

Figure 1. (a) Example of kinetic wearables transitioning from brooch to necklace (b) the robot without a cover.

In this paper, we aim to explore the future of kinetic wearables and its meaning for interaction and personal style. We build upon an existing on-body robot platform, [8], which we previously developed, to create Kino, a mobile accessory system. We describe the design space of Kino, and created several garment applications that explored clothing-specific design possibilities. We engaged fashion designers and participants with no fashion design experience to unpack the personal meanings and social functions dynamic accessories foster within personal style.

BACKGROUND AND RELATED WORK

Smart Jewelry: The emerging trend of smart jewelry seeks to transition gadgets into fashionable body-wear. However, interactions are limited to visual [6, 23] and tactile [13] output, or input through touch screens [13, 22]. Kino incorporates movement as a novel interaction modality.

Shape-changing Clothing: The fashion industry has explored adaptive clothing: Hussein Chalayan's animatronic dresses [28] reconfigure with motors and pulleys. ZipperBot [29] is a motorized zipper. Pneumatics [11, 19, 21] and shape memory alloys [2] have also been used for shape change. However, the work in this area is mostly task specific and does

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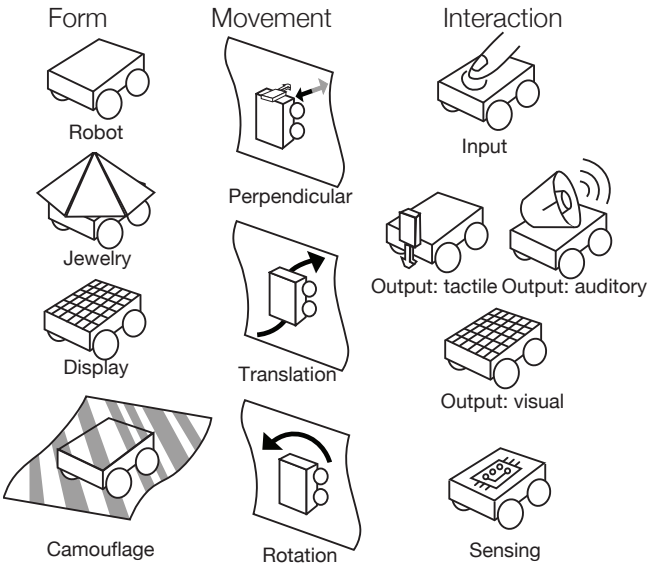

Figure 2. Design Primitives.

not realize a generalized platform. Moreover, the technology is often integrated into the clothing itself, while Kino can be fabricated outside of the soft goods realm and incorporated on top of existing garments.

On-body robots: The robotics field has realized systems which grip onto folds [5, 17] or penetrate into cloth [3] for vertical movement. Parasitic Mobility [15] sensor nodes jump from one human host to another. Saga et al. [24] created a mouse-like robot that moves on a arm-mounted rail. Nixie [7] is a wearable drone that can detach from the wrist and take selfies. Additional works explore actuation in fixed locations [16, 18, 20]. While these works demonstrate functional capabilities, applications and user perceptions are under-explored.

DESIGNING KINO

Mechanical and Hardware implementation

As shown in Figure 3, the main drive system consists of motors connected to magnetic wheels on top and underneath the fabric. This holds the robot in place regardless of its orientation. The robot is untethered with a custom circuit board and on-board battery. The robot's size is 4cm by 2.6cm. Additional details can be found in [8].

Design Primitives

To use Kino for on-body design, we outline the design primitives which consists of form, movement, and interaction.

Form. There is tension with computation jewelry seen as a gadget versus an object for decoration [25]. Individually, the form of the robots can enable different purposes.

- Robot. The bare structure is an on-body robot.
- Jewelry. Material and geometry are important design elements constituting a piece of jewelry. With the addition of an overlay cover on top of the structure, various materials and geometric designs can be explored. The material choice can enable a gem-like jewelry piece, or fabric-like and integrated with the garment.
- Display. With a LED matrix, it becomes a digital display for information presentation.
- Camouflage. These devices can become camouflaged with cover designs that blend in with the underlying fabrics. They become hidden, only drawing attention when in movement.

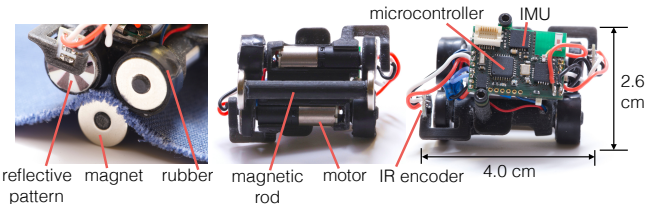

Figure 3. Mechanical and hardware implementation.

Movement.

- Perpendicular. The addition of a linear actuator can create motion perpendicular to the fabric. It can create tactile feedback on the skin or attach to objects
- Translation. Moving on fabric plane from point A to B.
- Rotation. The device can turn and rotate to navigate in different directions. Turning in a fixed location can enable fabric manipulation, providing visual feedback.

Interaction. The addition of various sensors and actuators can expand the interactive capabilities of the device.

- Input. The addition of a touch sensitive add-on transitions it to an input device.
- Output. Providing graphical output through displays and non-graphical output such as tactile and auditory feedback.
- Sensing. Integrating specific sensors, the device can detect environmental signals (light, temperature, proximity) or body movements (accelerometer, gyro).

Application Examples

Building on the design primitives, we present two types of applications (demos in accompanying video): (1) aesthetic-driven which alters the appearance of clothing for aesthetic presentation, and (2) function-driven which completes a task for the wearer. Function and aesthetics are not mutually exclusive, and we highlight opportunities for both.

Aesthetic-Centric Applications

Shape-changing jewelry. Multiple devices can become building blocks to form jewelry design. With its mobility, the individual pieces can form various shapes and designs. We present an application of a jewelry set that starts as a minimalistic brooch for going to work, and when the wearer later goes to a dinner outing, it is activated to shift into a necklace statement piece (see Figure 1a).

Pattern changing. Cover designs camouflaged with the underlying textile can morph between unique patterns effects. We

Figure 4. Aesthetic-centric applications: (a) pattern changing, (b) shape changing clothing for aesthetics, (c) pattern etching.

present an example of a stripe pattern with matching device covers (Figure 4a). By shifting its location on the body, the device creates different aesthetic effects.

Shape changing clothing for aesthetics. By attaching the robots to open ends of a garment, the robots can pull, flip, and shift the ends to alter clothing appearance. We present a shawl which shape-changes into a scarf according to how the wearer wishes to present herself (Figure 4b).

Etching patterns. When moving, the devices can etch into specific fabrics and "draw" patterns. On fabrics such as velvet, the robots leave visible tracks during movement - the clothing becomes a canvas to etch designs. The traces are temporary and therefore new patterns can be generated (Figure 4c).

Function-Centric Applications

Mobile on-body microphone. With addition of a microphone and speaker, the robot is a bluetooth microphone/speaker to receive phone calls when the wearer's hands are full. It normally sits as a decorative brooch, and when the wearer receives a phone call, it shifts close to the neck for the wearer to talk to the device (Figure 5a).

Shape changing clothing for function. The robots can trigger clothing to actively adapt based on the climate or comfort needs of the wearer. We created a coat and connected each drawstring of the hood to a device. Upon detecting an increase in temperature, the devices move downwards to unfold the hood (Figure 5b).

ENGAGING DESIGNERS AND WEARERS

We used the system as a material probe [10, 14, 27, 30] to study how mobility relates to one's perception of personal style. Referencing [9], we engaged wearers to understand how everyday people would interact with such a system, and fashion designers for expert perspectives of designing for the body. We seek to understand:

- What formulates one's perceptions of kinetic wearables? As a novel device, Kino lacks cultural and historical grounding, presenting a need to situate the device with regard to existing objects, experiences, and representations.
- What are envisioned use cases and interactions towards a kinetic wearable system?

Figure 5. Function-centric applications: a) bluetooth microphone, b) climate reactive clothing.

We conducted 60-min semi-structured interview sessions where participants were first introduced to the system, and then invited to wear and control the device. The researcher then demonstrated the functional and aesthetic applications described in the previous section. Participants were asked to select interactions they could see themselves using in everyday life, and to explain in detail how they would design/wear the device and situate the interaction. We also asked participants to juxtapose the system with alternatives which might serve similar functions, such as wearable devices, clothing, or jewelry.

17 individuals: 11 wearers (aged 20 to 31, M=25.5, 5M, 6F) and 6 designers (aged 23 to 33, M=28.3, 2M, 5F) participated in our study. The designers had a vast range of experience and worked for large brands or as independent designers. We used grounded theory approach [4] to transcribe from video recordings of all sessions.

Findings

Representation of Kino: Personal Companion

Participants described the device as a "companion", "pet", or "living animal." They compared it to a heart rate monitor or health tracker, but felt it was much more personal and possessed animalistic qualities. P2, a wearer, said it felt like "a dog licking my face" when it moved close to her neck. P10, a designer, compared it to ornamented beetles in Mexico which people would wear as a "living brooch." The fact she could "feel it moving" and "gripping to my clothes" made it "a living gadget." P8, a wearer, and P12, a designer, imagined developing a relationship with the robot by naming it and assigning it personalities. P8 imagined "talking to it all the time" and asking it to help her complete tasks. While many participants welcomed the experience, others described the initial encounter as "eerie", "creepy", or "foreign." P3, P7, wearers, and P9, a designer, compared it to "a bug crawling on my shirt." However, if its movement served a specific purpose and was not "aimless", they would then see it as "a little assistant" and not just "a random bug" over time. They suggested miniaturizing the device to the size of a button, and reducing the gear noise for a more seamless experience.

Envisioned Use Cases

1) Many outfits in one. P1, P6, P8, wearers, and P12, a designer, imagined enabling representations of "various sides

of self." P12 mentioned how "clothing in the morning, now, is the same when you put it back at night." He imagined being able to "change your appearance on the spot," and "leaving with one outfit in the morning, yet coming home with another." Specifically, P1 imagined altering between a "minimalistic classic look" where she could wear to class, versus a "loud statement piece" for going out at night. P8 and P6, wearers, imagined how the system might change their hairstyles by altering between long and short hair.

2) Personal assistant. P1, P4, P6, wearers, and P12, a designer, imagined the system as a personal assistant which performs just-in-time, specific tasks. P4 talked about his frustration with the "generic and never ending" notifications from mobile phones. He imagined being able to personalize and "assign meaning" to notifications. For instance, it would move towards his face to notify of a phone call, whereas it would move towards his legs to notify of yoga time. The "freedom" to program "specific" nudges shifted his perception of the device from "gadget" to "assistant." P10 contrasted how with the device, "you do get to choose what its doing" whereas "the smartwatch at the end of the day is just watch." The capability to designate its function made it "like your little helper."

3) Remote communication device. P4, P5, P11, wearers, imagined the platform for intimate communication between remote loved ones. P11 mentioned how it embodied the presence of a family member or significant other, "the fact it touches my skin [...] makes it feel human." P5 expressed he would like to "let it be controlled by someone that has a connection with me." For instance, when it tapped him, it would communicate presence or a playful interaction.

4) Active, functional garments. P13, P15, P17, designers, and P8, a wearer, imagined garments which actively engage with the wearer's body. P13 described it as a "wearable Nest thermostat" that would "learn your patterns." For instance, it would tighten his jacket according to temperature, and clinch it to the exact fit of his preference. P15, a designer, described an ultra-form fitting garment that could "move between a size 4 and 6" for a more professional or casual fit.

5) Fashion that moves. Participants described movement as a new aesthetic. P8, a wearer, saw the system as "fashion that moves", and "fashion that is alive." She imagined the devices fully integrated into the textile, and creating a "magical feeling" through slow, subtle movement. Both P8 and P3 contrasted this with LED-laden garments and found it to be "less frighteningly techy" and somehow "naturally integrated" with things they already wear. It "looked normal but with a pleasant twist." P16, a wearer, saw the "slowly, ambiguously changing" pattern as "a playful agency, a new fashion."

Discussion

Meaningful coupling of aesthetics with function

From the study, we observed a wide range of individual preferences. While some participants were function-inclined and others more aesthetic-centric, we observe a desire for the coupling of both for a truly wearable experience. The function provided reason to wear such a device as it assisted in the completion of a task unachievable by current devices, accessories, or clothing. Aesthetics, on the other hand, provided means for making sense of the object on the body: the careful integration of the device as part of the garment assigned it meaning. P8 mentioned she felt uncomfortable with "wearing a robot so close to my body," yet when she could "dress it up" her perspective shifted: "it's a wearable, but it's more integrated as part of my clothing [...] something that is part of who I am." Roland Barthes [1] noted, "Fashion is play, with the most profound of human questions: Who am I?" The action of "dressing up" links to our play with identity; being able to integrate the device with their clothing seemed to enable participants to carve out an identity for the novel, foreign device, which then made it easier to accept and embrace as a part of their everyday dress. The ability to personalize device appearance is also an emerging necessity in the wearable technology market [26]. Seemingly as technology moves ever closer to the body, assigning meaning is increasingly critical for its adoption.

Fluid representation of self

P9 described the system as "an aesthetic change of more than one state," and compared the system to "designing for a video versus a photograph." The addition of movement enables fluidity in presenting multiple states of self which was previously unachievable. As noted by Goffman's [12] theatrical representation of social interaction: "we all take different parts given the situations we give ourselves to be in" and "we adapt who we are based on who we interact with." Many participants seemed to want to seamlessly adjust between different aesthetic appearances or technical functions to represent their various roles, states and needs. To this end, mobility becomes an enabler for rapidly shifting representations of self.

CONCLUSION AND FUTURE WORK

In this work, we unpack perspectives of kinetic wearables and explore their relationship with individual style. We developed Kino as a material probe to elicit associations that shape perspectives towards wearable mobility. Assigning identity and meaning to the foreign, mobile object was achieved in the same way we craft our own identity though fashion: by "dressing up" and personalizing the appearance of the device. Mobility enabled more fluid representations of self, suggesting a dynamic future of the things we wear, and the multitudes of identities we can project. We extend mobility as an additional vocabulary for this possible future of personal style. In future work, we seek to overcome current technological constraints (e.g., size) to increase wearability, iterate the design with further user feedback, with all this leading to autonomous deployment in the wild for everyday usage.

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