Kinetic Wearables Toolkit

Actuator Mounts and Attachment Methods for Wearable Electronics Prototyping Applications

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Additional Keywords and Phrases: HCI; wearable electronics; motors; toolkit; 3D printing; DIY

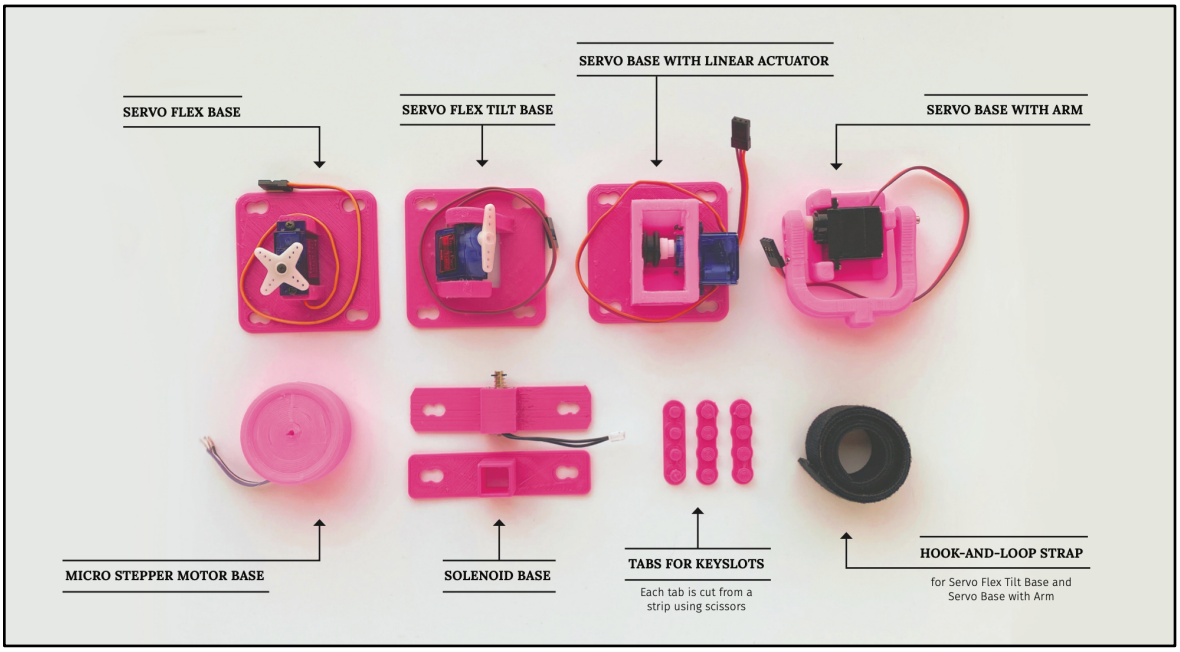

Figure 1: Methods for attaching actuators to the body prioritized the wearer's comfort and safety as well as the stabilization of the actuator's base.

1 INTRODUCTION

Developing wearable electronics projects requires a diverse skill set that includes circuit building, coding, fashion and/or industrial design. Since the initial release of the LilyPad Arduino [2] in 2007, a number of wearable electronics kits [1] have come to market to support the process of incorporating computational elements into garments without complex construction or specialized engineering expertise. These kits offer useful solutions for embedding small, static components like sensors, LEDs, and speakers into e-textile and wearable electronics projects. Other toolkits specific to e-textiles and wearable electronics have also been proposed [3, 8].

However, there are currently no wearable or e-textile toolkit components that make things move. Incorporating motors and other kinetic actuators on the body has remained a more specialized practice, mostly limited to larger teams capable of designing and fabricating specialized harnesses, housings, and moving parts from scratch, mounting these on special purpose garments [6, 7, 9, 10].

2 KINETIC WEARABLES TOOLKIT

This project aims to make it easier for the art, design, DIY electronics, and maker communities to incorporate motion in wearable electronics. Kinetic Wearables Toolkit offers the designer options for electronically animating clothing and wearable accessories via several kinds of motion in multiple axes using 3D printed parts and lightweight, inexpensive actuators.

We have explored design considerations for kinetic wearables including wearability factors, choice of actuators, types of motion, and attachment approaches, building upon design considerations for wearable technology [4, 11].

Wearability factors included the following:

1. Protection of motor/mechanism
2. Adjustability of motion
3. Stability of attachment to body
4. Integration with electronics and power
5. Protection from and dissipation of heat generated by motors
6. Pinching/tangling protection for wearer
7. Prevention of chafing and irritation

The actuators – a solenoid, a stepper motor, and two servo motors – were selected for their versatility, accessibility, low cost, low risk, and minimal expertise required.

The resulting designs (Figure 1) include a solenoid base, a micro stepper motor base, and for servo bases: servo flex base, servo flex tilt base. servo base with linear actuator, and servo base with arm, which produce both linear and rotary motion. Methods for attaching these bases to the body included pin attachment, strap attachment, and key slot & tab attachment (Figure 2). Designs were developed in Autodesk Fusion 360 and printed on a Bibo 2 Touch 3D printer in two materials: PLA (polylactic Acid - a rigid plastic that is easy to print), and TPU (thermoplastic polyurethane - a flexible plastic).

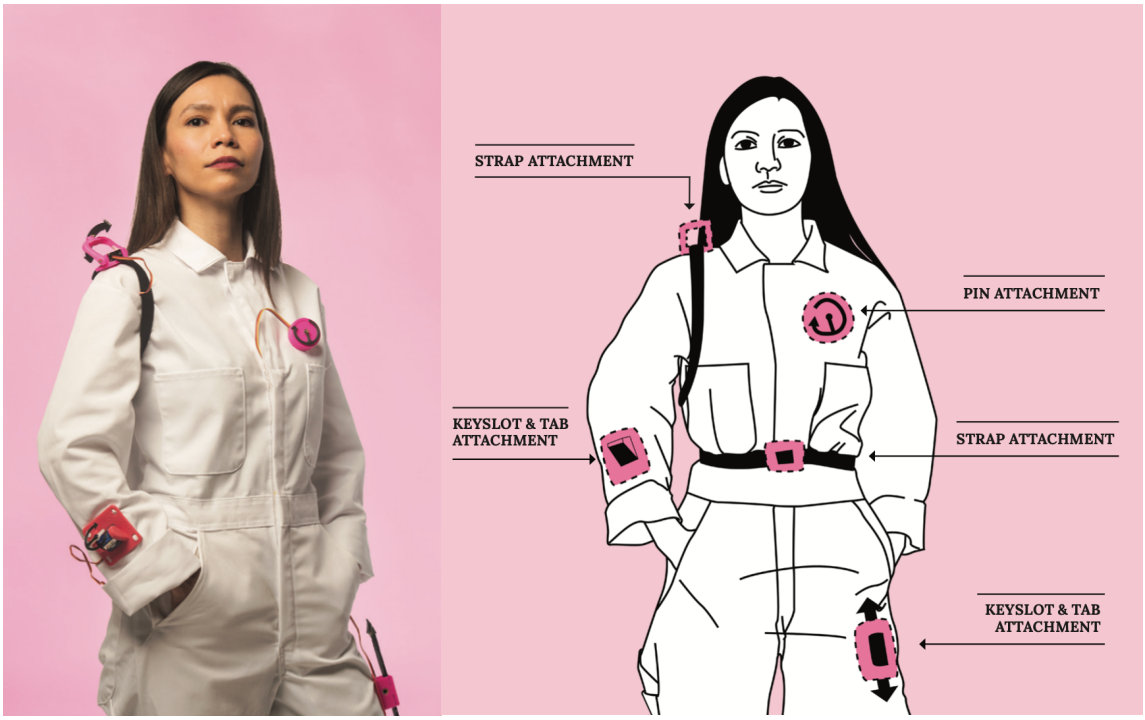

Figure 2: Methods for attaching actuators to the body prioritized the wearer's comfort and safety as well as the stabilization of the actuator's base.

3 FUTURE WORK

The toolkit elements enable quick experimentation with various motor positions and attachments without tools. Enclosures for batteries and microcontrollers are not included here, though a sample of suitable enclosures can be found in other works [5]. These initial designs provide a basis for building wearable prototypes, finished designs, and for experimentation and testing. The toolkit is accompanied by a bill of materials and editable CAD files for sourcing, customization and 3D printing. (See https://github.com/socialbodylab/KineticWearablesToolkit).

Future work will include cable management, power management and further designs, as well as formal user testing.

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