SKORPIONS: kinetic electronic garments

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1. Introduction

SKORPIONS are a set of kinetic electronic garments that use the shape-memory alloy (SMA) Nitinol to move and change on the body in slow, organic motions. The dresses are not interactive: their programming does not respond to sensor data. They behave like kinetic sculptures that display characteristics such as control, anticipation, and unpredictability. They have personalities and anthropomorphic qualities. They can be imagined as parasites that inhabit the skin of the host.

The garments shift and modulate personal and social space by imposing physical constraints on the body. They alter behavior, by hiding or revealing hidden layers, inviting others inside the protective shells of fabric, by erecting breathable walls, or tearing themselves open to divulge hidden secrets. They reference the history of garments as instruments of pain and desire.

2. Technical details

SKORPIONS integrate electronic fabrics, custom electronics, Nitinol, mechanical actuators such as magnets, and traditional textile construction techniques. The cut of the pattern, the seams, and other construction details are an important component of designing and engineering specific behaviors.

Nitinol is a shape memory alloy that has the ability to indefinitely remember its geometry. The range of applications has been increasing in recent years, especially in medicine. During its relaxed (or martensite) state, Nitinol is malleable and resistant; it can be integrated into a soft fabric substrate without causing any disruption in its natural movement and flexibility. Once heated to its shape memory (or austenite) state, a Nitinol wire becomes stiff and returns to its original shape with enough force to lift its own weight several times. The process happens around 500°C, so it is impossible to shape the Nitinol after integration into the fabric. This limits design and fabrication possibilities.

To develop the kinetic mechanisms utilized in the SKORPIONS, it was necessary to develop a variety of custom shaped Nitinol wires and explore techniques like knitting, beading, and hand stitching. Nitinol wire that has been previous shape-set can also be woven into a textile in its martensite state.

Textiles are traditionally flexible surfaces that can softly envelop the human body. To successfully merge textiles with electronics, we use conductive yarns, inks, and fabrics to allow the construction of soft electronic circuits. The traditional textile materials and construction methods such as weaving and embroidery allow us to merge functionality and aesthetics in our design process. For instance, we connect our custom control electronics to the Nitinol coils with decorative stitching made with conductive thread.

The use of snaps is another technique that allows a durable and seamless connection between the flexible threads and the rigid printed circuit board (PCB). The male snaps are soldered to the PCB, while the female are sewn into the dress and connected to the conductive thread with conductive epoxy. A small inside pocket holds the electronics and insulates them from skin and moisture. This modular assembly allows for the board to be completely removed when necessary.

Nitinol is not only used as the scaffold for the desired shape change, but it can also, through resistive heating, produce the heat necessary for actuation. Since the Nitinol wire needs to undergo a temperature change of approximately 40°C to be activated, it requires a considerable amount of power. These requirements are met by two small rechargeable lithium polymer cells that can power the dresses for a couple of hours, depending on the timing and frequency of activation.

3. Acknowledgements

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