Knitted Stretch Sensors for Sound Output

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Abstract
Stretch sensors appear to offer the physical computing and wearables communities a solution in their flexibility. This paper introduces an interdisciplinary project in which knit, weave and embroidery specialists were brought together to examine how a carbon rubber sensor might be integrated both aesthetically and functionally into different fabric structures. It reports on the drawbacks of the original commercially available sensor, and presents an exciting alternative direction using knit structures to build custom flexible sensors.

Keywords
Stretch sensor, textiles, knit, wearables

ACM Classification Keywords
H5.m. Information interfaces and presentation

General Terms
Design, experimentation, performance

Introduction
Following a collaborative sci-art project, one of our team had become aware of a novel stretch sensor [1], and was now seeking textiles expertise to work with [2]. A collaborative team was brought together comprising roles in wearables, weave, embroidery, knit

and pattern cutting. The carbon impregnated rubber cord stretch sensor was tested in integration with knit and embroidery. Early findings included a problem with friability, caused by the carbon particles and a serious issue with the return rates of resistance values [2].

Exploratory aesthetic approaches

We created back panels mimicking muscle stretch in the human body, laying in the sensor appropriately (Figure 1). I worked on a knitted panel, using channels and different structures to a shared aesthetic alongside woven and embroidered panels. The resulting concept pieces were exhibited as R&D project *Aeolia* [3].

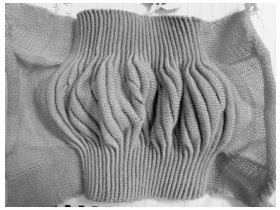

figure 1. Integration of rubber cord stretch sensor into (l to r) aesthetic embroidery, knit and weave structures. **Figure 2.** custom knit sensor using Bekaert steel yarn.

Misgivings with the Merlin stretch sensor led us to consider creating our own sensors by knitting with conductive yarn [4] (Figure 2). These gave more reliable results than the carbon sensor with a faster recovery rate. Persistent randomness may be explained by the complexity of interconnections between stitches [2], [4]. The first audio output was attempted in July 2009 with a cellist [5]. Sensor panels were built into a custom garment at the elbows and in a strap across the back onto the upper arm to generate stretch when bowing. Quickly, the sonic output revealed an important finding, that is, the first upper and lower limits of the values are replaced after the first stretch cycles with new, more stable limits, helping with recalibration issues [3].

Conclusion

While knit sensors remain unreliable for applications where accuracy and repeatability are critical, their built-in unpredictability occurs within reliable enough parameters to be a positive factor in the arts, and we aim to develop future work around this potential.

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Citations

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