

SysTex Student Award 2009

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Concept

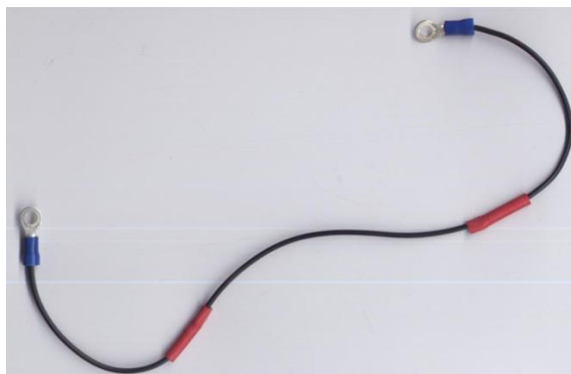
The initial concept for my electronic wearable was to attempt to produce a smart textile application which was fashion aware. I intended to do this by creating a garment that demonstrated a relationship between the body and technology as well as being part of an exciting and dynamic fashion collection.

After researching into existing wearable technology, it became apparent that many garments which utilised wearables either had; little attention to aesthetic and were purely functional or had a designed aesthetic that was either too conceptual for daily wear or looked like a stereotypical idea of what a 'smart wearable' should be. Part of my concept was to bridge these approaches and to develop a new way to both experience an electronic wearable and for the collection to be fashion led and appeal to a fashion conscious consumer.

Choosing technology to be integrated

As a fashion knitwear designer I was researching appropriate technologies to integrate with the properties of knit. This offered extensive possibilities for stitch structure and fabric development, along with the stretching characteristics of knitted fabrics which offer very suitable qualities for a smart textile. I decided to use a stretch sensor within fabric as it seemed appropriate and would exploit the aforementioned qualities of knitwear. The stretch sensor technology would be used in combination with LEDs within a parallel and series combination circuit.

The stretch sensor is made from carbon and acts as a resistor within a circuit. The stretch sensor is placed on the body through integration with a garment. When the body moves, the sensor is in turn stretched, so the resistance of the stretch sensor is altered. This change in resistance is then recognised by the capacitor and circuit board, resulting in a completed circuit which leads to the illumination of LEDs within the circuit.



The length in the middle and inbetween the 2 red connection points is the stretch sensor. The red plastic seals the wires connection to the sensor. The wires lead to the metal connectors at each end, which in turn, connect to the wiring in the circuit.

Aim of project

The desired outcome of the project was to develop a working prototype of a garment that utilized stretch sensor technology alongside LEDs to create a wearable piece of technology that had alert and warning applications through the consequential LED illuminations. The garment was also to sit alongside a catwalk fashion collection and therefore needed to integrate with this collection.

Initial Development

Key issues for initial development included a garment that allows the stretch sensor to stretch to its optimum amount:

1. A suitable location on the garment for the sensor to stretch to its optimum.
2. Channels for the circuit wiring and stretch sensor to run through.
3. A method to imbed the LEDs within the fabric successfully.
4. Concealed areas for the components (battery, circuit board and switch) to sit in.

1. A key aspect to be considered when designing the electronic wearable was that it was to be showcased in a catwalk show. As a stretch sensor needs movement from the wearer to create a change in resistance and as the model would walk down the catwalk, the movement would therefore come from the legs. An appropriate garment would therefore be a tight fitting skirt, which would stretch when the wearer walked.

From experimentation with the sensor and voltage reader, it seemed that the 10cm sensor needed to stretch 3cm to reach its optimum resistance level. To ensure that it would stretch to that length, it must be placed in the correct place on the skirt.

2. It seemed logical to place the sensor around the knees, as there would be more distance created in between the knees than around the thighs. There is obviously more distance created between the ankles, but this distance is not usually as consistent. Development was then needed in terms of which side of the skirt the sensor should be placed and also how slack the sensor needed to be for it to stretch 3cm when the wearer walked. Initial experimentation-



Fig. 1
Sensor placed at side of skirt



Fig. 2
Sensor placed at front of skirt

The sensor was tacked onto a toile of the final skirt to test the stretch. The red seals were also anchored with a few stitches to stop the wire from stretching and ensure that only the sensor stretched.

Initial thoughts that the side seam would stretch and the side being the most appropriate place for the sensor to sit were incorrect. As illustrated in fig 1. The skirt took most of the stretch caused by the movement. This meant that the sensor only stretched by 1cm, resulting in an optimum length when placed at the side of 11cm. Fig. 2 shows the sensor itself stretching, as it is being pushed forward by the knee, making it the most effective place for the sensor to sit. However, the sensor only stretched by +2cm, which was not enough. This was because it was a little slack when relaxed.

For the sensor to stretch by 3cm, the sensor had to lay completely taut against the knees, to create enough tension for the required amount of stretch.



Fig. 3 Sensor is pulled tauter around the front of the skirt

Fig. 4 Walking motion stretches front of skirt sensor to the required amount

3. The final fabric for the garment would need to have a combination of

tubular knitted horizontal channels and vertical channels that were knitted using high and low butts with alternate tubular knitting. This innovative stitch (fig. 5) allows for the circuit to run through the fabric. The channels would need to have varying openings for different components, such as the switch, circuit board etc to be connected to the wiring. This meant that the final fabric was to be a very time consuming and intricately knitted piece. The initial plan was to ensure the skirt would be made from this one piece of fabric that wrapped around the body. However, machine width restrictions meant that a separate panel had to be inserted down the back.



Fig. 5 Initial knitted sample of vertical, diagonal and horizontal channels

The final fabric on the right shows the channel layout (fig. 6). The lowest horizontal channel on the fabric is where the stretch sensor is threaded through. The 2 vertical channels that stem from it are where the wiring runs up. The wiring runs through the top horizontal channel and down the vertical channel that stems off it, to reach the circuit board, LEDs and switch. This channel has a sealed opening that follows into a pocket, where the battery, switch and circuit board sit.



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Fig. 6 Final skirt fabric with channels

4. The most appropriate way to imbed the LEDs into the fabric was to insert the legs (post and anvil) into the fabric through stitches, ensuring no tearing. When the LEDs are in place, the legs are bent

into rings with pliers. The LEDs are then connected to each other with conductive yarn that is sewn into the rings (fig. 7) connecting the LEDs in a combination of series and parallel circuits.



Fig. 7 LED legs twisted and sewn with conductive yarn

The use of the conductive yarn ensured that the circuit is soft and remained wearable. The back of the LEDs were covered by a layer of fabric that folded over the twisted legs. This meant that the LEDs were still accessible and connected to the rest of the circuit by 2 covered wires, which were soldered to the circuit board.

The switch, 9v battery connector and circuit board connected to the circuit through wiring. The switch, battery and circuit board all needed to sit in a pocket that took the weight of the components to ensure the wiring would not weaken. The folded internal pocket is not visible from the exterior and sealed by 2 large poppers, so the clean aesthetic is not interrupted.



Fig. 8 Switch soldered onto circuit board

Project Resolve

In conclusion, the stretch sensor skirt is aimed at a young, fashion driven consumer who will enjoy being part of setting trends. This novelty and fashion led product should increase the awareness of smart textiles to those who may be unfamiliar with the subject area. The idea of challenging preconceptions of smart textiles is to encourage the possibility of technology actually being integrated into the clothing that we would wear on a daily basis. It gives the

consumer a product that not only looks good, but also has another working function, which I believe is the future of fashion, as technology is becoming increasingly important in our lifestyles.

This could ultimately lead to a working application for this approach as a product that could utilise the warning and alerting properties that LEDs have. The skirt could work well as a night time and/or cycling safety device and the stretch sensor technology can also be developed into other garments such as leggings where the wearer would cycle and the movement along the knees would result in an illumination of LEDs. The sensor also could be placed on the elbow and when a cyclist motioned to indicate, the sensor would also stretch. This would therefore mean that the wearer would not need a reflective cycling jacket to carry around with them; they would already have the night time visibility function integrated into the clothes that they already wear. Other applications for the stretch sensor and LED skirt may lie in performance, to be used in conjunction with dance and expressive movement. There is also the opportunity for the stretch sensor to be used as a communicative device, for the less able bodied, whereby, it could trigger LEDs or a speaker. Overall, I believe the wearable electronic to be a proof of concept prototype that challenges the preconception of smart textiles, as the garment utilises both pleasing aesthetic and technical function.