Design of a smart shirt

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Subject:
Integrating Electrocardiogram electrodes into shirt so it can accurately measure ones heartrate

This project was carried out for a lectorate of Saxion University of Applied Sciences, the Smart Funtional Materials lectorate. They were aiding the small start-up BodyGraph in the development of a smart shirt with integrated sensors that can track multiple bodily functions. In this project the feasibility of integrating the components needed to measure just one of these funtions, the heartrate, is examined. The broad knowledge of an Industrial Designer was needed to combine the different (technical) fields of knowledge to create a working prototype.

The textile electrodes used in the shirt are a novel technology that not many products in the market offer. They can offer full integration into a garment, seamlessly transitioning between normal and conductive textile. This enables continous measurements while the user is moving, which can be valuable for professional athletes. The technology could also be of interest to the general public, as seen by the growing popularity of smartwatches and activity trackers and the increasing interest in movements like 'The quantified self', which is a group of people measuring anything they can about their body and daily routine.

Main research question:

"Is it possible to use state-of-the-art technology to fully integrate ECG sensors in a shirt so it can accurately measure heartrate?"

During the project multiple prototypes were created and tested. The results were discussed within the group and conclusions were formulated as to why the implemented adaptations led to the measured results. The design would then be altered with these conclusions in mind in order to see if they were correct and what the impact of the new adaptations would be. The main focus was providing accurate measurements for different body types and decreasing motion artifacts in the signal. These being largely impacted by the way the shirt stretches and fits, the placement of the electrodes, and the durability of the shirt.

The final prototype of the shirt provided accurate results for any user by making sure the electrodes remain in constant contact with the skin, reducing noise and motion artifacts in the signal. This shows that it is possible to fully integrate ECG sensors into a shirt so it can accurately measure the heartrate, even during intense movement. The textile electrodes also hold up well during wash tests, which was one of their main advantages when being compared to conventional electrodes. The prototype is relatively cheap to manufacture and was designed in such a way that the final product would require little human labour to produce, further decreasing its manufacturing costs.

However, the technology used to fabricate the electrodes may not be as promising in carrying the signal from the electrodes to the hardware, where using another technology would provide better results and a prolonged life-time. Although this would mean a decreased level of integration into the shirt it would provide more possibilities and design freedom when developing the product further as more sensors still need to be added.