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Editor

Embroidered E-Textiles

A playground for everyone

Nowadays, the integration of electronics into textiles is a playground for textile, electronic and mechanical engineers as well as for people in the textile & fashion industry. However, the most prominent question asked by these developers regards how to integrate the electronics into the textile in a production efficient way. Embroidery is the answer!

Through a single embroidery process, the electronic boards can be placed on the fabric and connected with conductive threads. The connection is reliable and fully automatic. Existing electronic boards like the Adafruit Playground boards (see Piano) or the especially for embroidery developed ZSK-E-Tex-Boards (see Dashboard) can be integrated into the textile to functionalize the fabric.

The piano example shows a prototype for the integration of an Adafruit board into a textile embroidery design. The piano keys are embroidered with conductive thread (Madeira HC 40) and each piano key is connected by embroidery with the Adafruit Playground board. Once you touch the piano keys, the Adafruit board plays the corresponding tone of the music scale. This way you can use it like a small textile piano. All connections are automatically embroidered by a ZSK embroidery machine.

The conductive paths between the piano keys and the board connections are covered with a non-conductive embroidery thread to protect the conductive material against mechanical stress and to integrate even the connections into the design by using a color similar to the fabric color.

Even the USB cable, necessary for power supply, is integrated in the design by embroidery. A covering satin stitch over the USB cable integrates the cable into the design and protects the cable against unplugging. If you want to play with your own embroidered textile pianos, you can buy a piano for 175 € which includes cord, board, sensors and connections.

The Adafruit boards are electronic boards created for hobbiest and developers. Their design is especially practical for manual connections through hand sewing. Therefore, the Adafruit boards are very rigid, thick, and not optimized for an embroidered electrical connections. Furthermore, many applications require an electronic board that can control more capacitive touch sensors or motion sliders than the Adafruit boards. Furthermore, the sensors must be electrically designed in a way that they work even through foam and leather to control integrated LEDs.

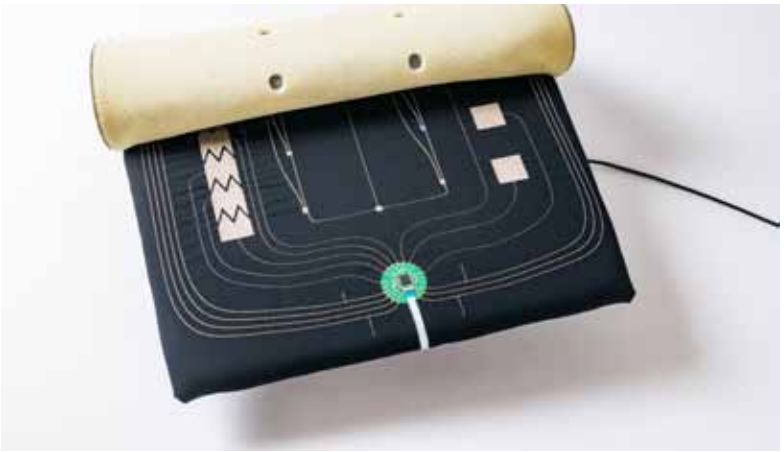
Because of the mentioned limitations of the existing boards, ZSK developed its own ZSK-E-Tex-Board. This board is especially designed to be used for embroidery. With its small size of Ø 40 mm and 2 mm thickness, the integration into a fabric is easier than ever. The power supply (Mini USB) and programmer port is on a separate board which can also be attached to the fabric by embroidery. The flex data cable between these two parts can easily be covered over and hidden with standard embroidery as well. The E-Tex Board can control up to 19 LEDs depending on how many of the 14 sensors for control you have in use.

If you are interested in creating your own prototypes by using the ZSK-E-Tex-Board, you can buy this boards for 150 € at ZSK.

A sample prototype obtained with the ZSK-E-Tex-Board is used in a demonstration piece for a car dashboard with integrated LEDs.

Functions: By sliding a finger over button 1 (Navi), 2 (Tel) or 3 (MP3), the LED 1, 2 or 3 will light up.

By using the slider on the left side by sliding over it the LED 4, 5 and 6 will light up. These sensors inputs can be easily modified by the purchaser to match their own custom project requirements.



The electronic elements are on a separate layer under a leather and a foam layer.

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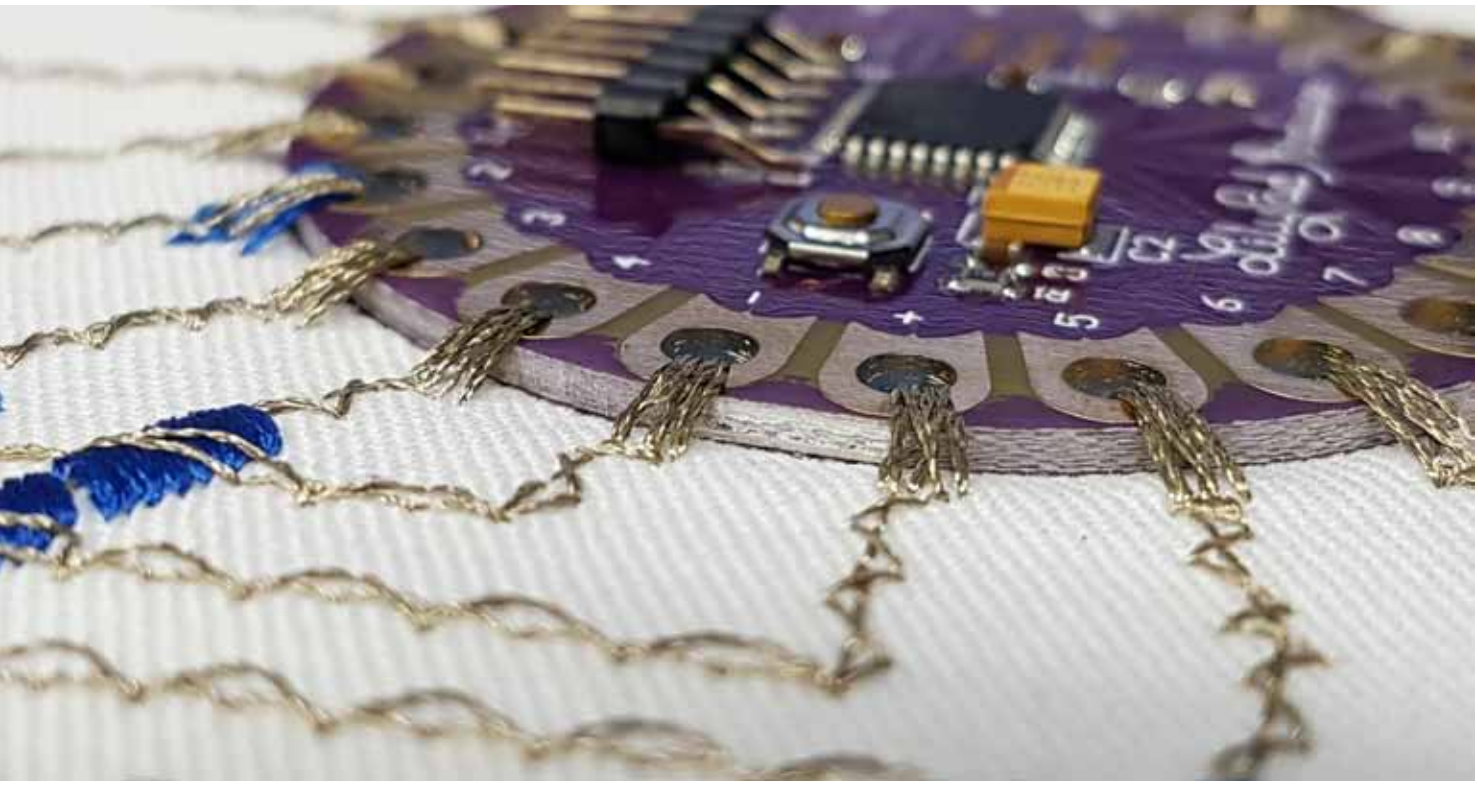

Technical Embroidery for E-Textiles

The missing stitch

Recently, a class of technical textiles called e-textiles has begun to emerge as a way of further functionalizing traditional fabrics. E-textiles, or the ability to embed electronics and their electrical properties into fabrics, allow for a new class of self-aware materials. These materials can have internal sensing capabilities as well as the ability to adapt themselves to various changing environments opening doors to data collection that was not previously economic or even possible.

Technical embroidery offers a host of methods to create new e-textiles and push the entire field forward. Due to embroidery's high maneuverability, quick adaptability to new designs, and established scalability, embroidered systems are increasingly being sought after to create prototypes and solutions for this ever-growing e-textiles market.

Technical embroidery can allow traditional circuit boards to be mechanically mounted to fabrics, while automatically creating conductive textile connections them. Aspects of traditional circuit board design such as creating conductive traces can also be incorporated using technical embroidery. Sensors can be integrated exactly where they are needed in an automated process. Furthermore, due to the ever-decreasing size of electrical components, a renewed interest in mounting components to embroidered sequins has opened up design possibilities.

Embroidering full boards mechanically

One of the most direct uses of technical embroidery is to quickly attach and stitch traditional printed circuit boards into fabric carriers. Stitching boards directly into the structure of the textile reduces mechanical strains on the connectors while allowing the control and processing electronics to be physically closer to their supporting electronics. This can have a range of benefits such as increased signal to noise ratio, decreased mechanical fatigue based failure, and reduced need for additional connectors.

If looked at from an electronics manufacturing standpoint, fabrics offer a new host of materials that not only carry the electronics, but also provide functional advantages over traditional materials and processes.

Embroidering connections to boards

Another advantage of technical embroidery in e-textiles manufacturing is the ability to embroider electrical connects automatically to the host board using various conductive threads. This process allows for the quick connection of potentially hundreds of electrical connections from a board to their fabric-hosted sensors. By registering the board during its embroidery to the host fabric, electrical connection points on the board are also registered for stitching. This can allow for a single stitched board to merge data from many sensor types into a single output.

Embroidering traces

By using techniques such as tailored wire placement, highly conductive materials can be placed into the structure of the fabric in order to create low resistance traces that better mimic traditional circuit board function. Size AWG 10 to AWG 40 wire has been successfully laid in this process.

Additionally, wire coatings such as enamel or PVC are unaffected by the embroidery process, opening a wide variety of insulative and coating materials. Furthermore, customized wires such as multicore and multifilament wires can be used to run multiple signals through a single conductive pass. Up to 32 signals in a single multicore line can be run, with the capability of going much higher.

Embroidered sensors

Traditional sensors such as temperature sensors can be embroidered into a textile by embroidering their host circuit board into the textile, or by including the sensor into a fibre carrier. Embroidering additional sensor boards into the fabric is a straight forward method of quickly integrating capability and function. Embroidering sensors within a fibre carrier can allow for a more elegant and compliant solution

However, more form fitting and haptic-sensitive textile based sensors are increasingly being investigated for their inclusion into a functional fabric. By using the properties of the conductive fibres themselves such as large surface areas, variable resistivity, and geometric conformability, solutions such as textile electrodes, stretch sensors, and sweat sensors can be reliably created.

Embroidered LED sequins

Another method of functionalizing fabrics is the inclusion of embroidered LED sequins. By mounting the required electronics onto a traditional sequin carrier, LED's can robotically be sewn into a garment in automatically during its creation. This has significant advantages over other e-textile processes as it does not require post-process soldering or additional conductive epoxies. In this way, the embroidery machine serves as a hybrid between traditional pick and place machines to select a component sequin off of a reel and a sequin machine as it stitches the component into the fabric's structure.

Embroidered antennas

Technical embroidery can additionally be applied to radio frequency engineering through the use of new and geometrically tunable antennas. As the shape of textiles in garments can vary dramatically from when the textile is being stored to when it is being worn, limitless possibilities generated by embroidering antennas of various tunable shapes exist. These designed textile antennas can have uniquely directional properties that traditional hard antennas do not have. As our world becomes increasingly wireless, textile antennas are an open and exciting area of research.

Scalability

Finally, one of the more important thoughts to have when evaluating any e-textile prototype is its ability to quickly and cost effectively scale. As embroidery is a well-established textile process with many configurations for production machines, the risk to scaling is much lower than when compared to other less known e-textile processes. In fact, many traditional embroidery companies can even utilize their existing equipment setup to turn their machines from traditional embroidery to technical e-textiles embroidery.

Technical embroidery offers multiple solutions that can help to advance the field of e-textiles. In combination with electronics manufacturers, new boards can be designed that best take advantage of the embroidery process. Additionally, the inclusion of new functionalized conductive threads and materials can rapidly speed development time and electrical source-ability.

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