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Optical Tactile skin: Development of an Optical Electronic Skin for Pressure Sensing Applications

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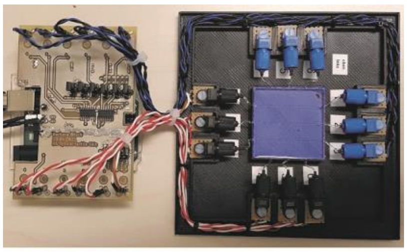
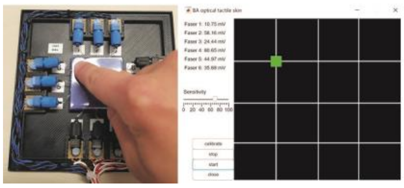
More and more robots are being used in the vicinity of people to support them in their daily lives which brings the risk of collisions. To prevent this collision, a tactile skin is used on robots. A tactile skin uses sensors under the skin to detect pressures on the skin. The goal of this bachelor thesis was to create a proof of concept of an optical tactile skin. Polymeric optical fibers of the type Geniomer® were used. That’s never been implemented in synthetic skin before. The principle of those optical fibers is when pressure is applied to the fiber, the light intensity decreases at the end of the fiber. A linearity of force and signal intensity was expected and, in fact, approved. The bachelor thesis was done in collaboration with the Swiss Federal Laboratories for Materials Testing and Research (EMPA). To achieve the goal of the bachelor thesis, a hardware was created at the beginning and connected to an Arduino Uno. Using the hardware, it is possible to connect and measure a maximum of 6 fibers. Afterwards several single fibers were measured. Then several skin samples were created and measured. One fiber was implemented in each of two different silicones, 'DRAGON SKIN FX-PRO' and 'SYLGARD 184', and with two different thicknesses of the silicones (4 mm and 10 mm). The Measurements were performed in an interval where the fiber had time to recover and one where the fiber was under continuous load. The measurement showed that the expected linearity of the skin sample in a range from 0 g to 2000 g was approximately true. The fibers are very robust as the measurements are practically the same at the different intervals. In addition, it has been noticed that the silicones have influence on the signal intensity, which is due to the refractive index. The ticker the skin became, the more the strength of the signal lost. Due to the poor connection from the optical fiber to the transmitter/receiver (the optical fiber was made artificially thicker with two shrink tubes), the measurement setup was very sensitive to external mechanical influences. Finally, a small demonstrator was built with a skin sample constructed from a 3 x 3 matrix with polymer optical fibers that can be controlled with an app in MATLAB. The demonstrator shows that the implementation of polymer optical fibers in synthetic skin is very feasible. With a higher quality connection between fiber and transmitter/receiver, linearity would be confirmed, and force measurement would be possible.



Structure of the demonstrator. Left: Printed circuit board plugged into an Arduino Uno. Right: Transmitter (blue components), receiver (black components) and skin sample with integrated matrix of 3x3 polymer optical fibers in the middle.



left: Skin sample with 3x3 matrix of polymer optical fibers and applied pressure top left. Right: detected pressure on the skin sample is marked with a green rectangle in the upper left corner of the app.