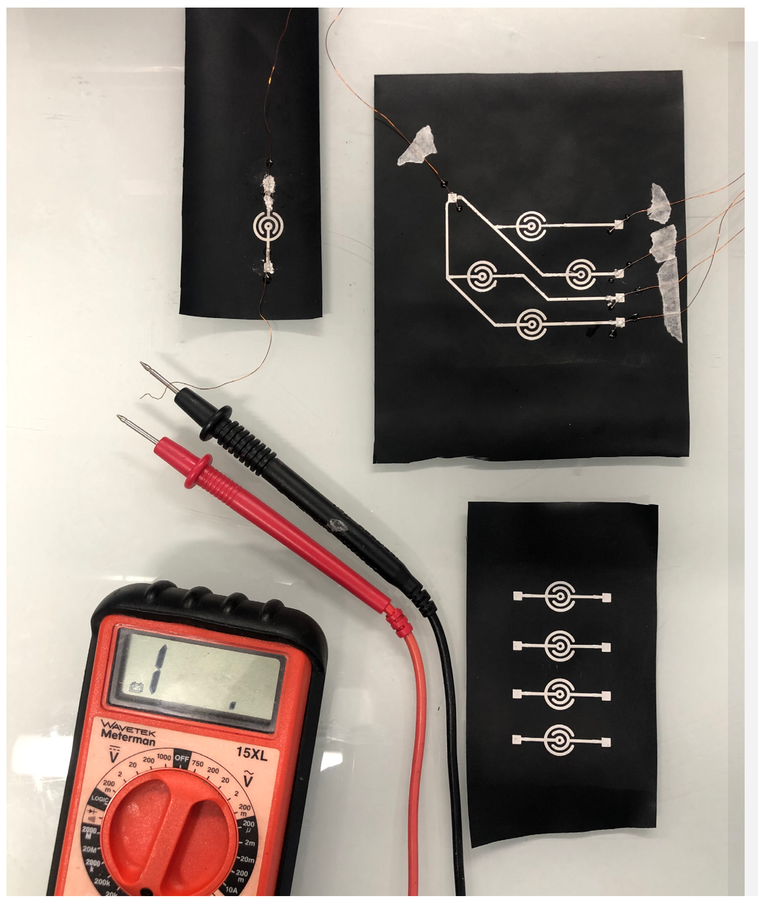
Final Master Thesis | Integrated Product Design

The main objective for this research is aimed at an exploration into the exponentially growing field of 3D printing to fabricate sensors on flexible materials to be used in wearable products. The research results in new ways of applying 3D fabrication techniques to develop easy to apply sensing structures to flexible, wearable applications.



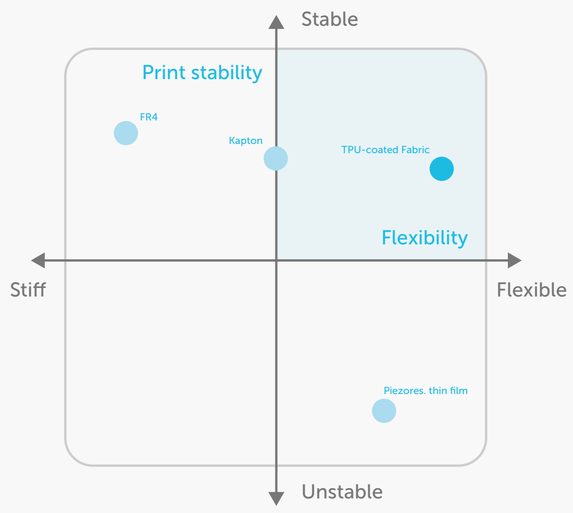
3D PRINTING ELECTRONICS TOWARDS FLEXIBLE TACTILE SENSORS

Rick van de Ven | TU Delft

Exploration & Selection

Exploration into sensing principles and sensor construction creates a solid foundation for the development of a 3D printed sensing structure. It identifies piezoresistive sensing and capacitive sensing as main design drivers for the development of the printed sensors.

Selection of 3D fabrication techniques using design thinking methods; involving trace design, substrate selection and 3D printing technique; defines the principles on which the design and fabrication of a final concept design is based. The selection identifies a new substrate that provides a combination of print stability and flexibility.



Validation & Discussion

Validation of the developed 3D printed tactile sensor is performed by a setup using loadcell control measurements and sensor sample analog resistive readout measuring. A linear load is applied using a linear rail setup. The readout data is plotted to observe and analyse the linearity, accuracy and hysteresis of the sensor.

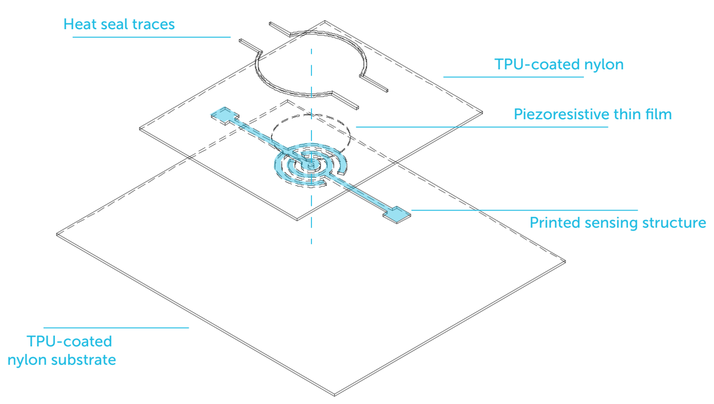
Validation shows evidence of significant measurement repeatability, while showing less proof for precise accuracy and resolution. Additional work needs to improve physical durability of the traces and connections.

Design & Fabrication

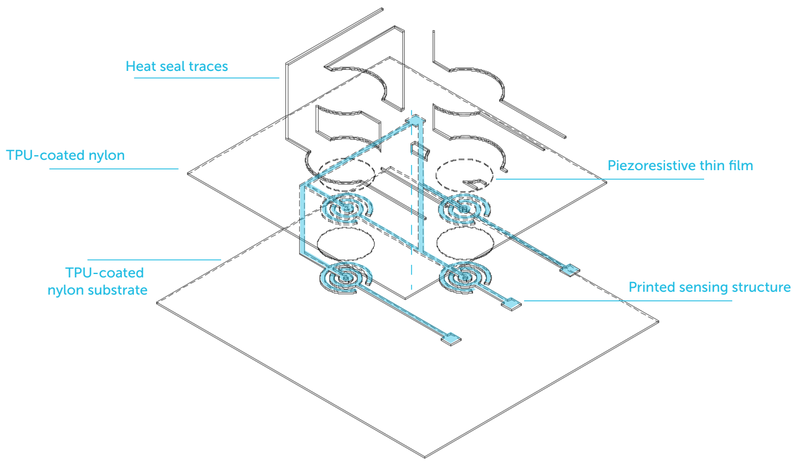
The final proposed sensor design is constructed by the use of a TPU-coated nylon substrate and is fitted with a printed sensing structure by conductive ink dispensing using a Voltera V-One 3D printer. A pressure-sensitive thin film (piezoresistor) is fitted on the surface of the structure, creating a pressure-dependant resistor, used as tactile sensor.

This sensor is embedded into a nylon sheet by heat-sealing a second TPU-coated nylon, creating a fabric with embedded tactile sensing capabilities. To be applicable in a large variety of tactile sensing applications, scalable and adaptable sensor arrays can provide tactile mapping capabilities allowing for increased spacial resolution of the embedded sensing capabilities.

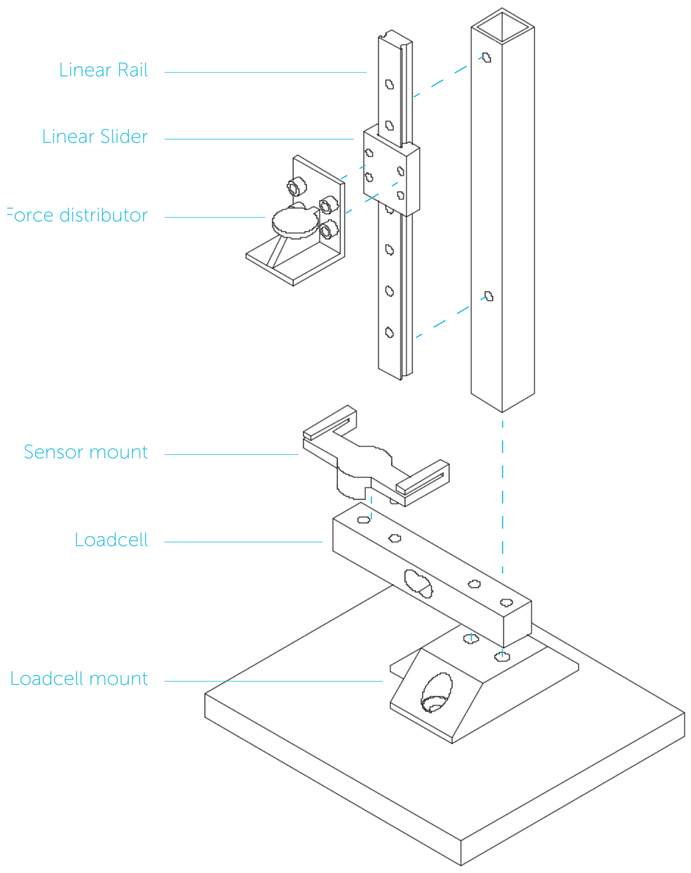
Single sensor design



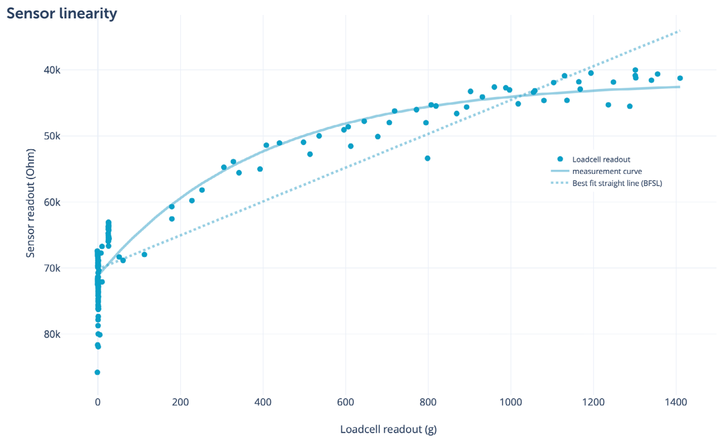
Sensor array design



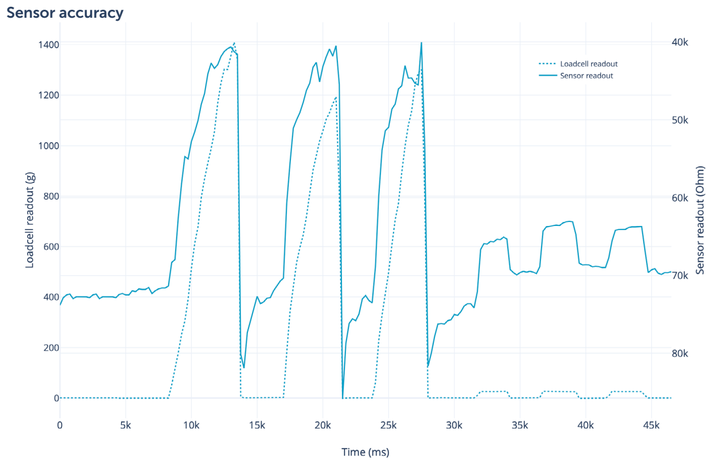
Validation setup



Sensor linearity



Sensor accuracy



Author
Rick H.C. van de Ven
rhcvdven@hotmail.com

Master Thesis
MSc Integrated Product Design
Faculty of Industrial Design Engineering

November 1st, 2021

Supervisory team
Dr. Song, Y.
Dr. ir. Doubrovski, E.L.
Kooijman, A.

Delft University of Technology
Faculty of Industrial Design Engineering
Landbergstraat 15
2628 CE Delft
The Netherlands

TU Delft