3D PRINTED DIFFERENTIAL FORCE AND POSITION SENSOR ON LOSSY TRANSMISSION LINES

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Introduction

Context It was shown previously that the force and position can be measured using a multi-frequency readout [1].

Novelty We show that it is also possible to do this using a single frequency readout.

Advantage This enables flexible devices with few connections that still are able to resolve the position where the sensor is pressed.

Approach We model a 3D printed differential capacitive sensor with piezoresistive electrodes and show that the imaginary part is only dependent on the force while the real part depends on both force and position.

Operating Principle and Model

Electrodes The sensor consists of three 3D printed electrodes made of a piezoresistive conductive thermoplastic polyurethane (TPU)

Dielectrics Both dielectrics are made of a soft 3D printed TPU dielectric. The top dielectric is printed with 70% infill, to create asymmetry between the top and bottom capacitor.

Model The sensor is modeled as two coupled lossy transmission lines. To model pressing the sensor, the sensor is split up in three parts with slightly different parameters. The transfer matrix method is used to combine these three parts.

Methodology

Fabrication The sensor was fabricated using a Diabase H-Series 3D printer. It was printed on a layer of BVOH to aid removal from the printbed. To connect the sensor, silver ink was applied which was clamped on copper tape.

Measurement Setup The sensor was placed on the bed of a Rova3D 3D printer, which was used a linear stage. A linear actuator was used to apply a range of forces at different positions.

Sensor readout The sensor was interfaced using a differential auto-balancing bridge circuit. This circuit is custom build using LTC6268(-10) opamps and a Tiepie HS5-540.

Conclusion and Discussion

Conclusion The change in the imaginary part indeed is largely independent of the position where the force is applied, while the real part is dependent on both position and force.

Discussion Multi-frequency might enable multi-touch and enhanced sensitivity. It is expected that a similar method can be applied in 2D.

References


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