

Topic Areas: Simulation, Soft robotics, Sensing

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Prior Knowledge: Finite Element Simulations, MATLAB

Soft robotics is an emerging field of science and technology that aims to develop robots capable of manipulating objects with human-like dexterity. Soft robots can handle delicate objects with care, but they lack practical sensors that measure their deformation for feedback control. Existing sensors can only measure single modes of deformation. Multimodal sensing requires combining multiple sensors into sensor arrays, which complicates mechanical and electrical design.

We are developing a sensor capable of multi-modal deformation sensing by exploiting voltage decay in capacitive structures. Experimental exploration of this sensor's parameter space is time-consuming and costly. To address this issue, this thesis focuses on the numerical simulation and design optimization of the sensor.

Your task will be to develop a physics-based model of the sensor response using partial differential equations (PDEs) implemented in COMSOL Multiphysics. Based on this model, you

will optimize design parameters of the sensor, such as geometry, lead placement, and material properties, to maximize the sensitivity of the sensor.

In this project, you work with the finite element software COMSOL Multiphysics for simulation and MATLAB for design optimization.

Key objectives of this thesis include:

1. Development and implementation of a COMSOL model of the soft sensor using the relevant governing equations.
2. Parametric studies investigating the influence of sensor geometry and material properties on sensor performance.
3. Numerical optimization of the sensor design in MATLAB.
4. Validation of the result using experimental data.

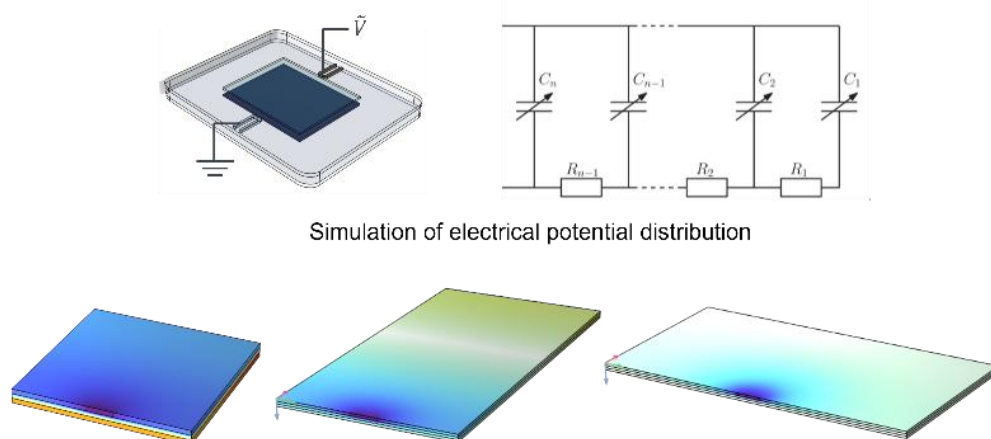


Figure 1. Multi-directional strain sensor working principle and simulation of potential distribution