

LC resonant sensor for highly sensitive continuous blood pressure monitoring

SmartShape is a project developing a minimally invasive blood pressure monitoring device capable of providing accurate, continuous and meaningful measurements to prevent uncontrolled hypertension.

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Introduction and Goals

Hypertension is considered the leading cause of cardiovascular diseases. It is estimated that 116 million US adults suffer from hypertension and more than a 1 billion worldwide with an underestimated prevalence for uncontrolled hypertension [1][2].

The current gold standard to control hypertension is an Ambulatory blood pressure monitor (ABPM) for a reliable estimation of true blood pressure (BP) over a period of 24 hours [2]. A method which only captures single measurements every 15 –

30 minutes and it is not suitable for long-term measurements as it may become uncomfortable for patients [3].

Our project has the goal of developing a cuffless BP measurement which is accurate, continuous and meaningful. The SmartShape project has achieved a sensor design through a simulated environment to optimize its dimension for suitable implantation.

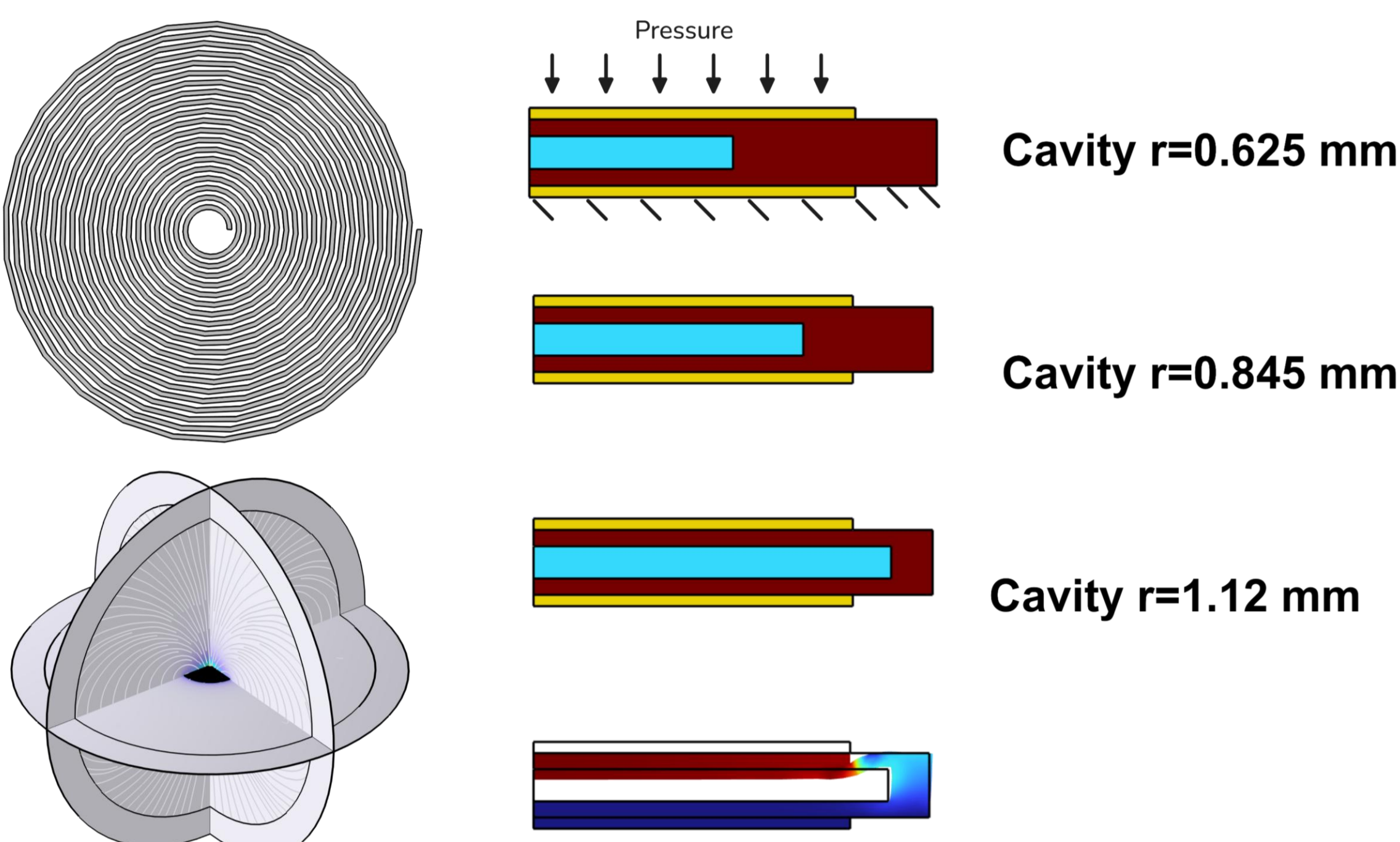


Fig. 1. Shows the inductor coil and its corresponding magnetic field simulation. As well as the capacitor plate design with different fluid cavity radii and how pressure interacts with the capacitor.

Methodology

The sensor is designed as an LC resonant circuit which is composed of an Inductor and a pressure sensitive capacitor. An LC pressure sensor encodes pressure in terms of frequency shift denoted by (1).

$$f_o = \frac{1}{2\pi\sqrt{LC}} \quad (1)$$

This work presents the framework for optimizing the capacitive element. The inductor is modeled as a coil using the Magnetic Fields interface, the inductive value is then used as a constant. The capacitor is then modeled a parallel plate capacitor with the Electrostatics interface. This work covers a dual dielectric interface, fluid and solid. The sensitivity optimization process is done through the variation of the dimensions of the dielectric material interface until the highest sensitivity is achieved.

Results

The sensitivity of the sensor is the slope of a linear regression fitted for each of the simulated results. Figure. 2 shows that with each increase of the cavity radius the slope, sensitivity, of the capacitor plate increases. As the radius increases, the capacitor plate starts to behave non-linearly once the cavity has a larger radius than the capacitor plate. The highest sensitivity was achieved at cavity radius of 1.12 mm and height 0.1 mm where the expected sensitivity is ~ 79 [kHz/mmHg] and an $R^2 \approx 0.996$.

Through these simulations our team has been able to estimate the operation of different sensor designs prior to fabrication.

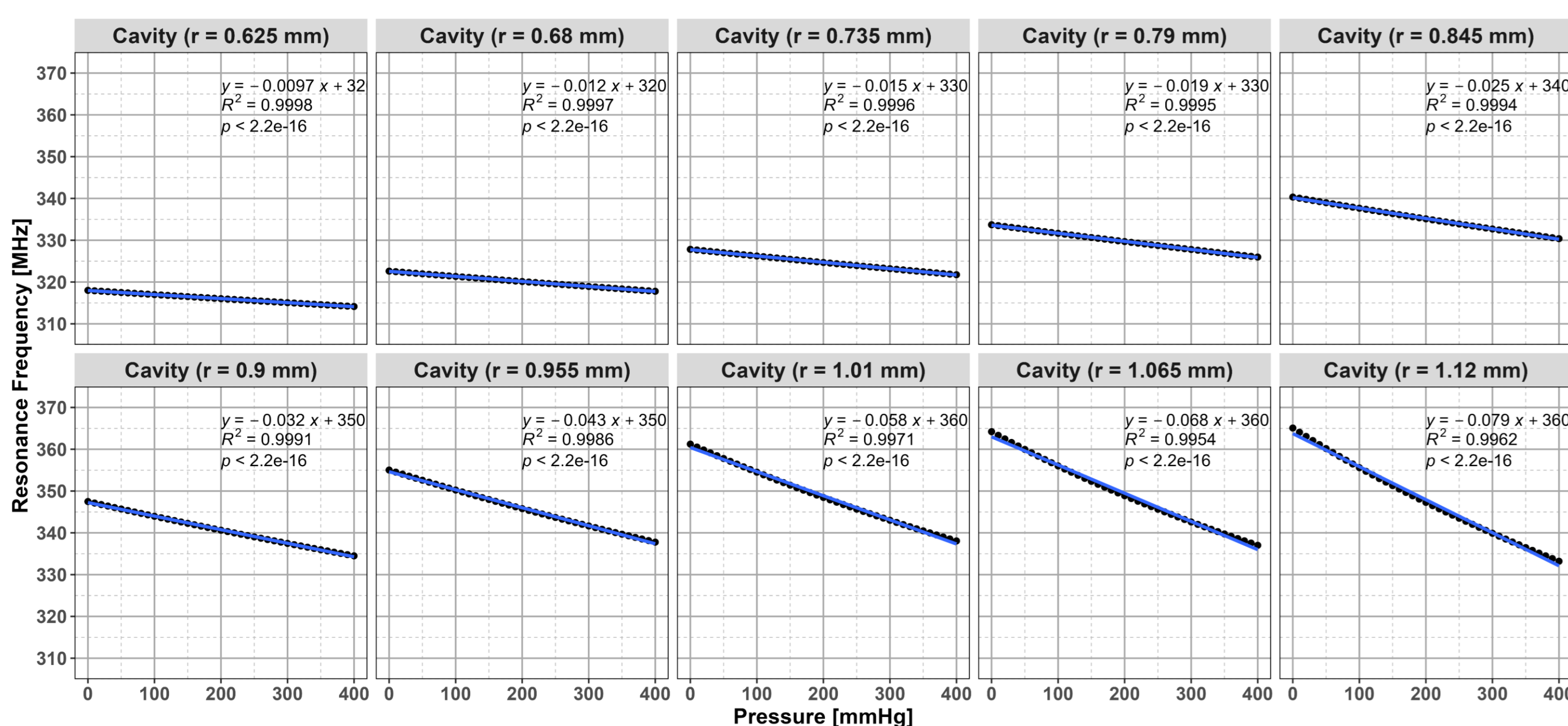


Fig. 2. Shows the change in sensor sensitivity (Slope) as the radius of the fluid cavity is increased.

REFERENCES

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