3D Printed Flexible Pressure Sensor for Wearable Applications

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Abstract

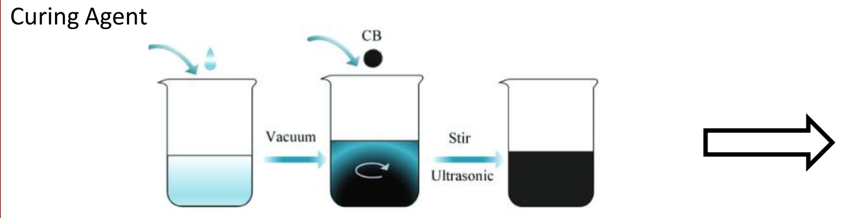
Wearable pressure sensors have become increasingly vital in various fields, such as healthcare and robotics. Wearable pressure sensors allow for precise health monitoring, motion detection, and human-machine interaction since signals are caused by mechanical deformation. However, current manufacturing methods cause excess waste and limited design freedom due to complex layering methods. The proposed research addresses this issue by using vat photopolymerization (VPP) to enable precise control of geometry with limited waste. VPP uses ultraviolet rays to cure photocurable resin, allowing for an extremely precise manufacturing process and a more sustainable and efficient method for creating such devices.

Research Objective

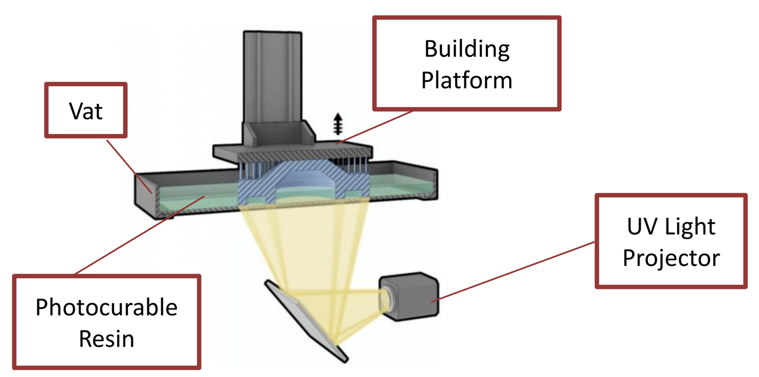
The objective of this research is to use VPP to develop a 3D-printed flexible pressure sensor which makes use of the piezoresistive effect to output a reliable and accurate pressure reading for wearable applications within robotics and healthcare.

Method

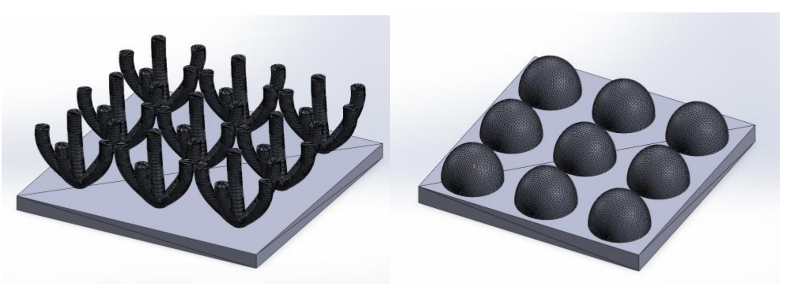
Preparation of Resin:



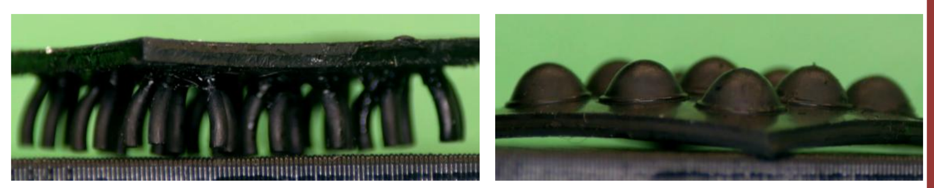
Vat Photopolymerization:



Top and Bottom Arrays:

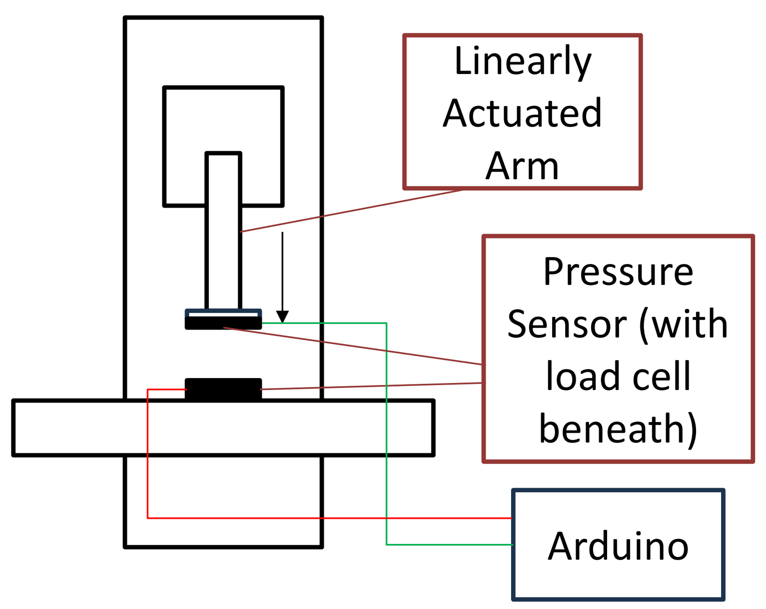


Applying Carbon Layer:

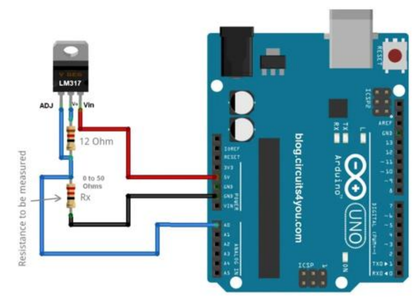


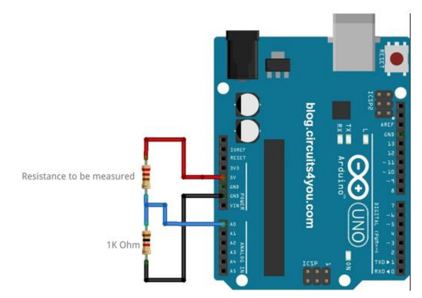
Testing:

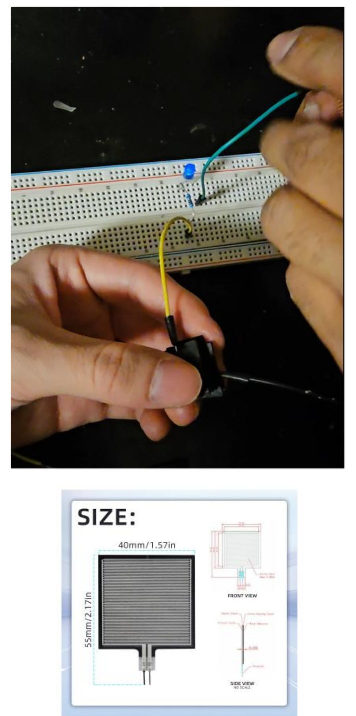
Experimental Setup:



Arduino Setup:



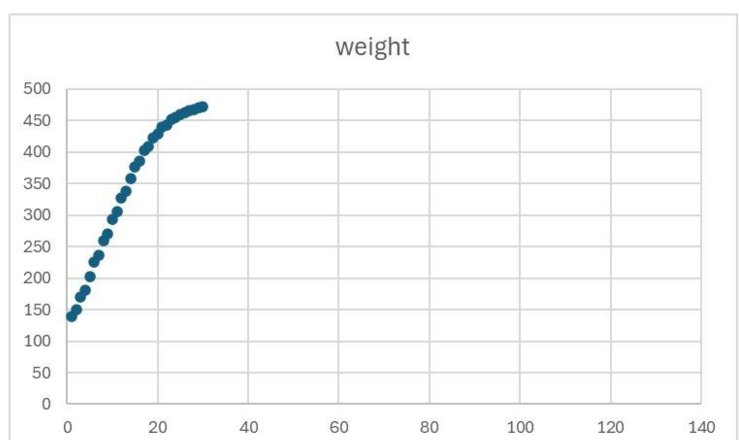


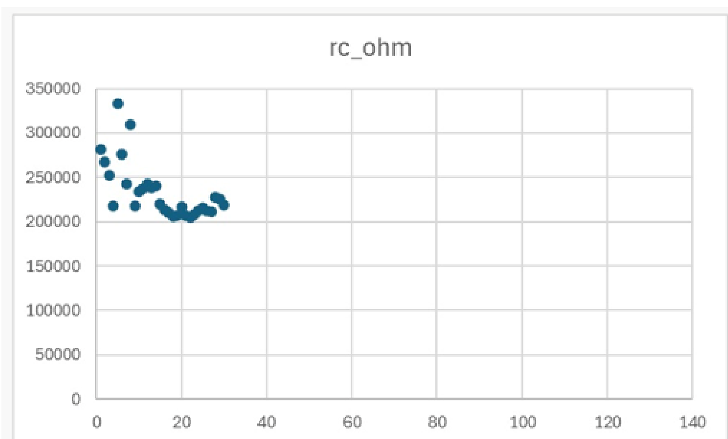


The sensor was first tested with an Arduino to ensure its capacitive qualities. Then, an alternate setup with a linearly actuated arm and a load cell was created to calibrate the sensor. A force was applied on the sensor via the arm, and the signal was then sent to an Arduino to be compared to the load cell.

Results and Discussion

Weight vs. Resistance:

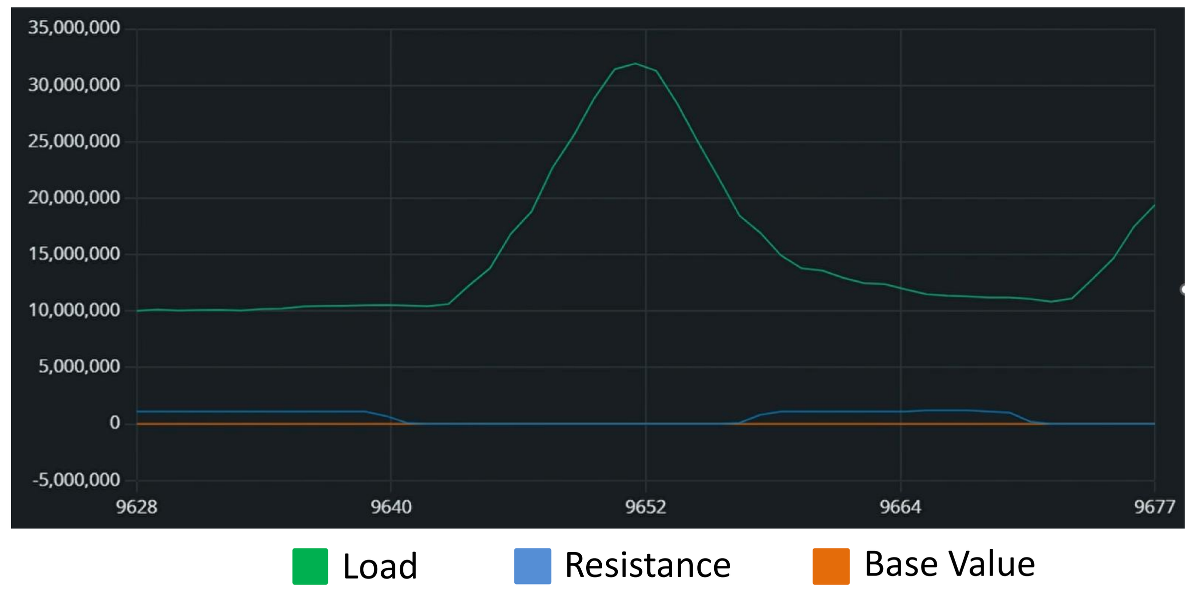




It was found that as the load increased, the resistance decreased, showing that the sensor did display piezoresistive qualities. Although a meaningful signal was acquired from the sensor, there were still large variations in the data due to noise. It Thus, it will be necessary to explore different testing methods and to improve the experimental process to get a more reliable signal. New geometries will also be explored to make a more stable contact surface.

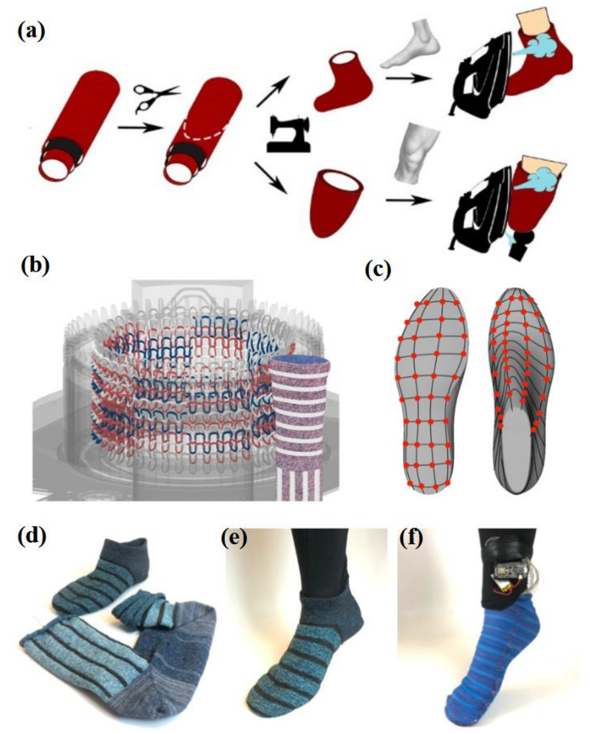
Live Readings:

As seen on the right, the sensor is able to give a steady signal. It is apparent that the resistance is inversely proportional to the load.



Future Work

1. Change number of elements in geometry and symmetry of sensor
2. Explore effect of number of claws in top part of sensor
3. Create reliable method for calibration
4. Create housing for wearable applications



Acknowledgements

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[2] Zhao, S., Ran, W., Wang, D., Yin, R., Yan, Y., Jiang, K., Lou, Z. & Shen, G. 3D dielectric layer enabled highly sensitive capacitive pressure sensors for wearable electronics. ACS Appl. Mater. Interfaces 12, 32023–32030 (2020).

[3] Wicaksono, I., Hwang, P. G., Droubi, S., Wu, F. X., Serio, A. N., Yan, W. & Paradiso, J. A. 3DKnITS: Three-dimensional digital knitting of intelligent textile sensor for activity recognition and biomechanical monitoring. Proc. 44th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc. 2448–2454 (2022).

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