Compliant Tactile Sensor Designed for Robotic Sensing

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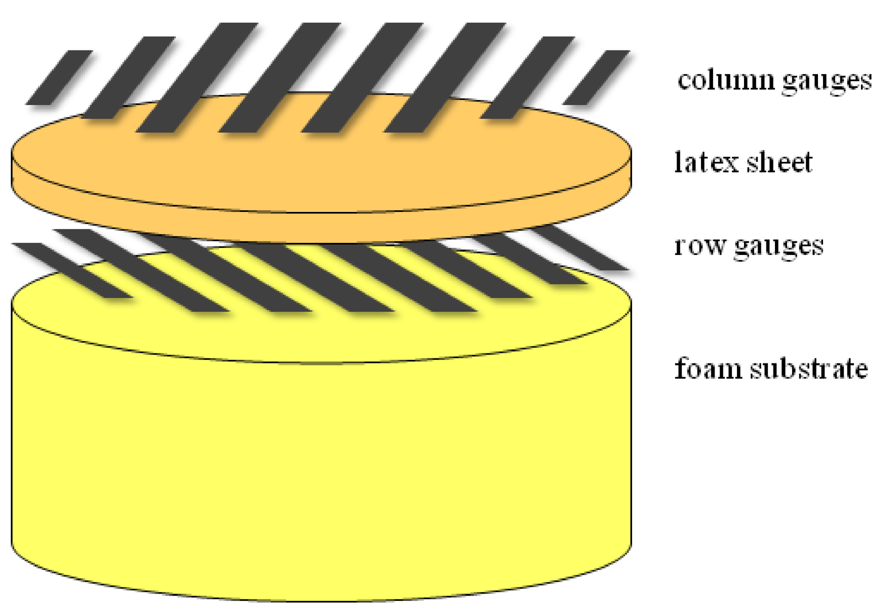
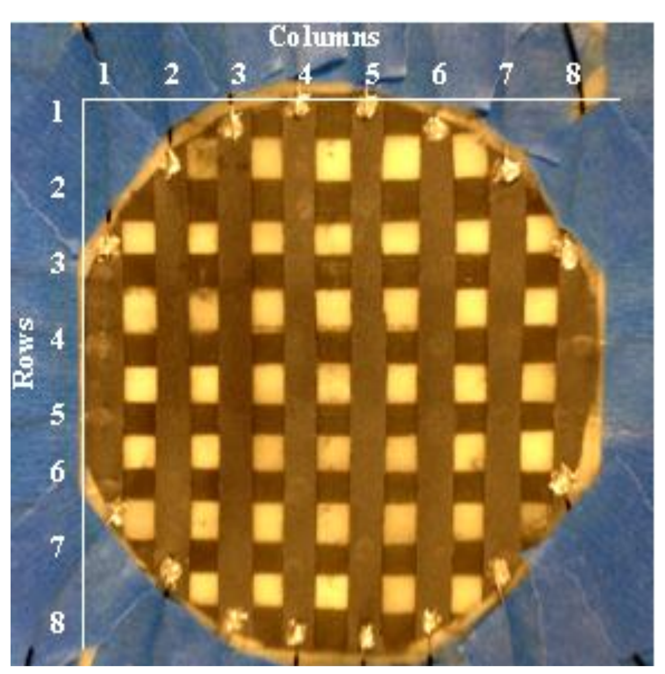
Motivation

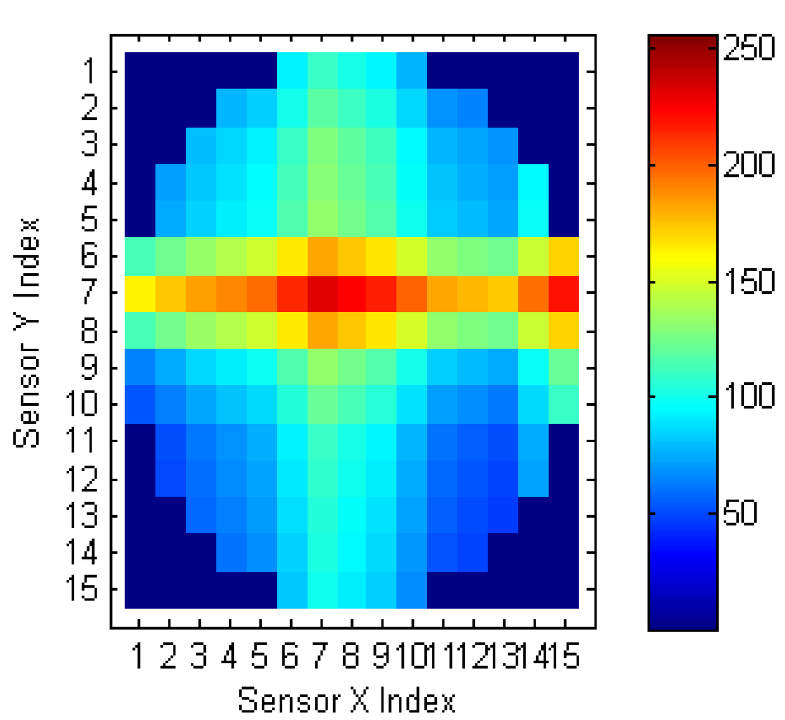
Robots are currently designed to execute programmed actions to satisfy specific commands and motions. If a robot could be taught to do an action by a guiding touch from a human, a single learning approach could be broadly applied to multiple robotic platforms. By developing a soft compliant robotic skin, a soft and teachable robot could be developed. My summer research was dedicated to this task.

Design and Manufacturing



The robotic skin was designed using 16 composite strain gauges arranged in a grid. These gauges are made of an Exfoliated Graphite (EG) and latex mixture that was sprayed onto a latex substrate. It was mounted on foam for a soft and compliant support.





By connecting each stain gauge into a data acquisition circuit, the voltage response from each strain gauge was processed into a visualization color map. This showed that the skin can be used as a tactile sensor.

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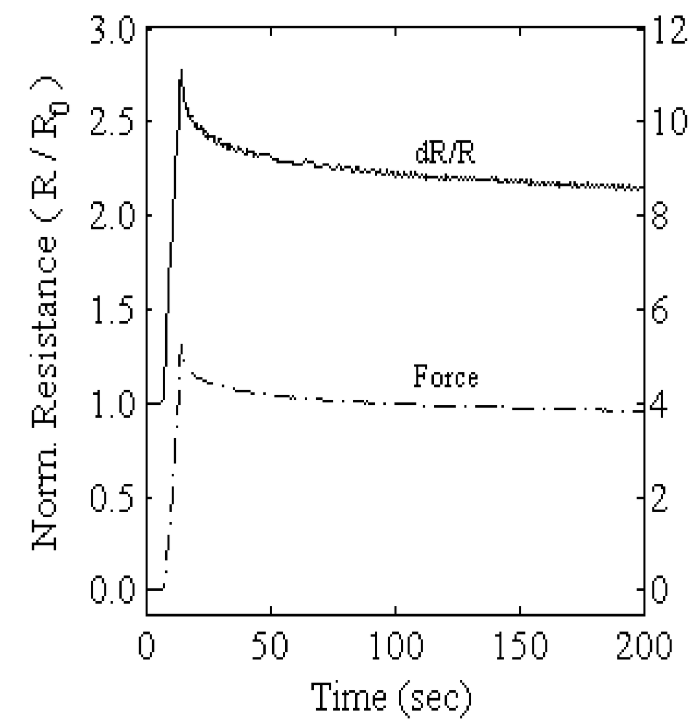
Experimental Characterization

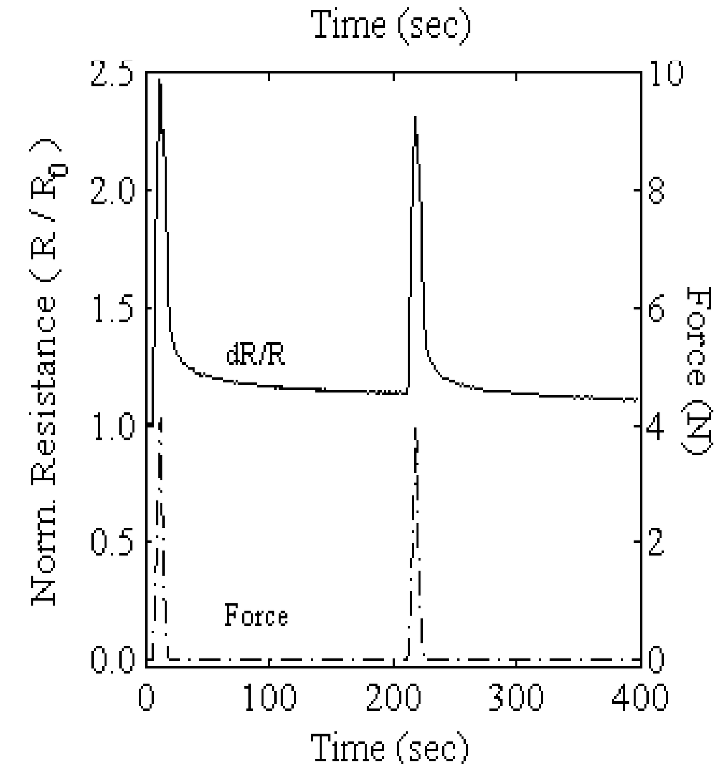
In order to characterize the response of the tactile sensor, voltage response and surface deformations were compared. Experiments included time dependant responses from constant and cycling deformations. The surface was deflected and sensor response was measured. Utilizing 3D Digital Image Correlation (DIC), the surface deflection was measured and used to develop a tactile response.

Results

Time Dependant Response

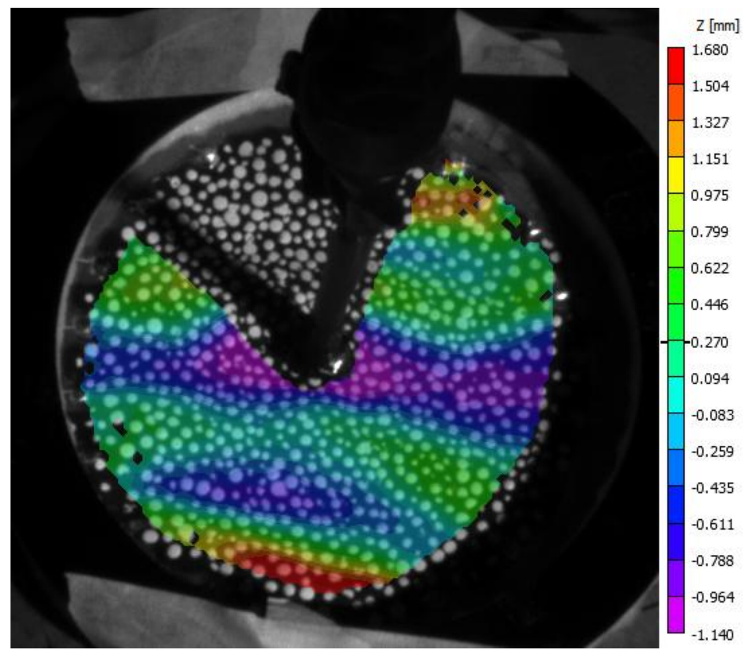


In the first experiment, a constant load was held and the sensor response and force were measured. The two responses were seen to decay over time. This suggests surface settling.



The second experiment is a cyclic loading. The response of the skin did not return to initial values after deflection occurred. This also suggests a physical change in the latex and EG composite strain gauges.

3D Digital Image Correlation

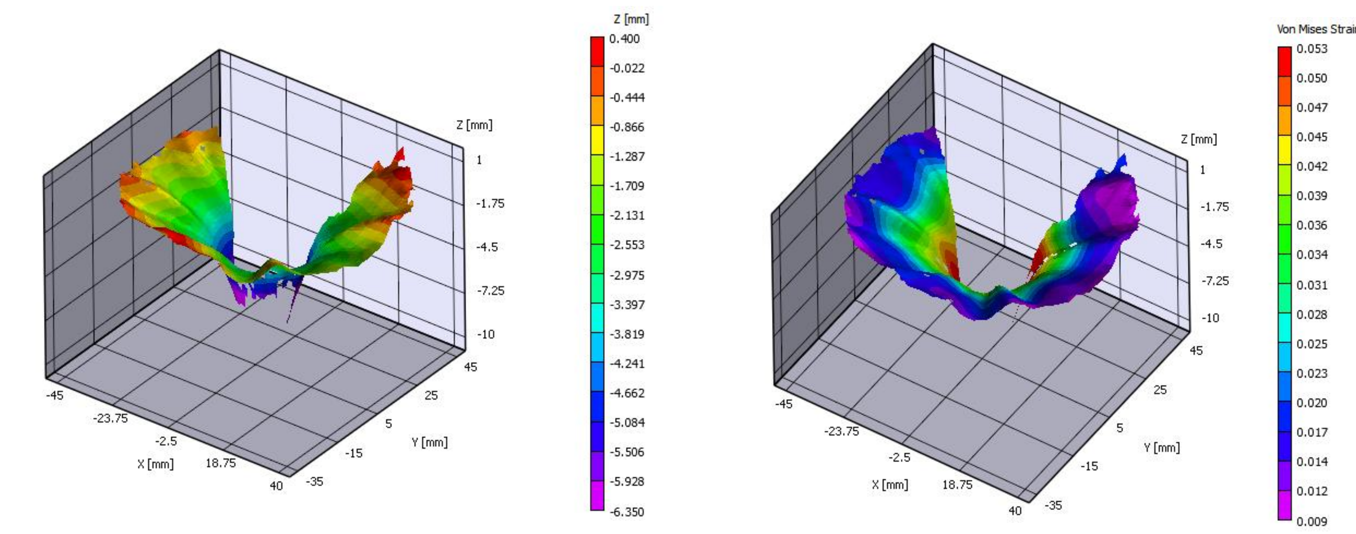


Using stereo cameras viewing a speckled surface under deformation, a 3D representation of the skins surface can be constructed. From this, strains and stresses in the surface can be calculated.

Results

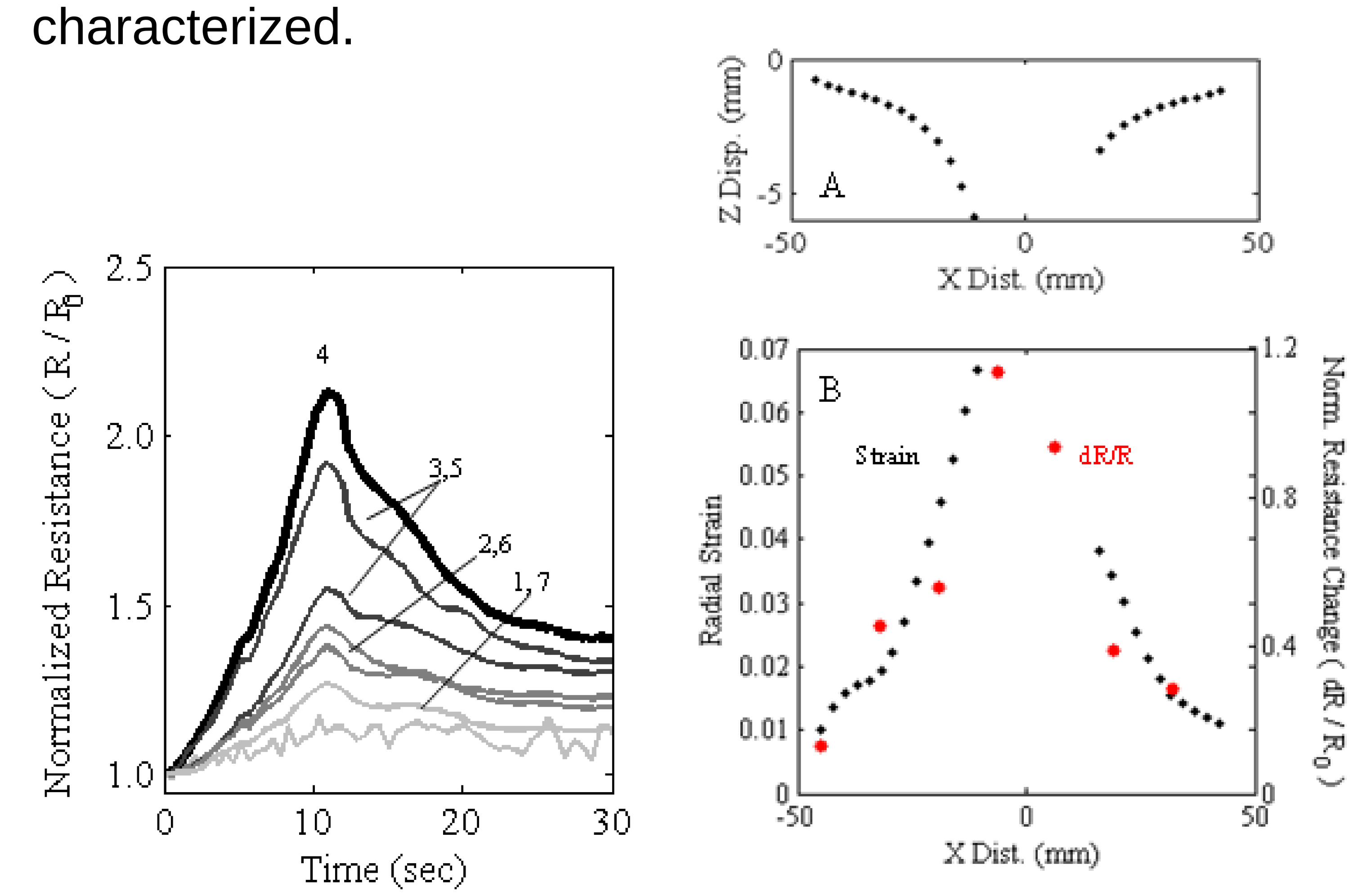
Skin surface strain calculation

By measuring the surface of the deflected skin, strains were calculated and used for reference against the skin's voltage response.



Tactile Response

The real test for the skin is how it responds to surface strains. When comparing the radial strain across the center of the skin to the responses from individual gauges, a demonstration of the tactile sensing capabilities was characterized.



Conclusion

The main purpose of the research was the development of a novel robotic skin. A 3D characterization of the skin's response was conducted. The skin was shown to accurately localize applied forces and mimic surface strains. Further characterization of the skin's response to forces and strain must be conducted in order to fully understand the performance.