



# CALIFORNIA STATE SCIENCE FAIR 2016 PROJECT SUMMARY

<b>Name(s)</b> <b>Andrew C. Chiang</b>	<b>Project Number</b> <b>J0907</b>
<b>Project Title</b> <b>Force Sensing Techniques for Robotic Arms</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The goal of this project was to investigate gripping force sensing techniques for robot arms. My design criterion was to control a robot gripper with a programmable gripping force from 50 gram-force (gf) to 500 gf at 50 gf increments.</p> <p><b>Methods/Materials</b> I designed and built a robot gripper using LEGO Technic parts. I incorporated Arduino DUE to control linear actuators and sense from Force Sensing Resistors (FSR), load cells (strain gauge), and stretch sensors. I implemented sensing circuits to interface the sensors to Arduino. I used standard weights to calibrate sensors. I then built lookup tables using sensor calibration data, and used the tables to estimate measured force. Later, I verified measurement accuracy by using standard weights. Lastly, I wrote a gripper control program in C++ to limit gripping force to a programmable value.</p> <p><b>Results</b> Stretch sensor deformation limited maximum force to 170 gf. Stretch sensor was affected by friction and was not effective in sensing gripping force. FSR and load cell can effectively handle force up to 500 gf. FSR force measurement accuracy was +/-120 gf or +/-30% in 0-500 gf range. Load cell force measurement accuracy was +/-20 gf or +/-10% in 0-500 gf range. FSR force measurement was sensitive to the shape of the contact point, but load cell was insensitive. FSR force measurement was sensitive to the centering of contact point, but load cell was insensitive.</p> <p><b>Conclusions/Discussion</b> Stretch sensors are not effective in sensing gripping force due to friction in the gripper. Load cell is more accurate in force measurement than FSR. Inexpensive but effective gripper with force sensing capability can be implemented with FSR and load cell.</p>	
<b>Summary Statement</b> I built a robot arm that used force sensing resistors and load cells to sense and control gripping force.	
<b>Help Received</b> I designed, built, and performed the experiments myself. My father supervised me in using power tools and soldering iron.	