Da Vinci Robot Haptic Feedback Gloves

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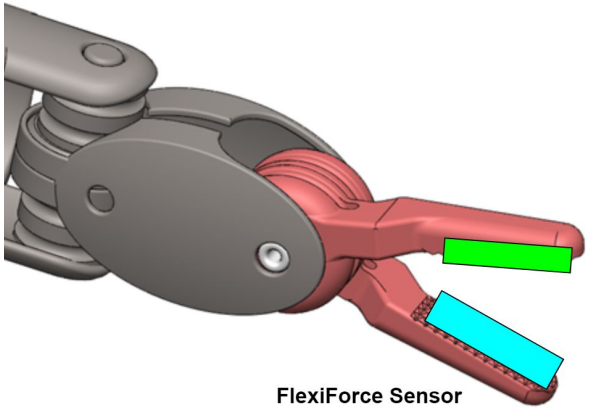
Problem Statement

Although Minimally Invasive Surgical (MIS) robots, such as the da Vinci Surgical System, have reduced post-op care and recovery time, the robot does not provide haptic feedback to surgeons.

Project Description

Our goal is to design soft robotic gloves that provide haptic feedback when the pressure applied by the Cadiere forceps approaches the maximum pressure that human tissue can safely withstand.

Our Overall Design



FlexiForce Sensor

Arduino Uno

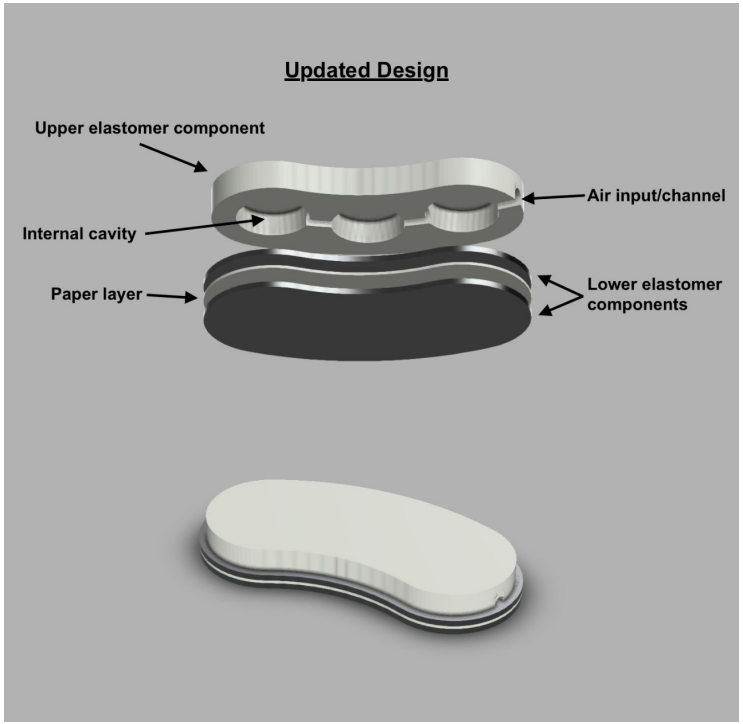
Electronics & Circuitry

Pneumatics

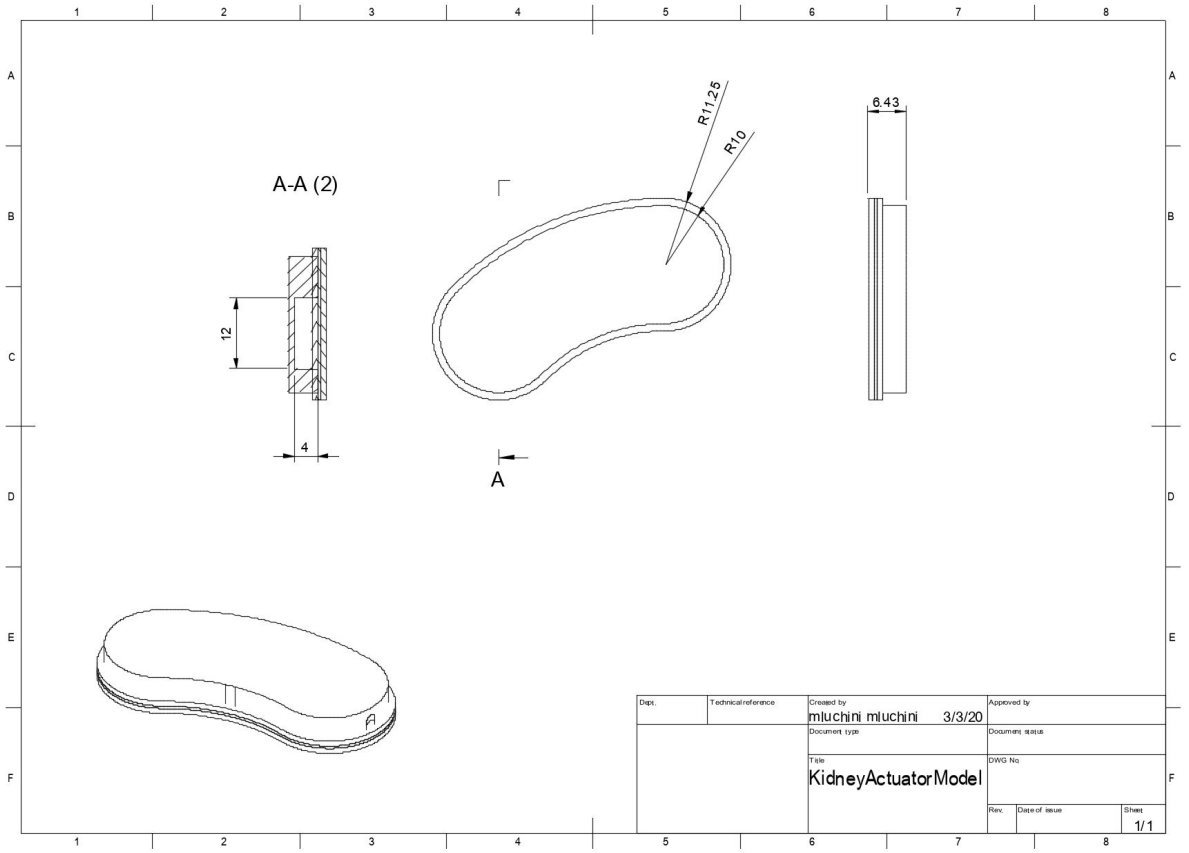
Fingerless gloves with embedded silicone actuators

Actuator


Step 1: Fill upper mold and half of bottom mold, apply paper layer to bottom mold
Step 2: Demold upper mold, fill remainder of bottom mold, using uncured elastomer in bottom mold as glue, bond the two cured components
Step 3: Demold cured actuator


Updated Design
Upper elastomer component
Air input/channel
Internal cavity
Paper layer
Lower elastomer components

Actuator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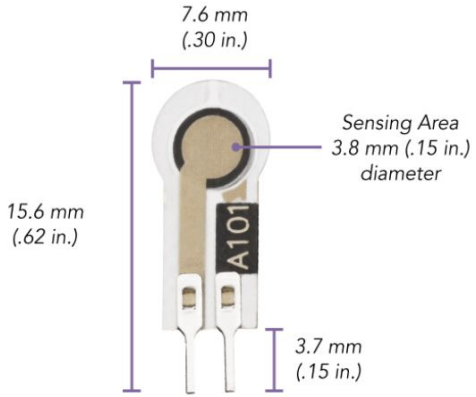
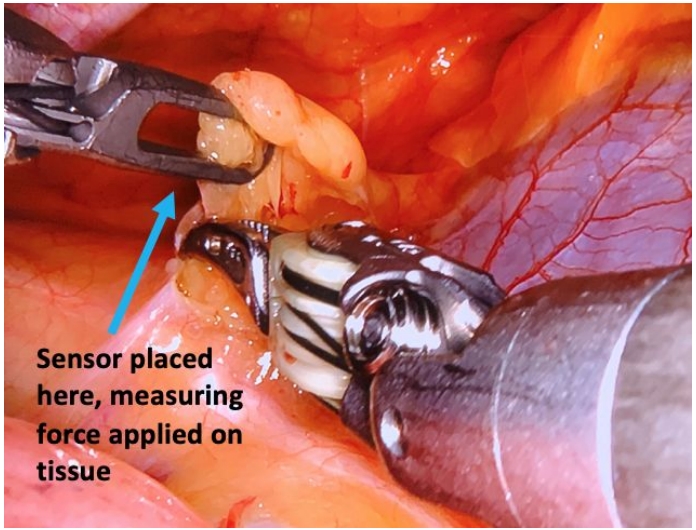
Sensor

Tekscan FlexiForce A101 Sensor

Piezoresistive sensor is easy to use with the Arduino and is placed on the tips of the Cadiere forceps.

In the circuit, the sensor acts as a resistor. The resistance is high when the sensor is unloaded and is low when the sensor is loaded

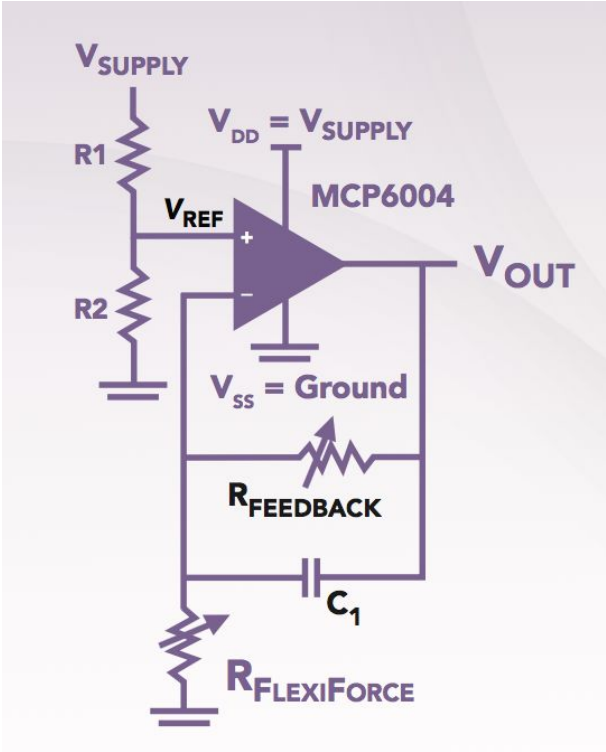




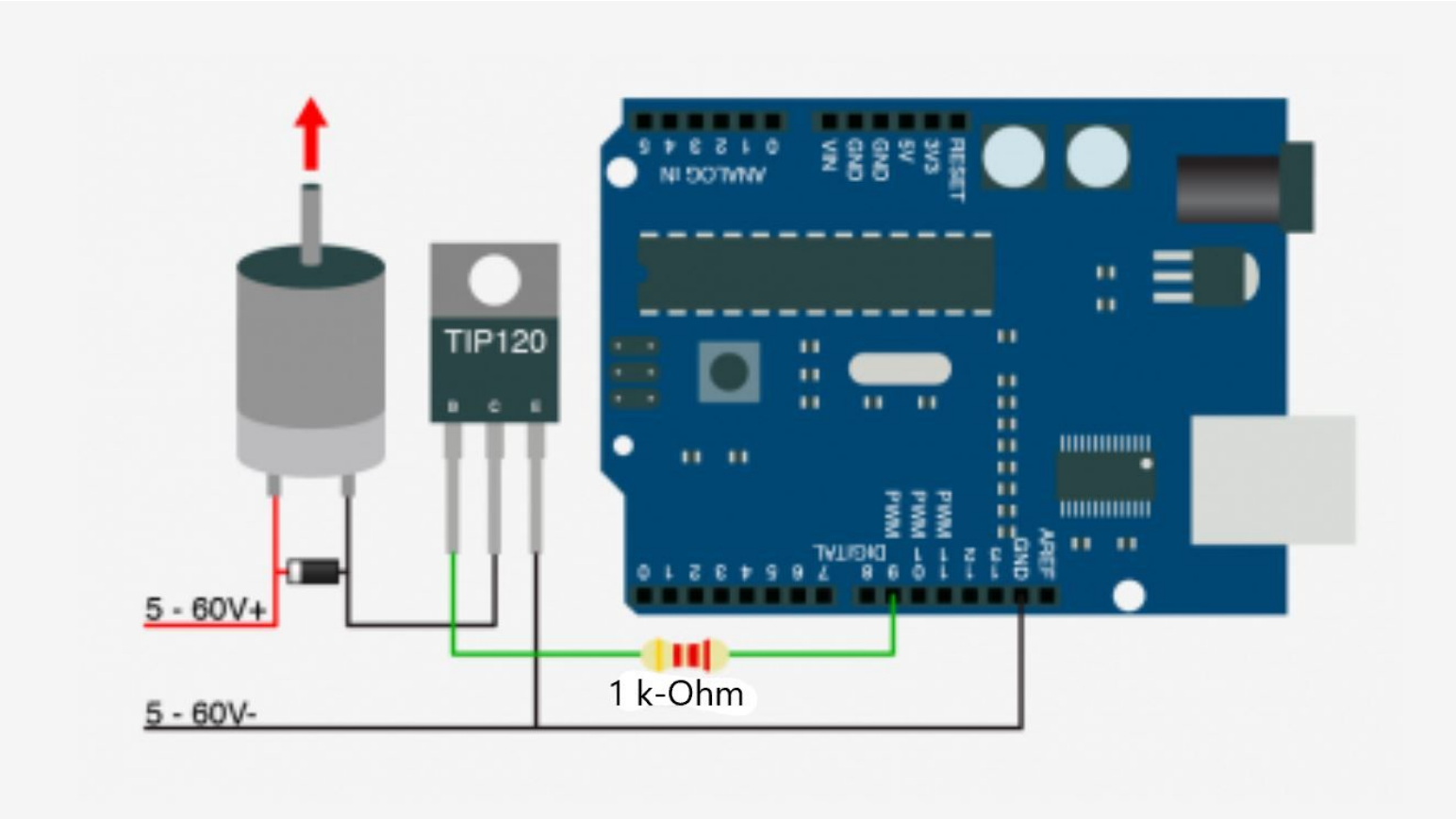
Sensor Circuitry

Integration of Flexiforce is done via non-inverting op-amp circuit.

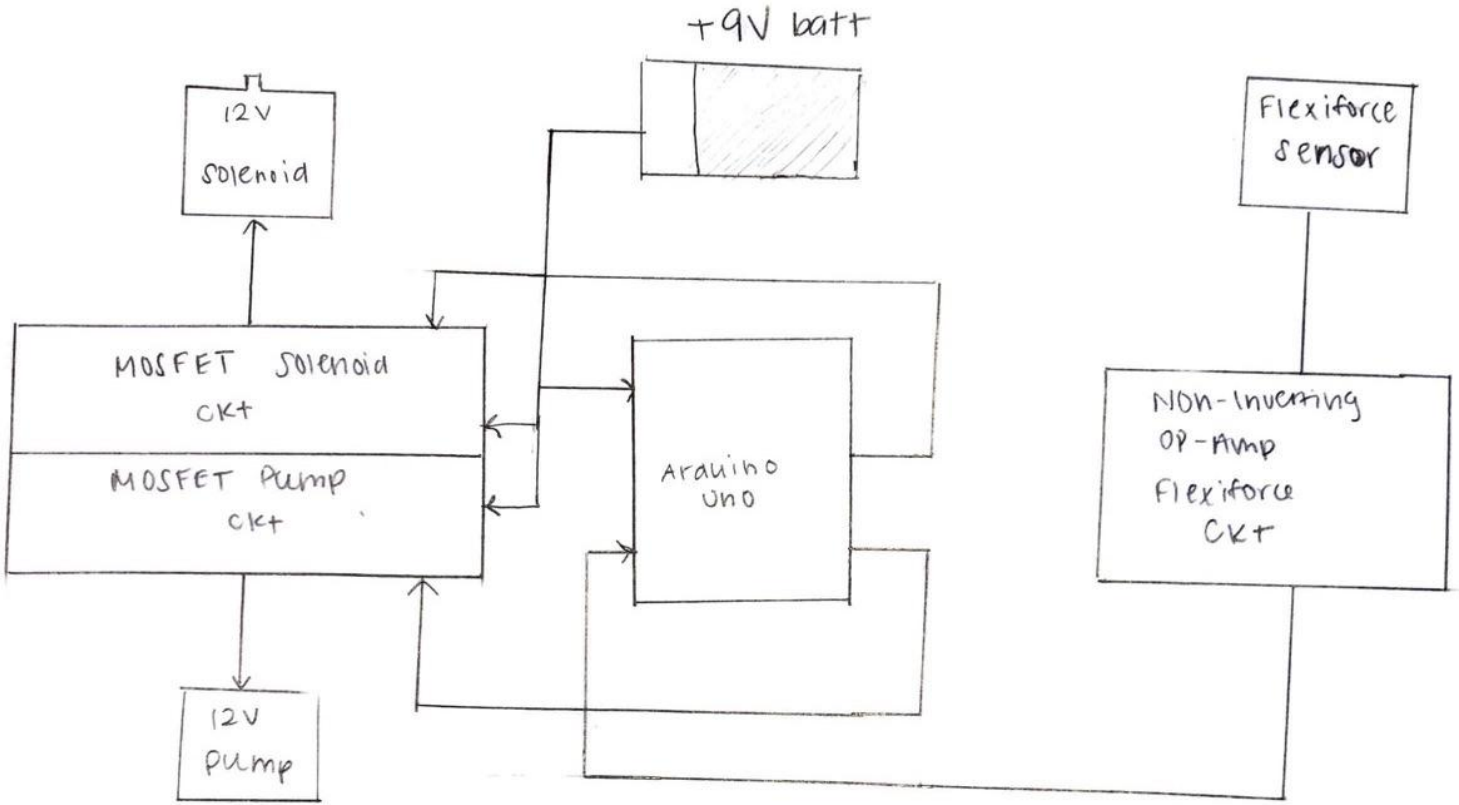
Feedback resistor and capacitor help to smooth out noise in sensor's response.



Actuator Pneumatics



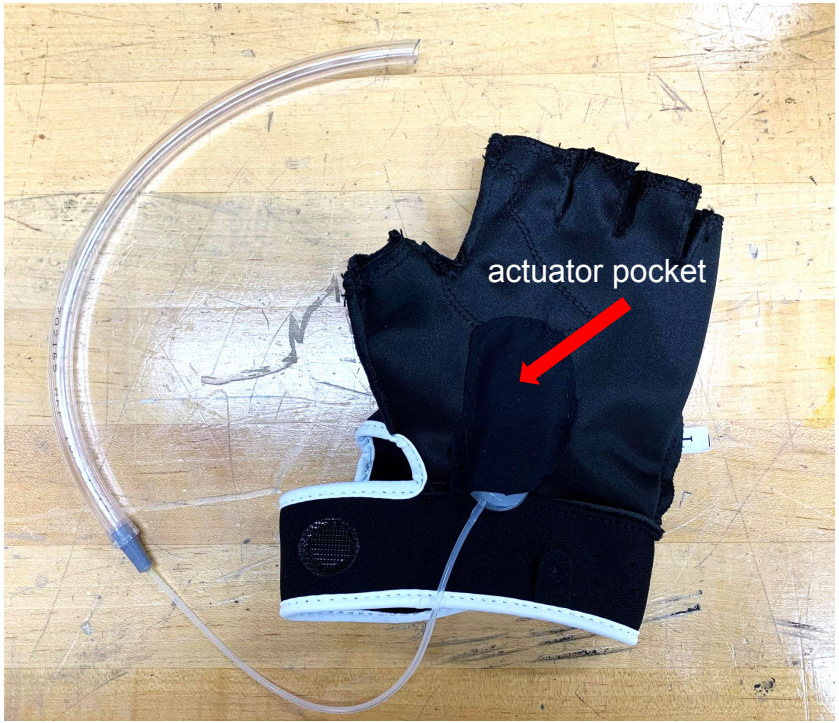
Overall Controls Flow Chart



Glove Design

We purchased simple fingerless nylon gloves for the prototype but will fabricate our own for the final product. The fingerless design allows the surgeon to maintain a better grip on the controls.

The actuator pocket is composed of a thinner fabric sewn into the palm of the glove interior.



Notes From Operating Room Visit

Dr. Suzuki's feedback on our initial placement of the actuator has caused us to reconsider using a glove in our haptic feedback system design.

We are contemplating alternative actuator placement for the final design.

Prototype Demonstration