

Laminate Underactuated Robotic Hand

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Robotic hands can cost thousands of dollars to develop due to design complexities and cost of material. Laminate prototyping was used in an effort to further the research of underactuated hands by investigating methods to rapidly prototype hand designs while taking advantage of the low-cost features of laminate fabrication

Laminate Prototyping is a method where devices are manufactured in flat sheets and utilize selective removal of material from different sheets. These sheets are then combined to form a device that takes advantage of the removed material to form hinges and joints. The prototypes developed for this project were manufactured in one day.

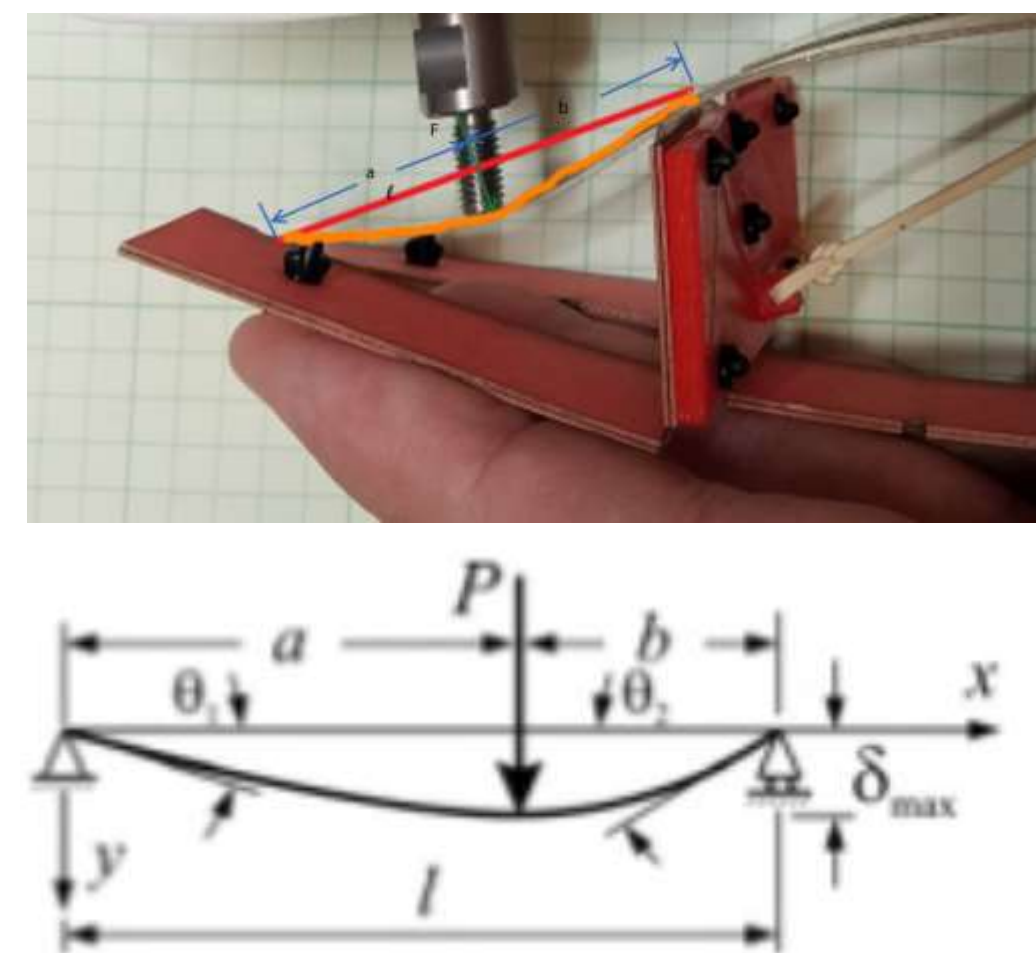
Figure 1



Left: Contact with objects cause the servo to overcome the spring enveloping the object.
Right: Open hand

Utilizing modified flex sensors embedded in the hand the issue of grasp feedback will be investigated using laminate prototyping on the developed hand platform. The laminate process allows for material selection to be exploited allowing for internal forces to be exposed.

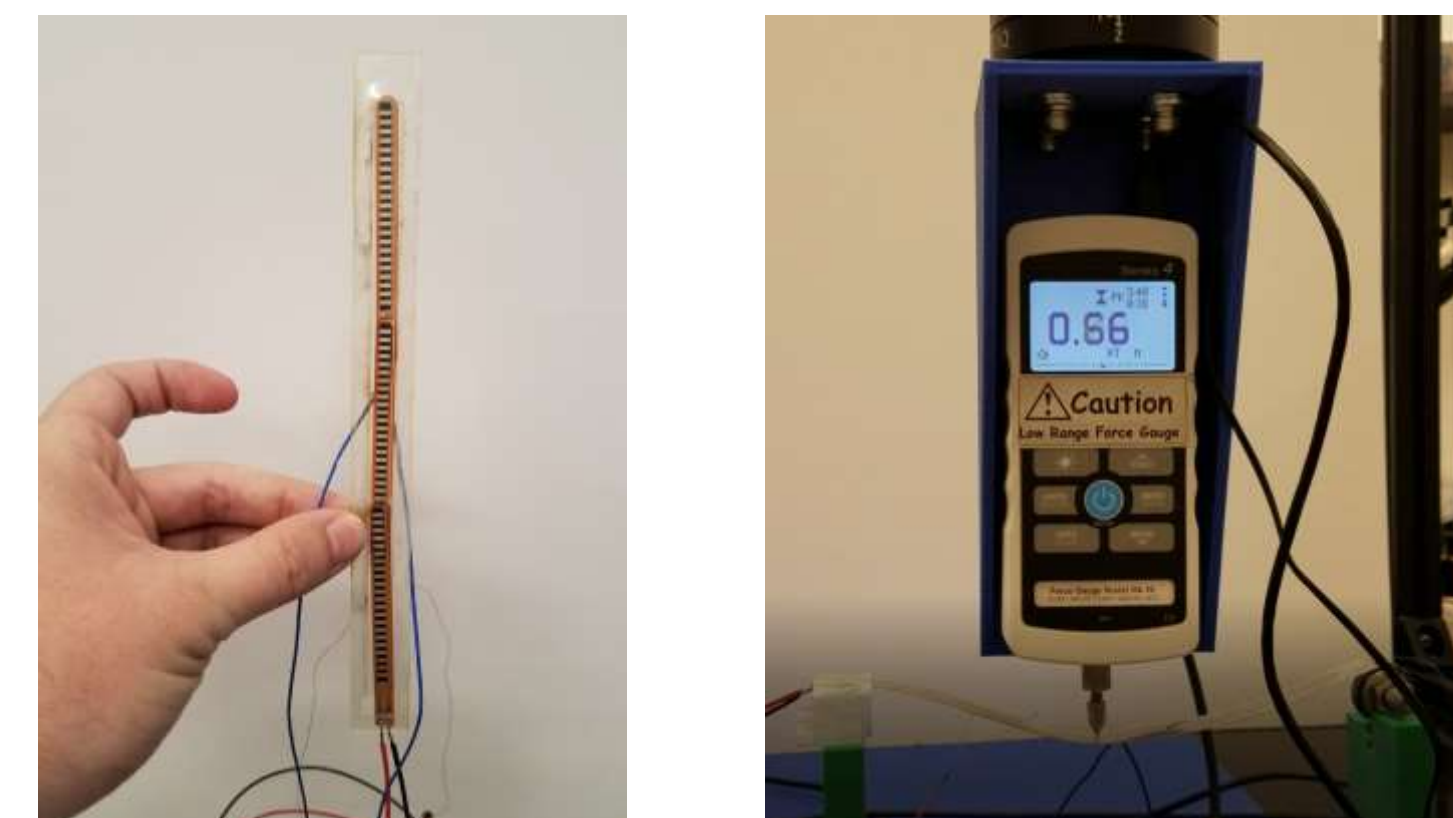
Figure 2



Top: Deflection of distal phalange modeled after a simply supported beam.
Bottom: Simply supported beam.*

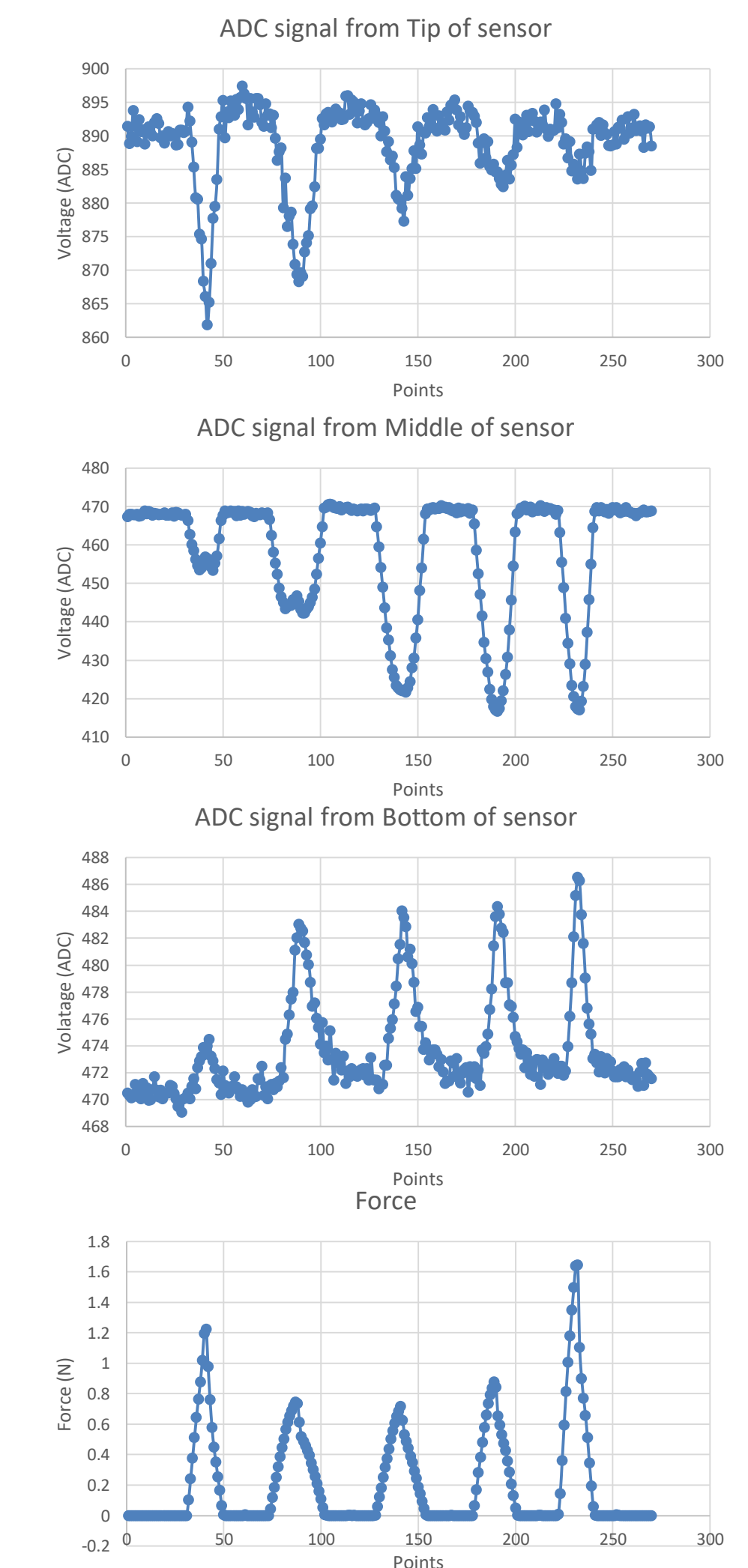
The contact points of the hand can be modeled after cantilever beams. This model finds the path of bend in a beam or contacting phalange and can derive the force being applied. Utilizing segments on the flex sensor the flex in each segment can determine the deflection in each segment providing a path of the bend in the whole flex sensor. The characteristics of the bend will provide the amount, location and number of forces acting on the grasped object.

Figure 3



Left: Tip, Middle, and Bottom Flex sensors laminated together.
Right: Force Gauge applying force on laminated flex sensor using UR robot arm.

Using a UR robot arm data was collected applying forces from the tip to the bottom of the laminated sensor. Using this data the force applied can be modeled using the ADC signal from the microcontroller.



*Simply supported beam found at <https://www.slideshare.net/mfrozi/beam-deflection-formulae>