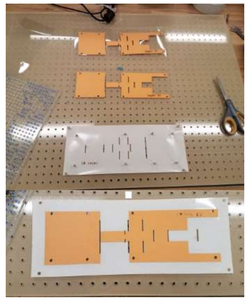
Laminate Underactuated Robotic Hand

Andrew Carlson, Robotic Engineering
Mentor: Daniel Aukes, PhD, The Polytechnic School

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

Figure 1



Top: Laminate pieces to be layered on top of each other.
Bottom: Combined laminate pieces.

Figure 2

Finished manufactured prototype prior to being assembled into device

During development of the underactuated robotic hand the issue of grasp feedback was uncovered. The option for low cost sensing was not readily available. Low cost options cannot provide the amount, location, or number of forces applied on an object.

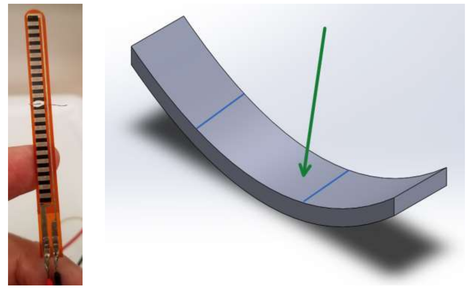
Laminate Prototyping is a method where devices are manufactured in flat sheets and utilize selective removal of material from different sheets. These sheets are then combined to form a device that takes advantage of the removed material to form hinges and joints. The prototypes developed for this project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

Figure 3

Top: Contact with objects cause the servo to overcome the spring enveloping the object.
Bottom: Grasped object.

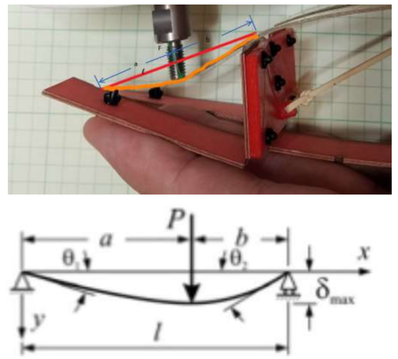
Utilizing modified flex sensors embedded in the hand the issue of grasp feedback will be investigated using laminate prototyping on the developed hand platform. The laminate process allows for material selection to be exploited allowing for internal forces to be exposed.

Figure 4



Left: Modified Flex sensor set up to detect separate deflections to provide more data of grasped object.
Right: 3 segmented flex sensor with off-center force.

Figure 5



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.

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

FURI

Ira A. Fulton Schools of Engineering
Arizona State University