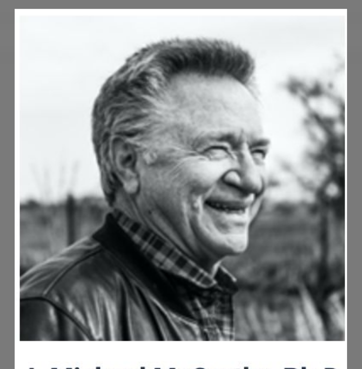
UCI Samueli School of Engineering

UCI ORIGAMI ROBOT

Sponsor:



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Executive Summary

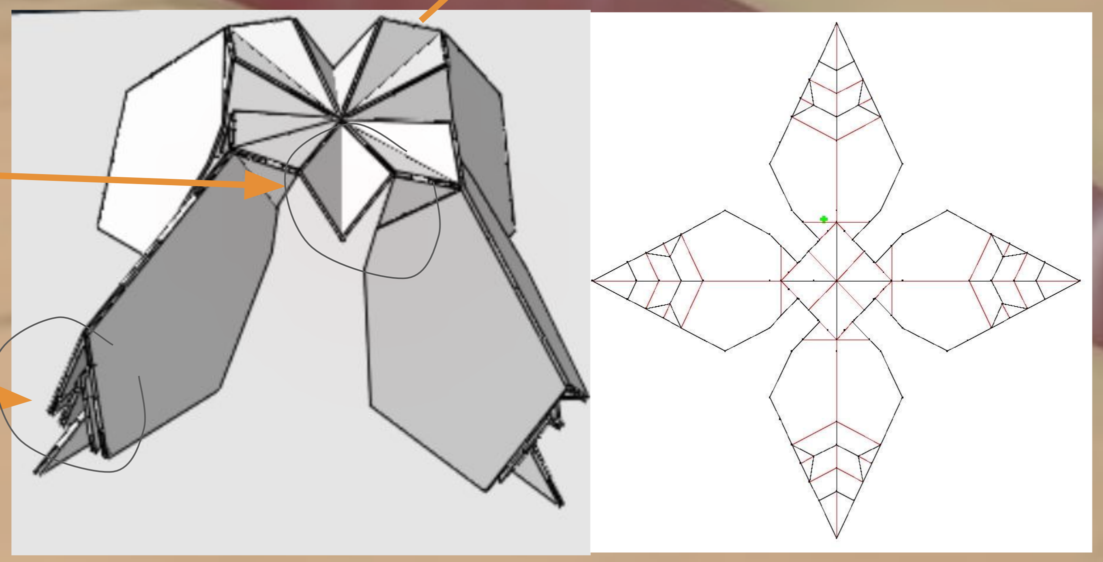
Objective:
Design and develop a large scale model of a micro-robot that can enter the human body and perform surgery
Mission:
Reduce human errors, accelerate recovery time, and reduce resuscitation time
Design solution:
Origami structure microrobot actuated by light weight airbags to perform accurate movements
Overall success:
Prototype with base and four legs that can withstand itself. Legs can perform basic movements with airbag.

Key feature

Crease (Connection design)

Make sure each leg can move in x/y/z axis independently

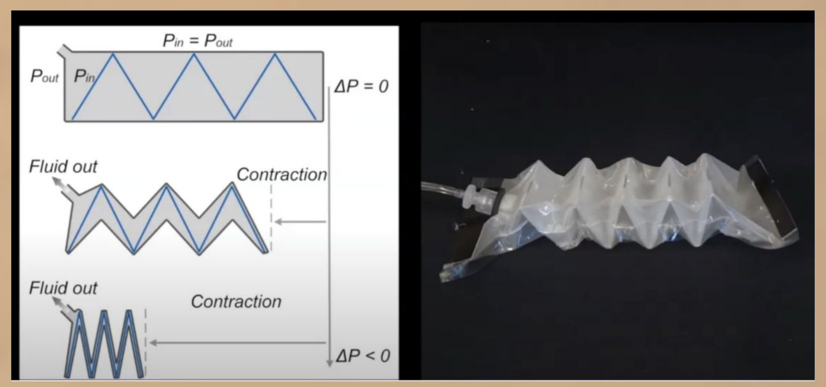
Accomplish suture
Move in arc(Push needle)



Sensor

- flexAR planar coil that can measure inductance
- Arduino powers the coil and code is created to display inductance and angle readings

Pneumatics
-Pneumatic 5V motors that will pump and vacuum air to and from airbags based on motor direction to control movement
-H-bridge motor driver to control pneumatic motor speed (PWM) and direction
-Motor control algorithm based on sensor data with Arduino microcontroller



Engineering Analysis

Sensor

- Measuring the inductance of a planar, flexible coil to determine the angle at which the arms bend. Usage of LCR meter assists in measuring and calibrating sensor.

Controls

- Determine appropriate feedback control based on sensor data and measure energy efficiency by comparing output values to input values.

Actuator

- Verify the movement feasibility of airbag structure.
- Measure the force when expansion to confirm the ability under loads.
- Analyze the relationship between moving distance and vacuuming time in order to perform under numeric control.

Mechanical

- Analyzing the vascular anastomosis surgery process
- Decomposing the surgery movement
- Use Origami structure to perform the movement independently
- Manufacture the origami structure
- Motion & Force Analysis based on the surgery process

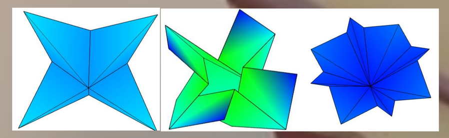


Figure 1. Strain Analysis of Folding Structure

The strain analysis help us to
- understand the strain distribution on the folded structure
- determine which one is suitable for 3D printing manufacturing—minimize the strain on the printed surface

Figure 2.
X-Y rotation of leg allow robot to walk forward or backward

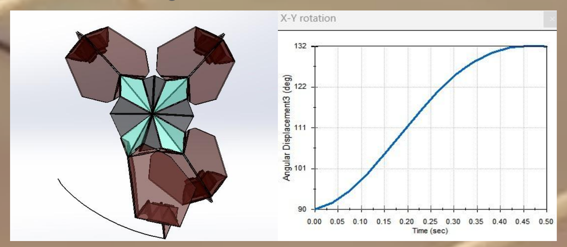
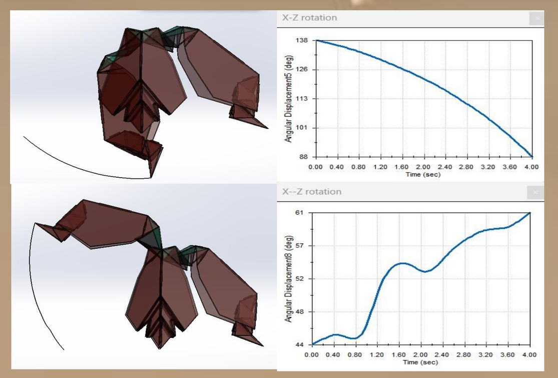


Figure 3&4.
X-Z rotation of leg allow robot to finish suture process—push and pull the needle



Final Design

actuator & control

control the air pump, vacuum and air valves through the circuit board to realize the function of inflating and deflating the airbag so that the robot can move through the expansion and contraction of the airbag. The goal of the proof-of-concept is to create an airbag connected to an air pump and a vacuum, and to realize that the airbag can expand and contract by inflating and deflating.the final performance will be the airbag actuator system can make the robot to fold, unfold, and sew

Sensor

Planar coil is able to precisely and accurately measure the angles produced by the folding structures.

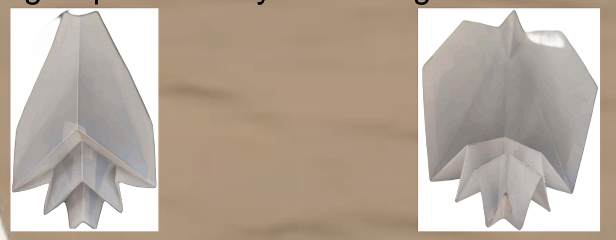


Figure shows the final design made by plastic

Shortcomings
- Integration of numerous actuators, sensors, and motors, complicating efforts to downsize the robot effectively.
- Material strength of the robot skeleton and airbag.
- The airbag needs to handle many actuations and be strong enough to handle the pressure exerted within it.

Recommend Future Improvements

- Test materials, and check if those materials have no harm to human body.
- Optimize the folding method for smoother robot movements.
- Switch to Arduino mega to control more motors
- Calibrate sensor to reduce measurement errors

References & Acknowledgments
- UCI 3D rinter Club
- “Fluid-driven origami-inspired artificial muscles.”
- Design and Evaluation of Compliant Hinges for Deployable Thick Origami Structures
- https://www.youtube.com/watch?v=NnKdmjX5pWU
- https://www.slideshare.net/salamppt/principles-of-vascular-anastomosis

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