A Novel Approach to Series Elastic Actuation in Neurorehabilitative Soft Robotics Using Resistance Pressure Sensors to Rotate Servo-Controlled Appendages Accurately

Sao, Amisha (School: Round Rock High School)

Individuals with limited hand motor function after neurological injury are often unable to return to an independent lifestyle, even after rehabilitation. Using flexible PLA (fPLA) and PLA to create servo-aided series elastic actuation (SEA), I created a soft robotic glove to test the hypothesis that non-casted, composite materials can effectively rotate fingers with pressure input. PLA and fPLA were layered and stitched to give support to force-sensitive resistor pressure sensors under the fingertips. The load-balancing mechanisms were created by attaching servo arms to each finger. External components used fPLA as a base and PLA for exoskeletal components, such as the wrist. Three trials were performed of picking up a ball of 5 cm radius, dragging it across a table, holding it back, and releasing it. Each trial was analyzed for linearity in the script, material data through a stress-strain analyzer, and statistical significance through a one-sample t-test. The pressure input was accurate to the angle output by the servo motor, demonstrating an almost linear relationship (mean slope of 0.8983, SD=0.0033 pressure per degree, n=17, $p<10^{-5}$). The angles achieved by each finger, on average, were between 7 and 86 degrees. PLA was much stiffer than fPLA; however, both helped the structure and flexibility of the glove. As the finger's angle increased, the curvature of each finger increased, visibly reducing the rotational velocity of each finger. This study indicated that this SEA method effectively rotated fingers with pressure input. The fingers rotate between 7 and 86 degrees–suggesting a safety feature–because of the fPLA composite. Further experiments will clarify the effectiveness of this device on patients.

Awards Won:

Fourth Award of $500

University of Texas at Dallas: Scholarship of $5,000 per year, renewable for up to four years