Control system for a 3D-printed pneumatic gripper

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Research Question

How can we control the dynamics behind human muscle with an artificial 3D printed variant that can effectively be attached to robots?

Impact Statement

Using Arduino and pneumatic controls to replicate human hand movement to allow for advanced manipulation

Abstract

Currently, robotic hands lack degrees of freedom, only being able to move, pick up, hold, and release objects. The present study builds upon previous research by using Arduino to control a pneumatic gripper at different angles. The focus is to be able to control the finger by supplying it with different pressure values to support twisting in addition to different bend angles of the finger. Due to how easily replicated the code is, this research could be easily replicated and explored further in future studies, creating a basis for high amounts of gripper control for Industrial and Biomedical use.

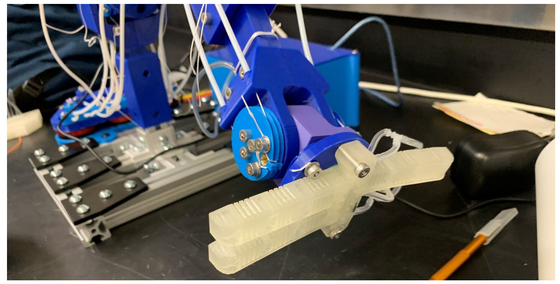
Research Challenges

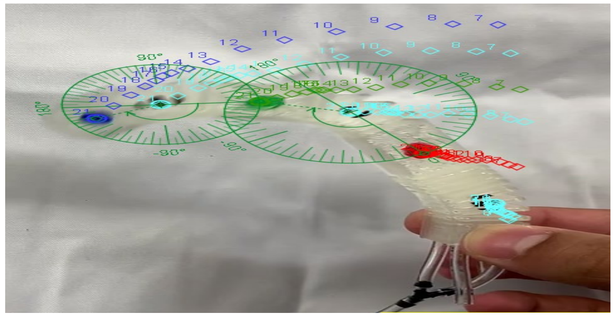
Although the hand is controlled through air pressure, there are challenges to address:

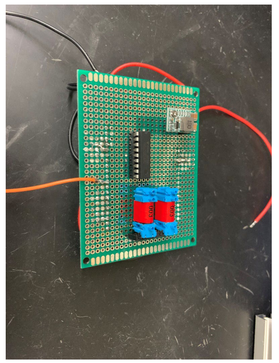
- How would we be able to further make the design portable for easy "transposing"?
- How can we further improve the design of the controller to make it stand out from current cutting-edge designs.

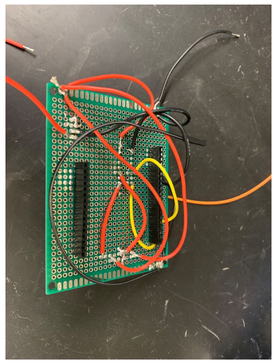
Methodology

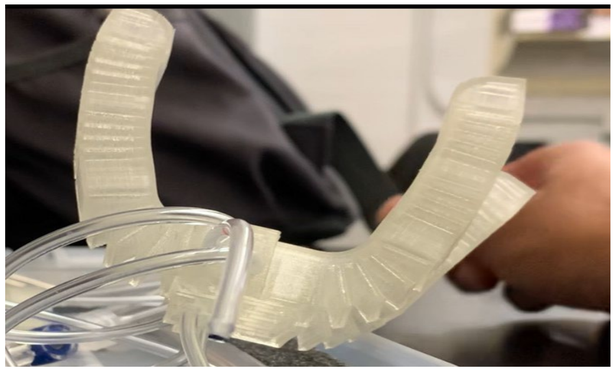
- Tested different bend angles, both theoretical and experimental, with Kyle Welsh to see how pressure values correspond to angle of joint
- Built a Pneumatic Setup to be able to Fill-Hold-Release for any joint in the Pneumatic Gripper
- Used Tracker Software to compare how bend angle of each joint depends on Pressure
- Built Control Circuit with an Arduino Nano using a Pressure sensor to find current pressure in finger, and using a force sensor to see how much force the finger is gripping objects with
- Compared Outputs between PID with PWM output vs. a Bang-Bang Controller to see which would provide a more accurate output in response to change in angle of finger
- Changed the frequency and duty cycle for respective valves to 22.7 Hz with 4.55% duty cycle
- Tested grabbing different objects with gripper, and trying to "Manipulate" them

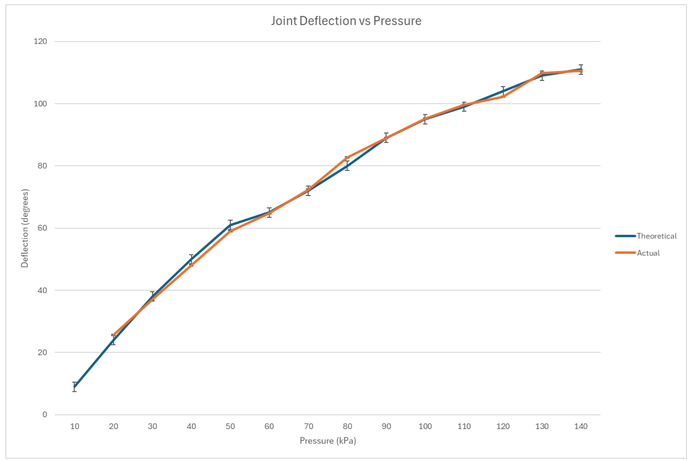


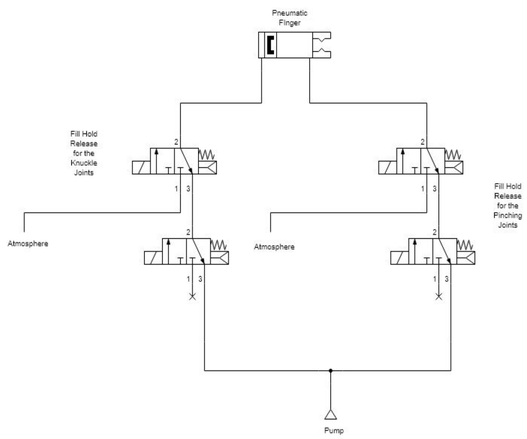












Future Work

- Switching from a pressure sensor to a strain/angle sensor to measure the exact angle the finger joint is at
- Adding separate valve system to each finger to improve overall control over hand

Acknowledgements

- Dr. Jiefeng Sun
- Kyle Welsh
- Van Ham, R., Verrelst, B., Daerden, F., Vanderborght, B., & Lefeber, D. (2005). Fast and Accurate Pressure Control using On-Off Valves. International Journal of Fluid Power, 6(1), 53–58. https://doi.org/10.1080/14399776.2005.10781211

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