Testing Coiled Nylon Threads as Artificial Muscles for Exoskeletons

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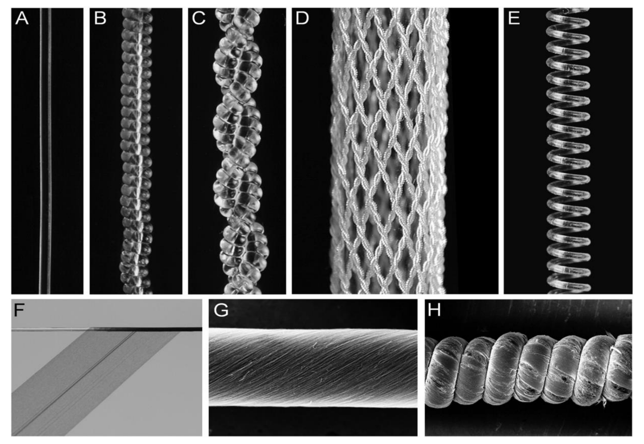
Introduction



Researchers have found nylon to be a reliable and cost effective artificial muscle [1,2].

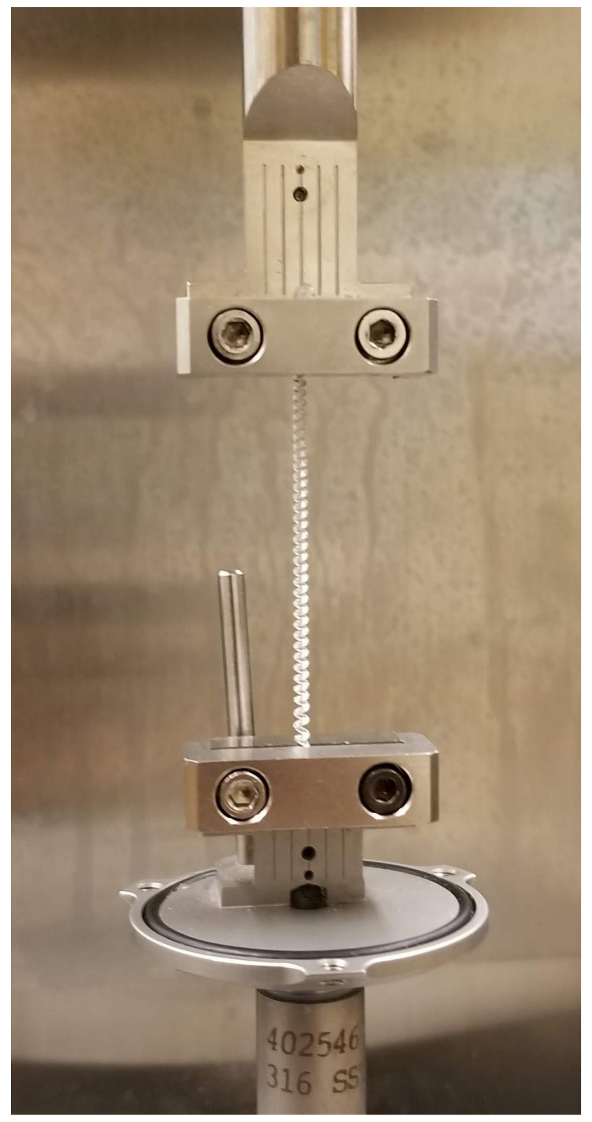
Common issue of most robotic exoskeletons is their high cost, large weight, and bulkiness

Objective

<u>Long Term:</u>
The eventual goal of this project is to develop a low cost lightweight exoskeleton for stroke rehabilitation

<u>Short Term:</u>
Develop manufacturing methods for artificial muscles and test their mechanical properties

Methods



- Tested two different fishing line (53 and 111N)
- Lines were hand coiled using an electric drill
- Tension was applied by 170g and 240g weights, respectively
- Used tensile testing machine to determine failure point
- Ten coils of each line type were tested to asses manufacturing method

Results

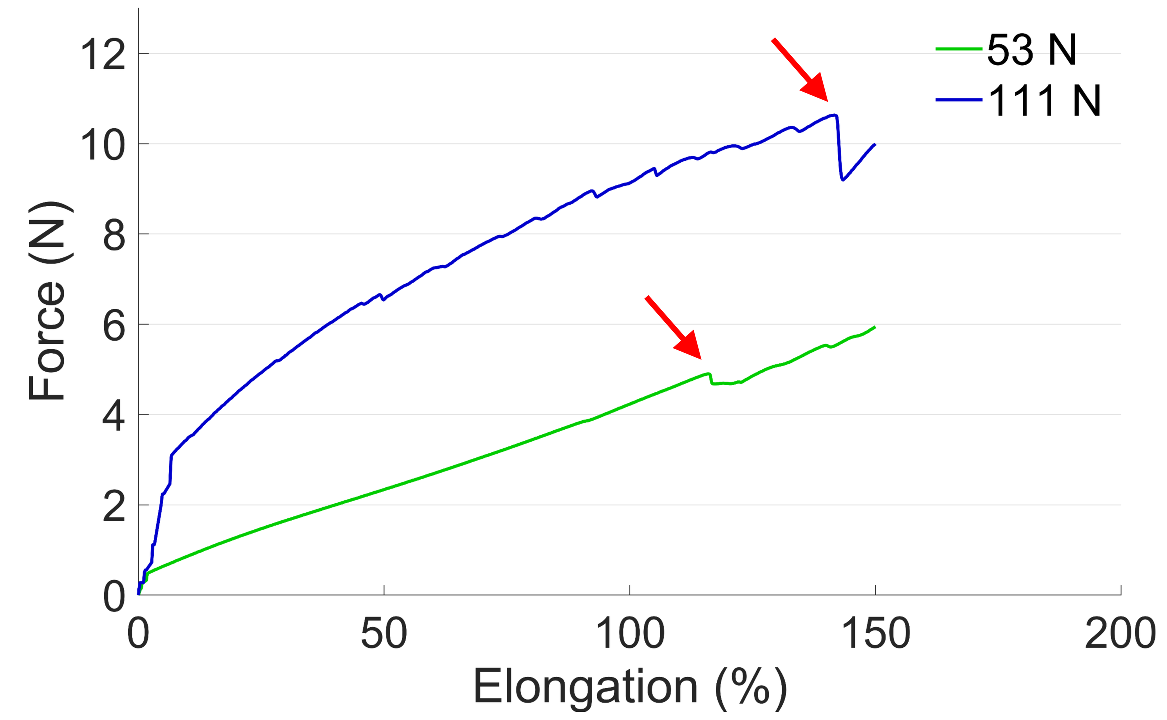


Figure 1. Example of a force - elongation curve of one coil for each fishing line. The red arrows points at the failure points.

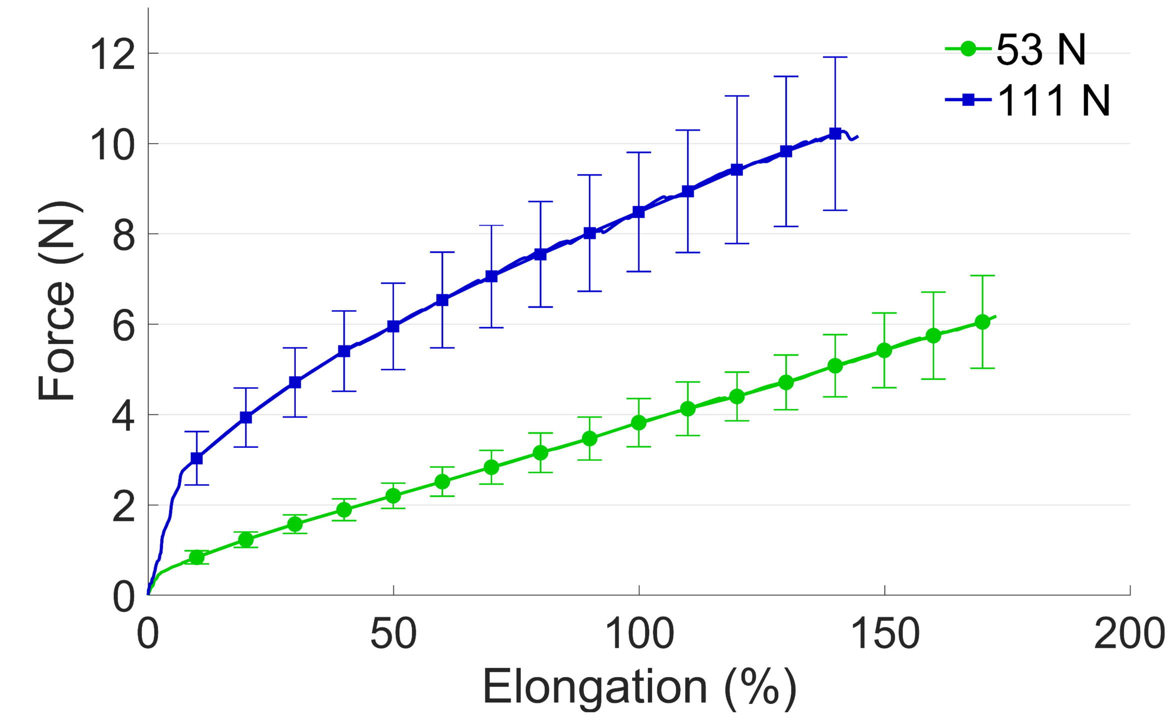
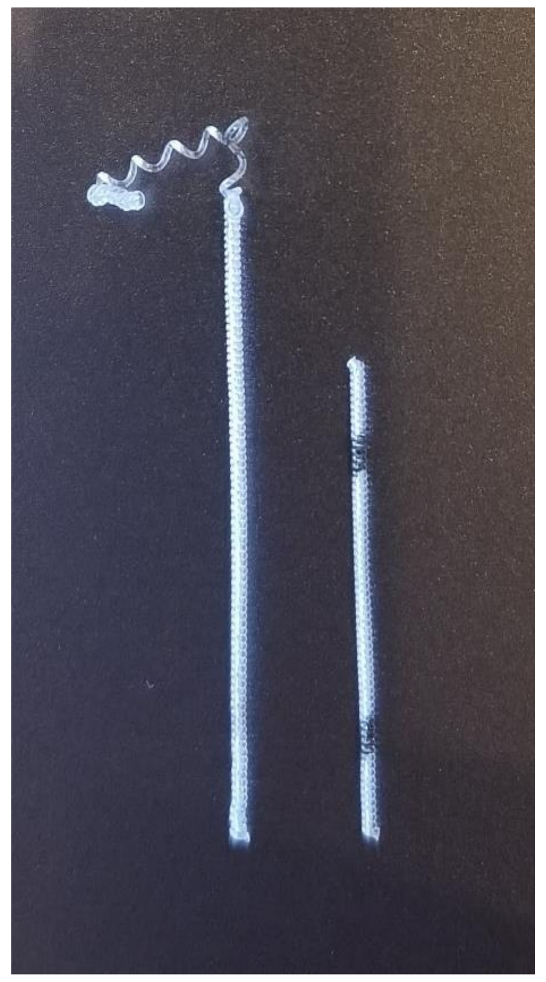


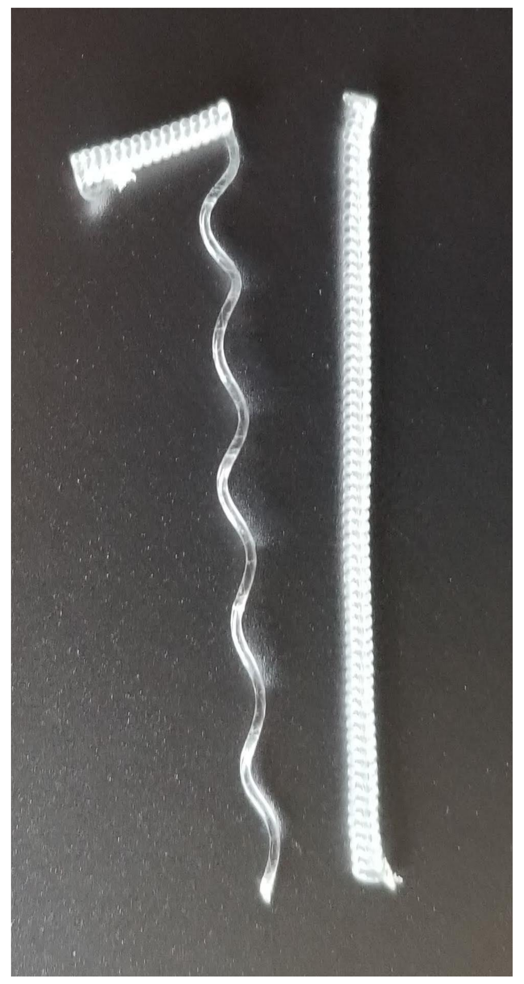
Figure 2. Average force - elongation curve for each fishing line. Curves represent the average for ten coils. Whiskers represent ± one standard deviation.

<u>Coils Before and After Testing</u>

53N



111N

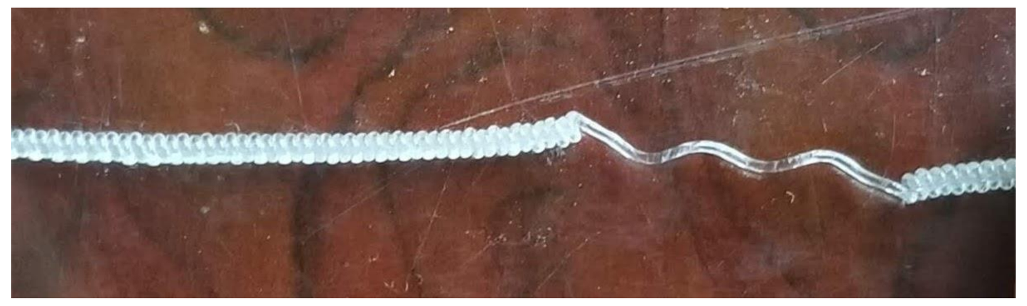


- Failure points defined from the jump in force on the force - elongation curves (Fig. 1).
- Range of forces at failure for 53N: [3.7 – 6.5] N
- Range of forces at failure for 111N: [6.1 – 11.2] N
- A maximal elongation of 100% can be attained for both types of coils without failure.

Discussion

- 111N coil displays higher tensile strength than 53N coil.
- Coil fails by unwinding before shearing.
- Coils retain contractile properties after unwinding.

- Coil unwinds at seemingly random locations.
- Random failure locations are assumed to be weak points caused by the manufacturing method



Conclusion & Future Work

<u>Coils can easily be manufactured to create artificial muscles</u>.

Future work:

- Develop an automated rig to create consistent process of manufacturing coils to decrease the variability of the force - elongation curves.
- Manufacture multiple individual muscles and assemble them to create larger forces.
- Use conductive nylon for thermoelectric heating.

<u>Acknowledgements</u>
The authors would like to thank TRIO McNair Scholars Program, the OK-LSAMP Program, and CEAT.

<u>References</u>

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[2] "Artificial muscles made with fishing line | Ars Technica." [Online]. Available: https://arstechnica.com/science/2014/02/artificial-muscles-made-with-fishing-line/. [Accessed: 20-Jul-2019].
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