Electrical Responses of Conductive Nylon for Application in Low Cost Exoskeletons for Stroke Rehabilitation

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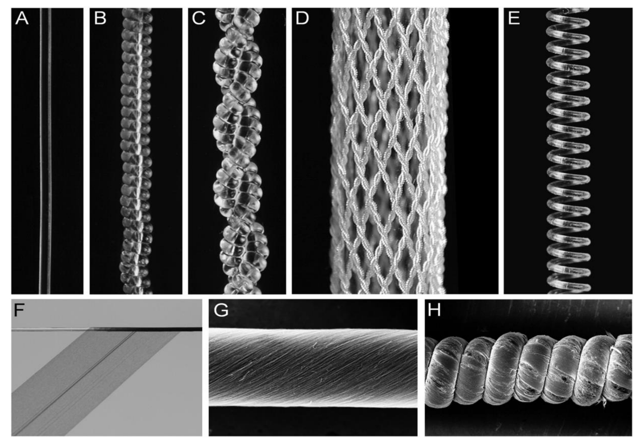
Biomechanical Analysis Musculoskeletal Modeling

Introduction



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

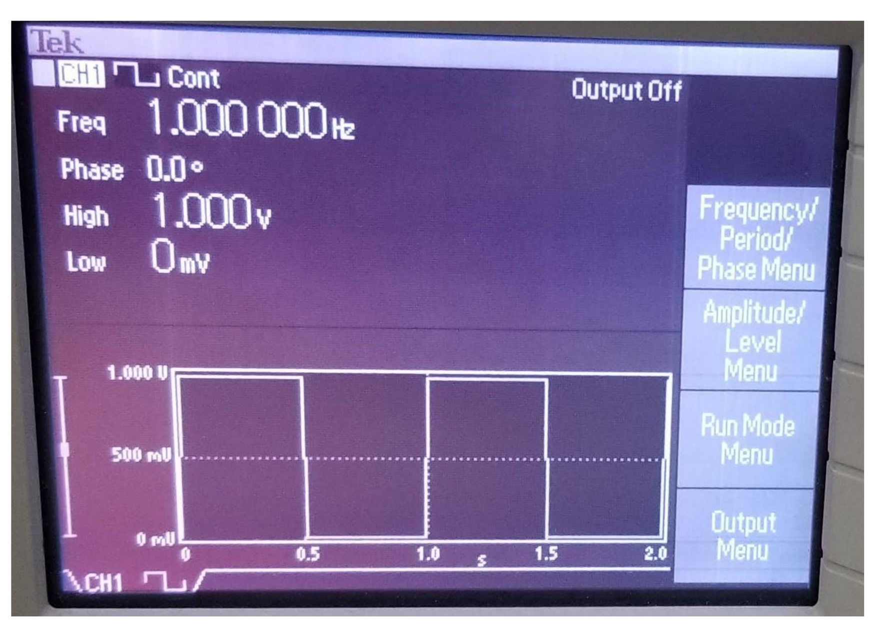
Common issue of most robotic exoskeletons is their high cost, large weight, and bulkiness

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 methods to show it is possible to electrically control conductive nylon coils for muscle actuation

Methods



- Coils made from nylon fishing line spun together with conductive nylon thread
- Voltages in increments of 500mV applied to coil with frequencies of 1Hz – 2Hz
- Tension was applied to coils while voltage was applied
- Coils' resistance was measured and used to determine general voltage and current responses

Results

Voltage Applied (mV)	Observed response
500	No change
1000	Contraction produced
1500	No change
2000	No change
2500	No change
3000	No change

Figure 1. Observed contraction response upon voltage application.

<u>Average resistance found in conductive coils</u>

R_{avg} = 22.22Ω

<u>Average current in responsive voltage</u>

$V = I_{avg}R_{avg}$
1V = I_{avg} * 22.22Ω
I_{avg} = .045A = 45mA

<u>Average power requirement of responsive voltage</u>

$P_{avg} = VI_{avg}$
P_{avg} = 1V * .045A
P_{avg} = .045W = 45mW

- Contraction force only found from application of 1000mV (1V)
- Low current and power specific to responsive voltage
- Variation of coil resistance was not significant thus average resistance used for calculations

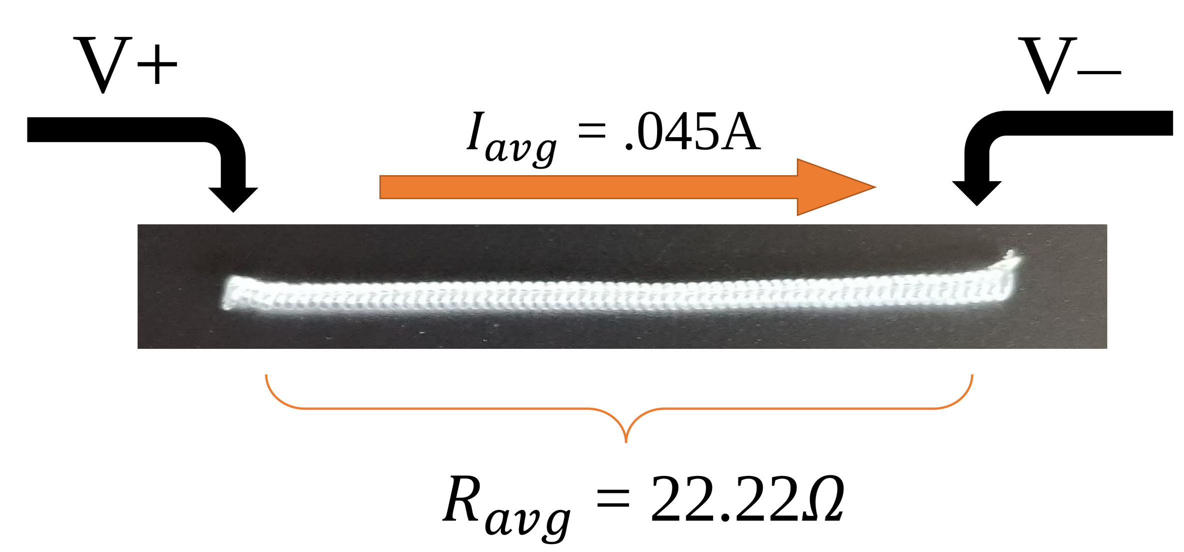


Figure 2. Electrical setup for response testing

Discussion

- Results imply that only one voltage and current combination creates coil response
- Other voltage responses could have been too weak to notice response
- Low power required for one coil implies that largely scaling number of coils could have a low power requirement altogether
    - i.e. 1,000 coils * .45mW/coil = 45W/1,000coils

Conclusion & Future Work

Conclusion:

- Application of electrically controlled conductive nylon as artificial muscles is feasible under right conditions
- Further testing must be conducted to find direct cause of response from voltage applied

Future work:

- Test other variations of commercially available conductive nylon for electrical responses
- Apply conductive nylon coils to various forces for response with voltage applied
- Create multiple bundles of conductive coils and apply various voltages to study response

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<u>References</u>

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