Conductive Paint Stretch Sensor DIY Manual

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Bill of Materials

- Conductive Paint
  - Bare Conductive Paint Pen - 10mL
- Fabric
  - 90% polyester, 10% lycra blend jersey knit
- Alligator clips or clamps
  - Alligator clips (100pcs)
- Popsicle stick or very narrow squeegee (Potentially a 3D printed part)
- Cardboard sheet 30% longer than the desired stretch sensor
- Stretch Sensor Fabrication Jig (3D printed part)

Optional

- Compression garment (many brands will work, order to size)
  - Longsleeve compression garment
- Microcontroller (pick one of the options)
  - Arduino Uno R3 (base microcontroller)
  - Adafruit Feather M0 WiFi (WiFi enabled microcontroller that runs through Arduino)
  - Digilent WF32 WiFi Microcontroller (WiFi enabled microcontroller that runs through LabVIEW)
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- Misc Electronics
  - 16-Bit ADC (optional, for added sensor resolution)
  - Power source (pick one of the options)
    - 9V battery & battery pack
    - LiPo battery
    - USB power
  - Conductive thread
  - Tin coated button snaps
  - 22 gauge wire kit
  - Capacitance touch breakout

Software (select one)

- Arduino IDE
- LabVIEW MakerHub

Introduction

We were first interested in wearable motion capture systems to measure movement outside of a lab environment. For the garments to be effective research tools they will need to be comfortable, accessible and affordable. Our research group was most interested in quantifying elbow and shoulder flexion because they are key metrics to validate the effectiveness of rehabilitative exoskeletons and assess infant development. While this was our primary focus, these types of stretch sensors can be used to measure other joints and even non kinematic analysis or physical activity applications.

Based on the joints we were measuring, we fabricated 2" and 6" stretch sensors but any length sensor should be possible as long as it is stretched 30% (or to the maximum elongation percentage you plan on stretching your sensor).

Instructions

1. Cut a 2" wide strip of fabric and to the desired length of your sensor
2. Cut a rigid base (most likely a thick piece of cardboard) 30% longer than your desired sensor length. If you are using thin cardboard (from a standard shipping box) you may need to tape 2 cardboard layers together for a more rigid base
    a. If you want a 6" long sensor, then cut a 7.8" long piece of cardboard
3. Place the fabric on the cardboard and clamp one side using alligator clips
4. Stretch the fabric and clamp the other side
5. Slide the "Stretch Sensor Fabrication Jig" under the stretched fabric between the fabric and the cardboard.
    a. This jig is optional but we found the sensor achieved better results when we used it because it expands the fibers earlier making it easier to coat individual threads
6. Draw a line of conductive paint using the conductive paint dispenser
    a. You can get a gauge of thickness by watching the "Stretch Sensor Fabrication" video
7. Using a flat object (popsicle stick, or small 3D printed part) as a squeegee to spread the paint into the fabric
    a. Continue to spread the paint until there are no shiny areas
        i. Shiny areas indicate the paint is too thick and will take longer to dry and crack under strain
8. Let dry while stretched for 30 mins
9. To integrate into the compression garment, have the user first don the garment
    a. Draw lines on the garment with tailor's chalk across the joint you would like to measure
10. Have the user doff the garment
11. Stitch the stretch sensors with a running stitch running perpendicular to the line of stretch

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12. Can be attached to a microcontroller through a number of methods
    a. We found that stitching conductive thread through a tin coated button snap to secure the snap to the sensor, and then soldering 22 gauge wire to the top end of the other part of the button snap was the most effective
13. The resistance of the sensor will change when the sensor is stretched
    a. Further research may find a more linear relationship between stretch and capacitance over stretch v resistance