Research Plan

**Question or problem being addressed:**
Currently, there are no methods for detecting joint bleeds in hemophiliacs other than waiting for physical symptoms to manifest. Late detection of bleeds greatly increases chances of permanent joint damage, affecting hemophiliacs' quality of life.

**Goal of the project:**
The goal of this project is to engineer an accessible device that accurately detects early symptoms of a joint bleed such as decreases in mobility and increases in skin temperatures and alerts the user to go see a doctor.

**Procedure/Plan of Action:**

**List of materials:**
- Goniometer
  - Magnetic position sensor
  - Diametric magnet (2)
- Skin temperature sensor
  - *Medline* thermistors
- Computer (Surface Pro)
  - Java programming
  - Arduino programming
- *Mayoclinic* Elbow Brace
- LED light

**Skin temperature sensing**
- Using multiple thermistors, experiment with different configurations around the joint to give the most precision.
- Expose temperature sensors to materials of different (and known) temperatures
  - Temperature ranges will be chosen to simulate human temperatures (96, 98.4, 100 degrees Fahrenheit)
  - Theoretical temperature will be taken using temperature sensing Arduinos. These will not be used on the actual device because not all temperature sensors are suitable for skin.
- Determine optimum placement/number of temperature sensors.
Goniometer

- Fit a magnetic position sensor and two diametric magnets on the side of the brace, equal lengths from the sensor.
  - Magnet position sensor will be able to collect angle measure data using the magnetic fields of the diametric magnets
- Perform several trials of walking with the brace with varying degrees of joint mobility for data collection
  - 3 degrees of mobility will be provided by adding and removing knee stabilizers from the brace
  - High schoolers will be the testing cohort

Data Collection and Expected Results

- Take in separate numerical data from all sensors
- Write a Java program with conditional logic taking in combined input from all the sensors and establishing criteria that would signify a bleed
- Test extensively for false positives or failure to recognize bleed conditions
  - Normal physical activity will be used to simulate the conditions in which a joint bleed can occur
  - Bleed conditions
    - increase in skin temperature above 98.4 degrees ALONG WITH decrease in mobility (do an ANOVA between the three degrees of joint mobility for a person)
  - Improve code or prototype in response
- Expected results: High skin temperature, and limited angle ranges signify a joint bleed in which case an LED light will turn on.
  - If time permitting, put the data into an app to eliminate incidents where the LED fails to function or runs out of battery

Safety

No inherently dangerous tools are being used, however, if there is a need to use school engineering lab equipment, all necessary safety precautions will be taken and someone else will be in the room supervising me while I am using equipment.

An informed consent form will be provided to all test subjects saying that they have the right to stop testing at any point and their data will be kept anonymous. The subjects will only have to walk around with a brace for the duration of one school day. The brace is an Ace Dual Reinforcement knee brace designed for comfort and protection, and because it is adjustable, there is no risk of the brace being too tight. The knee stabilizers that the brace comes with are designed to still allow mobility while creating a stiffer environment as to prevent injury. The stabilizers will be used as one degree of the independent variable in this experiment, and because they are meant to be worn as part of the brace, there are no added risks associated with them.

Bibliography:


