Animatronic Hand

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Special Thanks to:
Duane L. Marcy & William C. Tetley

Hardware Components

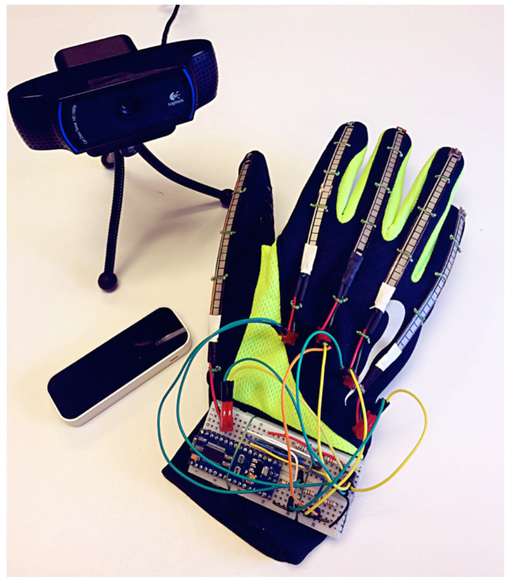
- **Glove with flex sensors:** Capture the finger motion
- **Robotic hand:** Flexible joints driven by servos, 3D printed model
- **Leap motion:** Detect the hand movement
- **Camera:** High resolution live video stream
- **Step motors and timing belts:** Drive the X-Y axis of the belt tensioner
- **Beaglebone and Arduino:** Embedded system

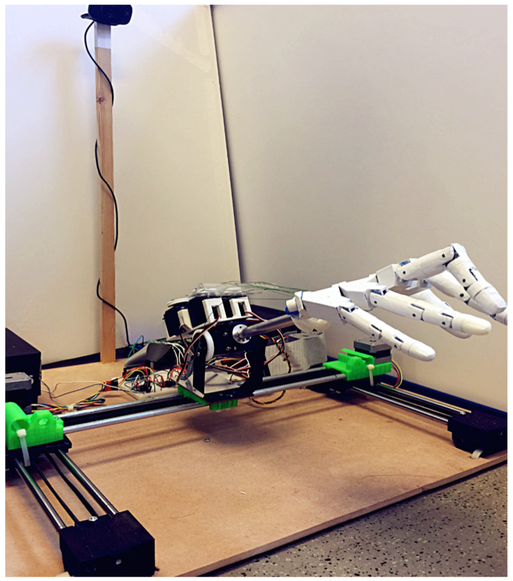
Software Implementation

- **Python in Beaglebone:** GPIO to control stepper motors, UART to transmit data to Arduino , TCP and UDP , and Multi-threading for synchronization
- **C# in PC:** Leap Motion, Video Transmission, GUI, OpenCV (Skin Color detection (HSV), Surf FeatureDetector)
- **C in Arduino:** Detect sensors, control servos, and data Mapping

System Description

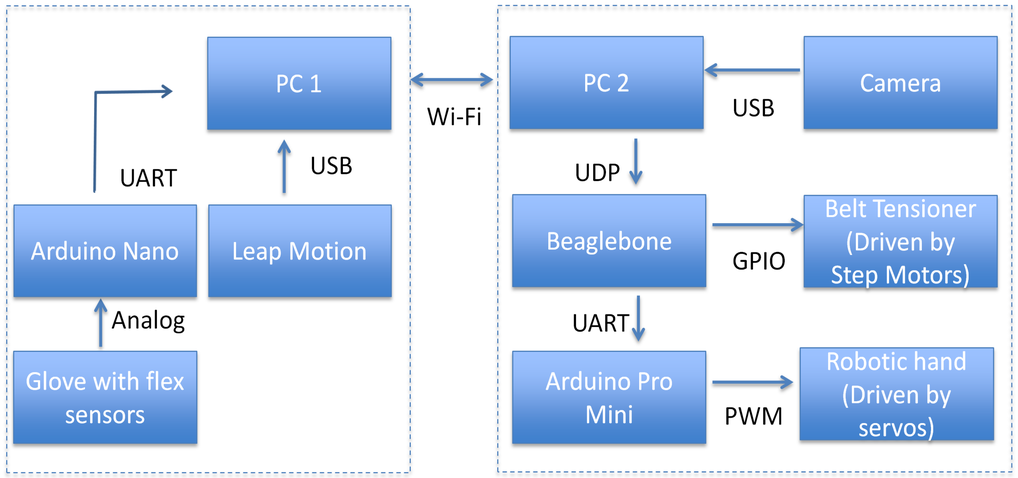
Animatronic Hand is a robotic hand with flexible joints. It is wirelessly (Wi-Fi) controlled by leap motion and a customized glove with flex sensors, which are used to detect the movement of user's fingers. Therefore, after putting on the glove, the hand movement will be immediately performed by the robotic hand.





System Architecture

- Smooth rods, bearings, step motors, servos
- Beaglebone Black, Arduino
- 3D – printed robotic hand
- Customized glove with flex sensors
- Camera, leap motion
- Pulleys, timing belts



Application

- **User Control:** Users put on a customized glove and control the hand gestures of the robotic hand, while leap motion captures user's hand position.
- **Imitation:** Using OpenCV to track hand gesture and the robotic will imitate immediately.
- **Auto painting:** Robotic hand is able to print out English Alphabets automatically according to the user's input.

Engineering Challenges

- **Agility and power of robotic hand**
  - The fingers of robotic hand are as flexible as human fingers, and has enough power to move certain objects.
- **Mechanical System Balance**
  - The belt tensioner system hold and move the robotic band stably.
- **Wireless Communication**
  - The communication between the Animatronic Hand system and control workstation
- **Control system feedback**
  - The robotic hand reacts to the users' control immediately.
- **Image processing**
  - The camera captures and analyses the users' hand gestures accurately.
- **Synchronization**
  - Data synchronization