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EMG sensor on Human limb

Design Credit Project

Submitted by:

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Objectives:

- To integrate EMG sensors with IMU sensor set-up for measurement of muscle stress.
- Conduct experiments to verify the working of IMU sensors and EMG sensors together.

Overview:

In this project, we will discuss

- Electromyography technique
- The components used
- The connections between those components
- The results we have obtained using electromyography technique for people with different strengths.

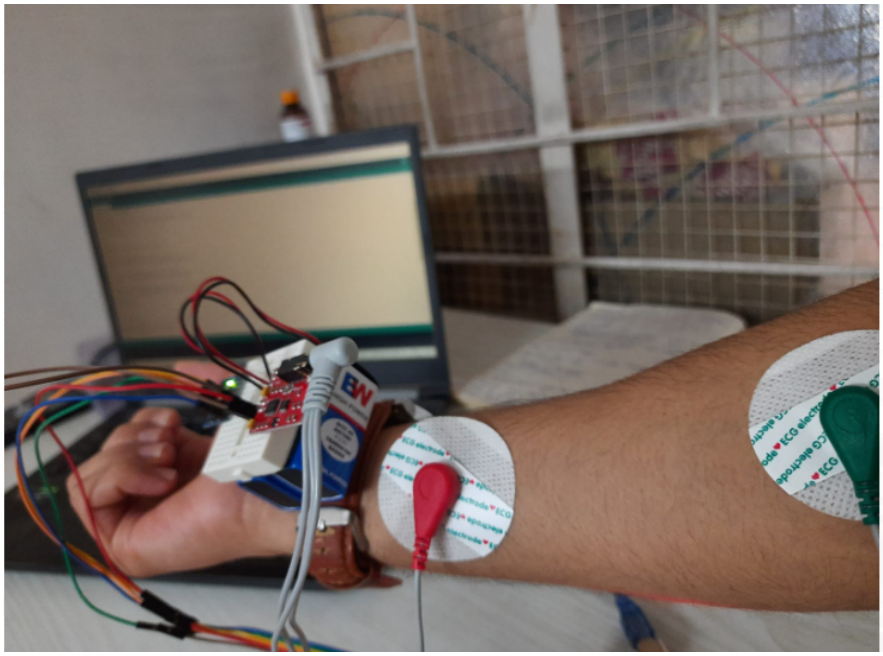
Electromyography:

Electromyography (EMG) is an electrodiagnostic medicine technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG is performed using an instrument called an electromyograph to produce a record called an electromyogram.

Electromyography signal is an aggregate electrical signal from skeletal muscle which denotes the electrical activity of a muscle during contraction which is reliant on the anatomical and physiological properties of the muscles. The electric signal produced during muscle activation, known as the myoelectric signal, is produced from small electrical currents generated by the exchange of ions across the muscle membranes and detected with the help of electrodes.

EMG sensor, also known as electromyography sensor is one that measures electrical signals generated by your muscles when you move them.

Most of the standard EMG measurement systems are expensive and not feasible for personal applications.

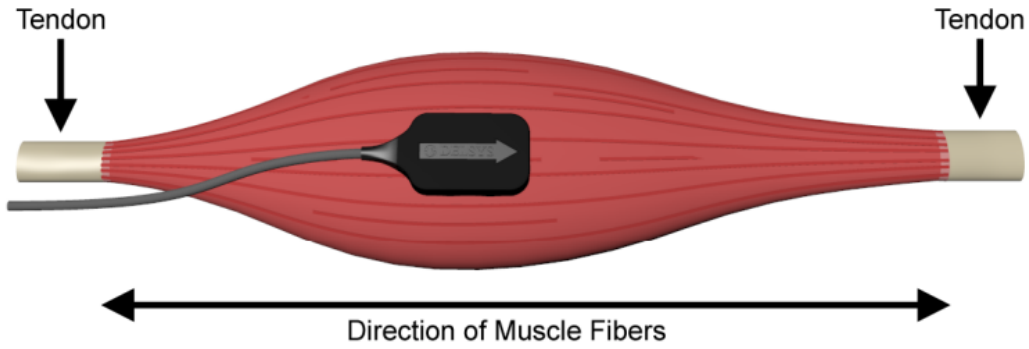


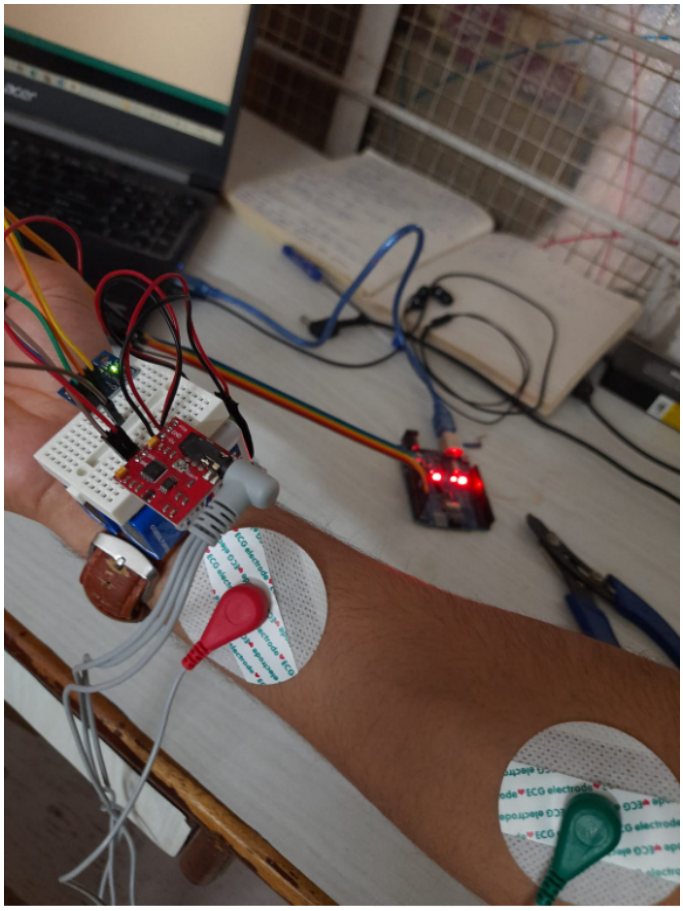
EMG sensor location:

Proper EMG sensor location is critical for detecting quality surface EMG signals. The user should consult an anatomical atlas to determine the precise location, origin, insertion, and function of the muscle being studied as well as any nearby muscles that may produce undesirable signals (crosstalk).

1. Place the sensor along the longitudinal midline of the desired muscle with the arrow parallel to the muscle fibers.
2. DO NOT place the sensor at the outside edges of the muscle. In this region, the sensor is susceptible to detecting crosstalk signals from adjacent muscles.
3. Place the sensor between a motor point (innervation zone) and the tendon insertion or between two motor points.
4. DO NOT place the sensor on or near the motor point. The motor point is that point on the muscle where the introduction of minimal electrical current causes a perceptible twitch of the surface muscle fibers. This point usually, but not always, corresponds to that part of the innervation zone of the muscle with the greatest neural density. This is a poor location for a surface EMG sensor because the electrical activity propagates in multiple directions and, therefore, cancels itself out when differential amplification is used.
5. DO NOT place the sensor on or near the tendon of the muscle. As the muscle fibers approach the fiber of the tendon, the muscle fibers become thinner and fewer in number, reducing the amplitude of the EMG signal. Also in this region the muscle is physically smaller, which makes it difficult to accurately place the sensor and to avoid crosstalk from adjacent muscles.

6. Once the general location for the sensor is determined, contractions of the muscle should be performed to ensure that quality signals are being detected. The location can be easily adjusted to find the optimal position. As the desired muscle is contracted, the location of the sensor is slightly shifted until the detected signal is maximized. In the same way, the sensor can be moved to minimize the detection of surface EMG activity from adjacent muscles

7. 

8. 

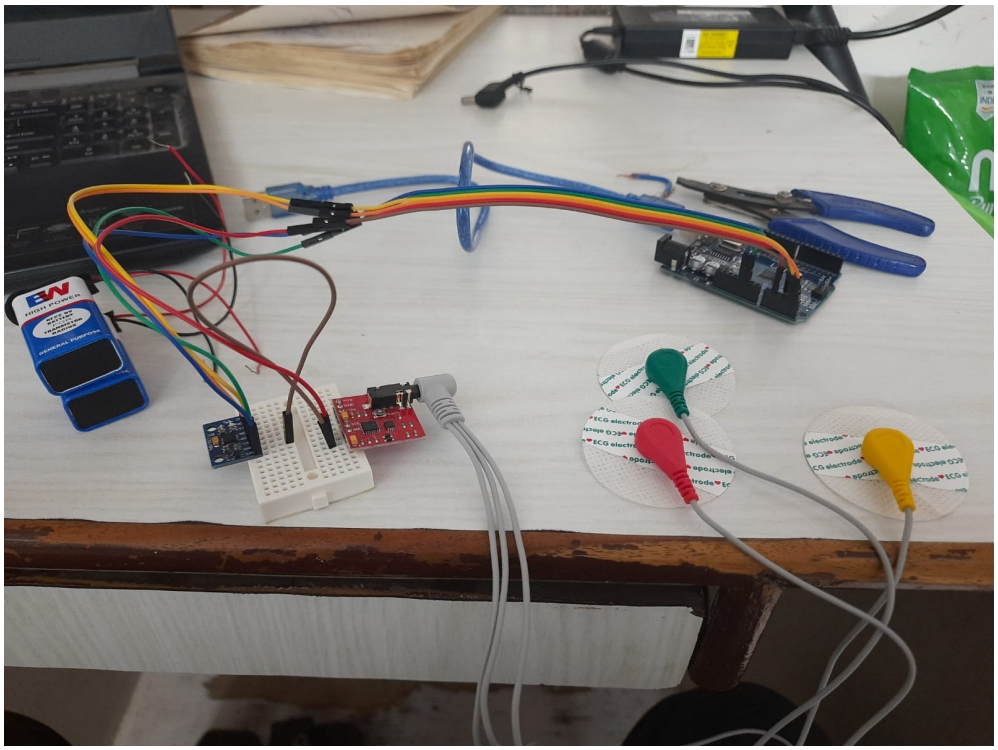
What is an EMG sensor used for?

EMG sensors are mostly used for biomedical applications that range from:

- Helping doctors diagnose muscle and nerve disorders of patients for early prevention/treatment
- Research tool for kinesiology
- A control signal for prosthetic devices; hands, arms, and lower limbs

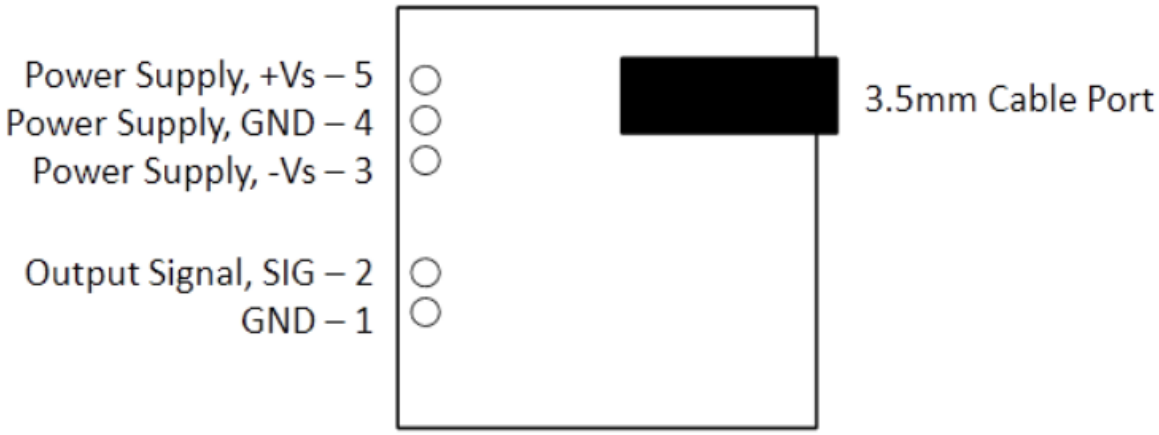
Components:

1. Arduino
2. EMG sensor
3. Electrode pads
4. Connecting wires and jumper wires
5. 9V batteries x 2



Components

Interfacing EMG sensor with Arduino:

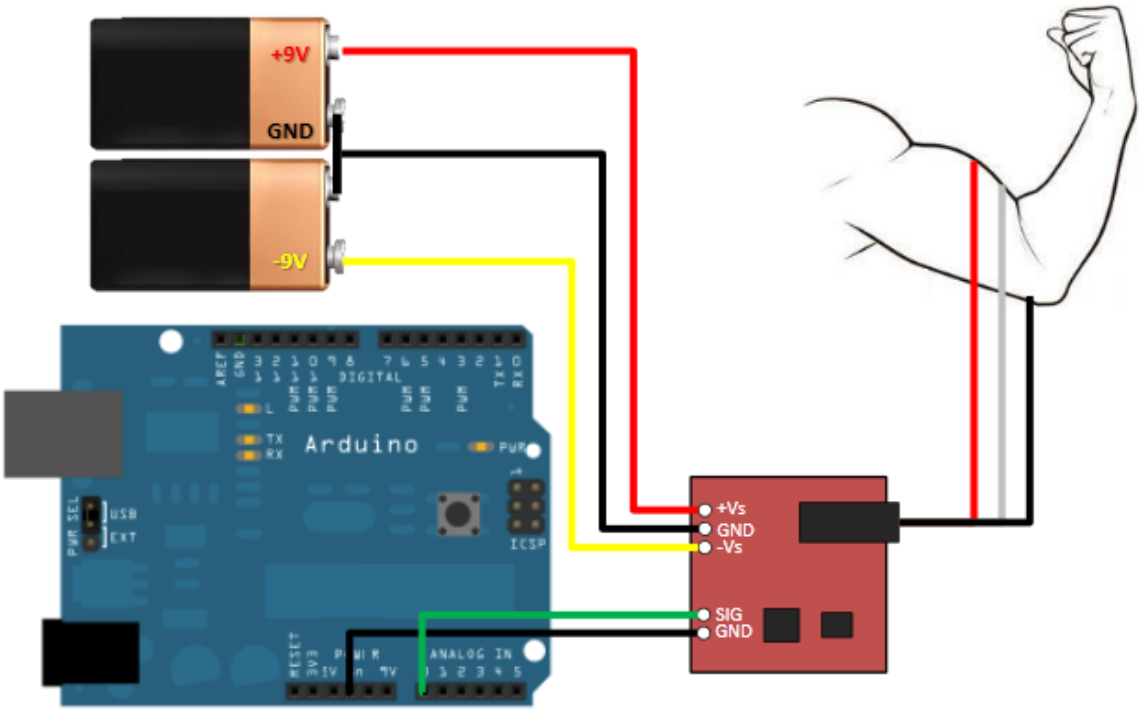


EMG sensor includes a 3 pin set and a 2 pin set.
A 3-pin set that includes +Vs, GND, and -Vs terminals.
A 2-pin set that includes the signal and GND terminals. It's used to interface the board with the microcontroller.

To begin, you'll need the two 9V batteries. Connect the positive terminal of one battery to the +VS pin. Then, connect the negative terminal of that same battery with the positive terminal of the second battery, joining it to the GND pin in the 3-pin header.

Next, connect the negative terminal of that second battery to the -Vs pin. This provides the +/-9V dual-supply to the sensor.

To interface with Arduino, connect the GND pin in the 2-pin header to any of the two ground pins on Arduino UNO. Lastly, connect the signal pin to any analog input pin, such as A1.



Connections

Ensure the 3-lead cable that's equipped with a 3.5mm jack, is connected to the sensor board. The EMG/ECG electrodes can, then, be attached to the cable.

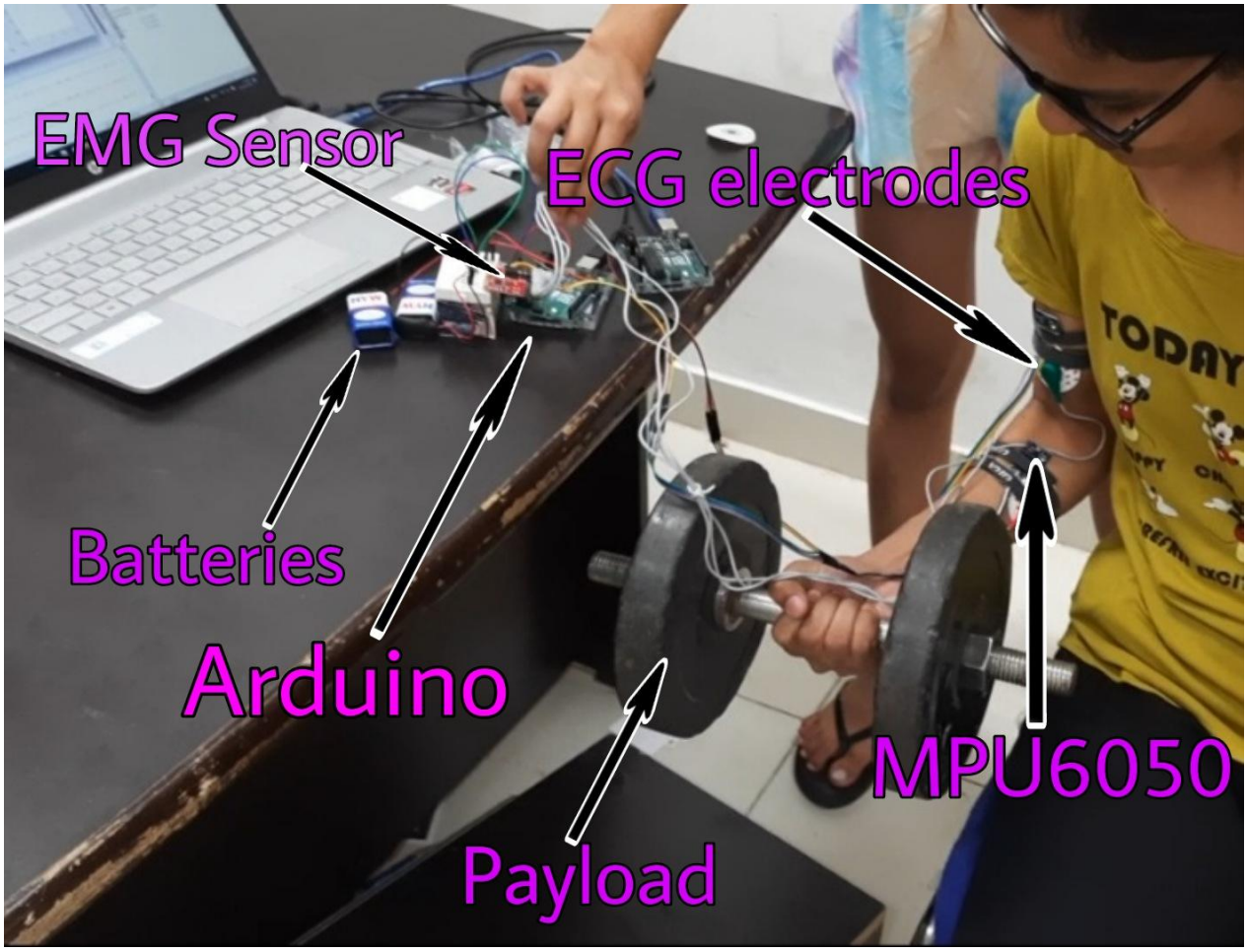
Pick a muscle group to monitor, such as a bicep or calf. Place one electrode in the middle of this muscle group and attach the red cable's snap connector to this electrode. Next, place a second electrode at one end of this muscle group, attaching the green cable's snap connector to this electrode.

Then, place the third electrode on a bony or non-muscular part of the body that's near the same muscle group. Attach the yellow cable's snap connector to this electrode.

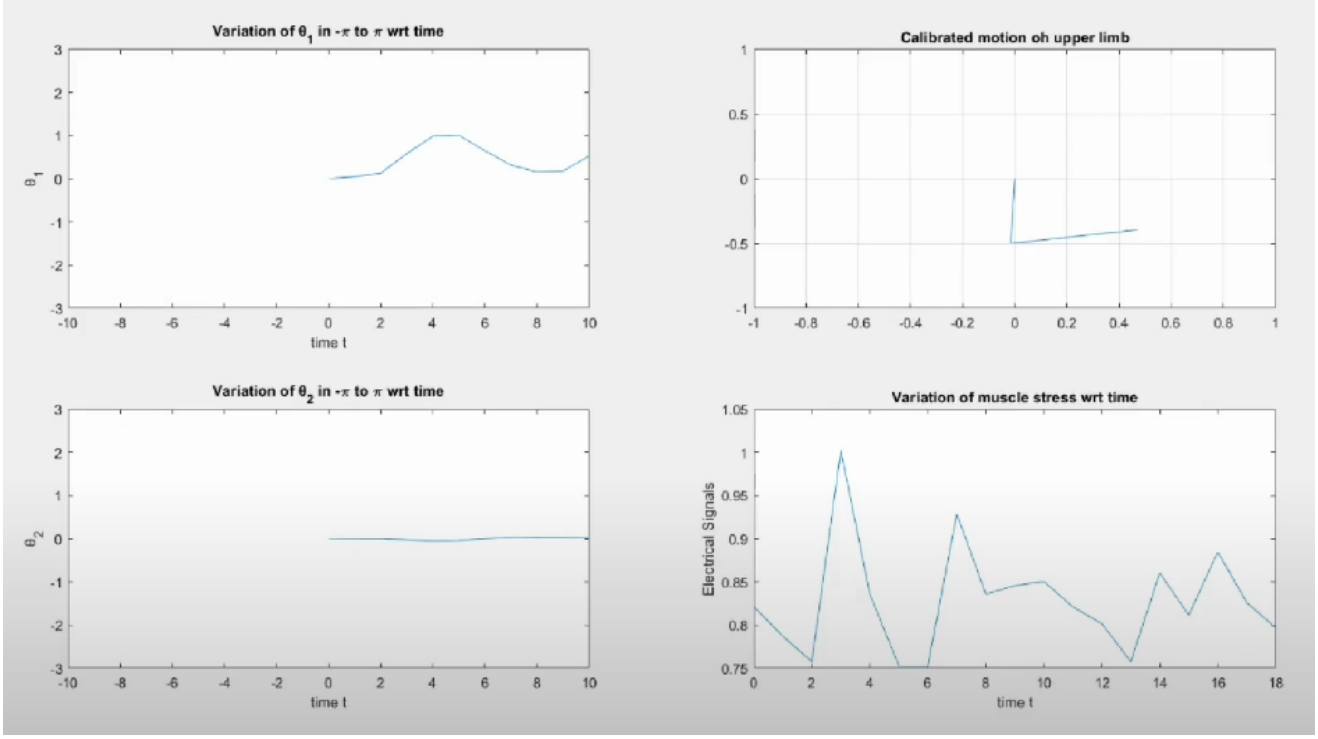
Arduino code:

```
int emg_pin = A1;
int emg_val = 0;

void setup()
{
  Serial.begin(115200);
}

void loop()
{
  emg_val = analogRead(emg_pin);
  Serial.println(emg_val);
  delay(50);
}
```

Integrating EMG sensor with IMU sensor set-up:

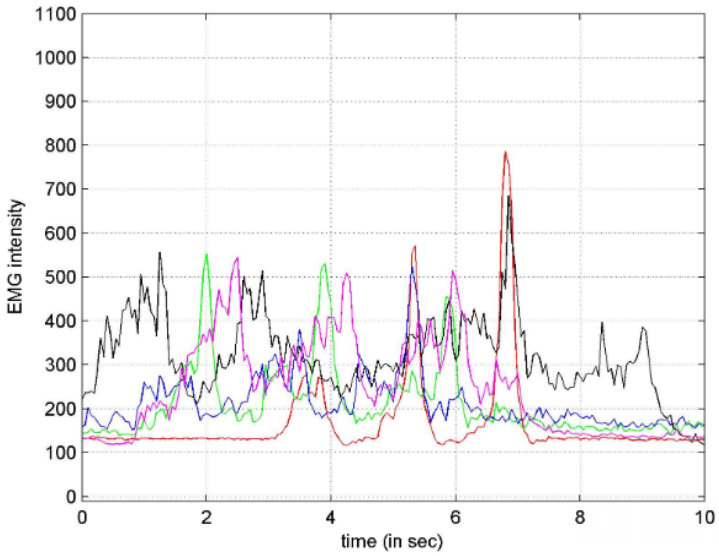


Getting the EMG signals and IMU readings

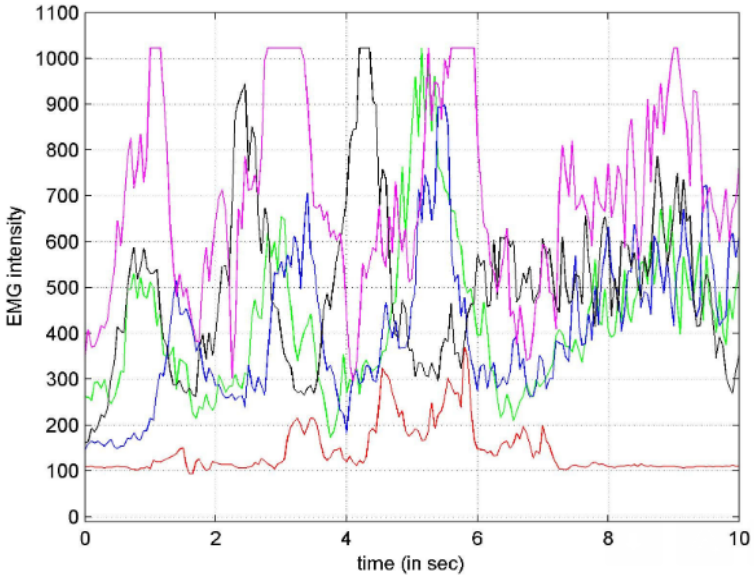


In the above figure, the 1st plot is showing the forearm angle, the 2nd plot(bottom left) is showing bicep angle. The 3rd graph is the real time simulation of human limb and the 4th plot has the EMG signal data.

Observations:



Emg data for regular Gym-goers



Emg data for non Gym-goers

Conclusion:

- We can see from the above two results that the EMG signal for gym-goers is less as compared to the non gym-goers because their muscles are developed after lifting heavy weights for a long time.
- The EMG sensor and the IMU setup are integrated.

References:

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