IBE Lab Report - 3

Introduction to Bio-Potential Signals

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AIM:

1. Understand the fundamentals of biopotential signals and their use in clinical applications.
2. Learn the physiological mechanisms behind each signal and how they can be used to diagnose medical conditions.

MATERIALS REQUIRED:

1. Maker Uno
2. Amplifier
3. Electrodes
4. Wires

THEORY:

A. Electrocardiography (ECG)

ECG is a measurement of the electrical activity of the heart over time. It is commonly used to diagnose heart conditions such as arrhythmias, heart

attacks, and heart failure. ECG is a non-invasive procedure that involves placing electrodes on the skin (near the nerve on the wrist).

B. Electromyography (EMG)

EMG measures the electrical activity of muscles. It is used to diagnose neuromuscular disorders such as muscular dystrophy and nerve damage. EMG is a non-invasive procedure that involves placing electrodes on the skin or inserting needles into the muscle.

C. Electroencephalography (EEG)

EEG measures the electrical activity of the brain. It is used to diagnose conditions such as epilepsy and sleep disorders. EEG is a non-invasive procedure that involves placing electrodes on the scalp.

D. Electrooculography (EOG)

EOG measures the electrical activity of the eye muscles. It is used to diagnose conditions such as eye muscle weakness and nerve damage. EOG is a non-invasive procedure that involves placing electrodes around the eyes.

PROCEDURE:

1. The connections between the amplifier and the Maker Uno were made as in figure 1 below.

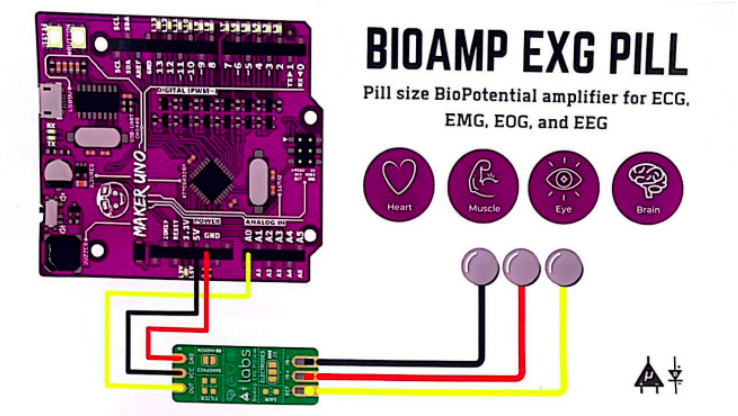


Figure 1: Circuit Diagram

2. After this circuit was completed, the three electrodes were placed at different places on the body to collect the signals from those locations. The placement of the electrodes for each signal can be seen in figure 2.

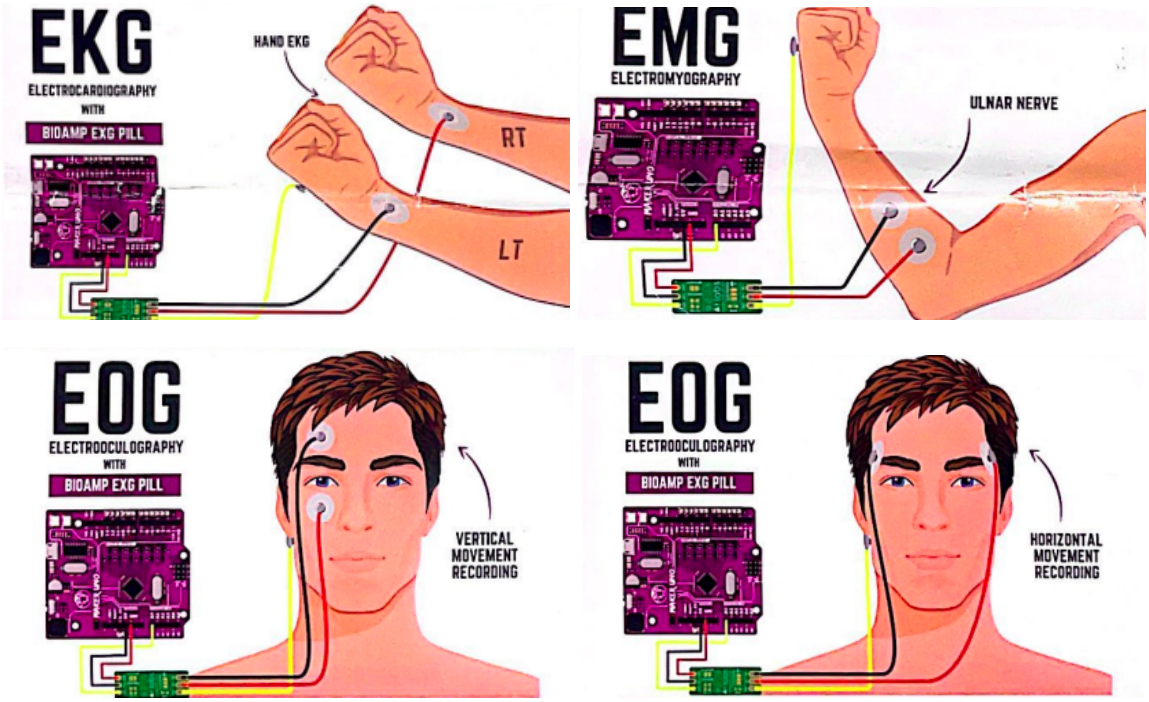


Figure 2: Placement of Electrodes for collection of various signals

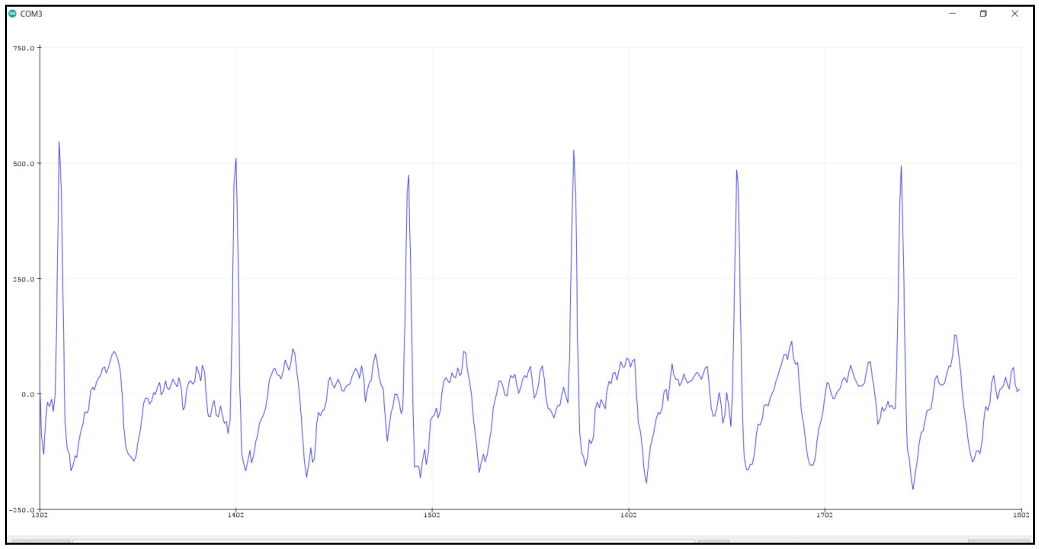
3. The EMG, EKG, EOG signals were collected. The horizontal and vertical movement variations were recorded for the EOG signals.
4. The signals were plotted and observed.

OBSERVATIONS:

A. Electrocardiography (ECG)

The signal from the electrode is read and visualized using the Serial Plotter of the Arduino.

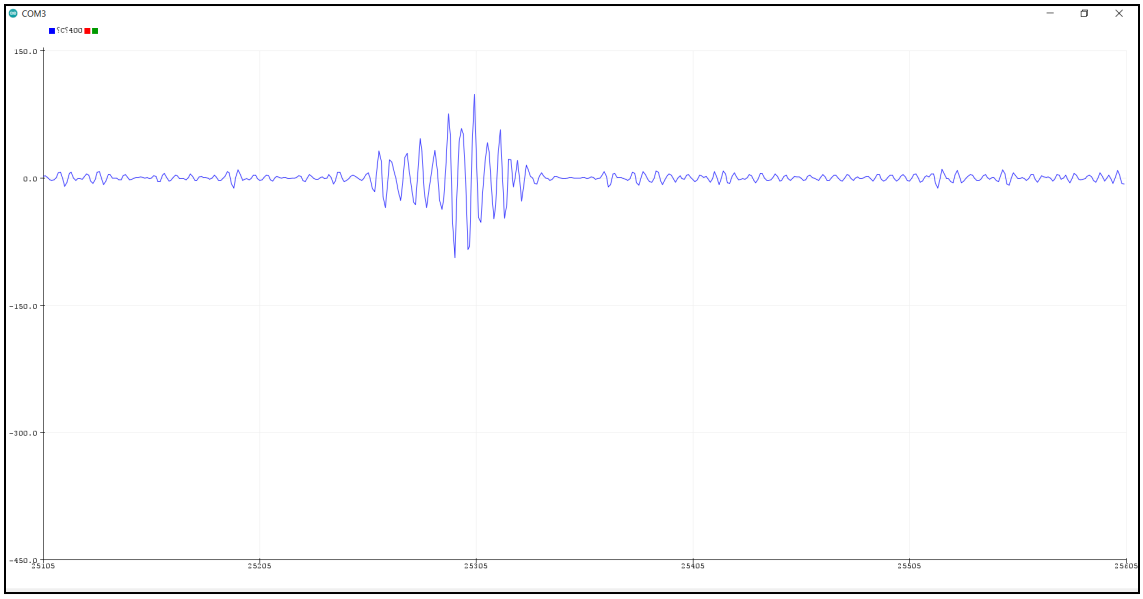
SIGNAL READ:



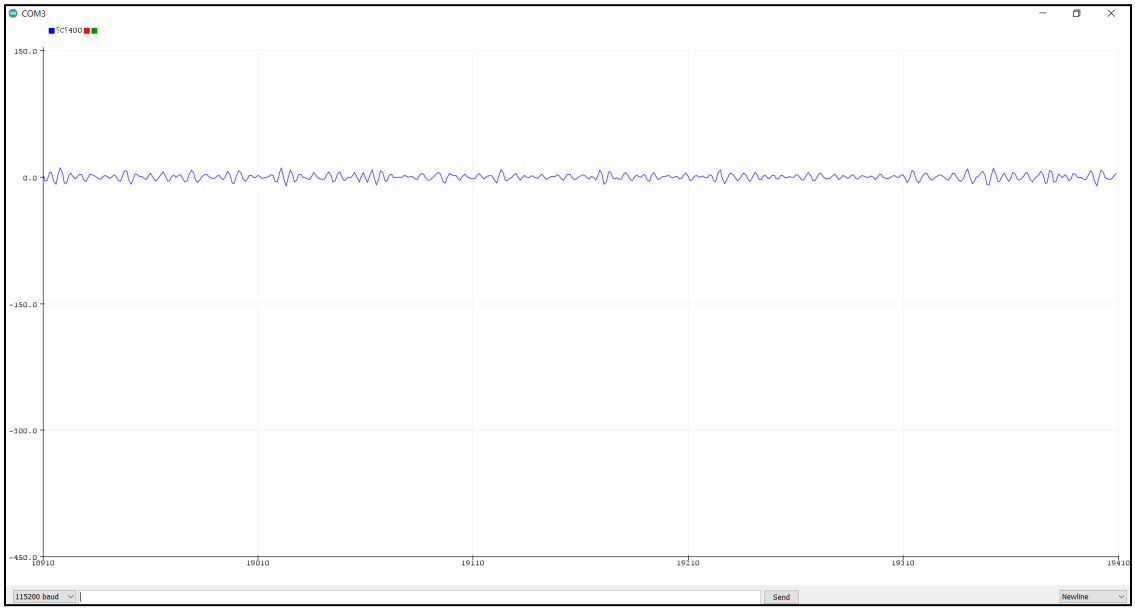
B. Electromyography (EMG)

Once again, the signal from the electrode is read and visualized using the Serial Plotter of the Arduino. This time we also measure a 'base signal', which is the signal output when no input is given (i.e, no movement).

SIGNAL READ:



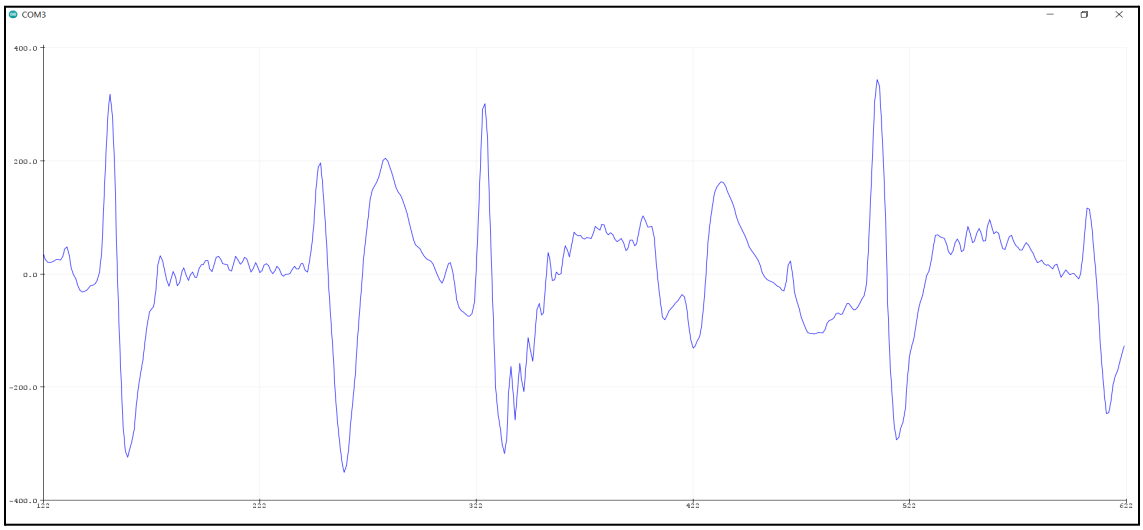
BASE SIGNAL:



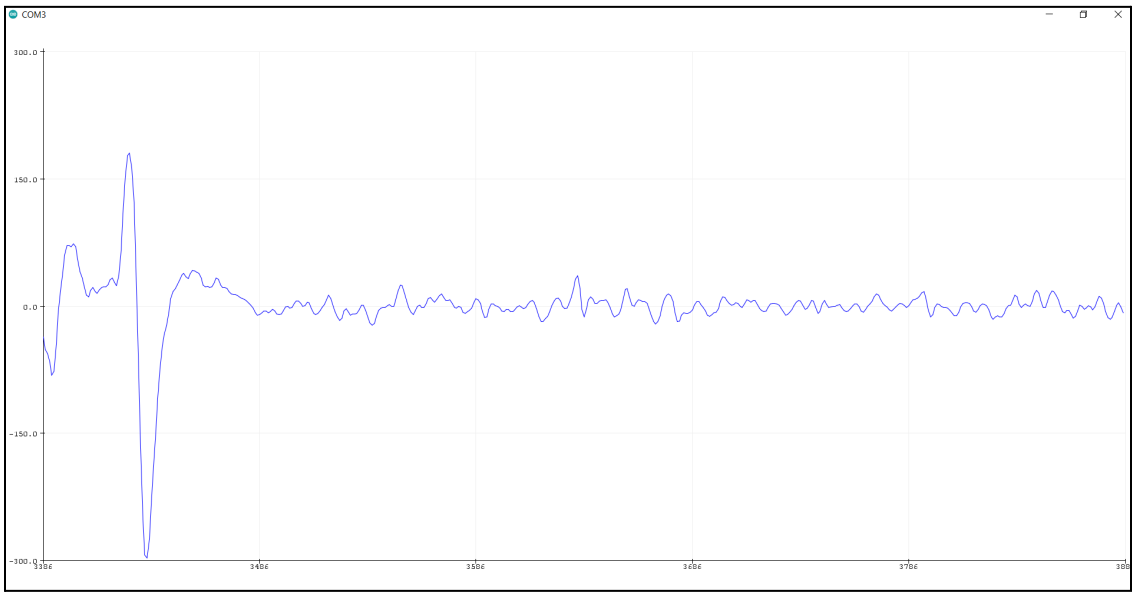
C. Electrooculography (EOG) - Vertical Movement

Just like an EMG signal, we measure the signal when the eyeball is moved vertically. We also measure the base signal when no movement occurs.

SIGNAL READ:



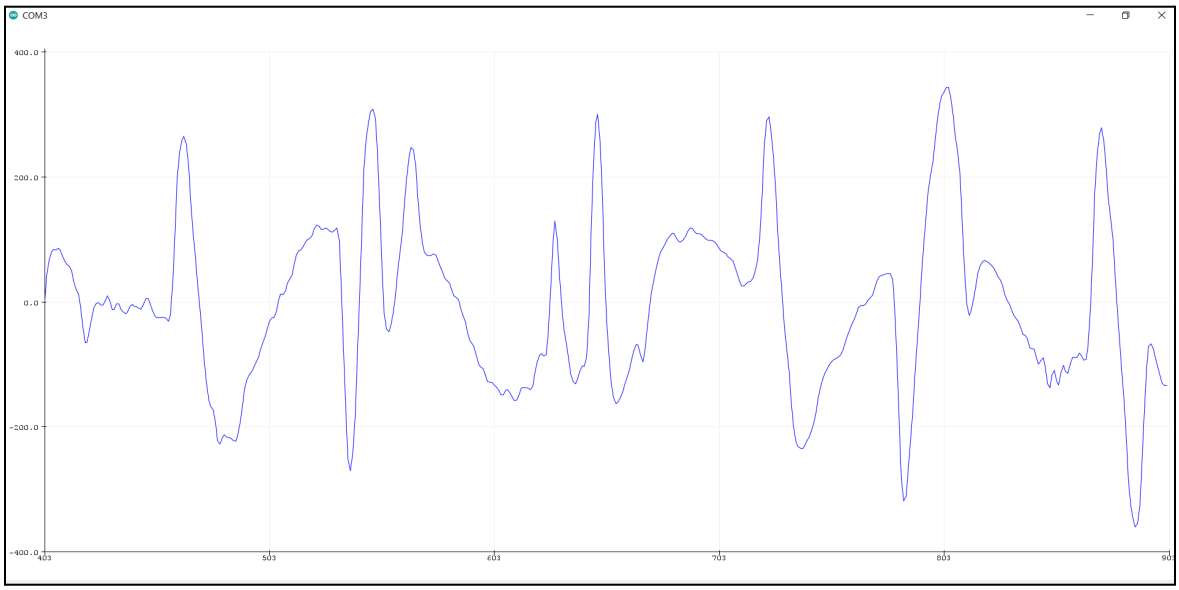
BASE SIGNAL:



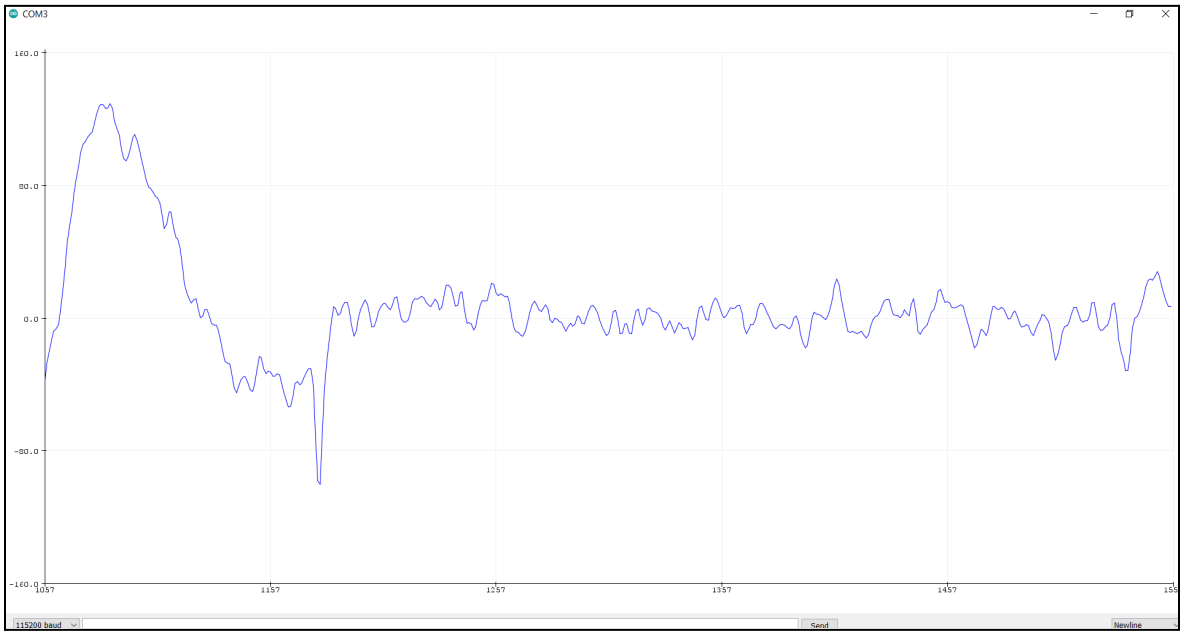
D. Electrooculography (EOG) - Horizontal Movement

We repeat the same procedure as EOG vertical movement, except this time, we move our eyes horizontally instead vertically.

SIGNAL READ:



BASE SIGNAL:



APPLICATIONS:

The measurement of all these bio-potential signals have a number of uses in the field of medical analysis. Some are mentioned below.

A. Electrocardiography (ECG)

An aberrant heart rhythm that can point to the presence of a cardiac ailment can be found with the use of an ECG test. Heart attacks, strokes, and heart failure are problems that can be avoided by early identification and treatment of cardiac diseases. In order to assess the heart's reaction to exercise and identify underlying cardiac problems that can become worse with exercise, ECG can also be employed during exercise stress testing. In general, ECG is a useful tool for the early diagnosis and treatment of heart disorders in those who are at risk.

B. Electromyography (EMG)

Using EMG signals, the motion control aspect of exoskeleton robots can be controlled. Exoskeleton robots are mechanical constructions that contain actuators for influencing human motion by being attached to human body parts. This is helpful for rehabilitation training of disabled individuals, or for recovery from accidents and surgeries. This is an active area of research.

C. Electroencephalography (EEG)

EEG is also used in the field of neuromarketing to study consumer behavior and preferences. One of the main advantages of using EEG in neuromarketing is that it provides a direct measure of brain activity, which is thought to be closely linked to consumer behavior. By analyzing the EEG

signal, researchers can identify patterns of brain activity that are associated with specific emotions, cognitive processes, and behaviors.

D. Electrooculography (EOG)

Sleep stage classification is an important task for the timely diagnosis of sleep disorders and sleep-related studies. Surprisingly, EOG can help us determine which sleep stage a person is currently in. This process is called 'Sleep-stage scoring'.

EOG records eye movement by detecting the voltage difference between the cornea and the retina. Sleep can be divided into six stages and each stage is characterized by a unique eye movement. Abnormalities in the eye movement of each stage can be detected and specific solutions can be applied to correct it.