Electromyography

- Eswara Rohan (2020102002)

Aim –

To develop EMG Signal acquisition system which is generated by the muscle action potentials triggered by external or internal simulations. The outcome should be more filtered and noise free so that it can be integrated into fields like diagnosis and prosthesis.

Introduction –

Electromyography (EMG) is a technique for evaluating and recording the electrical activity produced by skeletal muscles performed using an instrument called an electromyograph to produce a record called an electromyogram. The test is used to help detect neuromuscular abnormalities.

EMG measures the electrical activity of muscle during rest, slight contraction and forceful contraction. When a muscle fibre is stimulated, an action potential propagates along the fibre membrane in both directions away from the neuromuscular junction. Circuit design which is able to extract EMG signals with the help of surface electrodes.

Description –

In the first part, single channel EMG signal is obtained from human muscle using non invasive electrodes. This signal has no practical use as the captured signal is in mV range and also contains wide range of signals coming from other body parts than muscle (Noise). So, further this EMG signal is processed by the signal acquisition circuit to get desired outcome.
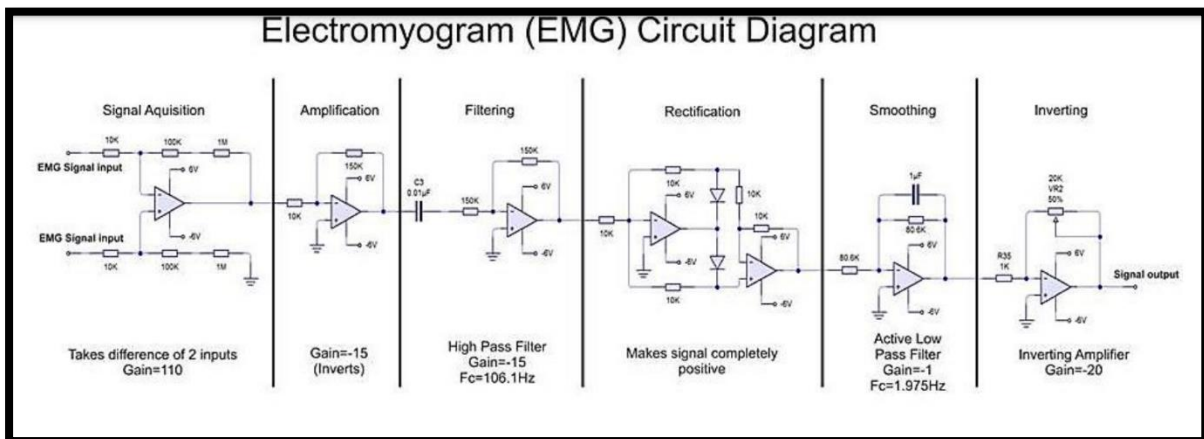
Electromyography

Procedure –

1) Extraction of single channel EMG signal –

At first, we apply electrode gel to the skin where the surface electrodes are needed to be placed. This increases the conductivity of the surface. These electrodes are of two types – Electrodes for the simulation and the electrodes for recording electrical signals. Further, electrodes for recording electrical signals are divided into two types – Firstly, needle electrodes which are inserted into the muscle to record signals or electric potential at muscles directly and secondly, sheet of electrodes placed on skin used to record muscle electrical signals to indicate weight.

2) Signal acquisition circuit–

Since the EMG signal is too small, Enhance circuit is needed.

Electromyogram (EMG) Circuit Diagram

Sequential arrangement of amplifiers provides a two-step filtration which reduces associated distortions of the source signal. Additionally, the proposed design allows ample amplification for user viability

Electromyography

Enhance circuit consists of 6 sectors −

1) Difference− Measure difference between the input signal.

2) Amplification− Amplifying the signals from the differential circuits.

3) High Pass Filter − Since EMG Signal obtained has a lot of unwanted noise and offset voltage, it can affect the signal analysis. Thus, an active high pass filter is applied in the signal acquisition circuit to eliminate offset voltage and reduce noise.

4) Rectification − Generally, the EMG signal will be fluctuating in the range between positive and negative value during the muscle movement. This circuit is responsible for converting the negative wave to positive waveform.

5) Smoothing − The process of smoothing the signal is done by an low pass filter. Low pass filter will only allow the low frequency and block the high frequency. Hence, it able to smoothing the fluctuated EMG signal by using the low pass filter.

6) Inverting Amplifier − Inverting Amplifier is used here to amplify and invert the signal.

Comparision Of Circuits Studied -

### 1) Analog reconfigurable technologies for EMG signal processing-
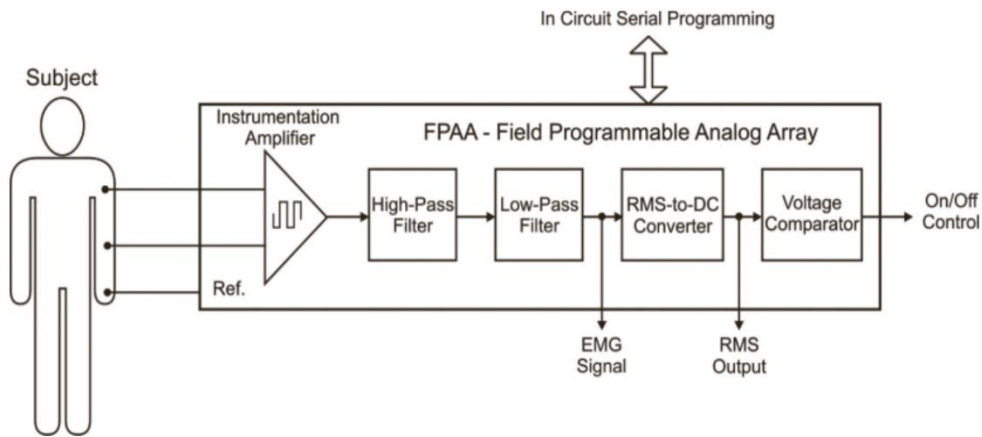
In this circuit, Field Programmable Analog Array (FPAA) is used as they allow to have complete analog circuits required in one single component which is programmable.

The advantage of this circuit is it provides better reliability and flexibility of the system and a reduced size and cost of the circuit.

The disadvantage of this circuit is that CMRR can be even higher in order to have better suppression of noise signals.

Electromyography

2) Design of an Electrical Prosthetic Gripper using EMG and Linear Motion Approach
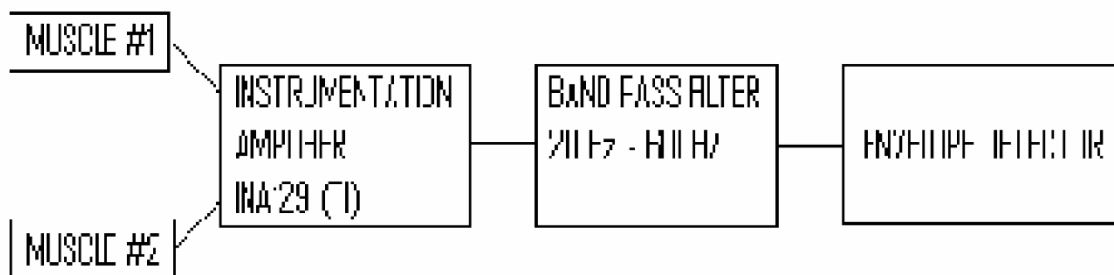
In this circuit, INA129 is used as instrumentation amplifier. The main advantage of this is it gives good accuracy and it is a low power instrumentation amplifier. The output of the instrumentation amplifier is then passed through a band pass filter designed for frequencies 20HZ to 650HZ.
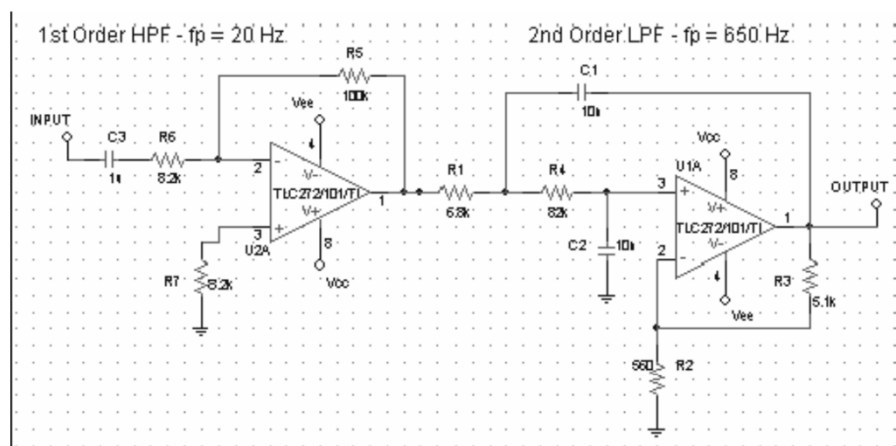

Fig. 5.   Schematic diagram of the Band Pass Filter [12].
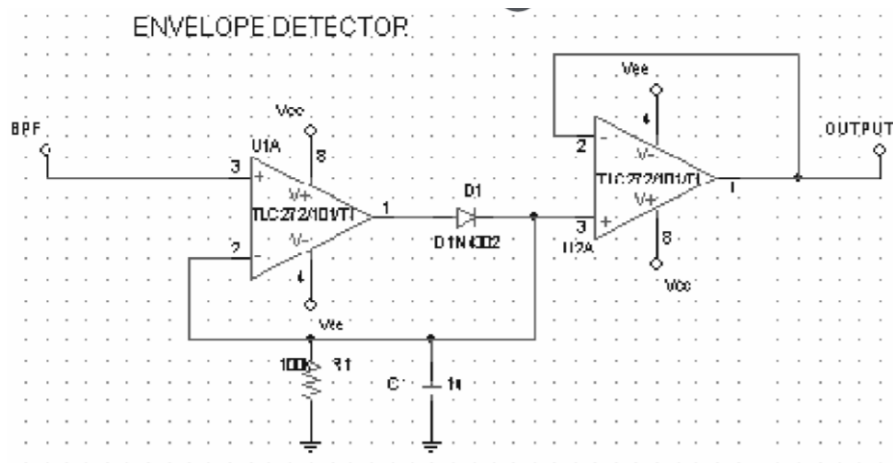
Electromyography

Fig. 6. Schematic diagram of the Envelop Detector [12].

The disadvantage of this circuit is that the CMRR of Instrumental Amplifier can still be kept higher by selecting some alternative, cost of the Instrumental Amplifier is on the higher side, and instead of envelop detector a simple rectifier circuit can be used, which will not only keep the cost of the complete circuit less but will also keep the dimensions of the circuitry smaller.

3) <u>Fuzzy Control of a Robotic Arm using EMG Signals</u>

Fig. 7. Schematic diagram of DRL circuit [15].

This does not employ an off the shelf Instrumental Amplifier instead a circuit of Inst Amp having a CMRR of 46 dB along with a driven-right-leg (DRL) circuit to further boost the CMRR is used.

The signal is passed through a high pass filter and then through a low pass filter to remove higher frequencies over 1KHZ to evade aliasing effects.

The main disadvantage of this circuit is it has low CMRR and the limit of Low Pass Filter is unnecessarily kept high.

Advantages Of EMG Signal –

1) EMG Signal is vital to analyse a patient's health condition and therefore can be of great importance in the diagnostics sector in the healthcare system.
2) As constructed here, cost-effective bio signal acquisition system will uplift the bio signal extraction research sector of the underdeveloped and developing countries of the world.
3) The purpose of this EMG system is to help weak or elderly people to check their muscle strength level and acquire useful muscle signals for rehabilitation purposes.
4) In prosthetic arms, the electrical signal generated by EMG is used to control the servo motor helping the disabled people.
5) Electromyography (EMG) signals can play a pivotal role in the field of active prosthetic devices and also in determining the abnormality in muscle activities which leads to various diseases.

References –

1) IEEE – Design and Analysis of an Electromyography (EMG) Signal Acquisition System By – MD ZAHIRUL ALAM CHOWDHURY, DIVYA PRADIP ROY
2) IEEE – Optimized Circuit for EMG Signal Processing By – Ali Salman, Javaid Iqbal, Umer Izhar, Umar Shahbaz Khan, Nasir Rashid
3) IEEE – Electromyogram (EMG) Signal Processing Analysis for Clinical Rehabilitation Application By – Ismail Saad, Nur Husna Bais., Bun Seng C., Mohd. Zuhir H., N. Bolong
4) IEEE – Artificial Human Arm Controlled by Muscle Electromyography (EMG) By – Chanin Joochim, Nuttawut Siriwatcharakul.
5) Analog reconfigurable technologies for EMG signal processing
6) Design of an Electrical Prosthetic Gripper using EMG and linear motion approach.
7) Fuzzy control of a Robotic Arm using EMG Signals