Bionics using EMG

Abstract-

The project Investigate the usability of muscle contractions detected by surface electromyography (EMG) Sensor as an input channel for a gestural or electrical device such as a robotic arm. A wearable prototype consists of a sensor, an amplification and filtering unit, a microcontroller unit and actuators. Signal detection techniques will be used to detect muscle contractions which will in turn control the actuators of the robotic limb. Extensive research is needed to respond to precisely control the arm by the contractions.

I. INTRODUCTION

More than 50% of physical disability comes from the amputees worldwide. Although there are products that are available in the market to counter the disability but it is either not practical or are very expensive. So, our aim is to develop a market ready easy to install prototype of a Bionic arm using cheap alternatives which is light weighted, comfortable and most importantly affordable

II. STUDY OF SIMILAR PROJECTS OR TECHNOLOGY\ LITERATURE REVIEW

Extensive research is already been done in the same field like the work is been done by researchers in the Institute of Electronic Music and Acoustics, Graz. Electrolarynx Control using Electromyographic Signals being there major field of implementation. Another company open source company and the only we are aware of is Open Bionics which makes customizable prosthetic arms for the upper amputees. But their product starts from around 6500$ (₹ 484,480/-).

III. TECHNOLOGY USED

1. **Electromyogram:** In 1990 Knapp and Lusted introduced "Biomuse" [1]. a bioelectric controller for computer music applications This system consists of two separate components. A bioelectric interface and a signal processing unit. The bioelectric interface consists of electrodes and sensors that are placed on the user's body, which sense Electromyography (EMG) , Electroencephalography (EEG) i.e. the brain's electrical activity, and EOG (Electrooculography) i.e. eye movement activity. The incoming signals are connected to a patch box and are then processed in the signal processing unit. There the signals are digital-analog converted, filtered and analyzed by a digital signal processing (DSP) chip. The unit analyses all input signals in real-time and receives and sends information to a host computer over a standard RS-232 serial interface. In addition, it receives and sends MIDI information. The Biomuse can be used to control synthesizers, sequencers, drum machines, or any other MIDI device.

2. **Digital Signal Processing:** It is the use of digital processing, such as by computers or more specialized digital signal processors, to perform a wide variety of signal processing operations. The digital signals processed in this manner are a sequence of numbers that represent samples of a continuous variable in a domain such as time, space, or frequency. In digital electronics, a digital signal is represented as a pulse train. [2][3]

3. **3D Printing:** also known as additive manufacturing, is the construction of a three-dimensional object from a CAD model or a digital 3D model.[4] The term "3D printing" can refer to a variety of processes in which material is joined or solidified under computer control to create a three-dimensional object,[5] with material being added together (such as liquid molecules or powder grains being fused together), typically layer by layer.

IV. BASIC CONCEPTS

1. **Myoelectric Signals:** Myoelectric signals are measurable signals which appear during muscle activation. During muscle contraction, small electrical currents are generated by the exchange of ions across muscle fiber membranes [6]. There are two types of EMG: surface electromyography (SEMG, non-invasive) and needle electromyography (NEMG, invasive). Surface EMG records muscle activity on the skin surface that surrounds a muscle. Electrodes are attached to the skin and provide a crude assessment of the muscle activity below. SEMG provides information on the onset time, duration and relative intensity of muscle activation. While an electrode is placed over the muscle on the skin in SEMG, a needle inserted through the skin into the muscle is used in needle EMG. Needle EMG is more accurate and is therefore preferred in medical diagnostics for the assessment of muscle disease or ongoing pathology [7]. Invasive needle electrodes acquire signals better and can access individual muscle fibers. In surface EMG the signal is a composite of all the muscle fiber action potentials occurring in the muscles underlying the skin. Intra-muscular recordings can be painful and have only medical applications. Surface electrodes do not inflict pain to the user and for this reason they are preferred in HCI and are used in this project to acquire muscle activity in satisfactory quality, as we will see later. There are two types of SEMG electrodes: wet and dry SEMG electrodes. SEMG electrodes are applied to the skin using conductive gel as an intermediate layer to ensure good conductivity between the skin and the electrode. It is recommended to clean the skin before placing the electrodes using either rubbing alcohol or a special skin preparation fluid for SEMG.

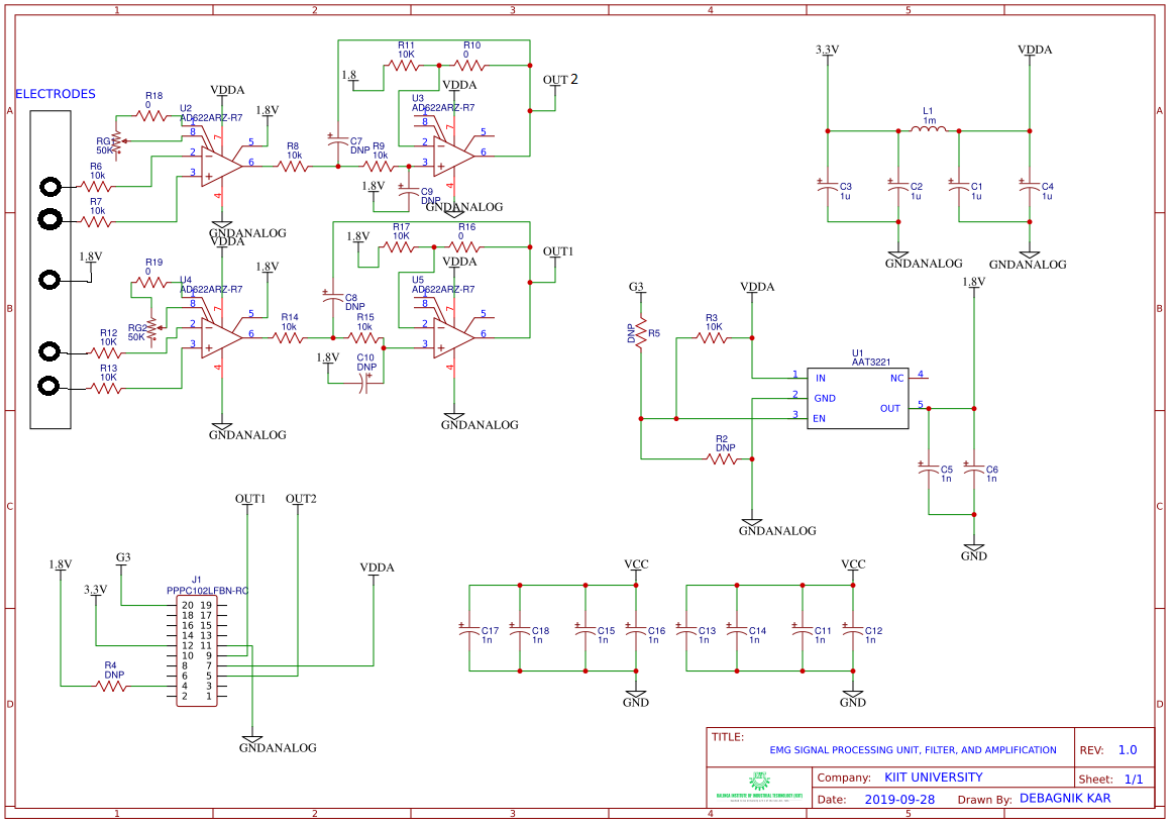
2. **Superposition of the action potentials:** The nervous system controls muscle contraction by activating discrete motor units and the corresponding muscle fibers at variable firing rates. The number of muscle fibers within each unit can vary. The activation of a motor unit leads to the activation of all its muscle fibers. Muscle tissue conducts electrical potentials similar to the way nerves do. These are called muscle action potentials (MAP). The combination of the muscle fiber action potentials from all the muscle fibers of a single motor unit yields the motor unit action potential (MUAP) [8]. This is the linear sum of all active motor units.

V. IMPLEMENTATION.

These are the plans for implementing the project it is subject to change according to the newer research. This is not the final prototype.

The Robotic arm is directly forked for the open bionics project and could be customized according to its needs.

The circuit of the sensor will be consisting of the electrodes and the amplification and filtering unit:



The output will be sent to an ADC and the to a Microcontroller to control the actuators.

VI. Conclusion:

This field is an untapped technology and a new medium of Human – Computer Interaction. Further research is needed to develop this project and bringing this to a market. Developing this sensor will also promote the use of this device in the music industry as a MIDI input.

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