SOFTWARE & HARDWARE PROJECT COMPETITION

Documented Report

(To be filled and submitted by student)

Team ID: T121	Date: 29th March, 2019 (Friday)
Room No.: Microcontroller Lab, 4th Floor	Total Number of Members: 3
Project Name: EMG Signal Processing Domain : Hardware and Software	
Grade/Remarks: Signature of Examiner 1:	Grade/Remarks: Signature of Examiner 2:

Participant Details:

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EMG Signal Processing

Introduction and description about the project

Biomedical signal means a collective electrical signal acquired from any organ that represents a physical variable of interest. This signal is normally a function of time and is describable in terms of its amplitude, frequency and phase. The EMG signal is a biomedical signal that measures electrical currents generated in muscles during its contraction representing neuromuscular activities. The nervous system always controls the muscle activity (contraction/relaxation). Hence, the EMG signal is a complicated signal, which is controlled by the nervous system and is dependent on the anatomical and physiological properties of muscles. EMG signal

acquires noise while traveling through different tissues. Moreover, the EMG detector, particularly if it is at the surface of the skin, collects signals from different motor units at a time which may generate interaction of different signals. The main reason for the interest in EMG signal analysis is in clinical diagnosis and biomedical applications.

The technology of EMG recording is relatively new. There are still limitations in detection and characterization of existing nonlinearities in the surface electromyography (sEMG, a special technique for studying muscle signals) signal, estimation of the phase, acquiring exact information due to derivation from normality. Surface electromyography (sEMG) is a non-invasive procedure involving the detection, recording and interpretation of the electric activity of groups of muscles at rest (i.e., static) and during activity (i.e., dynamic). The procedure is performed using a single or an array of electrodes placed on the skin surface over the muscles to be tested. Recording can also be made using a hand-held device, which is applied to the skin surface at different sites. Electrical activity is assessed by computer analysis of the frequency spectrum, amplitude, or root mean square of the electrical action potential. Surface electromyography is occasionally used as an aid to diagnose neuromuscular disorders, determine the need for surgery in individuals with low back pain, and assist in evaluating the prognosis of disorders involving muscle lesions. The technology has also been utilized to monitor the effects of rehabilitation programs and evaluate muscular function in occupational and sports programs .Needle electromyography is an invasive procedure that records the electrical activity of individual muscles and is considered a more reliable technology .Paraspinal sEMG, also referred to as paraspinal EMG scanning, has been explored as a technique to evaluate abnormal patterns of electrical activity in the paraspinal muscles in individuals with back pain symptoms such as spasm, tenderness, limited ROM, or postural disorders. The technique is performed using electrodes placed on the skin surface, with recordings made at rest, in various positions, or after a series of exercises.

In this project we are taking raw EMG signal for different gestures, for example – hand close, right hand, fist etc and then filtering, rectification of the signal take place also we are getting the envelope of the signal.

Technical or Hardware Description of the Project

Arduino

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control both physically and digitally.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or breadboards (*shields*) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

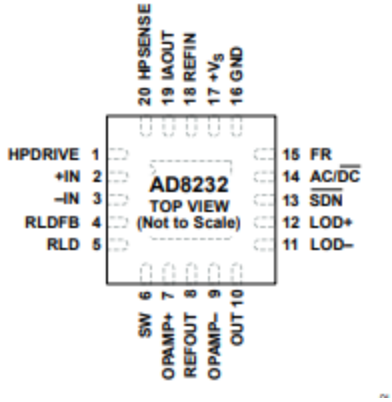
Python

Python is a popular programming language. It was created by Guido van Rossum, and released in 1991.

It is used for:

- web development (server-side),
- software development,
- mathematics,
- system scripting.

AD8232



The AD8232 is an integrated front end for signal conditioning of cardiac biopotentials for heart rate monitoring. It consists of a specialized instrumentation amplifier (IA), an operational amplifier (A1), a right leg drive amplifier (A2), and a midsupply reference buffer (A3). In addition, the AD8232 includes leads off detection circuitry and an automatic fast restore circuit that brings back the signal shortly after leads are reconnected. The AD8232 contains a specialized instrumentation amplifier that amplifies the biopotential signal while rejecting the electrode half-cell potential on the same stage. This is possible with an indirect current feedback architecture, which reduces size and power compared with traditional implementations

EMG electrodes

These high quality disposable electrodes are to be used to measure EEG, ECG and EMG. They are to be used once and are very handy because of integrated gel.This ECG/EMG/EEG electrode is ideal for a variety of purposes and is frequently used for Neurofeedback and Biofeedback.These disposable electrodes has a unique, patented pre-gelled adhesive side with non-irritating gel, especially developed to prevent allergic reactions. These foam electrode is latex free and therefore suitable for every skin type.The snap-on connector can easily be pushed on or removed from the electrode lead. Therefore you have optimal user friendliness as you dispose this electrode after every session! No more greasy electrodes as it will cover the surface of the electrode. This extends the life of your electrodes.

Functionalities of the Project

We have conducted experiments with surface EMG sensors using three detecting electrode channels.

Our project working starts with the measurement of the raw signal of EMG and then rectification is done. Rectification is the translation of the raw EMG signal to a signal with a single polarity, usually positive. The purpose of rectifying the signal is to ensure the signal does not average to zero, due to the raw EMG signal having positive and negative components. Two types of rectification are used: full-wave and half-wave rectification. Full-wave rectification adds the EMG signal below the baseline to the signal above the baseline to make a conditioned signal that is all positive. If the baseline is zero, this is equivalent to taking the absolute value of the signal. This is the preferred method of rectification because it conserves all of the signal energy for analysis. Half-wave rectification discards the portion of the EMG signal that is below the baseline. In doing so, the average of the data is no longer zero therefore it can be used in statistical analyses

Pros and Cons of the Project along with a real life use

An EMG is a helpful diagnostic adjunct when there is concern about mononeuropathy (carpal tunnel syndrome, wrist drop, foot drop); polyneuropathies; radiculopathies (when MRI does not identify clear nerve root compression); disorders of the neuromuscular junction (myasthenia gravis); and myopathies or muscular dystrophies

Surface EMG can have limited use in real life due to inherent problems associated with surface EMG. Adipose tissue (fat) can affect EMG recordings. Studies show that as adipose tissue increased the active muscle directly below the surface decreased. As adipose tissue increased, the amplitude of the surface EMG signal directly above the center of the active muscle decreased. EMG signal recordings are typically more accurate with individuals who have lower body fat, and more compliant skin, such as young people when compared to old. Muscle cross talk occurs when the EMG signal from one muscle interferes with that of another limiting reliability of the signal of the muscle being tested. Surface EMG is limited due to lack of deep muscles reliability. Deep muscles require intramuscular wires that are intrusive and painful in order to achieve an EMG signal. Surface EMG can measure only superficial muscles and even then it is hard to narrow down the signal to a single muscle.

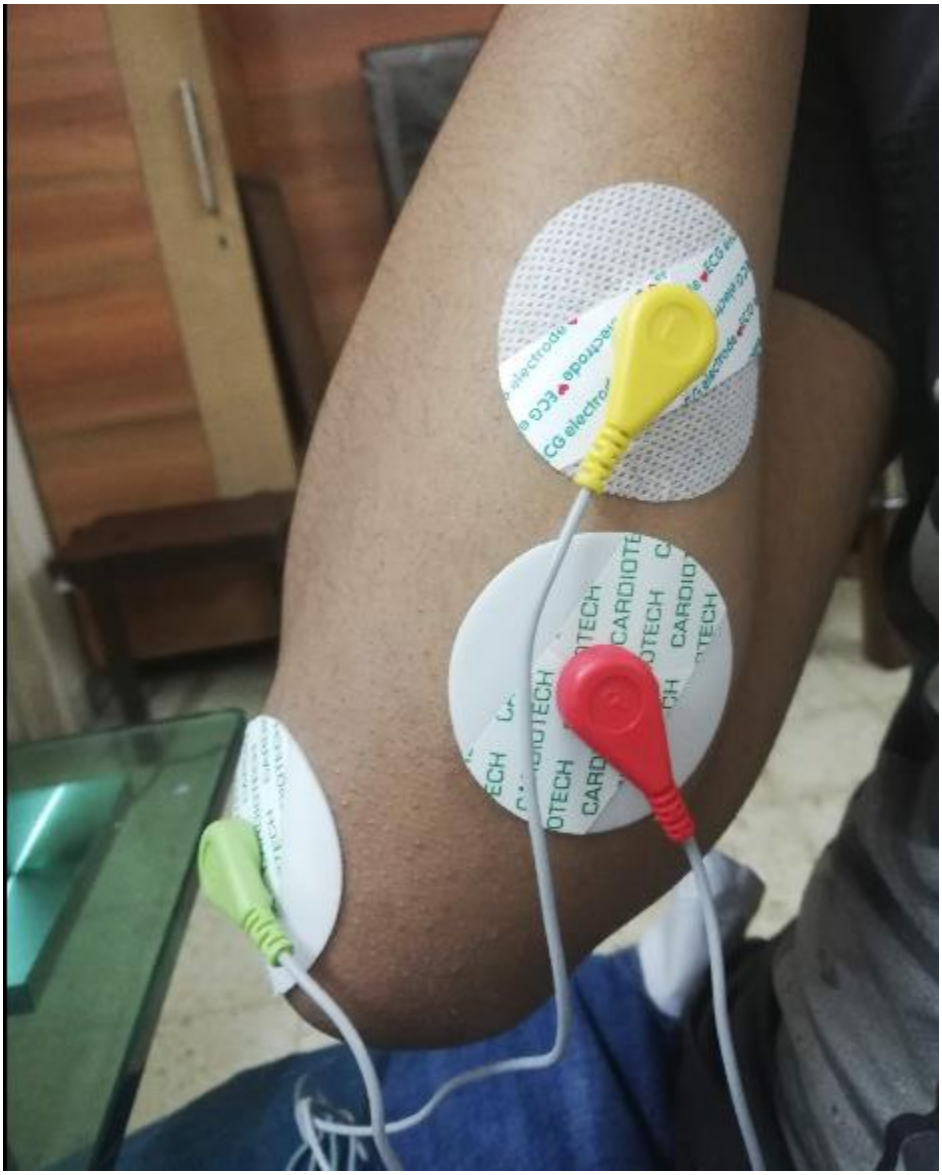
Real Life Use:

- EMG Analysis Methods on Robotic Gait Machines
- Electromyography in the Study of Muscle Reactions to Vibration Treatment
- The Role of Electromyography (EMG) in the Study of Anticipatory Postural Adjustments Application of Surface Electromyographic Signals to Control Exoskeleton Robots
- Trunk Muscle Activity Affects the Level of Performance in Human Body
- EMG in People with Different Heel Height Condition
- Muscle Activation Patterns During Level Walking and Stair Ambulation
- Experimentation and Structural Modeling of Stimulus-Evoked Electromyography in Muscles During Electrically-Elicited Fatigue Process
- EMG Analysis of a Pilates Exercise
- Electromyography Monitoring for Complete and Incomplete Transections of the Spinal Cord in Humans Who Received a Cell Therapy Combined with LASERPONCTURE® or LASERPONCTURE® Only: Methodology, Analysis, and Results
- EMG Applications in Studies of Arts
- Surface Electromyography During Both Standing and Walking
- Arthroscopic Treatment of Suprascapular Nerve Neuropathy
- An Uterine Electromyographic Activity as a Measure of Labor Progression
- The Role of Pelvic and Perineal Muscles in Reproductive and Excretory Functions
- Electromyography Usefulness in Diagnosis of Functional Status of Pelvic Floor Muscles in Women with Urinary Incontinence
- Electromyography as a Biofeedback Tool for Rehabilitating Swallowing Muscle Function
- Relating Surface Electromyograms of the Facial Muscles During Mastication to the Mechanical and Sensory Properties of Foodstuffs
- Electromyography and Facial Paralysis
- Movement-Related Cortical Potentials Associated with Oral and Facial Functions in Humans

Conclusion and Future Scope of Project

A linear enveloped EMG circuit was developed to measure and obtain EMG signals from subject FDS muscle. Increasing angles gives resulted in increasing peak-to-peak value from EMG signal. The information will be used in future work to establish the relationship between EMG signal from forearm muscle and hand grip strength. The information also can be used as application for prostheses and exoskeleton.

Screenshots of the model




COM3 (Arduino/Genuino Uno)
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