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**ASSIGN  
BUSTER**

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12 Task 11- Write a research paper based on the results findings of your assignment 12 Reference. 13 Figure 1(A Simple Model of the EMG Signal, 2018) 4Figure 2 (The Nervous System Pathway, 2018) 5Figure 3 (The Structure of a Neuron, 2018) 5Figure 4 (Diagram of a Muscle Cell, 2018) 6Figure 5 (Arduino, 2018) 10 Techniques of EMG signal analysis: detection, processing, classification and applicationsEMG EMG abbreviation is Electromyography, a way to measure muscle by taking the electrical activity to a nerve's stimulation. Measured by a signal which requires an advanced method for detection, decomposition, classification and processing.

Since it is used on life forms it is called Biomedical Signal. Biomedical signal means a collective signal taken from any organ that shows a physical variable of response. The EMG signal is a complicated signal since the muscle are all controlled by the nervous system. It is dependent on the physiological properties of the muscle. Moreover when on the surface of the

skin a signal is recorded it collected from different motor units at a time which may have different signals. Since the technology is increasing vastly the importance of using powerful and advanced methodologies in bioengineering is as well. Method of Using EMG To measure the signal from the muscle.

A test is used to detect the neuromuscular abnormalities. Electric activity is detected in form of waves, here's the thing it is detected by inserting a small concentrated needle also known as electrodes. It is then shown on an oscilloscope (a monitor that displays electrical activity in the form of waves).

There are three stages it is measure: · Muscle during rest · Slight contraction · Forceful contraction Having no signal when rest is normal but when the needle is inserted there will be a detection of a signal for a brief period of time.

After an electrode is inserted, they may ask you to contract the muscle for example by lifting or bending your leg. The oscilloscope provides information about the ability of the muscle respond when the nerve is stimulated which are created by the size and shape of the wave. When detecting and recording the EMG signal there is the main issue which fiddles the signal. The first is the signal to noise ratio.

As in the ratio of the energy in the EMG signals to the energy in the noise signal. Next would be a distortion of the signal meaning that any frequency component should not be altered. Invasion and non-invasion electrode are the two types of electrode. Note that when the signal is taken on the skin where many signals are collected from the muscle at once and it occurs at

random interval. So at any instant, the EMG can be either positive or negative. If needed to find the signal of a single muscle the nit can be found by inserting directly into it. The combination of their muscle fibre actions potentials from all the muscle fibres of a single motor unit is the motor unit action potential (MUAP) which can be detected by an electrode placed on the surface of the skin, or by a needle electrode (invasive) inserted in the muscle. Figure 1(A Simple Model of the EMG Signal, 2018)Where,  $x(n)$ , modelled EMG signal  $e(n)$ , point processed, represents the firing impulse,  $h(r)$ , represses the MUAP,  $w(n)$ , zero means addictive white Gaussian noise and  $N$  is the number of motor unit firings.

Typically a differential amplifier is used as a first stage amplifier, more can be added if needed. Frequently, the user is interested in the amplitude of the signal to the high and low frequency can be processed to eliminate. As mentioned about signal and sensor all starts with something called a neuron.

So what is? The nervous system is both controls the body and communications system of the body. When you move your hand the brain sends the message to the spinal cord after the cord sends it through neurons to a motor neuron which then moves your hand. And reverse the same backward but rather than motor neuron it sends it through the sensory neuron. Figure 2 (The Nervous System Pathway, 2018) Therefore, the nervous system consists of three main parts: the brain, spinal cord and the peripheral nerves. A neuron is basically the structural unit of the nervous system and vary in size and shape. Neurons are one the most specialized cell that conducts message in the form of nerve impulses from one part of

the body to another. And this transfer of message passes so rapidly (432 km/h or 275 mph is the speed, just imagine!).

Figure 3 (The Structure of a Neuron, 2018) Figure 4 (Diagram of a Muscle Cell, 2018) Next would be the muscle cell which this assignment is all about. The muscle cell is also as the nerve specialize as well. Its action is only two, contraction and relaxation. The primary function of these cells is to generate forces, movement and the ability to communicate like writing, giving a speech and so on. Muscle tissue is elasticity and extensive, also have the ability to receive and respond to stimuli. Muscle tissue has three types which it will come down to: Skeletal Muscle, Smooth Muscle, Cardiac Muscle. The EMG is in fact connected to the skeletal muscle since we need the signal from the motion. The contraction of the skeletal muscle is stated by impulse in the neurons to the muscle and is usually under voluntary control. EMG History We are using, talking, finding the EMG signals.

So how in fact was it found? The impotent of EMG started with Francesco Redi's documentation in 1666. The document tells us that specialized muscle of the electric ray fish generated electricity. By 1773, Walsh had been able to demonstrate that Eel fish muscle tissue could generate a spark of electricity. In 179, a publication entitled " De Viribus Electricitatis in Motu Musculari Commentarius" appeared, written by A. Galvani, where the author showed that electricity could initiate muscle contraction.

Six-decade later, in 1849, Dubois-Raymond discovered that it was also possible to record electrical activity during a voluntary muscle contraction.

The first recording of this activity was made by Marey in 1890, who also introduces the term electromyography. In, 1922, Gasser and Erlanger used an oscilloscope to show the electrical signals from muscles. Since it was in the old days the information obtained was unclear. But has improved since the 1930s through the 1950s and improved electrode more widely.

Prosthesis I'd say is the future for the amputees to regain their function to the nearest. By the time I think it even may come closer to a real human leg. Early days they used you may know the peg leg which really doesn't have the required angle of motion.

Then comes the 20th century where there is an acceleration to the technology development, it still is. Newer material is made where it is harder and lighter. Isn't it ideal? Prosthesis even has a kind of realistic skin too.

It is hard to use at first so people must rehabilitate once it is fixed.

AssignmentThe EMG which is said all comes down to this " The Assignment". We are meant to do a project of making a prosthetic leg. It can have single or two joint. But we chose a single joint. We should take the EMG signal from electrodes and amplify it. Next, have to convert it to a digital signal and make a prosthetic leg having the same signal.

The flow of the assignment is below as shown:

Assignment Task Flow Aim of the assignmentThis assignment aims to develop the various following skills of the learner· Capture sensory signals· Signals conditioning· System development· Mathematical modelling· New algorithm development· Literature research· Writing a research paperTask

01 – EMG Capture Use gel electrode to detect EMG signals from lower limb knee joint. Do the following. 1.

Conduct a literature research on· EMG signals· EMG electrode placements· EMG signal frequency· Filtering techniques

2. Place the EMG electrodes incorrect position on the upper limb to detect EMG variations. Task 02:

EMG Signal Amplification In this stage, you have to amplify the captured EMG signal from stage 01. Do the following

1. Conduct a literature research on bio amplifiers. 2. Built your own bio-amplifier which suits amplify the EMG

signals. Task – 03 – Analogue filtering In this stage, you have to design an analogue filter to remove the noise of the captured EMG signal.

Do the following. 1. Conduct a literature research about noise types and frequency range of those noises in EMG. 2. Conduct a literature research on noise filtering on EMG 3. Install Filter lab software on your computer. Filterlab is freely available at [www.microchip.com](http://www.microchip.com)

4. Design an analogue filter to remove the above-found noises of the EMG. 5.

Simulate and test the above-designed filter using OrCAD/Pspice. 6. Build and test the above-designed filter. Use 0 – to — 1000Hz (1 kHz) as per the test signals. 7.

Test the designed filter for the real captured EMG signals. Task 04 – Capture signals using Arduino In this stage what you need to do is capture the EMG signals which you detected, amplified and filtered from stage 01 to 03. Do the following. 1. Conduct a literature research on capturing EMG using data

acquisition2. Conduct a literature research on capturing EMG using Arduino3. Conduct a literature research on Arduino muscle sensor4. Write an Arduino program to capture the EMG data coming out from stage 03.

5. Built and test the hardware to capture the EMG using Arduino. 6. Plot real time the EMG using Arduino GUI Figure 5 (Arduino, 2018) The one you see above is called an Arduino board. It's like a small computer you can program to do some things. It's like an ultimate tinkering tool. Arduino consists of both a physical programmable circuit board and a portion of software that runs on a computer. Arduino has become popular with people who are just strung out with electronics.

It can be simply a USB cable and moreover, it has a simple C++ version. Arduino provides the functions of the micro-controller into a more accessible package. Task 05 MATLAB GUI (Plotting EMG using MATLAB)At this stage, you need to develop a MATLAB GUI to plot and visualize the captured EMGsignals on stage 04. Do the following.

1. Conduct a literature research on how to capture and display real-time signals fromArduino & MATLAB. 2. Write a MATLAB code and develop a GUI interface Arduino to capture the realtime EMG signals. 3. Capture the real-time EMG and plot that signals using designed MATLAB GUI(Graphical user interface). Task 06 Set up an experiment to measure Voltage (EMG) & Knee angleIn this stage, you have to set up an experiment to research and find out the relationship ofEMG voltage variations due to upper limb movement.

Do the following 1. Setup an experiment to measure the voltage (v) against the knee angle. 2.



Select a movement pattern of the lower upper limb. 3. Measure EMG (voltage) with respect to the Knee angle.

4. Task 07 – Plot Voltage (EMG) vs Knee angle For this task, you have to plot the EMG (Voltage) against knee angle1. Plot the EMG (voltage) vs Knee angle. 2. Literature research on curve fitting on MATLAB. 3.

Best fit the curve which you plotted above. 4. Find a mathematical expression for the above best-fitted curve. Task 08 – Find the transfer functionDevelop a transfer function considering the graphs you obtained above to be used to control a motor.

Do the following. Consider the input and output of the following system develop a system transfer function. Task 09 – Apply signal processing techniques for the captured EMG. (FFT / Signal average /Correlation)At this stage, you should apply different signal processing techniques as mentioned below.

Apply the following mentioned signal processing techniques for the recorded EMG signals. 1. FFT2. Correlation3. Wavelet transform4. Any preferred other signal processing techniques. Task 10 – Develop an algorithm to control a motor by the captured EMG1. Considering all the research facts you obtained to develop an algorithm to control a motor using EMG signals.

2. Practically demonstrate and evaluate the motor control using EMG. Task 11- Write a research paper based on the results findings of your assignmentFor this, you have to write a research paper based on the experiments you conducted and the results found. A maximum participant

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