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Electromyography (EMG) is a technique for evaluating and recording the electrical activity produced by skeletal muscles. An EMG detects the electrical potential generated by muscle cells when these cells are electrically or neurologically activated. The signals can be analyzed and transformed into a digital signal to control a function in a microprocessor.

Many people in the world are confined to a wheelchair due to injuries or illnesses, which cause muscle weakness. One such illness is a genetic condition known as muscular dystrophy; patients suffering from this have limited muscle movement, which can result in muscle wasting, muscle hypertrophy and muscle pain. An exoskeleton device, which will give such peoples their independence as well as the ability to function as a normal human being, can be controlled via these electrodes.

Measurement System:

The EMG requires three electrodes. The reference electrode or ground electrode is necessary for providing a common reference to the differential input of the preamplifier in the electrode. For this purpose, the reference electrode should be placed as far away as possible and on electrically neutral tissue i.e. Bone area. The two signal electrodes are then placed at two different points on the muscle, one in an active area of contraction and the other slightly off center. This gives a point of reference for muscle activity compared to the signal of muscle relaxation.

Dynamic Factors:

The amplitude of the EMG signal is stochastic (random) in nature and can be reasonably represented by a Gaussian distribution function. The amplitude of the signal can range from 0 to 10 mV (peak-to-peak). The usable energy of the signal is limited to the 0 to 500 Hz frequency range. Usable signals are those with energy above the electrical noise level and hence a band pass filter is used to eliminate frequencies below 50Hz and above 400Hz in order not to detect the power sources frequency [1].

Static Factors:

The signal-to-noise ratio is a function of complicated interactions between the electrolytes in the skin and the metal of the detection surfaces of the electrode. There are several approaches for reducing the noise, such as using large surface areas for the detection surfaces, employing conductive electrolytes to improve the contact with the skin, and removing dead (less conductive) dermis from the surface of the skin.

It is also important that the impedance remains consistent over the duration of the measurement session. For the reasons similar to those above, the signal to noise ratio will wander if the impedance drifts during measurements. That is, low impedance (<10 kOhm) resulted in a high level of energy for EMG frequency components compared to high electrode–skin impedance (>100 kOhm) [2].

Signal Processing, ADC and Digital Processing:

The electrical signal is usually very small. This in turn requires a repeated measurement signal in order of Millie Volts. For an accurate EMG design, the readings must be perfectly stable and in the center of a large muscle. Any change in the gain resulting from temperature drift will affect the accuracy of the reading. Typically, a high-resolution analog-to-digital converter (ADC) then follows to digitize the amplified voltage. A microprocessor with a built-in ADC will be utilised to sample at a frequency of at least 800Hz (Nyquist).

The signal is to be recorded for integration with measurements systems for analysis. Therefore, there is the necessity for non-permanent memory (real time calculations) and semi-permanent memory (Data Storage). Real-time processing is limited by the sampling speed and the capacity of the data storage.

[1] Surface Electromyography: Detection and Recording, Carlo J. De Luca , 2002 by DelSys Incorporated.

[2] Important Factors in Surface EMG Measurement By Dr. Scott Day ,Bortec Biomedical Ltd .