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Estimation of Hand Muscle Power

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Abstract: *In this research paper, the use of surface electromyogram is used to evaluate the hand muscle power during various activities to grade the muscle strength. Our muscles have various rotations of movement and actions, but with ageing, stroke, accident we lose some of its function. It can be a minor one like the action of movement which are restricted when we do some physical actions. The losses can also be calculated from the EMG of the muscle as for every motion the muscles produce an internal force. In this research work, analysis of the function of upper limb is performed by recording the various EMG with different actions of the upper limb. This proposed method will try to improve the existing method of muscle power grading and the muscle functioning.*

Keywords: *Hand Muscle Power, Components, Electromyography, Signal Processing, Grading*

I. Introduction

Electromyography (EMG) is a technique for evaluating and recording the electrical activity which is produced by the skeletal muscles. The EMG is performed by using an instrument which is called as an electromyography, to produce a record which is called as an electromyogram [1][2]. An electromyography detects the electrical potential which is generated by the muscle cells when these cells are electrically or neurologically activated. The signals can be analyzed to detect the medical abnormalities, activation levels and recruitment order or to analyze the human or animal movement. The EMG potentials range in between 50 μV and up to 20 to 30 mV depending on the muscles which are under observation [2][3]. In clinical practice, the hand muscles are most often evaluated by using manual muscle strength testing by using the Medical Research Council (MRC) Scale [2][4]. In this scale, the muscle strength is graded on a scale from 0 to 5. For evaluating the strength of the intrinsic hand muscles, a small modification to the standard MRC grading has been made so that grade 3 indicates "full active range of motion" as compared to "movement against gravity" [4][5].

Grade 5: Full active range of motion and normal muscle resistance
Grade 4: Full active range of motion and reduced muscle resistance
Grade 3: Full active range of motion and no muscle resistance
Grade 2: Reduced active range of motion and no muscle resistance
Grade 1: No active range of motion and Palpable muscle contraction only
Grade 0: No active range of motion and no palpable muscle contraction

Manual muscle testing however has a number of limitations. The limitation of this method is that the scoring depends on the judgment of the examiner. Also with the 6-point ordinal MRC scale, it is difficult manually to identify relatively small but clinically relevant changes in the muscle strength [5][6]. In order to create more quantitative assessments of hand muscle strength, the dynamometers are more sensitive to the change as compared to the manual muscle testing and render the outcome on a continuous scale [1][6]. In clinical evaluation and research studies on patients with hand problems, muscle strength measurements are usually based on the grip strength and pinch strength dynamometry. This research work aims to develop a procedure which will aid in grading the muscle power in an automatic manner [5][6].

II. Research Methodology To Be Employed

The research work mainly consists of two parts such as EMG Acquisition and then analyzing the EMG signal.

2.1. EMG Acquisition

The acquisition of EMG can be done by using two basic types of electrodes viz. surface electrode and needle electrodes. The former method is non-invasive and the latter method is invasive. But the level of information which is obtained from the needle electrodes is high because the basic layers of skin are bypassed. For primary screening, the surface electrodes are used for intense testing needle electrodes are used [1][5]. In this research work, bipolar method of EMG acquisition is done. Two electrodes are placed on the biceps muscle for EMG pick up while the third electrode acts as the ground to cancel the surface noise. The picked up signal is passed to the EMG amplifier circuit which consists of instrumentation amplifier, high pass filter and low pass filter [2][6]. The instrumentation amplifier amplifies the signal difference and rejects the input signals which are

common to both the input leads. The high pass filter has a cut-off frequency of 20 Hz while the low pass filter has 3 KHz. The total gain of the EMG acquisition circuit is 1000. The circuit is interfaced with the computer by using DAQ card [4][5].

2.2. Signal Analyzing

The acquired EMG signal is analyzed by using the MATLAB. For the analysis purpose, only one half of the signal i. e. the signals which are lying above zero level is considered. So the signal is chopped from the center to get only one half. Then the signal is converted to absolute form. During any action or contraction of the muscles, the EMG signal produces a burst. The burst size, amplitude etc. varies according to the muscle strength and the work is performed by the muscle. So this burst is separated from rest of the signal. Finally, the burst analysis is done [2][4].

Figure 1 shows the processing of the EMG signal. Figure 1(a) shows the acquired signal, digitized EMG signal, which is a bi-directional one. Figure 1(b) the rectified EMG signal. Whenever there is a muscle contraction, EMG will appear as a burst. From the rectified signal, such EMG bursts alone are considered by threshold method and windowing technique. The contraction burst is then used for analyzing the RMS, standard deviation, maximum amplitude and the burst time [2][6].

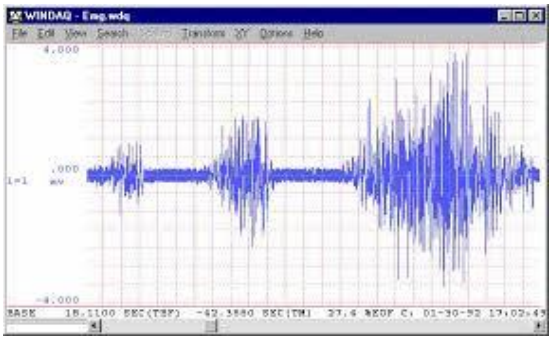

Figure 1 Acquired EMG Signal

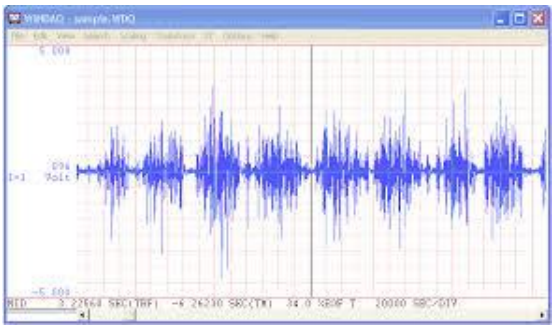

Figure 2 Positive Half of the Acquired EMG Signal

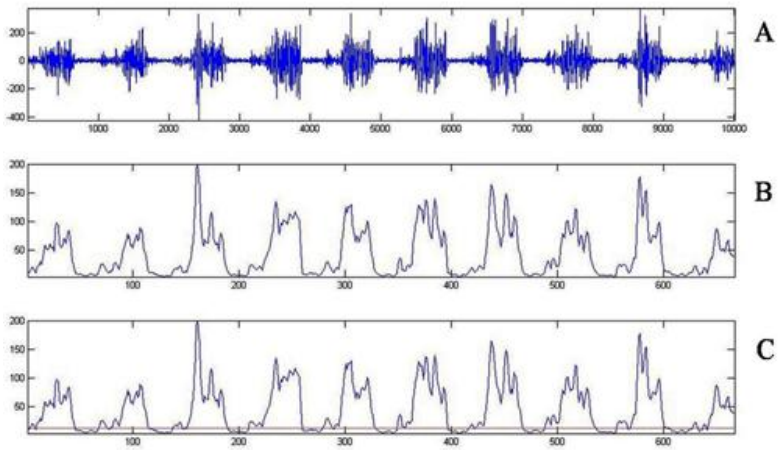

Figure 3 Burst of the Acquired EMG Signal

III. Results

In this research work, the EMG circuit has been designed with a gain of 1000 with a frequency of 20 to 3 KHz. The signals have been acquired from fifty persons with different actions. The people are in the age group of 20 to 25 years. The RMS value, maximum amplitude and burst time directly gives the strength of the muscles. The table shows the various analyzed values of a normal person [1][4].

Table 1 EMG Signal of a Normal Person

Performance Parameters	Wrist Movement	Normal Contraction	Strong Contraction	Contraction With Resistance
RMS	0.0125	0.0148	0.0165	0.0176
Maximum Amplitude	0.3872	0.9504	1.8692	1.9526
Burst Time	0.4500	1.0420	1.320	2.133

IV. Conclusion

The EMG circuit is designed and the signal is acquired. The amplitude analysis such as the RMS contraction energy, maximum amplitude, standard deviation and one time analysis like the burst time for a contraction will help in grading the muscle.

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