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Researcher

Tareenjit Kaur Dhillon a/p Bhathal Singh
tareenjitkaur.bhathalsingh@qiu.edu.my

Correlation between EMG, Thermal Imaging and Ultrasound for the Muscle Strength Measurement of Biceps Brachii

Synopsis

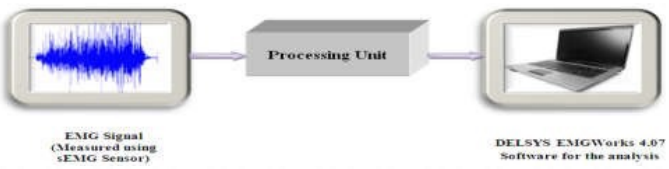
Electromyography (EMG), thermal imaging, and ultrasound are the three frequently utilised medical base investigation appliances and apparatuses for muscle strength measurements. Lately, numerous studies have reported concurrent collections of the sEMG variable signals, ultrasound images and the images of thermography, which have been recorded by different applications (devices) for the assessment of muscle strength. Nevertheless, there is an inadequacy of research as no study has reported the correlation between these three modalities.

In this project, the correlation between EMG, thermal imaging and ultrasound for the muscle strength measurement of biceps brachii were implemented. The muscle strength was measured during two tasks: first during the contraction without load, and then contraction with a 10-pound dumbbell load. Eight male subjects with strong biceps brachii muscles were selected for the experiment. The results demonstrated a good performance in its experimental analysis, and all three modalities were strongly correlated with its muscle strength level. Besides, a mathematical function of muscle contractibility was generated.

The results of the correlation show that there is an increase in amplitude for EMG; increase in temperature for thermal imaging; and an increase in muscle compression for the ultrasound when the muscle is contracted using a load. Moreover, there is a significant difference in data collected when the muscle is contracted without using a load and with a 10-pound dumbbell load. The data of all the parameters on all three modalities show a higher output value when the muscle is contracted using a load, as compared to the data with a lower per unit value when the muscle is contracted without using any load.

Methodology

Conducted the experiment on 8 male students with strong **bicep** muscles.



Overview of sEMG signal

Thermal Image Acquisition on the Right Biceps Brachii Muscle

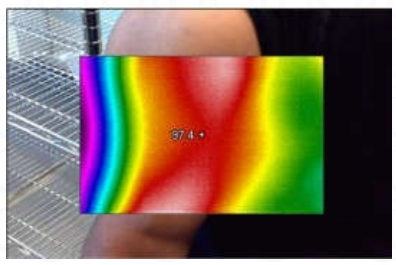
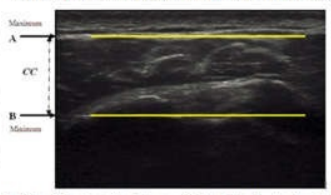


Image of the estimation on how the ultrasound image is acquired



Profile of Contraction Change (CC) of the Biceps Brachii Muscle

$$CC = AB_{max} - AB_{min}$$

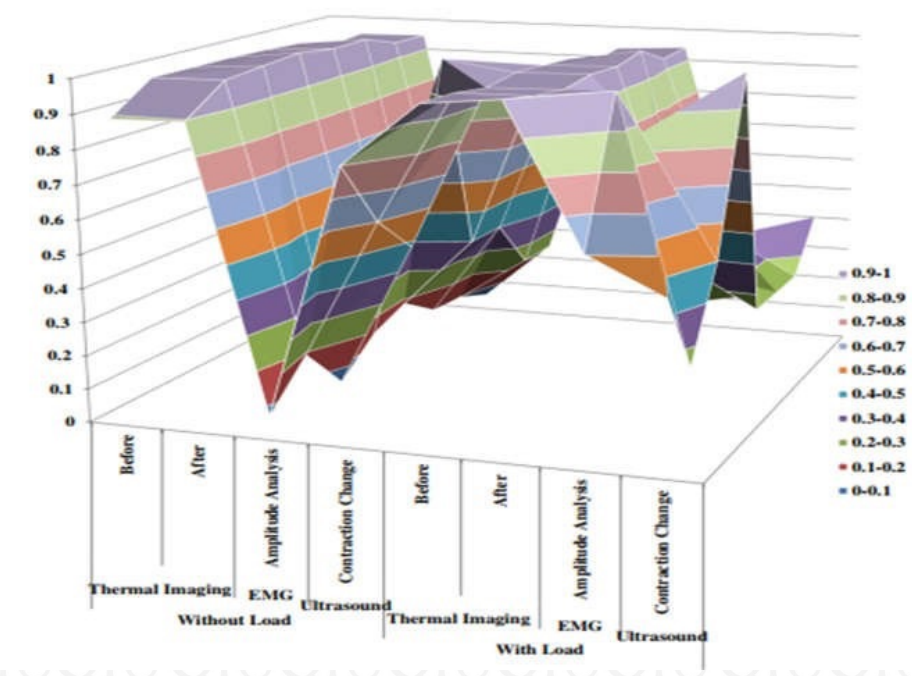
EMG
- Equipment: 16 Channel Trigno Wiress EMG Set (DELSYS)
- Software: EMGWorks Software 4.07
- Parameters: Amplitude Analysis MAV RMS

Thermal Imaging
- Equipment: Fluke Ti32 9HzThermal Imager
- Software: Fluke SmartView 3.1 Software
- Parameters: Temperature (°F)

Ultrasound
- Equipment: Ultrasound Machine GE Logiq E BT 2011
- Software: MATLAB
- Parameters: Muscle Compression

Results

3D surface plot diagram for the correlation of EMG, Thermal Imaging, and Ultrasound.



The results and analysis of the correlation reveals that it showed a very good relationship (performance) on the muscle contractibility. A mathematical function is generated from the correlation of the three modalities. The function is given by the equation below:

$$Muscle\ Contractibilty, M_c \propto f(E_A, T_I, \frac{1}{h})$$

where:
E_A: Amplitude of EMG
T_I: Temperature of Thermal Imaging
$1/h$: Muscle Compression of Ultrasound

It is proven that the contractibility of the muscle is proportional to the increase in temperature of thermal imaging, amplitude for the EMG, and muscle compression change for the ultrasound when a force (load) is applied to the muscle during its contractions.

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