EMG Signal Analysis of Posture-Based Muscle Fatigue

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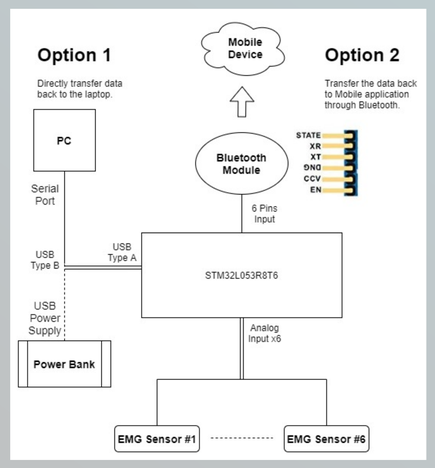
Background

Surgeons typically require the use of magnification tools like microscopes to perform microsurgeries. This results in a hunched posture, which can cause muscle pain, joint pain, and circulation issues over the long run. To prevent a hunched posture, Alcon developed a heads-up, three-dimensional imaging technology that enables surgeons to sit straight by looking at a screen instead of into a microscope. The goal of this project is to quantify the muscle fatigue level difference between the hunched and straight posture by capturing EMG signals from back and neck muscles.

Overview

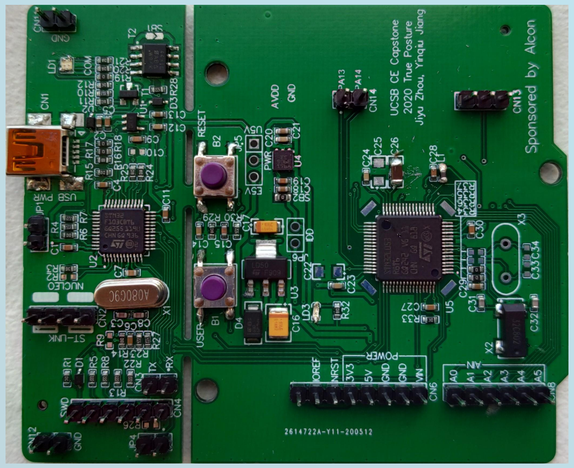
Electromyography (EMG) is an electrodiagnostic medicine technique for evaluating and recording the electrical activity produced by skeletal muscles. Due to the recruitment of motor units, the EMG signal amplitude shows an increase, whereas the frequency based mean or median frequency of the total power spectrum shows a decrease over contraction time. In this project, we record, analyze, and compare the EMG signals of the hunched and straight postures over a specified period of time.

Block Diagram

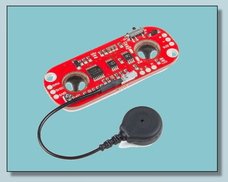


The board was specially designed to increase user mobility and safety. The Bluetooth module allows wireless data transmission that enables the user to freely move while collecting data. The board also draws power from a power bank instead of a wall outlet to reduce the risk of a current surge that can potentially harm the user.

Final Printed Circuit Board

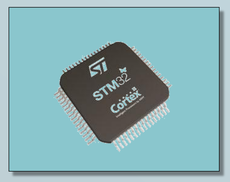


Key Components



EMG Sensor

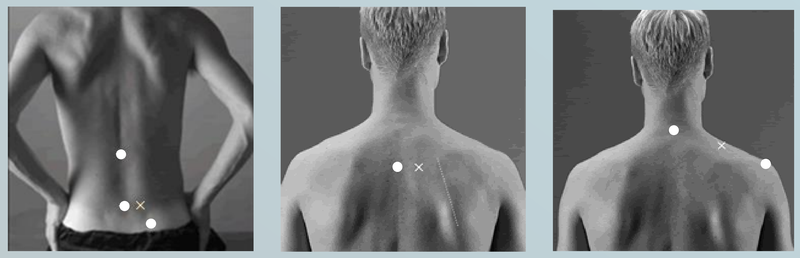
The MyoWare™ Muscle Sensors (AT-04-001) measure the filtered and rectified electrical activity of a muscle (EMG) and output analog signals.



STM32L053R8T6 MCU

This low-power ARM® based MCU provides a 12-bit ADC at 1.14 Msps with up to 16 channels, enabling data collection from multiple muscle sensors.

Sensor Placement



We place EMG sensors in three main positions: multifidus (lower back), transversalis (upper back), and trapezius descendens (shoulder). The results we present here are the data collected from the multifidus.

Conclusion

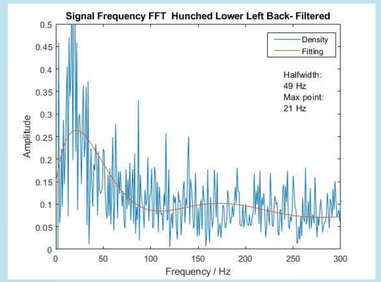


Figure 1

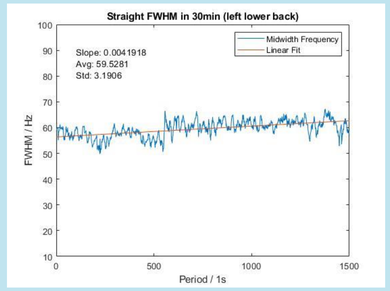


Figure 2

Fig. 1 is the amplitude spectrum of the left multifidus muscle's signal frequency, in the hunched posture, over 1 second. We calculated the full width at half maximum (FWHM) of the best fitting curve for further trend analysis. Fig. 2 is generated by the FWHM of every second of data collected over a 30 minutes period. Slopes of the liner fittings are recorded to show frequency shifting trends.

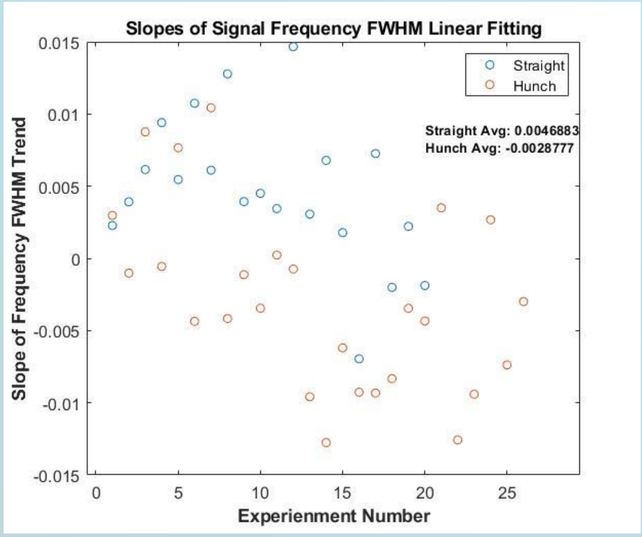


Figure 3

Fig. 3 shows the distribution of the slopes of signal frequency FWHM linear fittings. It can be observed that the hunched posture causes more fatigue in the lower back muscles than the straight posture does. With a straight head-up posture, surgeons can better protect their back muscles during surgeries.

Acknowledgements

Special thanks to Yogananda Isukapalli, Aditya Wadaskar, and Kyle Douglas from UCSB, and Yuepei Hu and Gillian Myers from Alcon