Development of Dynamic Arm Support for children with Duchenne Muscular Dystrophy

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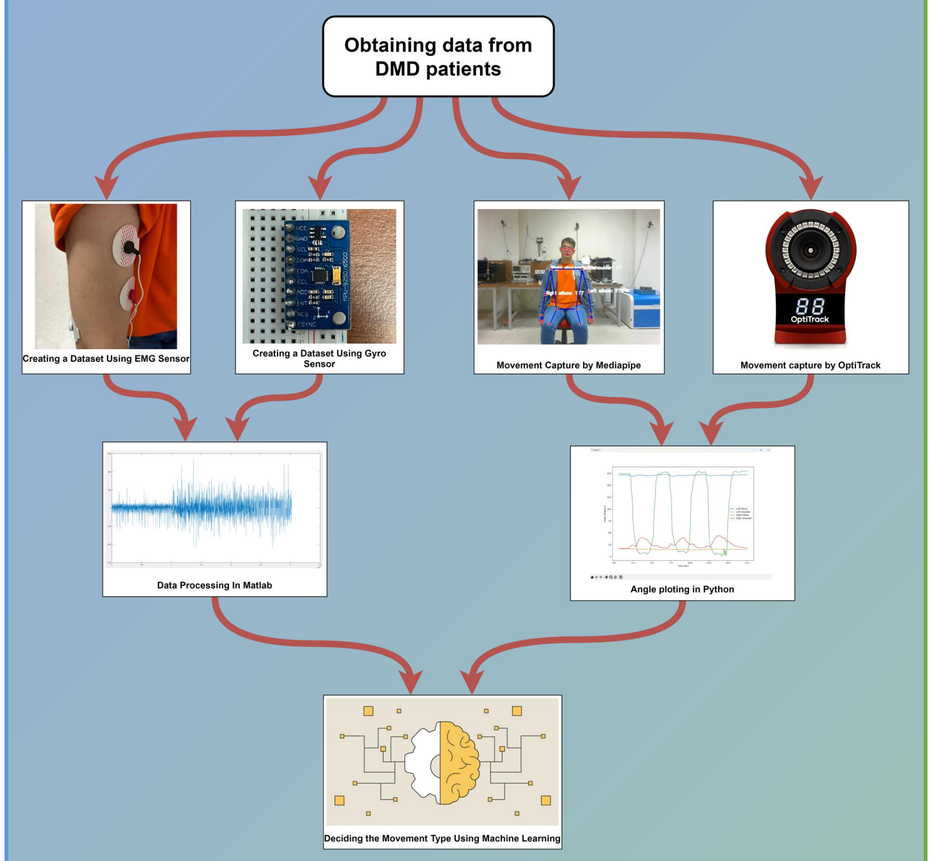
Introduction

This project has two major branches.

First branch of the projects aims to development of an exoskeleton system for children with Duchenne muscular dystrophy (DMD), a hereditary condition affecting 1 in 3,500 male births. The project focuses on Dynamic Arm Support, utilizing EMG sensors, gyro sensors, microprocessor and machine learning algorithms to detect movement set for DMD patients and support to complete the movement with motors.

The second branch of the project aims to analyze the patient's movements using cameras and softwares such as MediaPipe and OptiTrack. By capturing and evaluating the angles, this phase ensures the accuracy and efficacy of the exoskeleton's support

Design Process

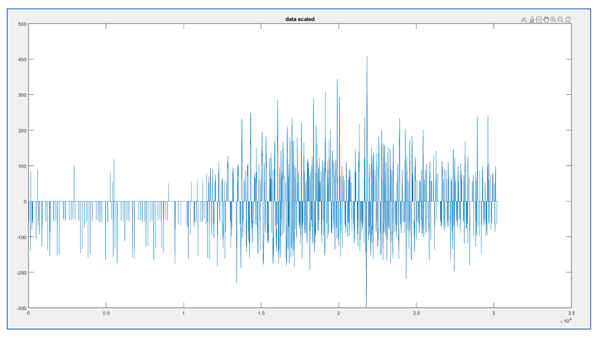


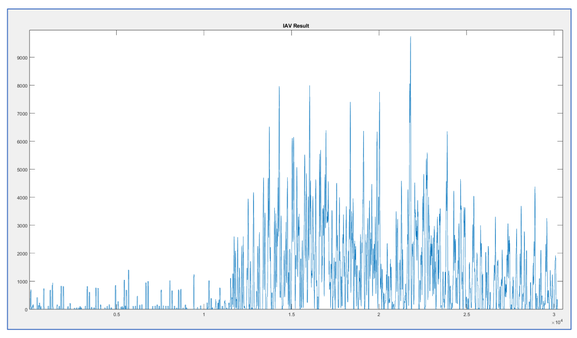
Methodology

The dataset is created with using mostly EMG sensor and less gyro sensor via STM - Nucleo F446 which is more than 100. This datasets are used to train artificial intelligent. The K-Nearest Neighbor, Artificial neural networks algorithms and 13 different features are used for creating dataset. The weights which are gotten from artifial intelligent are used to detect the movement of the user from 3 movement sets.

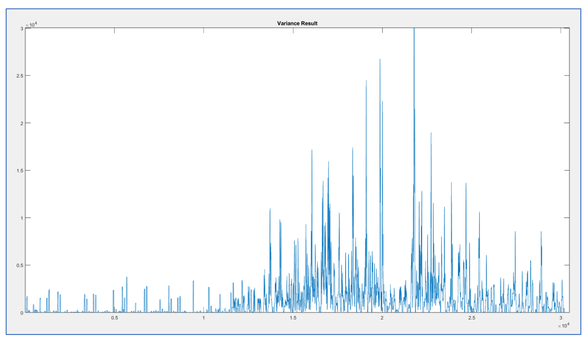
In addition to the EMG and gyro sensor data, we also recorded the patient's movements and captured four angle values from both the right and left sides, focusing on the shoulder and elbow joints using cameras. We then compared the accuracy of these angle measurements.

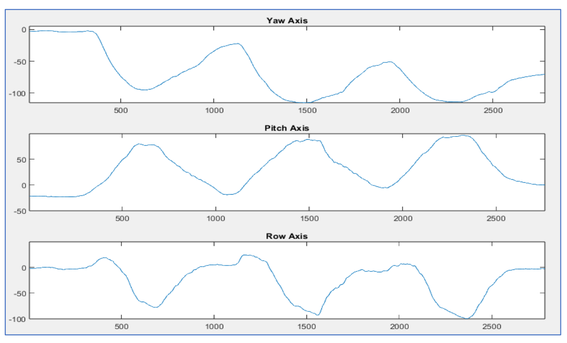
Direct Measurement Techniques





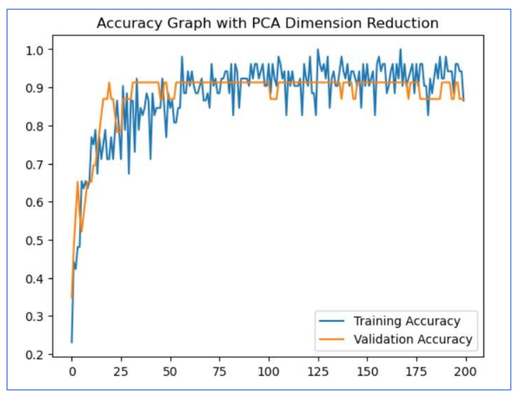
In the left picture, the raw EMG data when the patient move his/her hand from release position to his/her mouth. In the right picture, the changing of IAV feature in time domain in 40 sample window range.

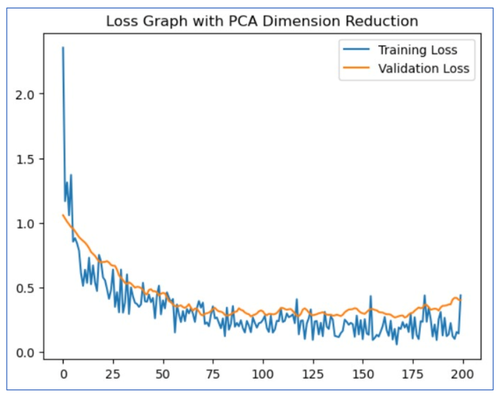


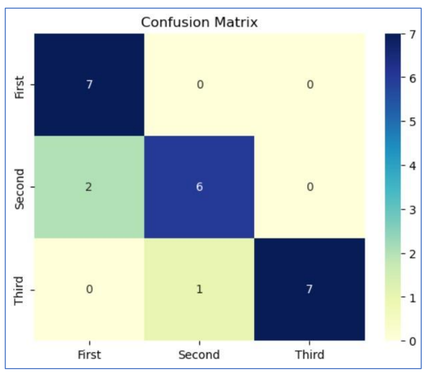


In the left picture, the changing of variance. The changing in yaw, pitch and row axis taken from gyroscope sensor when patient is moving his/her hand from release position to his/her mouth 3 times in a row.

Machine Learning Accuracy Loss and Confusion Matrix Result



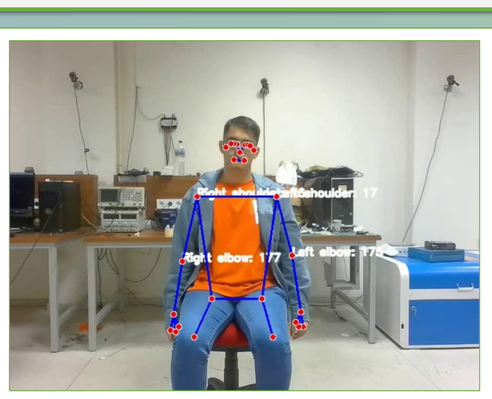




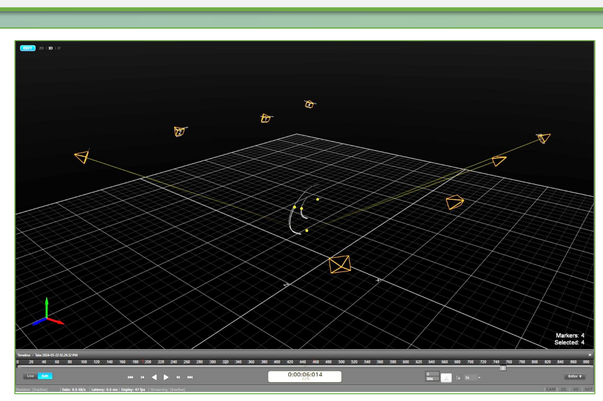
Accuracy Rates of Machine Learning Techniques

- The accuracy rate is %83 when logistic regression method is used.
- The accuracy rate is %70 when SVM is used.
- The accuracy rate is %83 when reduce feature count to 5.
- The accuracy score is up to %91 when neural network is used.

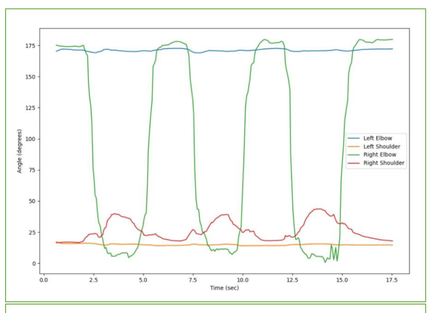
Imaging Based Measurement Techniques

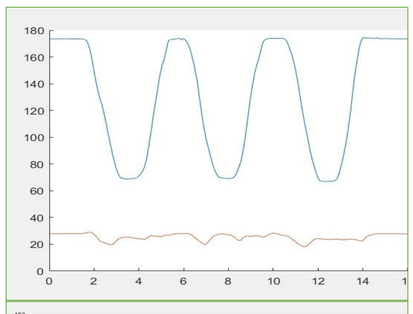


MediaPipe

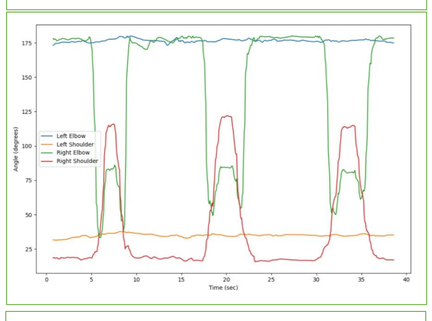


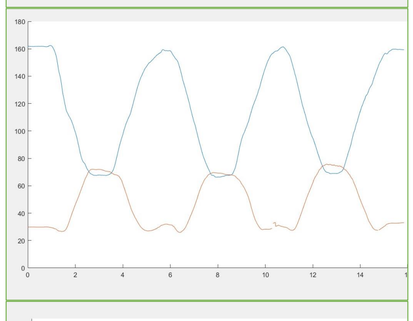
OptiTrack



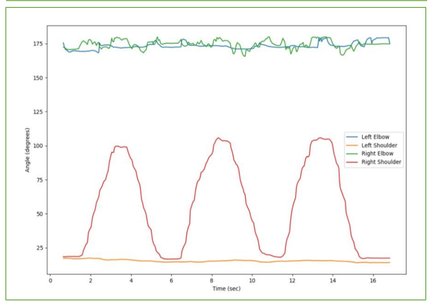


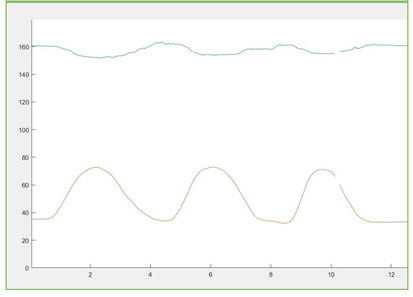
Hand to Mouth





Hand to Head





Arms Outstretched

As shown above, overlaying data from two separate sources allows us to evaluate the accuracy of the angle graphs, with the variations in the shoulder and elbow angles clearly visible.

Acknowledgements

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