Development of dynamic arm support for children with duchenne muscular dystrophy

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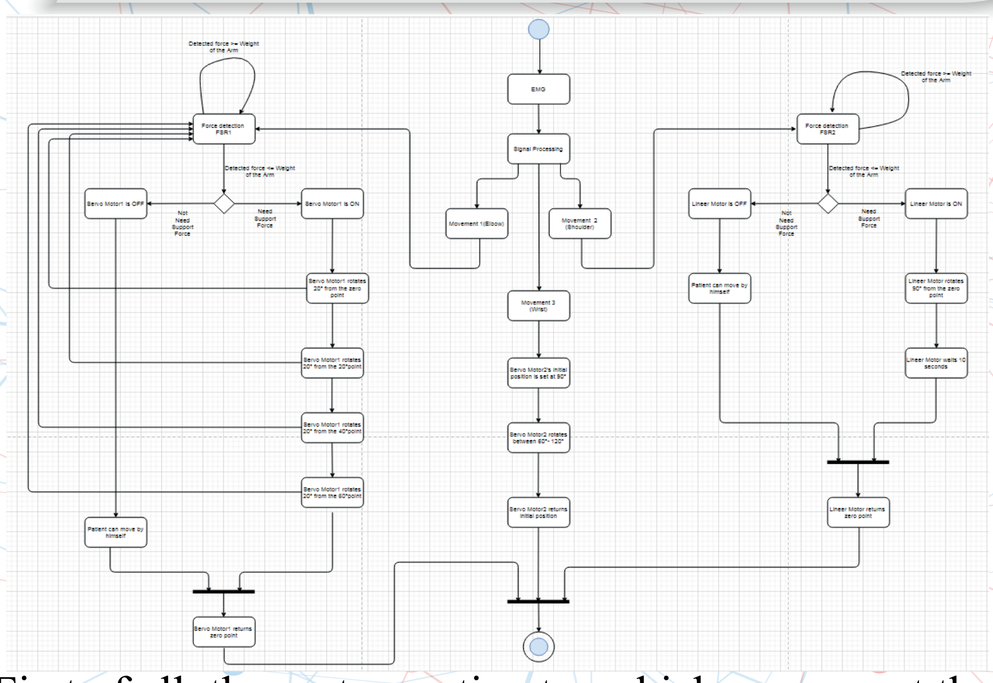
Introduction

Children with Duchenne muscular dystrophy disease lose their mobility and need different types of orthoses at a high rate over time. The project is inspired by improving the quality of life of these children. It aims to develop an arm orthosis to help arm movements and provide physical therapy remotely for the needs of these children.
The study focused on the elbow jointworking with position control with the help of EMG and force sensors.

Specifications and Design Requirements

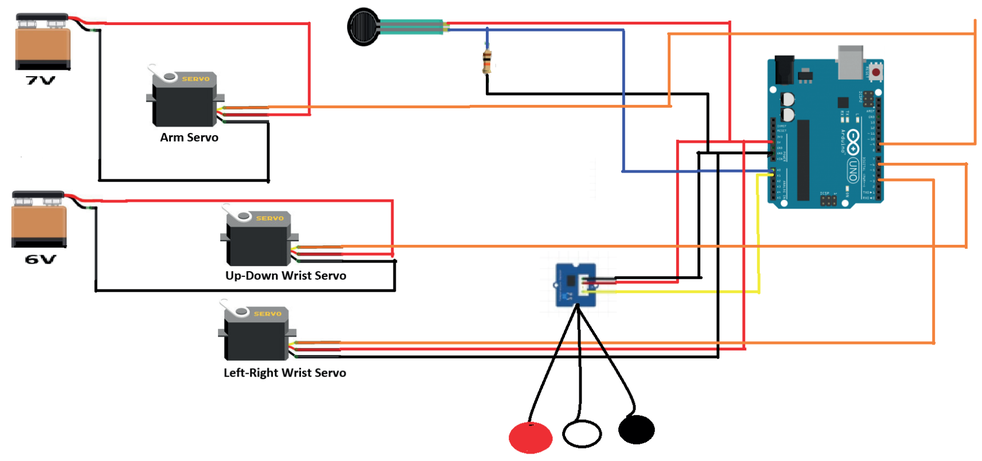
The design includes an outer frame supported with velcro intended to be attached to an exoskeleton or wheelchair. The lower frame is 21 cm long and has a wrist joint with a movable 5 cm rail system. The upper frame is 25 cm inside the arm to accommodate to the armpit, while the outer length of the orthosis arm is 30 cm. The lower arm and hand joint can be adjusted with velcro and suitable for different arm sizes. The width of all parts is 4 cm and thicknesses are 0.5 cm. There is three servo motors for wrist joint right left movement, wrist joint up-down movement, and elbow joint up-down movement which has different torques and working angle respectively 16 kg.cm- 270°,270kg.cm- 180°, and 40kg.cm- 120°.
FSR and EMG sensors are used for detection and control of movement stages in the design for force and EMG based control. System operation is controlled by an Arduino UNO board.

Solution Methodology



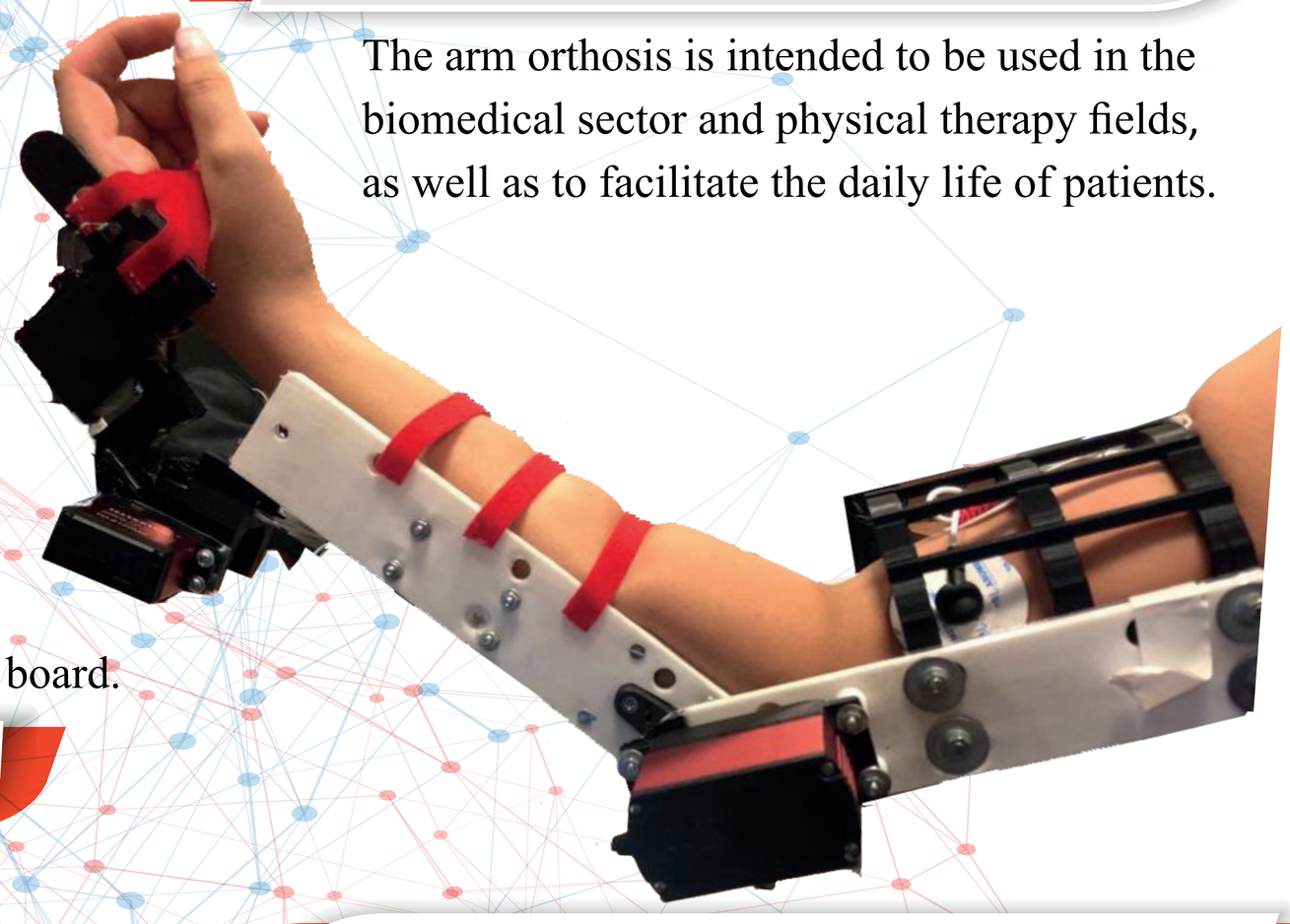
First of all, the system estimates which movement the user wants to make by using the EMG sensor.
Three movement types were defined in the system according to the threshold values of the EMG signals coming from the arm muscles:elbow,shoulder,wrist.
The shoulder movement is designed to bring the user's arm to a certain point and fix it there.

Wrist movement is designed as movements that repeat at regular intervals for the user to exercise.
Fsr sensor was used for elbow movement. By using the Fsr sensor, the force of the user was controlled in different positions of the arm. In this way, the user was provided to move his arm in a controlled manner.
The electronic circuit of the system is shown below



Application Areas

The arm orthosis is intended to be used in the biomedical sector and physical therapy fields, as well as to facilitate the daily life of patients.



Results and Discussion

There are three types of movement on the orthosis,wrist right-left, wrist up-down and elbow up-down.These movement is done according to EMG signals.
Signals are detected from biceps muscle and processed. When the processed signals are compared with the threshold value, it is determined whether the lower arm will be lifted or not. FSR control is activated once the arm lift intention is understood. If the patient cannot lift his arm, the force applied tothe FSR will continue to be at a high level, so the motor arm lifts it up to the next state. FSR control is repeated for each state. If there is no intention to raisean arm, the motors in the wrist joint are active and physical therapy is applied by exercising the wrist in the right, left, up, and down direction.