CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

36428

Project Title

A New Mechatronic Platform for Neuromuscular and Joint System Rehabilitation: Tested for Parsonage Turner Syndrome

Abstract

Objectives/Goals

This project designs and fabricates a programmable mechatronic platform for universal neuromuscular and joint systems rehabilitation through interchangeable end-effectors. The objective includes testing of rehabilitation motion profiles.

Methods/Materials

The design and fabrication includes (a) mechanical design specification and material selection, (b) interfacing of electronic control systems, and (c) development of motion profile algorithm. The mechanical structure was developed in CAD software (PTC CREO). After structural analysis, the model was fabricated. Required components and mechanisms such as hex shaft, bearings, shaft collars, chains, sprockets, couplers, etc., were purchased to integrate with the structure. Distributed automation scheme using CAN Bus was implemented. The important electronic and electrical components are motors, Talon speed controllers, NI roboRIO microprocessor, quadrature encoders, sealed lead-acid battery, power distribution panel, and wires. A software backend was developed in MATLAB to generate motion profiles in 3D space using Bezier curves. A LabVIEW GUI was developed to drive the motors in the assembled structure to follow the desired motion profiles.

Results

This project directly applies scientific principles to manufacturing and practical uses. The designed universal mechatronic platform works as per the objective. The end-effector movement mechanism performs user-defined movements with precision and accuracy of 5% and 10%, respectively. The dynamic response is improved through PID loop tuning. Through active position control, the prototype is capable of generating the required complex motion profiles in 2D and 3D using Bezier equations and Hobby splines. For validation, the platform was tested to generate and execute motion profiles for Parsonage Turner Syndrome.

Conclusions/Discussion

The design and development includes mechanical design and fabrication, electronic control systems, and software development for automating the platform. The design is universal in that it can accommodate several types of neuromuscular and joint-system rehabilitation, in contrast to available, dedicated types. The design is original.

Summary Statement

The new universal mechatronic system with interchangeable end-effectors is capable of generating complex 3D motion profiles with Bezier curves and executing them for neuromuscular and joint-system rehabilitation.

Help Received

(1) Mr. Bob Cain from Harris Manufacturing (Fresno), (2) Mr. Le from ADCO for inspecting standards, and (3) Abhijit Suprem from Fresno State for mentoring.