

ASSISTIVE PARTIAL LIMB EXOSKELETON (APLE)

Aaron Arana[1], Shouling He[2], Hossein Rahemi[2], Mohammed Benalla[2]

[1] Mechatronic Engineering, Vaughn College of Aeronautics and Technology, NY, USA
[2] Faculty Advisor, Vaughn College of Aeronautics and Technology, NY, USA

Corresponding Author: Mohammed Benalla
Email: mohammed.benalla@vaughn.edu
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ABSTRACT

The objective of this project is to develop a robotic orthosis using non-invasive sensors and motors to facilitate enhanced musculoskeletal function of the lower and upper forearm. The way to achieve it is by developing a partial exoskeleton using a digital servomotor located at the elbow joint of the arm, as well as a combination of surface electromyography (EMG), strain gauges, linear displacement sensors, and potentiometer sensors. The target consumer of this product would be hospitals to treat patients that suffer from injuries and diseases such as spinal cord injuries (SCI) or ALS, also known as Lou Gehrig's disease. As the sensors detect electrical signals to the muscles of a patient, the motor would assist in extending and contracting the arm. The use of linear displacement sensors would aid in monitoring the range of the movement and regulate the movement of the motor, as not to overextend the patient's axis of rotation. Developing a partial exoskeleton not only simplifies the construction and reduces the price, but it also acts as a framework for independently functioning limbs. Rather than using a full body harness, one can use the partial exoskeleton to help the body to do physical exercises.

Keywords: Exoskeleton, Robotic Orthosis, Electromyography, SCI, ALS, Potentiometer Sensors, Rehabilitation

INTRODUCTION

The target consumer of this product would be hospitals who treat patients that suffer from injuries and diseases such as spinal cord injuries (SCI) or Lou Gehrig's disease, also known as ALS. In the year 2019, there were approximately 249,000 to 363,000 people in the USA living with SCIs, and an average of 17,730 new spinal cord injuries each year [1]. Given the permanence and often damaging effects of these conditions, forms of physical therapy and rehabilitation are limited. This produces a need for a targeted, universally usable, and adaptable assistive technology that can help these patients regardless of what stage their disability is. Developing a partial exoskeleton not only simplifies the construction and reduces the total cost, but it also acts as a framework for independently functioning limbs. Rather than using a full body harness, one can use a partial exoskeleton to target sections of the body that need physical assistance. It would also decrease the total weight while increase the ease of use for the patients while operating.

METHODS

The research and development process for this project were conducted over an eight-month period. Four months to research information on the dynamics and mechanical principles of exoskeletal technologies, application and installation of servomotors, how to detect and relay sEMG signals from the body to the motors, as well as writing and running Arduino code for the control system. The next four months were spent ordering electronics and smaller elements, designing and rapid-prototyping 3D printed components on eMachineShop out of PETG and PLA