International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 03 | Mar 2020 www.irjet.net p-ISSN: 2395-0072

POWERED EXOSKELETON FOR ASSISTING UPPER LIMB DISABILITY USING ARTEMIS

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Abstract - *To design a cost efficient wearable upper arm exoskeleton that can potentially be used to assist and train arm movements of stroke survivors or subjects with weak musculature. This publication will provide the user the ability to have flexion and extension movement of the elbow joint. The control of the exoskeleton will be through a joystick. The exoskeleton will be made of a lightweight material making the subject have a lesser strain and difficulty to wear. The exoskeleton will be designed to carry minimal load to complete day to day activities of the subject.*

Key Words: Power motor driver, upper limb disability, strain tolerance, flexion and extension.

1. INRODUCTION

Exoskeletons are wearable machines that enhance the abilities of the people who use them. Just like in the movies, exoskeletons can make their users stronger. They can provide support and reduce fatigue. They even enable people in wheelchairs to stand up and walk again. An exoskeleton and the person wearing it work together. It is truly a meeting of human and machine, with enormous benefits for the human.

Fig.1. Upper Limb Exoskeleton

An exoskeleton contains a frame that goes around a user's body or part of the user's body. The frame is sometimes made out of a hard material, such as metal, and sometimes out of soft material, such as special kinds of fabric. Some exoskeletons contain sensors, which monitor and respond to users' movements. Just as there are different kinds of frames for exoskeletons, there are also different ways to power them. Exoskeletons can be motorized or mechanical. Some run on electricity, while others, which don't need electrical power, offer more freedom to their users.

Disability can affect physical or sensory functions. Limitations in physical functions are very often related to impairment in motor or sensory functions of the lower limbs (paraplegia). Sensory deprivation is usually related to hearing or visual dysfunction.

2. METHODOLOGY

In our project, we designed a powered exoskeleton for upper limb disabled subjects. The exoskeleton is designed for early stage Rehabilitation, Weak Musculature and for assisting in load up to 15 kg. The Exoskeleton can be controlled by a joystick to perform flexion and extension operation, and the exoskeleton is operated by a Power Window Motor.

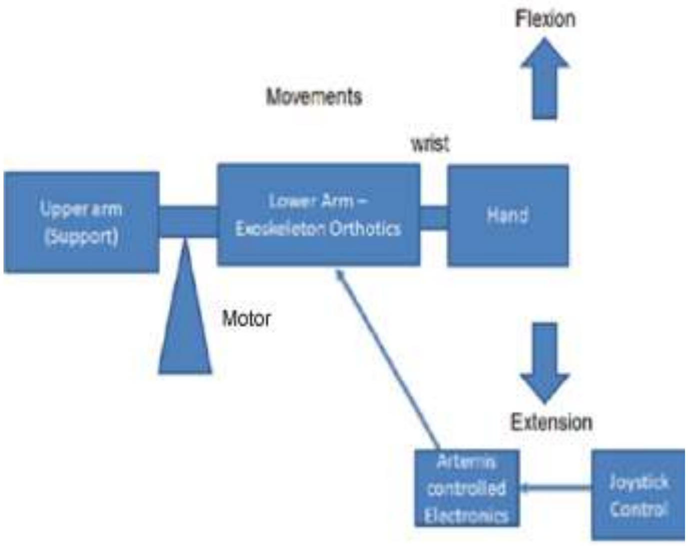

Fig.2. Exoskeleton Design

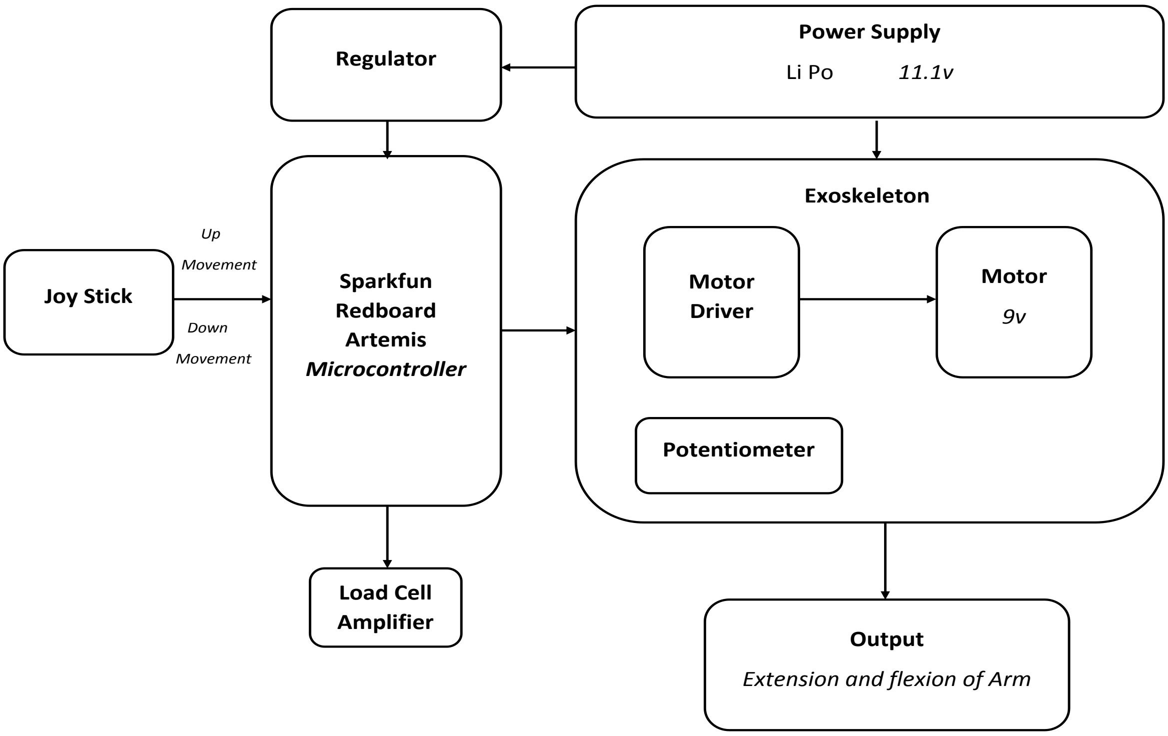

Fig.3. Block Diagram of Exoskeleton

3. PROPOSED SYSTEM

Power Supply:
The Exoskeleton requires battery backup to operate and thus the usage of a rechargeable battery to ensure easy handling and efficiency. The battery used is of optimum level to run the motor as well as the Artemis.

Exoskeleton:
The skeleton is designed using HDPE rather than conventional aluminium. The exoskeleton comprises of the 9v Dc Power Window Motor, motor driver and Potentiometer.

Microcontroller:
The Red Board Artemis takes the incredibly powerful Artemis module from SparkFun and wraps it up in an easy to use and familiar Uno footprint with support for Arduino IDE.

Motor driver:
The motor driver does the operation of controlling the input of the motor, since the Artemis has an output of only 5v. The motor driver is used to control the voltage to the motor.

Motor:
The Motor is a 9v Dc Power Window Motor which provides sufficient torque and Power.

Load cell Amplifier:
The Load cell Amplifier is used to detect the load given to arm.

Controlling Mechanism:
Joy stick is used to control the Exoskeleton to perform Flexion and Extension operation.

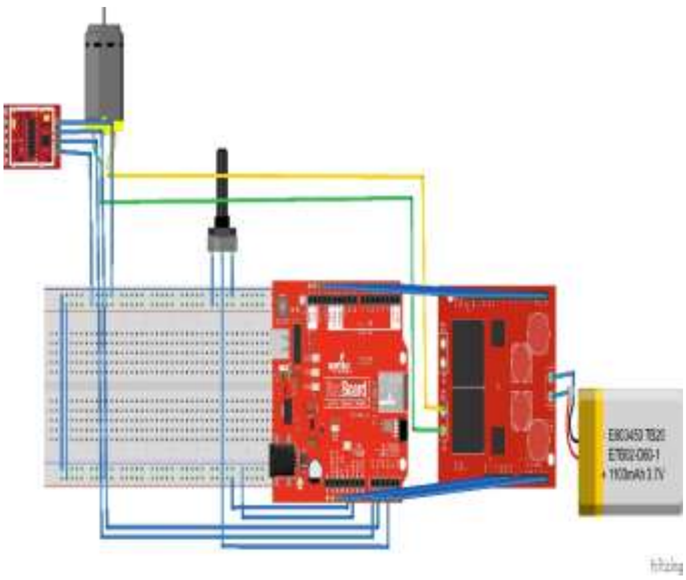

Fig.4. Circuit Diagram of Exoskeleton

The Skeleton is made up of HDPE which comprises of the Motor, Potentiometer and the load cell amplifier being fit into it. The Microcontroller and the remaining components are encapsulated and are strapped to the back of the subject.

When the Joystick controller is operated forward the signal is sent to the Artemis which will cause the motor to do extension and similarly for backward push of the Joystick Flexion Operation is done. The Load cell Amplifier acquires the load given to the arm using the strain gauge sensor and transmits the data to the Artemis which will control the motor to lift the load and the Potentiometer controls the degree of motion of the hand movement. To prevent damage for the arm for the subject while using the exoskeleton, the arm has a 3 Stage safety management in which 2 hardware oriented and a software-based safety mechanism are installed.

4. CONCLUSIONS

Weak Musculature and Stroke subjects are types of Upper Limb Disability, subjects with these two types of disabilities can have difficulty to proceed with their day to day activities in life. This Project is built in mind for those people and to help them rehabilitate back. Therefore, we can achieve back the original capacity of the limb, and to prevent the workload been carried only by one symmetrical axis of the body.

Also, it prevents the disorders developed by the continuous sore in the limb along with preventing progressive muscular atrophy which leads to totally disabling the function by limb.According to the "use and disuse theory" by Jean- Baptiste Lamarck "An organism tend to develop a specialized function in the body due to some environmental need and also has the possibility to discard the existing function which are of not used". Henceforth our project built on focusing to prevent the loss of function and gain back the original strength.

Hence, the project provides a suitable exoskeleton which helps in early stage rehabilitation of stroke subjects and for weak musculature subjects to lift nominal loads. The Exoskeleton is made up of HDPE to make the assist device weightless and portable to prevent it from causing any strain to the body of the subjects. The future work may be done by making the assist device more compact and support for multiple movement of the arm.

5. ACKNOWLEDGEMENT

We would like to thank our Head of Department Dr. Kayalvizhi M. for providing this great opportunity and would like to also thank our project guide for Mrs. Karthiga M. for guiding us and motivating us to do the project.

6. REFFERENCES

[1] Riaan stopforth- "Control Investigation of customizable/adjustable exoskeleton upper-limb", South Africa, Industrial Robot: An International Journal, Vol. 40 Iss 2 pp. 132 - 142 ,2013.

[2] M. Brown, N. Tsagarakis and D.G. Caldwell- "Exoskeletons for human force augmentation", Manchester M5 4WT, UK, Industrial Robot: An International Journal Volume 30 Number 6 2003 pp. 592 –602.

[3] Kristin Buhaug, Bente Elisabeth Moen and ot Irgens1-"Upper limb disability in Norwegian workers with hand-arm vibration syndrome", Buhaug et al. Journal of Occupational Medicine and Toxicology 2014.

[4]KristjanBerce,"https://hackaday.io/project/20663-affordable-exoskeleton-arm-exoarm"

[5] Johan van der Vorm, Rachel Nugent, Leonard O'Sullivan- "Safety and risk management in designing for the lifecycle of an exoskeleton: A novel process developed in the Robo-Mate project", Limerick, Ireland, by Elsevier B.V.,2015.

[6] Robert Bogue- "Exoskeletons and robotic prosthetics: a review of recent developments", Okehampton, UK, Industrial Robot: An International Journal 36/5 (2009).

[7] Christian Dahmen, Christin holzel, Frank Wollecke, Carmen Constantinescu- "Approach of Optimized Planning Process for Exoskeleton Centered Workplace Design", Germany, by Elsevier B.V.,2018.

[8] Michiko Matsudaa, Yasuhiro Sudoa, Fumihiko Kimurab- "A multi-agent based construction of the digital eco-factory for a printed-circuit assembly line",Japan, by Elsevier B.V.,2015.

[9] John J Gangloff,Jr.,Elizabeth Brackbill, Ying Mao, Vivek Sang wan-"Design and Optimization of a cable driven upper arm Exoskeleton", Newark, Journal of Medical Devices,2009.

[10] Carmen Constantinescu, Daniela Popescu, Paul-Cristian Muresan, Sebastian-Ioan Stana- "Exoskeleton-centered process optimization in advanced factory environments ", Romania, by Elsevier B.V.,2015.