EXOSKELETON ROBOTIC HAND FOR WEIGHT BEARING

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ABSTRACT

This project focuses on designing an innovative exoskeleton hand for weight lifting applications, aiming to overcome current limitations in wearable robotics. This robotic arm assists with people affected from diseases muscular dystrophy, myasthenia gravis, multiple sclerosis and spinal cord compression etc. The design prioritizes durability, weight optimization, and user comfort for extended use. Precision motors seamlessly synchronize with the user's movements, providing augmented power while maintaining natural hand kinematics. An adaptable activator system allows users to transition between powered assistance and manual control, accommodating various tasks and load requirements. Rigorous testing ensures the exoskeleton hand's robust load-bearing capacity across different weights and dynamic scenarios. The intuitive user interface empowers users to customize assistance levels based on their preferences. Safety features and ergonomic considerations prioritize user well-being during extended use. Real-world application testing with individuals in physically demanding activities evaluates practical utility, providing insights for potential refinements. In addition to the mentioned features, this innovative exoskeleton hand utilizes X, Y, and Z-axis sensors fixed within the human hand to precisely record movement data during weight lifting tasks. This data is stored in the system for further analysis of hand performance. Additionally, the exoskeleton hand incorporates serial communication capabilities, enabling seamless interaction with external devices or systems for enhanced functionality and control. This project envisions advancing wearable robotics, particularly in weight lifting, with potential applications in manufacturing, construction, rehabilitation, and assistive technologies.

Keywords: *Exoskeleton, Robotic arm, X, Y, Z axis sensors, Actuators, Precision motors*.

1. INTRODUCTION

This project endeavors to revolutionize wearable robotics with the development of an innovative exoskeleton hand tailored for weight lifting applications. Targeting individuals affected by conditions such as muscular dystrophy, myasthenia gravis, multiple sclerosis, and spinal cord compression, the exoskeleton arm prioritizes durability, weight optimization, and user comfort for extended use. Precision motors synchronized with natural hand kinematics offer augmented power, while an adaptable activator system allows seamless transitions between powered assistance and manual control, catering to diverse tasks and load requirements.

Rigorous testing ensures robust load-bearing capacity across varying weights and dynamic scenarios, complemented by an intuitive user interface for personalized assistance levels. Safety features and ergonomic considerations prioritize user well-being during prolonged use, while real-world application testing with physically active individuals provides valuable insights for refinement. Furthermore, the incorporation of X, Y, and Z-axis sensors within the exoskeleton hand captures precise movement data during weight lifting, stored for subsequent analysis. With serial communication capabilities facilitating interaction with external devices, this project envisions advancing wearable robotics across sectors including manufacturing, construction, rehabilitation, and assistive technologies.

2. LITERATURE SURVEY

Liming Zhao et.al.,[2020] explained in a wearable hand exoskeleton (WHE) system with light weight and adjustable character. The mechanical structure of the WHE is based on articulated linkages. The multi-mode signal acquisition module consists of two wearable sensors for detecting the electromyography (EMG) signals and the fingertip force signals. EMG based control is applied to the WHE system. The performance of the WHE system was tested through the free motion task and the grasping object task.Shahrol Mohamaddan1et.al.,[2021]explained in Hand motor impairment is a common disability among stroke survivors that severely affect their ability in activities of daily livings (ADLs), reducing independence and quality of life. Throughout the rehabilitation process, stroke patients able to regain partially or fully the hand motor function. However, the conventional rehabilitation process is limited by the insufficient number of therapists, labor-intensiveness, and low compliance. The objective of this study was to support the rehabilitation process and ADLs through the development of the Flexible Linkage Hand Exoskeleton Rehabilitation Robot (FLEXOR), a five fingers 3D printed prototype actuated by linear actuators. Xiaoshi ChenLi et.al.,[2020] explained in a human machine interaction system in the field of stroke rehabilitation, based on the concept of mirror therapy (MT). It aims to improve the hand motor function of stroke patients, enabling a true synchronization between the affected hand and non-affected hand (healthy hand) for the stroke patient. It consists of a soft exoskeleton glove, a surface electromyography (sEMG) signal collecting armband and machine learning (ML) algorithms. The glove is developed by integrating low-power motors to provide force strength for the hand movement. Unlike the rigid exoskeleton devices, the glove is comfortable to wear and lightweight, so it is more suitable for rehabilitation training of stroke patients in daily life. Ghaith Aljallad,et.al., [2020]Explained in modeling approach of pneumatic artificial muscles used to drive an upperlimb exoskeleton suit. In addition, a master-slave control method is implemented using an inertial measurement unit (IMU). Pneumatic muscles have numerous advantages such as their high power-to-weight ratio, light weight, and robust design, which makes them a favorable choice to be used as actuators in exoskeleton suits. To investigate the behavior of pneumatic muscles it is desired to build both a static and a dynamic model. Pavana Kumara B et.al., [2021]**.**explained in the field of R&D. With extensive research and the desire to obtain abilities beyond the human capability, the concept of anthropomorphic equipment came into being. The thirst for indomitable power was quenched by the development of the “Human Exoskeleton.” A Human Exoskeleton also known as Powered Armour, Exoframe, Hardsuit, or Exosuit, is a wearable mobile machine that can be powered by a system of motors, pneumatics, levers, or hydraulics that amplifies the force of the operator and enables them to possess superhuman strength. This concept has a wide scope for improvement and is a tantalizing topic for research. With the dawn of this advanced technology, the term „weakness" can be eliminated from the human perception. N.S.K. Ho et.al.,[2020]Explained in a exoskeleton hand robotic training device is specially designed for persons after stroke to provide training on their impaired hand by using an exoskeleton robotic hand which is actively driven by their own muscle signals. It detects the stroke person's intention using his/her surface electromyography (EMG) signals from the hemiplegic side and assists in hand opening or hand closing functional tasks. Kyushu Sangyo et.al.,[2021]**.**explained in a light wearable robotic hand/arm system is proposed for patients to whom hand or arm rehabilitation training is conducive for the recovery. It is lighter and more comfortable to get a patient equipped with than currently available aids so that one can make a move more easily. . The elbow module is consists of a joint, exoskeleton supporting frames and a hydro-pneumatic actuating module, which is including a moving cylinder, micro compressor and controller.

3. EXISTING SYSTEM

Being able to provide personalized and engaging assistance as soon as possible seems therefore to be a key to unleash the potential of wearable robotics. Videogames have the potential to increase the focus of the users and competing against peers can also be a factor to further increase participation. This is a challenging problem when dealing with healthy individuals: we not supporting people with physical impairments simply further increases the complexity. It is important to underline that this review focused only on devices that were utilized in testing protocols involving a clinical population The use of passive exoskeletons in manufacturing lines is beginning to proliferate among large private enterprises, particularly in the automobile industry. This is driving interest in the subject of assistive wearable robotics.

4. PROPOSED METHODOLOGY

Designing the system to respond dynamically to user movements, ensuring a fluid transition based on the specific requirements of different weight lifting tasks.Incorporate advanced load-bearing technology to monitor and analyze the forces exerted during weight lifting. Enable real-time feedback to the control system, allowing for adaptive adjustments in motor assistance levels to accommodate varying load conditions. Implement user-friendly controls that allow for quick adjustments, catering to individual preferences and the specific demands of different weight lifting scenarios. By strategically incorporating precision motors and activators, the exoskeleton hand enhances user strength and control during weight lifting tasks. Proposed System: Implementation of X, Y, and Z-axis sensors embedded within the exoskeleton hand to precisely capture movement data during weight lifting tasks, facilitating real-time performance monitoring and analysis. systems, enabling enhanced functionality, control, and data exchange for optimized user experience and performance. The mechanism used here is rotary to linear mechanism.

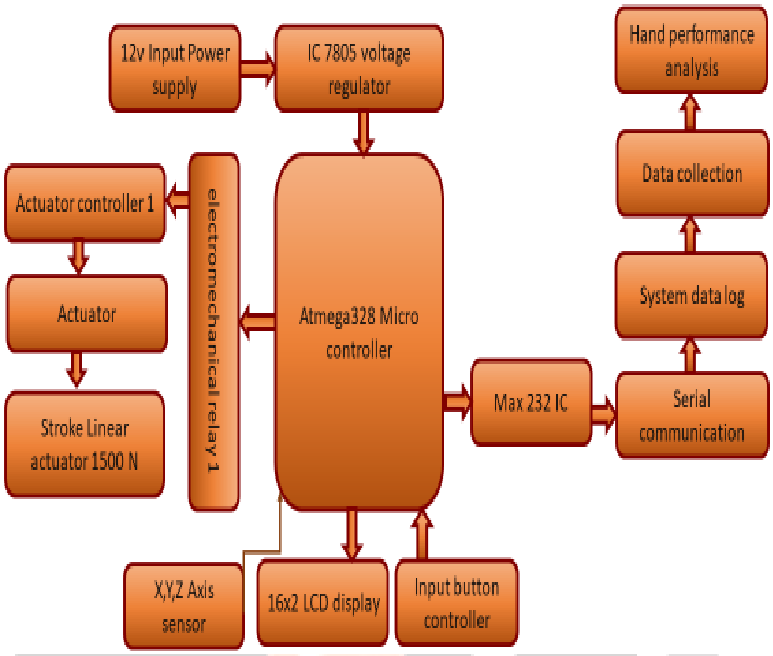

FIG.1 BLOCK DIAGRAM

5. CIRCUIT DESCRIPTION

The circuit diagram consider the components of core components like LCD display, Relay, Regulator, Power supply, AVR controller, Motor. The supply from the main power source 12v is give to voltage regulator it converting 12v to 5v. Then 5v is given to controller board. LCD display has 8 pin connection , VCC pin is connected to 5v supply, VSS pin is connected to GND and remaining 6 data pins are connected to controller digital pins. Electromechanical relay has three pins,(+) pin is connected to 1v supply, (-) pin is connected to GROUND and data pin is connected to controller analog pins and Actuator controller connected to relay. Axis sensor has 4 pins, positive and negative pin connected to regulator and signal pin connected to digital pin. The project leverages both the software and hardware part to create a robust and versatile solution for weight bearing using the exoskeleton robotic arm which is made as an working model and can be further develop as an wearable using the polymers .This starts from ac supply (220-240v)that is transmitted through adapter and then converted into 5v by voltage regulator which helps in maintaining the volltage level over fluctuation.Then, using 5v power supply atmega 328 microcontroller gets powered, which provides an extended instruction set multiply instructions for handling larger program memories.From microcontroller the connection reaches driver unit which is a max 232 IC that is widely used for serial communication among Microcontrollers & PC.The supply then reaches the bluetooth module which is HC -05 device that can be used as a master or slave device to send and receive data wirelessly as it serves as an transceiver.The driver unit gets powered by lead acid battery(7 amphs) which is a a rechargeable battery made of alternating lead oxide electrodes, porous separators, and a sulfuric acid solution that is used in case to avoid firing and helps to be precautionary.The working module which is a hand is pasted with xyz sensors which help in maintaining the stability through the access of app.

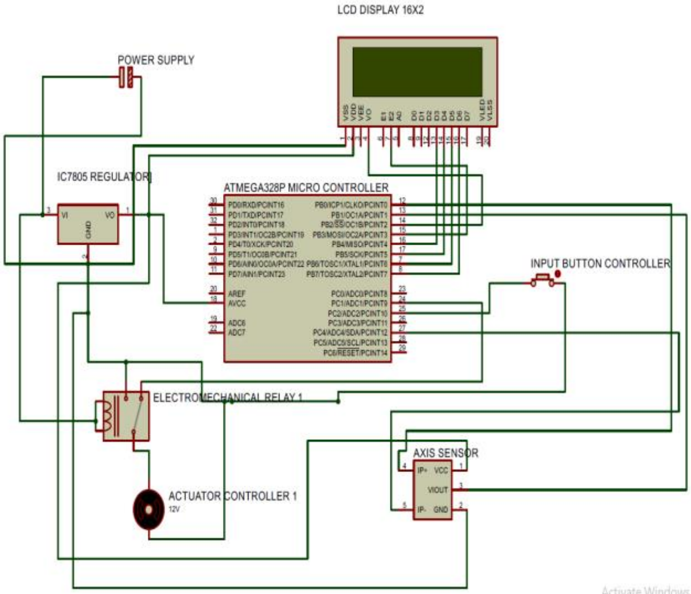

FIG.2 CIRCUIT DIAGRAM

6. RESULT & OUTPUT

The innovative exoskeleton hand designed for weight lifting applications successfully addresses limitations in wearable robotics, particularly benefiting individuals affected by muscular dystrophy, myasthenia gravis, multiple sclerosis, and spinal cord compression. Through prioritizing durability, weight optimization, and user comfort, the exoskeleton hand provides augmented power while maintaining natural hand kinematics, enhancing both safety and efficiency during extended use. Real-world application testing validates its practical utility, positioning it as a promising advancement in wearable robotics with diverse applications in manufacturing, construction, rehabilitation, and assistive technologies.

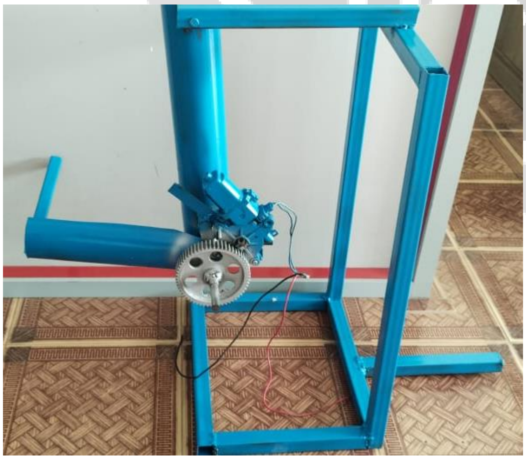

FIG 3 WORKING MODEL

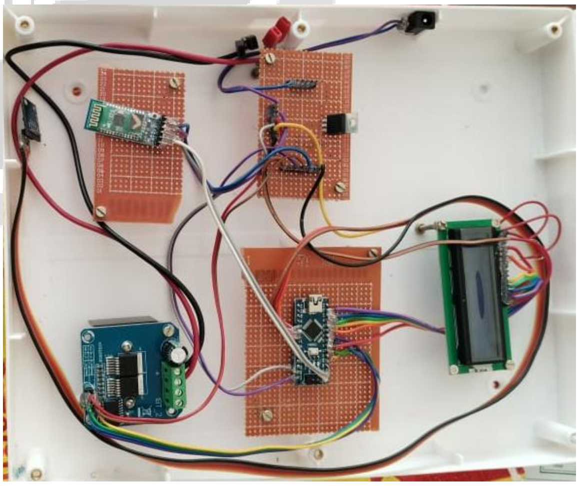

FIG 4 HARDWARE KIT

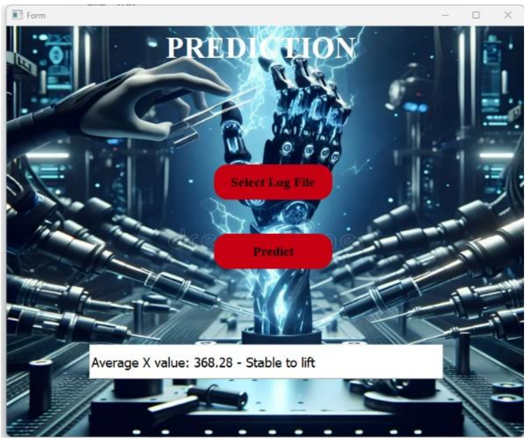

FIG 5 OUTPUT PAGE 1

FIG 6 OUTPUT PAGE 2

7. FUTURE SCOPE

This project proposes the working model of the exoskeleton robotic arm for weight bearing. It can be developed further by using biomaterials like polymers and the can be designed with less weight and with higher flexible design. Polymers are an unavoidable part of robotics. The components of robots require a lightweight as well as durability and flexibility and, hence, polymers play an inevitable role. This project can be extended by using light weighted actuators and can remodelled with the help of 3D printing which easily assists the human movement. This exoskeleton modelling is a boon in the field of rehabilitation and provides revolutionary changes in human assistance therefore improving the quality of life. With reducing the costs the project can be acquainted treating many muscle related diseases such as myasthenia gravis, muscular dystrophy, multiple sclerosis and Spinal cord compression etc,.

8. CONCLUSION

In conclusion, this project signifies a significant advancement in the field of wearable robotics, particularly in the design of an innovative exoskeleton hand tailored for weight lifting applications. By addressing current limitations and prioritizing durability, weight optimization, and user comfort, this exoskeleton hand offers augmented power while maintaining natural hand kinematics, catering to individuals affected by various muscular diseases. The adaptable activator system and intuitive user interface provide versatility and customization, enhancing usability across different tasks and load requirements. Rigorous testing ensures robust load-bearing capacity and safety features prioritize user well-being during extended use. Furthermore, the integration of X, Y, and Z-axis sensors and serial communication capabilities not only enhances performance but also facilitates data collection and interaction with external devices. With potential applications spanning manufacturing, construction, rehabilitation, and assistive technologies, this project lays the groundwork for transformative advancements in wearable robotics, empowering individuals and industries alike.

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