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Motor-Based Exoskeleton Arm

Yash Dandekar[1], Sumit Singh[2], Harsh Shah[3], Anupriya Gandhewar[4]

[1,2,3,4] New Horizon Institute of Technology and Management Thane (w)

Abstract

Motor-powered exoskeleton arms have emerged as a promising technology with significant potential to enhance human capabilities, improve quality of life and assist individuals with limited mobility.

This research paper provides a comprehensive review of motor-powered exoskeleton arms, covering their technology, applications and future prospects We discuss the working of exoskeleton arms, their components, control systems and design considerations. We also explore the wide range of applications, from medical rehabilitation to industrial assistance and discuss the challenges and opportunities associated with this transformative technology.

We have also created a model exoskeleton arm to using a worm gear reduction motor to demonstrate the use and application of such exoskeleton arm for

Keywords: Motor-powered, Exoskeleton arm, Worm gear reduction motor.

INTRODUCTION

Motor-powered exoskeleton arms, often referred to as robotic exoskeletons, are wearable devices designed to enhance and assist human arm movements. These devices have the potential to revolutionize the way people with physical impairments regain mobility and increase the strength and endurance of users in various applications. This paper explores the key aspects of motor-powered exoskeleton arms, including the technology, mechanics, control systems, materials, and their diverse range of applications.

Biomechanical Principles and Design The design of motor-powered exoskeleton arms is deeply rooted in biomechanical principles, aiming to closely mimic human arm movements while providing support and augmentation. Key considerations in the design process include joint flexibility, force transmission, and anthropomorphic form. Researchers focus on creating devices that are lightweight, comfortable, and ergonomic, ensuring a natural and intuitive interaction between the user and the exoskeleton.

Motor-powered exoskeleton arms rely on advanced control systems to provide users with seamless and intuitive control over the device. These systems often employ sensors, such as accelerometers, gyroscopes, and EMG (Electromyography) sensors, to detect user intent and translate it into precise, coordinated movements of the exoskeleton. Machine learning algorithms and neural networks play an essential role in enhancing the adaptability and responsiveness of these control systems. Materials and Actuators The choice of materials for motor-powered exoskeleton arms is crucial in achieving a balance between strength, weight, and comfort. High-strength, lightweight materials, such as carbon fibre composites and lightweight metals, are commonly used for the exoskeleton structure. Actuators, including electric motors, pneumatic actuators, and shape memory alloys, provide the necessary power to drive the arm's movements while maintaining a low profile and reducing energy consumption.

Despite the numerous benefits, motor-powered exoskeleton arms face several challenges and limitations, including cost, limited battery life, bulkiness, and the need for continuous user training. Ensuring safety and reliability, addressing technical issues, and reducing the economic barriers to access are critical areas of improvement.

2. Using Worm gear reduction motor to provide torque

An 11 RPM 90 kgcm worm gear reduction motor is a specialized electromechanical device designed to provide controlled and precise rotational motion at a low speed with high torque output

The motor's output shaft rotates at a speed of 11 revolutions per minute (RPM). This low rotational speed is ideal for applications where precise and gradual movement is necessary, such as in conveyor systems or slow-moving robotic arms. The motor is capable of delivering a high torque of 90 kgcm. Torque represents the rotational force or twisting power generated by the motor's shaft. A high torque output enables the motor to drive heavy loads or overcome

resistance in mechanical systems effectively. The motor in the setup is a DC servo motor, hence it can rotate in both clockwise and anticlockwise directions. This allows the arm to return to its original position by just reversing the polarity of the circuit.

3. Using a 12V/3A AC to DC adapter for power supply

A 12V/3A AC to DC adapter is a versatile and commonly used power supply device that converts alternating current (AC) electrical power from a mains power outlet into direct current (DC) power suitable for powering various electronic devices. The adapter typically comes with a standard plug that can be inserted into a wall outlet or power strip. This plug is designed to accept AC power, usually at voltages ranging from 100V to 240V, depending on the region and standards. The AC power from the mains is fed into a transformer within the adapter. The transformer's primary winding receives the input AC voltage, while the secondary winding produces a lower voltage suitable for conversion to DC. The AC voltage from the transformer's secondary winding is converted into pulsating DC voltage by a rectifier circuit. This circuit typically consists of diodes arranged in a bridge configuration, which ensures that the negative half cycles of the AC waveform are converted into positive DC.

Overall, a 12V/3A AC to DC adapter is a compact and efficient power supply solution that provides a stable and reliable source of DC power for a variety of electronic devices and applications. Its versatility, safety features, and robust design make it an essential component in the exoskeleton arm apparatus

Alternatively, we could also use a rechargeable 12V/3A power cell which can increase the mobility of the robotic arm and also eliminate the requirement of an AC to DC conversion circuit

5. Using DPDT Switches to control the motion of the arm

A DPDT (Double Pole Double Throw) switch is a versatile electrical component commonly used in circuits where multiple inputs need to be switched between multiple outputs. It essentially consists of two separate SPDT (Single Pole Double Throw) switches controlled by a single lever or toggle mechanism. The DPDT switch's ability to control two separate circuits simultaneously makes it highly versatile. It can be used for various functions, such as reversing polarity, which will allow the motor to change direction quickly and repeatedly

These switches can also be easily controlled by the user making it easier to use

6. Using limit switches a safety measure for the user

Due to the high power of the motor the user can be at a risk of physical harm as a result of the arm not stopping at the joint limits in time, to prevent this limit switches can be used and attached the ends of the required angle of rotation. This will forcefully stop the movement of the arm once it reaches the end but cutting of the current supply the motor. This will prevent any accidents ore mishaps and also will make the arm safer for the users.

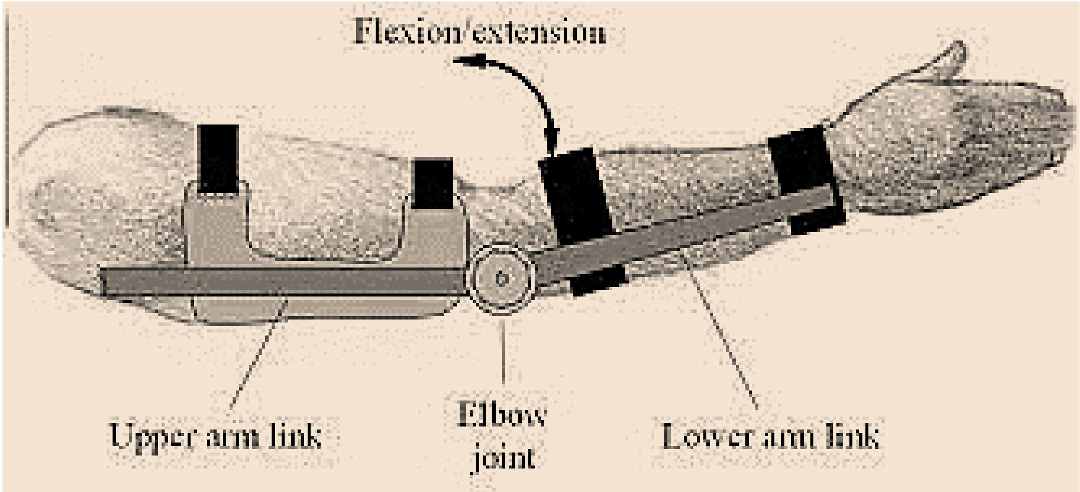
7. Design

Frame and Structure: The exoskeleton arm's frame is constructed from lightweight and durable materials, incorporating adjustable joints and linkages to mimic the natural range of motion of the human arm.

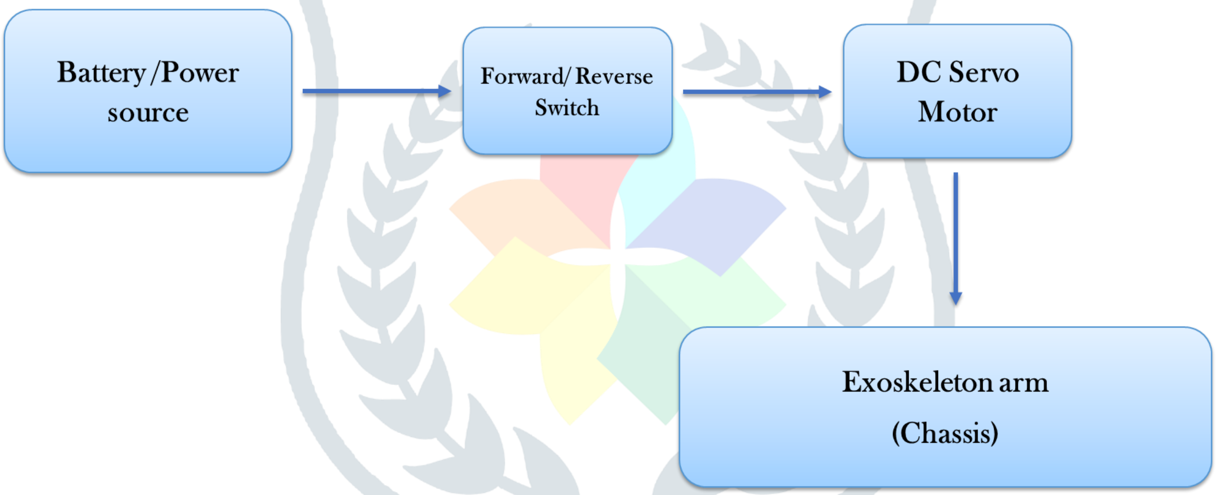
Actuation Mechanism: Electric motors are selected to actuate the exoskeleton's joints, providing the necessary torque and speed for assisting arm movements.

Control System: A microcontroller-based control system is developed to interpret switch inputs and coordinate the exoskeleton arm's movements. The control system includes safety features such as emergency stop functionality and collision detection.

User Interface: Switches are integrated into the exoskeleton arm to provide a user-friendly control interface. The placement and design of the switches are optimized for easy accessibility and operation.



Design Diagram



Construction flow char

Conclusion

In conclusion, the design and construction of a motor-powered, switch-controlled exoskeleton arm offer a viable solution for assisting individuals with mobility impairments. By incorporating lightweight materials, ergonomic considerations, and a user-friendly control interface, the exoskeleton arm provides support and enhances arm movements effectively. Further research and development efforts will continue to refine the design and explore potential applications in rehabilitation, healthcare, and assistive technology.

We made our exoskeleton frame out of aluminium metal to reduce weight economically. However, carbon fibre can prove to be a better alternative albeit at a higher cost. Using push buttons instead of sensors to control the movement of the arm also provides better control to the user due to sensors sometimes malfunctioning and misreading inputs. It also helps in reducing the overall cost of construction and maintenance of the arm.

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