Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 45 No. 4 (2024)

Design and Fabrication of Mark Xx Exoskeleton

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Abstract:- An Exoskeleton is an external skeleton that supports and protects an animal's body. Some insects/crustaceans such as grasshoppers, cockroaches, crabs, lobsters, snails, and tortoises have an endoskeleton (internal skeleton) as well as an exoskeleton (external skeleton). Exoskeletons contain rigid and resistant components that fulfil a set of functional roles including protection, support, and musculature. Most use of Exoskeletons are mechanical structures that humans can wear to increase their strength and endurance. The purpose of this paper is to explain how exoskeletons can be used to improve performance across five phases of manufacturing. During this process, they get affected by muscle cramps or permanent dislocation of elbow or shoulder joints. To overcome this problem, exoskeletons are devised that help workers in lifting as well as holding weights. As a part of this project dissertation, an exoskeleton has been modelled, fabricated and tested using pneumatic actuation Exoskeleton to lift a weight of 60kgs is modelled and fabricated using mild steel. Pneumatic actuations are fitted within exoskeleton for lifting weights. Finally, it is tested on 60kgs and found it working.

Keywords*: Exoskeleton, belt, rigid bars, Strength, Pneumatic actuator.*

1. Introduction

It has been claimed that there will be a "rise of the robots" throughout workplaces. Yet despite such claims, there are reports of increased robotics leading to reduced manufacturing performance, which necessitates the removal of robots and reemployment of human workers. One reason for poor outcomes from expensive investments in robotics is the limited ability of robots to deal with frequent production variations arising from demand uncertainty in assembly-to-order and engineer-to-order (ETO) production [1]. This is a challenge that cannot be overcome easily through artificial intelligence (AI). Hence, humans continue to perform better than robots where production work involves frequent variations. Importantly, the frequency of production variations will increase as demand uncertainty increases due to expansion of customization and personalization [2]. Given the profound challenges of improving the ability of robots to deal with more frequent production variations, an alternative for improving production performance can be to use industrial exoskeletons. Exoskeletons are mechanical structures that humans can wear to increase their strength and endurance. The purpose of this paper is to explain how exoskeletons can be used to improve human's physical performance [3]. The objective of this study is to assess the effect of a passive trunk exoskeleton on functional performance for various work-related tasks in healthy individuals. Wearing the exoskeleton tended to increase objective performance in static forward bending, but decreased performance in tasks, such as walking, carrying and ladder climbing [4]. A significant decrease was found in perceived task difficulty and local discomfort in the back in static forward bending, but a significant increase of perceived difficulty in several other tasks, like walking, squatting and wide standing [4]. Especially tasks that involved hip flexion were perceived more difficult with the exoskeleton. Design improvements should include provisions to allow full range of motion of hips and trunk to increase versatility and user acceptance. Low-back pain is one of the major health problems, causing largescale personal suffering [5].

Studying the acceptance of exoskeleton in the industry has gained more attention. Exoskeletons (wearable support devices) are thought to reduce the workload. Assessing what factors influence the use of exoskeletons is important, because influencing these factors can have a positive impact on the adoption of industrial exoskeletons [6].

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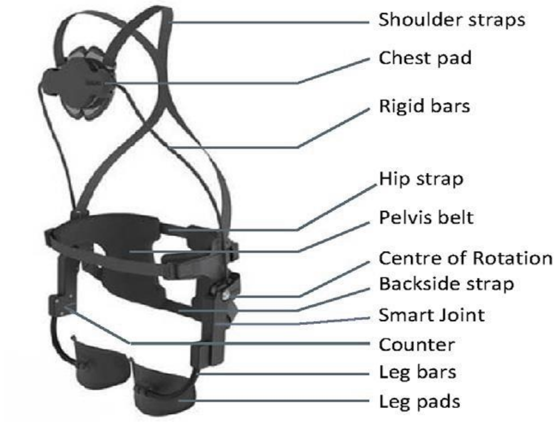

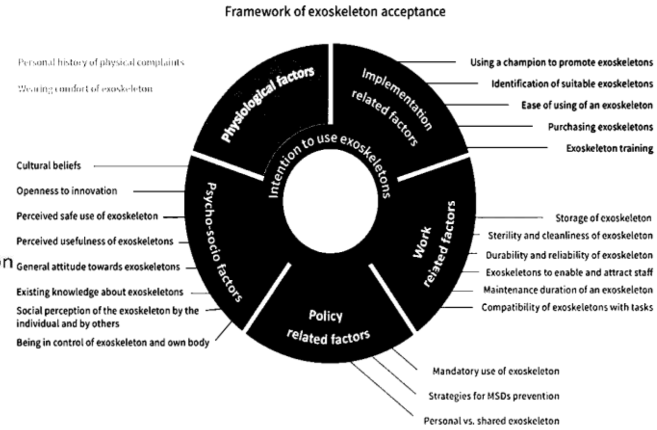

Fig 1 **Passive trunk exoskeleton** **Fig-2. frame work of exoskeleton acceptance**

A robust system, initially developed does not use any type of actuator, instead uses building materials, springs or dampers that have the potential to store energy harvested by man movement and use this as needed to support posture or movement [7]. The ideal exoskeleton, for example, it may retain energy when a person bends forward, and while in this state, this force may to support a person to maintain that position or to erect a body while lifting an object [8].

2. Modeling And Fabrication:

Pressure observer-controller design for pneumatic cylinder actuators. Pneumatically operating systems have excellent compliance advantages, high payloads and loads to volume, high speed and high-power capacity and easy operation. As a result, compact, lightweight manipulators can be developed in a cost-effective way for a variety of applications in the home environment and heavy industry [9].

3. Calculations:

Area of the piston (A) = $(\pi/4) \times D^2$

Area of piston rod (a) = $(\pi/4) \times d^2$

Active area (Aa) = A – a

[A= Area of the piston]

[a= Area of the piston rod]

Pressure (P) = x bar

Force (F) = P x Aa

[P=Pressure]

[Aa=Active area]

Lifting capacity = Force / Gravity

[Value of gravity constant = 9.8m/s2]

Volume of the cylinder = Aa x l

4. Results:

Present work on active exoskeleton to lift a load of 60kg has been modelled through CATIA V5. Based on a selected purpose of lifting weights, essential kinematics are Proposed. Links, joints are modeled, assembled and tested for kinematic Validation. Assembly components are analysed for load bearing, Exo Skeleton is fabricated and assembled with essential pneumatic drives and actuators. Assembly is tested for final interest.

The model has been successfully tested for kinematic interference and was found perfectly suitable for manufacture. There were no dead center positions as the kinematic analysis was checked for less than 900 elbow motion.

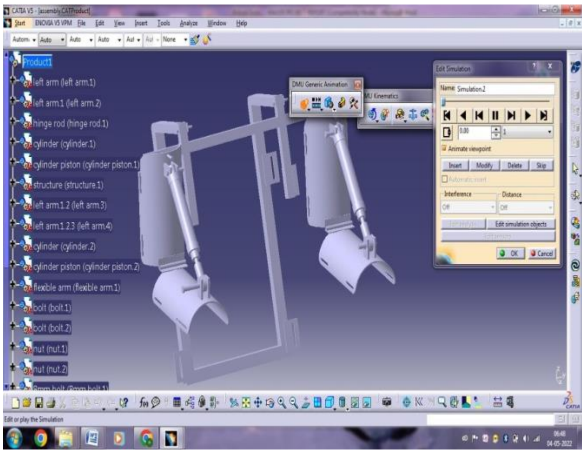
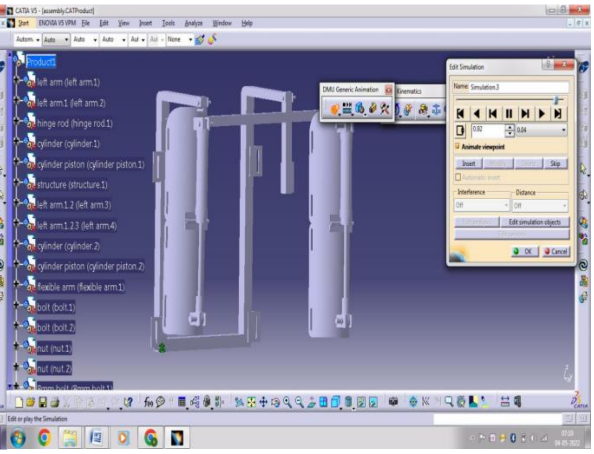

Fig 3. Kinematic assembly at 90^{0}foldFig 4. Kinematic assembly at unfolded limbs

Simulated models in two extreme positions are shown in above figures. Fabrication of the equipment as per the design guidelines was carried out. A regulated air pressure has been used in operating the hydraulic cylinders after assembly shown in fig 5& 6.


Fig 5 Pneumatic cylinder Fig 6. Model fabricated as per the design standards and mounted

Lifting power of the cylinders was calculated on the basis of 20% contribution of human muscle power and remaining 80% from active power.

5. Conclusion

To advance exoskeleton technology, it is important that scientists and engineers write down and share their successes and failures with research community. This theme of present work highlights the need. A major factor that has contributed to the development of powerful artificial limbs in the past has been a lack of carefully controlled scientific studies and open publication of technological advances. While this collaborative work may not produce peer-reviewed literature, providing opportunities for scientists as well engineers to learn from each other in a way that it is very beneficial for the field. In Today's world of testing our limit exoskeletons lay a hand in pushing physical limits of a human being to a great extent. Various technologies have been induced into these exoskeletons to reach super human states when working under extreme physical conditions.

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