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Belagavi, Karnataka 590018

A Project Report on

"DEFENCE SAFETY ARMOR EXOSKELETON SUIT"

Submitted in the partial fulfillment of the requirement for the award of the Degree of
Bachelor of Engineering in Mechanical Engineering

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CERTIFICATE

Certified that the project work entitled ***"DEFENCE SAFETY ARMOR EXOSKELETON SUIT"*** carried out by

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The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the said Degree.

Signature of the Guide	**Signature of the HOD**	**Signature of the Principal**
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ACKNOWLEDGEMENT

I extend my deep sense of gratitude and sincere thanks to our Principal **Dr. Udaykumar. S. Hampannavar** the of **SKSVMACET** for giving me an opportunity to be a student of this reputed institution.

I express my sincere gratitude to my guide **Prof. S. M. Patil** for his valuable guidance and suggestion technically and logically for doing my Project work. I also express my gratitude to **Dr. Maheshwar C Y** for helping and guiding us throughout the project.

I extend my respect to our Principal **Dr. Udaykumar. S. Hampannavar** for his valuable support to conduct this Project under **SKSVMACET**. It is my Privilege to thank the HOD of the Department **Dr. Maheshwar C Y** Department of Mechanical Engineering for his support and guidance for doing my Project. I also express my gratitude to all my faculty members, parents and fellow mates who have helped me to carry out this work. Last but not the least, I thank almighty God for his blessings showered on me during this Project period.

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ABSTRACT

Exoskeletons are wearable devices that are widely used in various fields as; medicine, military, or industrial applications for human performance augmentation. They are highly complex systems and mostly used for specific purposes such as handling certain weights. Since this paper is concerned with the latter, therefore, a detailed literature review and industry research, with specific focus on relevant engineering standards has been conducted. To overcome difficulty faced by soldier at the time of hiking in the sweltering heat carrying heavy backpacks ammunition and weaponry. Exhaustion would quickly take over. Due to this there will be decrease in stamina or fatigue. To reduce the heavy weight of backpacks weapons in special operations may cause reducing in the speed, reaction time and stamina which leads to loss of life or life threatening injuries.

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CHAPTER 1

INTRODUCTION

It’s becoming a booming industry, seemingly overnight, particularly when it comes to exosuits worn within the construction industry. Experts predict the robotic exoskeleton market will hit $1.8 billion by 2025, a rise from $68 million in 2014. Last year, 6,000 suits were sold worldwide, mainly for rehabilitation purposes. But by 2025, estimates show there will be about million on the market. It also gives the wearer superhuman powers. So, it is perfect candidate for Industry, military and rescue fields. Idea is to design and simulate an electric-powered full- body exoskeleton suit with aim of long battery life, better controls, weightlifting capacity of up to 300 kg & total weight under 60 Kg. In general, manufacturing industries with 30-250kg subassemblies typically use hanger mechanism, cranes, robots,semi-automatic lifters. The initiative taken by the Robo-mate is one of the first propositions made to retain the exoskeleton notion to the production sectors for restricting the manufacturing industries to preserve the employment opportunities. For 13 out of 26 industrial exoskeletons, some evaluations of the physical load reductions were performed.

Exoskeletons are important machines to decrease the risk factors associated with Stressed work musculoskeletal injuries. At this point, however, several issues hinder acceptance in industrial applications. The main issue is human-machine interaction and implications for standardization. According to a study, more than 72% of exoskeleton robots use an electric motor for actuation. Around 20% of exoskeleton robots are pneumatically powered. Hydraulic actuation was utilized by about 5% and about 3% use alternative or hybrid actuation methods. Pneumatic Air Muscles (PAM) actuation is not feasible due to its precision and control An exoskeleton, defined here as a body-worn mechanical device that works in parallel with the user, has the potential to enhance mobility. Current exoskeletons can be classified according to their various power states (active or passive) and structures (hard or soft). Active exoskeletons, describe devices that require a power source, whereas passive devices, have no external power and typically utilize springs or serve as an external support. Further, the structure of the device may include hard rigid components such as aluminium or carbon fiber, soft textile or cable components,6, 13 or a combination of both. Recent developmental efforts have yielded devices that reduced metabolic cost by up to 15 or potentially minimized injury risk by offsetting the external load outside the musculoskeletal system during common military tasks such as walking and load carriage.

While reducing the metabolic cost of walking and the potential for injury are highly important, equally important may be the ability of exoskeletons to improve both thephysical and cognitive capacity of the individual dismounted combatant, as well as the effectiveness of a combat unit as a whole.

The DSAES is type of suit made for soldier which is worn by them over a regular uniform to augment his strength. Exoskeleton technologies can bring new capabilities to fighting forces and improve endurance and safety in industrial settings. Lockheed Martin continues refinement of next-generation industrial products with our primary focus on powered exoskeleton as demonstrated its ability to increase mobility and reduce fatigue of its users. By reducing the effort in walking and climbing, this technology can literally help soldiers and first responders go the extra mile while carrying mission essential equipment.

Exo-suit rigged up on a soldier is expected to enhance his addition load carrying capacity. Soldiers who patrol in high altitude terrains like LAC &LOC wear a leg-gear that assists them in walking in snow and 50% of the load burden, thereby, reducing the risks of injury to the troops. Musculoskeletal injuries due to manual handling are physically damaging to personnel and financially costly to the Indian Defence Force. Exoskeletons may minimize injury risk by supporting, augmenting, and/or amplifying the user’s physical abilities. Exoskeletons are therefore of interest in determining how they could support the unique needs of military manual handling personnel.

CHAPTER 2

LITRATURE SURVEY

1. Mohamed Abdelmomen, et.al

- They have done research on upper-body exoskeletons for performance augmentation of production workers.
- Exoskeletons are wearable devices that are widely used in various fields as medicine, military, or industrial applications for human performance augmentation.
- Since this paper is concerned with the latter, therefore, a detailed literature review and industry research, with specific focus on relevant engineering standards has been conducted.
- The exoskeleton technology is evolving quickly but still needs interdisciplinary research to solve technical challenges, e.g., kinematic compatibility and development of effective human–robot interaction.

2. Ashish Singlaa, et.al

- They have study on Lower Limb Exoskeletons Brief Review.
- The paper presents review of the exoskeletons produced to date describing their constructional and technological features and there maiming gaps in technology.
- The paper discusses the challenges that need to be addressed and the future trends in the exoskeleton domain
- One of the key issues facing elderly persons relates to personal mobility which is essential for independence and good quality of life.
- With advances in technology, conventional methods like walkers, crutches and wheel chairs for providing mobility are being overtaken by wearable robots, commonly known as exoskeletons. This technology represents the future of mobility solutions for the elderly.

3. R.K.P.S. Ranaweera, et.al

- They have done research on Powered Ankle Exoskeletons: Existent Designs and Control Systems.
- This paper performs a comprehensive review on active ankle exoskeletons powered by external means. Initially, anatomy of the ankle joint complex is

highlighted.

- Here, exoskeletons designs from 2005 to 2017 were studied to recognize the latest paradigmshifts. As such, this paper provides a classification, a comparison and overview of related technologies.

CHAPTER 3

OBJECTIVES

- To overcome difficulty faced by soldier at the time of hiking in the sweltering heat carrying heavy backpacks, ammunition and weaponry. Exhaustion would quickly take over. Due to this there will be decrease in stamina or fatigue.
- To reduce the heavy weight of backpacks weapons in special operations may cause reducing in the speed, reaction time and stamina which leads to loss of life or life threatening injuries.

CHAPTER 4

METHODOLOGY

Our main focus is to make a working prototype which simulates the working of actualconcept. The following methodology process is divided into four step.

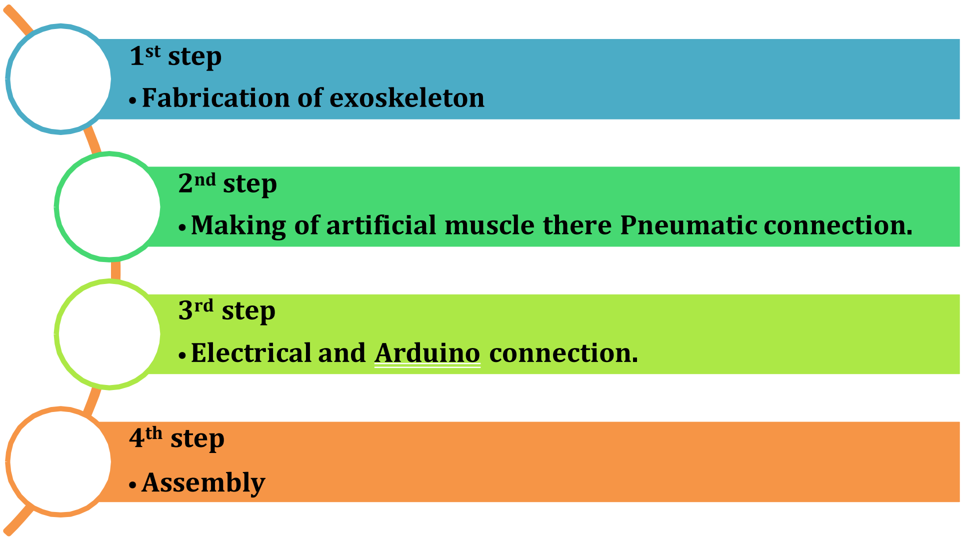

Fig 4.1. Steps of Methodology flow chat.

4.1. Fabrication of exoskeleton.

As per the design the following four components were used for fabrication of exoskeleton.

- Aluminium bars.
- Aluminium rivets.
- Hinges.
- Nets bolts.

4.2. Making of artificial muscle and there pneumatic connection.

Material required.

- Latex tube.
- Flexing nylon wire sleeve.
- Pneumatic pipe.
- 5/2solenoidvalue.
- Clamp.

4.2.1. Working of artificial muscle:

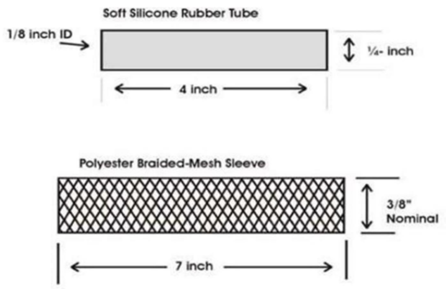

Fig.4.2. Artificial muscle

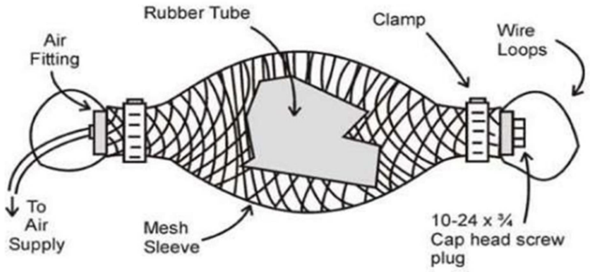

Fig.4.3. Latex tube and flexing nylon

This exoskeleton is powered by Pneumatic where we are using as artificial muscles. Itis muscle-like actuators, are materials or devices that mimic natural muscle and can change theirstiffness, reversibly contract, expand, or rotate within one component due to an external stimulus. The three basic actuation responses– contraction, expansion, and rotation can be combined within a single component to produce other types of motions (e.g. bending, by contracting one side of the material while expanding the other side). Conventional motors and pneumatic linear or rotary actuators do not qualify as artificial muscles, because there is more than one component involved in the actuation. Owing to their high flexibility, versatility and power-to-weight ratio compared with traditional rigid actuators, artificial muscles have the potential to be a highly disruptive emerging technology. Though currently in limited use, the technology may have wide future applications in industry, medicine, robotics and many other fields. The pneumatic muscle is used in between to links which connect them. When compressed air is passed in muscle it get expand due to this the length of muscle become shorter which leads to moment in links. The pneumatic / artificial muscle is used in between to links which connect them. When compressed air is passed in muscle it get expand due to this the length of muscle become shorter which leads to moment in links.

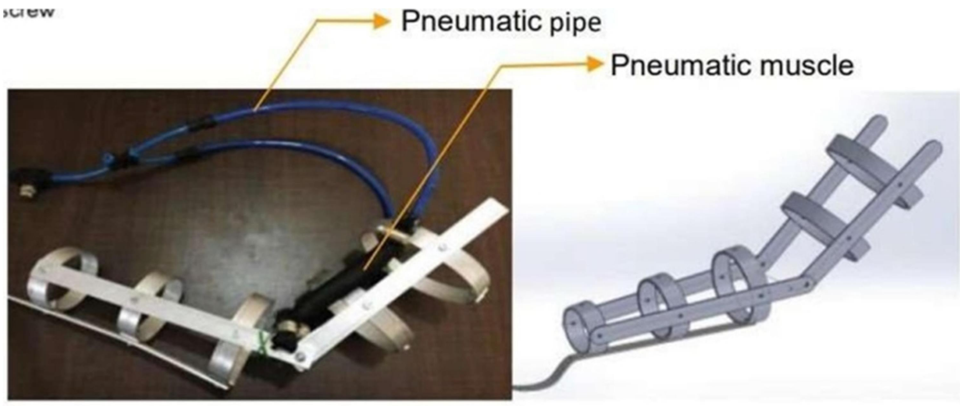

Fig.4.4. Prototype of artificial muscle with exoskeleton suit

4.3. Electrical and Arduino connection.

Material required

- Arduino UNO
- Muscle pulse sensing sensor (EMG Muscle sensor) / IC INA 128
- Relay
- Jumper cables
- Wires.

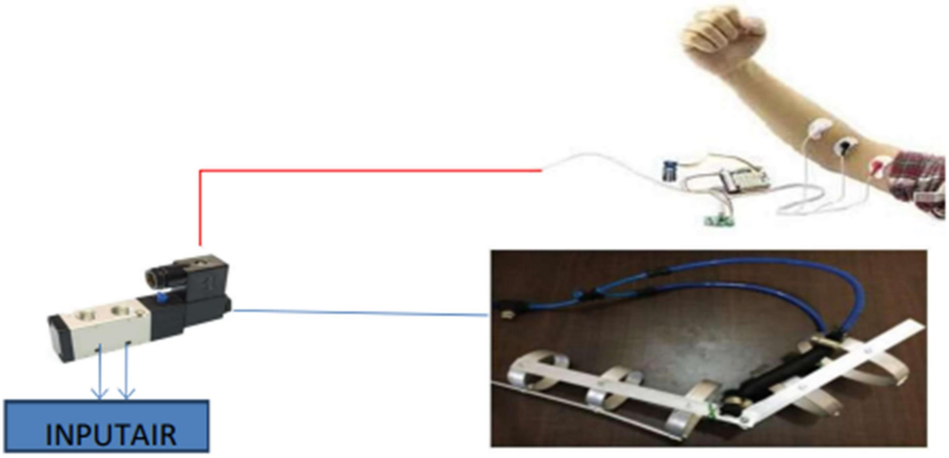

Fig.4.5. Electrical connection

4.3.1. Working;-

- When the valve is opened the artificial muscle undergo compression process which leads to moment of the links.
- The solenoid valve is controlled by arduino NANO which is programmed to open the solenoid valve when Muscle pulse sensor senses the input signal from the pulse of muscles.

4.4. Assembly

Fig.4.6. Pneumatic artificial muscle prototype

Fig.4.7. Exoskeleton prototype

Fig.4.8. Prototype of exoskeleton

CHAPTER 5

TESTING

Project idea of developing a full body exoskeleton suit prototype which is intended to be used for heavy duty application in manufacturing sectors, defence sectors & some civilian sectors .the design was fully mobile type & is not restricted to any particular space. Static validation was done by manual computation. Although Static structural analysis was done the dynamic analysis was not performed due the limitation in hardware & tools , here dynamic analysis can be done in future which will further give us the result with more precision, here the suit design is simple which is convenient for most of the uses ,but can be changed depending upon the payload characteristics The pneumatic muscle is controlled by the use of arduino UNO which was used around the a part of hand for the detection of signal for pneumatic muscle . The gait Assist function introduced in the prototype which helps us in reducing lag, this function also can be used as a reference limit of drive control which the device is arduino UNO.

As per the design and the parts of the suit is assembled and tested by wearing it. By the working artificial muscles is connected pneumatic muscles arm and controlled by 5/2 solenoid value. As 5/2 solenoid value is connected to the relay which listens the command of arduino UNO.

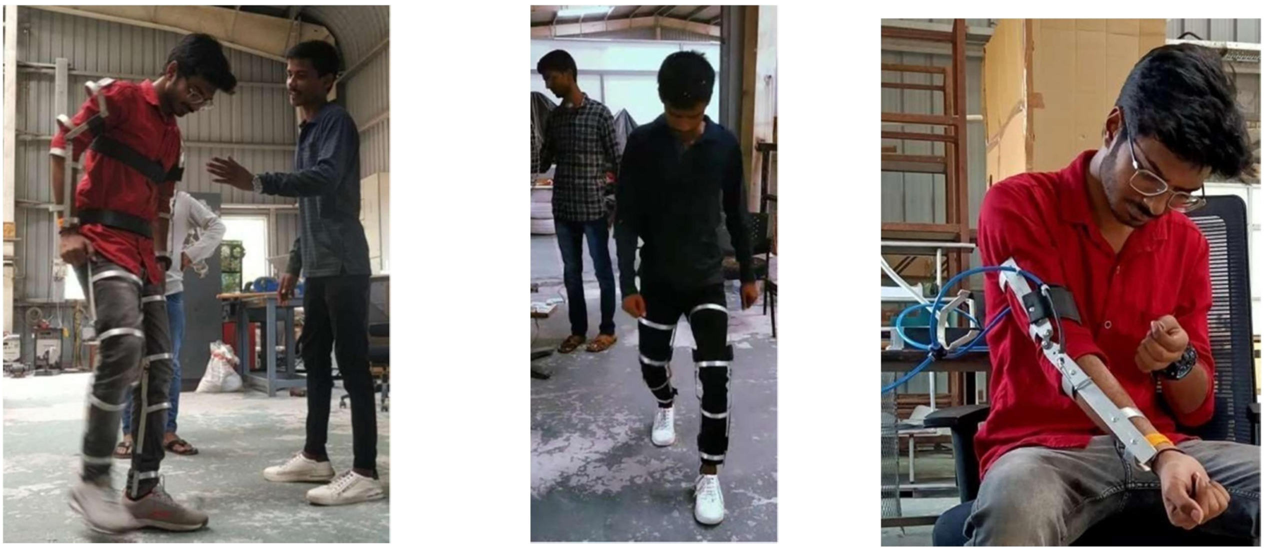

Fig.5.1 Testing of exoskeleton suit

CONCLUSION

As a research on the exoskeleton suit motivated to develop exoskeleton suit. So far development of this suit provides hands-on experience and knowledge. Exoskeleton suit not only has important implication value for military but also can be widely used in civilian areas such as rescue, disaster relief, mountain climbing, construction, tourism, and helping the disabled. Capabilities such as new soldier weapons, situational awareness, command, control, communications and navigation. But as of now it has been a difficult problem for the exoskeleton suit system getting to be mature how to make the exoskeleton suit perceive human body movement intentions and track human body movement while bearing load.

SCOPE FOR FUTURE WORK

Those of us who are slow or reluctant runners or walkers might soon be able to slip on a lightweight, lower-body exoskeleton and up the speed and ease of our exercise, according to several new studies examining the effects of these high-tech robotic devices Personal, or wearable, exoskeletons, usually amalgamated from motors, cables, straps, springs and ingenuity, can shoulder a substantial portion of the work when we walk or run, the new studies show, potentially allowing us to move much faster or farther. They can even harvest energy from the movement almost enough to power a cell phone.

But the latest exoskeleton research also raises provocative questions about what we want from exercise and whether making it easier necessarily makes it better. Exoskeletons have been staples of science fiction for eons, enabling fictional soldiers, cops, everymen and Avengers to outgun, out-sprint and outlive their nemeses. In these stories, exoskeletons tend to be full-body, armored, stylish and indestructible.

Real world exoskeletons under development at most human-mobility labs today are none of those things. Some modern exoskeletons encase much of the body with the goal of helping people paralyzed by illness or spinal injury to stand and walk. But most are abbreviated devices, centered on either the legs or upper body. Some include motors; others are self-powered, usually by springs; and some, known as exosuits, are made of soft, pliable materials that resemble clothing. All provide assistance to muscles and joints.

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APPENDIX

Estimation

MATERIAL	PERMETERS	QUANTITY	COST IN RS
Aluminium bars	12cm X4mm 20cm X 4mm 15cm X4mm 36cm X 4mm 26cm X 4mm 12R cm X 4mm 20R cm x 4mm 25R cm X4mm 15R cm X 4mm 60cm X 4mm 10 cm X 4mm	2 6 6 4 4 6 11 4 4 1 2	1000
Aluminium rivets	6mm	112	150
Hinges		5	25
Bolts and nuts	6mm	25	15
Arduino		1	550
INA 128 IC (EMG Muscle sensor)		1	600
Relay	Single mode	1	300
wires Jumper cables		15	15
Latex tube	2m X 6mm	1	350
Flexing nylon wire sleeve	2m X 10mm	1	250
Pneumatic pipe	1m X 8mm 2m X 6mm	1 1	340
5/2 solenoid value		1	750
Clamp		3	15
Cable tie	6mmX100	1	60
Total			**4420**