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Design and Analysis of Lower Body Exoskeleton System

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Abstract: In present the first and foremost important quality and aspect of any research or development paper is its property of advancement in field of automation and reduce manual work. It is very difficult to stand and work about 8hour to10 hour per day in the company by a worker. This will reduce efficiency of worker. The solution to this problem is to have a portable device which has an ergonomic design, low cost exoskeleton. The aim of exoskeleton actuator system is to provide forces against to external load carried by user during walking, sitting, and standing motion. The objective of this project are to study, analyse, and develop a new mechanism that assist the human locomotion, to learn in details about how the lower body exoskeleton works. This paper deals with entire process related in the designing and development of the chair less chair.
Keywords: lower body exoskeleton, actuator, ergonomics.

I. INTRODUCTION

The world is getting compact day by day and we know the most useful devices are compact in size. If you are working in a restaurant kitchen, factory you will know you are tired for many hours. In manufacturing company keeping employee healthy has been major problem and challenges for companies around the world hence it needs to manufacture the “chair less chair” or “exoskeleton based pneumatics support”. It is not possible to carry a stool around with you at every time that’s why we are introducing this exoskeleton based pneumatic support. This exoskeleton based support helps to stand for long times. It improves walking and running economy and reduces the joint in pain or increases the strength in joint. It transfer load directly to ground. The exoskeleton is powerful mechanical devices. In pneumatic support, a pneumatic cylinder is used to engage and hold the person body it only wrap around thighs, so it reduces fatigue and increases the productivity.

II. LITERATURE SURVEY

In this paper we are very much interested in the wearable devices which help in increasing the efficiency of the human and decrease the rate of fatigue of human during work. The device discussed here is the passive device. This device is known as chair less chair which helps the wearer to work effectively at any location in sitting posture.

H. Zurina and A. Fatin has worked on design and development of lower body exoskeleton.in this paper an attempt has made to evaluate the possibility of using the chairless chair that will have been increasing efficiency and offer weight support when the user feel tired. Other than that in term of ergonomics and the objective is to give comfort to user by choose their comfort degree level from 450 to 900.

Aditya Bhalerao and Sandesh Kamble have work on pneumatic portable chair for employees to seat while working. A basic idea of how an exoskeleton using pneumatic or hydraulic cylinder can be used to reduce the fatigue by using simple kinematic mechanism.

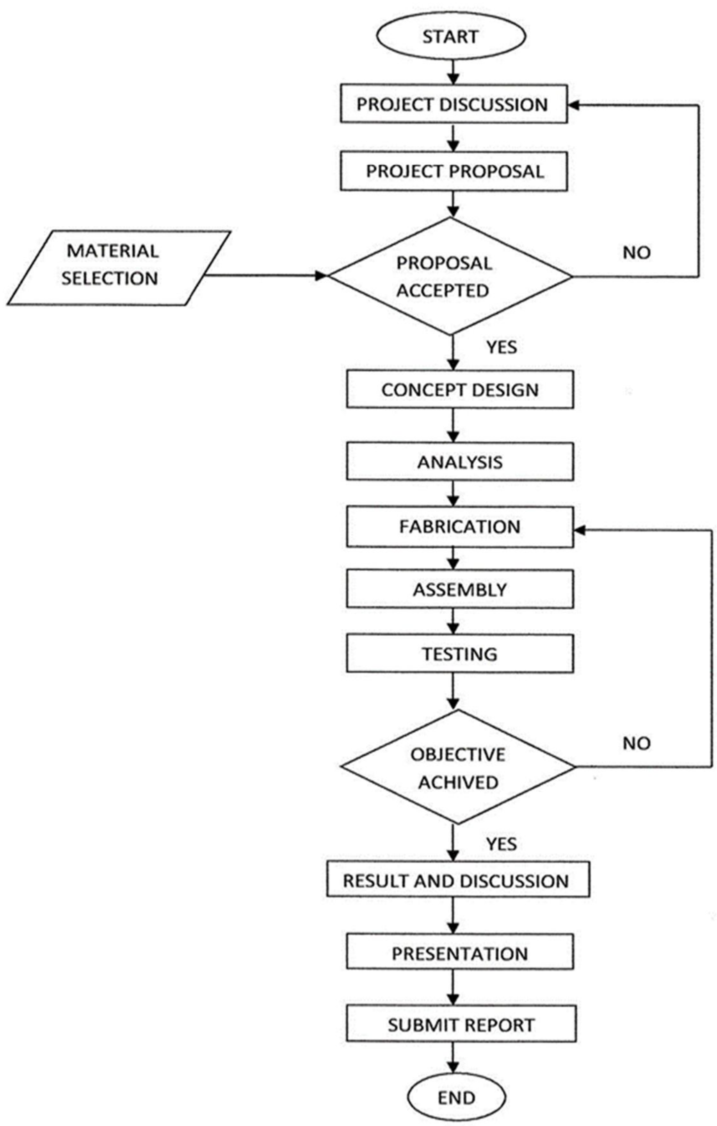
III. RAW MATERIAL AND STANDARD MATERIAL

Sr. no.	Part Name	Material	Quantity
1	Cylinder 20 bore 250 stroke	STD	2
2	Pad	Mild Steel	2
3	Belt	Nylon	4
4	Shoe	Leather	2
5	Pivot Joint	Mild Steel	2
6	Shoe Holder	Mild Steel	2
7	Pop Rivet	Aluminium	14
8	Nut Bolt M10	Mild Steel	4
9	Round Pipe	Mild Steel	2

IV. EXPERIMENTAL PROCEDURE

Firstly, we need to design the work piece metal chair less chair as plan by using CAD. Then, cut the work piece metal into parts. After that, the work piece is welded and assembled in order to combine the parts of the product and link bar. Run the project and the discussion is made based on the result of the chair less chair. Some precaution steps need to take in action while conducting experiment to avoid any unnecessary accidents for example during the welding, we have to protect our eyes by using the protection that provided by the lab

V. FLOW CHART



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VI. MODELING

Modelling the component by using solid edge.

For 90^0

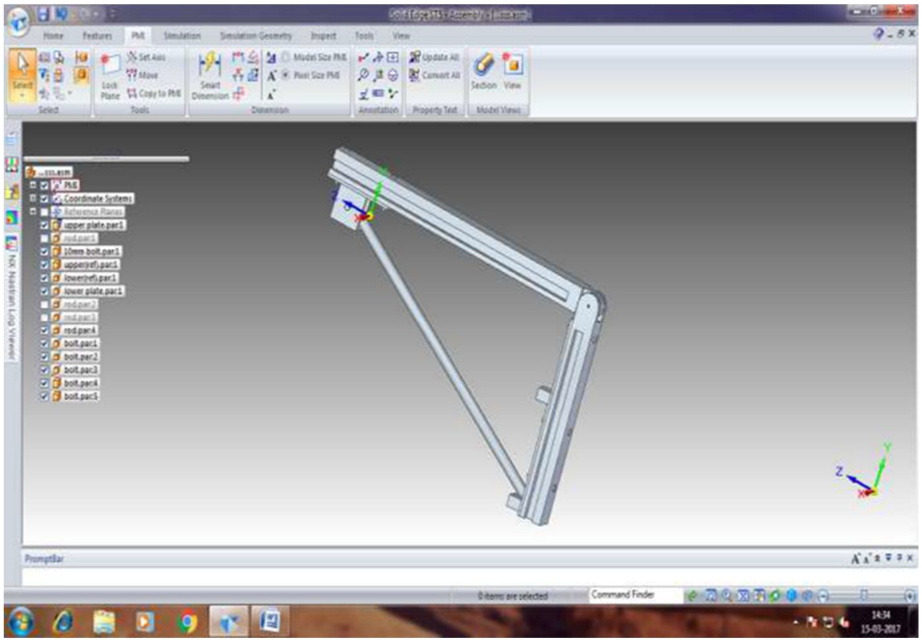

Fig 1 Locking Arrangement For 90^0

For 120^0

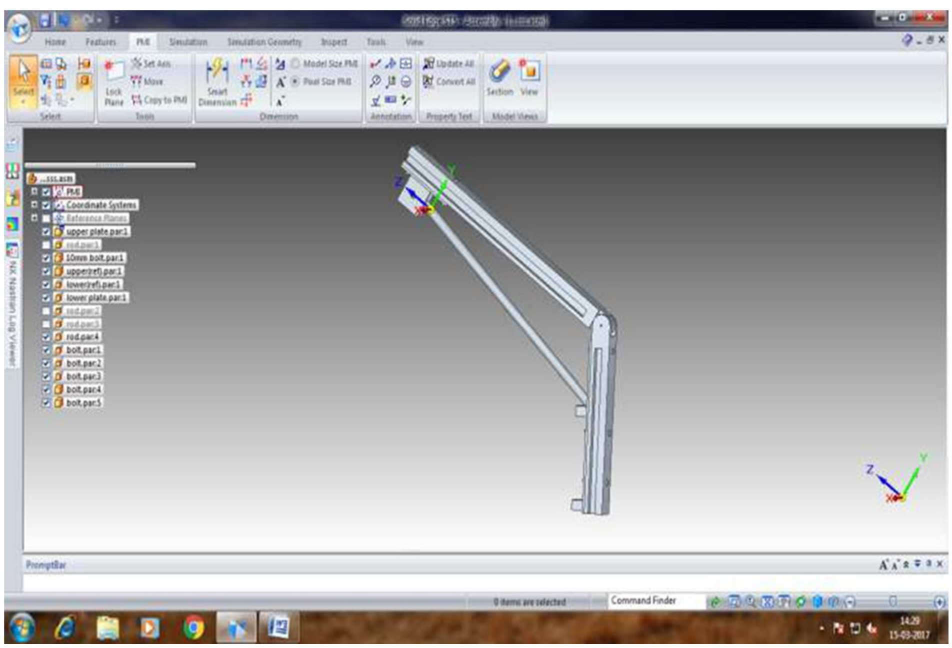

Fig 2 Locking Arrangement For 120^0

VII. STRESS TABLE FOR DIFFERENT ANGLES:

Angle	Total Deformation (mm)	Maximum Shear Stress (Pa)	Equivalent Stress (Pa)
90	1.27	$2.3534*10^{7}$	$4.6242*10^{7}$
120	3.55	$7.1504*10^{7}$	$1.3156*10^{8}$

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VIII. DESIGN CALCULATION

A. *Calculation*

Area *Pressure = Force output
Consider average weight of human = 100 Kg
Force = 100*9.81
=981 N
Now, area of cylinder = 314.15 mm2
P = 3.122 N/mm2

- *Design of cylinder*

Thickness of cylinder wall; t = (p*d)/(2*tensile strength)
Cylinder material is aluminium alloy 6061-T6
Having yield strength =241 MPa
Ultimate strength=300 MPa
Consider factor of safety = 2
Thus, tensile stress = 300/2
=150 N/mm2
(3.122*20)/ (2*150) = T
T= 0.208 mm
But standard available size of cylinder having thickness 3 mm
Outer diameter =inner diameter +2*t
=20+ (2*3)
= 26 mm

B. *Design of bolt*

Bolt will fastened tightly; thus it will take load due to rotation
Stress for C-14 steel; Ft=420 kg/cm2
From table of design data book,
Diameter of M10 =8mm
F = (π/4)*82*Ft
Ft = 19.51 N/mm2
The calculated ft. is less than the maximum ft. hence our design is safe.

IX. CONCLUSION

The chairless chair is developed successfully and assembled. The aim for this project to fabricate a simple model to show how the system works is successfully achieved. In this project, a lower extremity exoskeleton mechanism is designed to support human walking, sitting, and standing motions synchronously with human and also it is developed to take significant portion of external load carrying by the user. Once this is achieved, exoskeleton could become practically useful and start to appear in everyday life after make some improvement.

X. FUTURE SCOPE

In the future, we want to reduce the weight, we can replace the iron steel structure with fibre glass or plastic. Fibre glass is a good strength to weight ratio component but it is quite expensive. Others alternatives is to use plastic but the selection of plastic must be analyse wisely. Sharp edge at the chairless chair must be removed in order to prevent injuries to the users. Besides that, we have to encounter our safety when using this chairless chair as their chairless chair built based on the theory that said most suitable angle for balanced seating in between femur bone and lumbar curve. Thus, the safety might be increasing by adding some safety issues in the future. Our objective is to solve ergonomic problem occur during work for long term of period. So any extra ergonomic problem should not occur while using this lower body exoskeleton.

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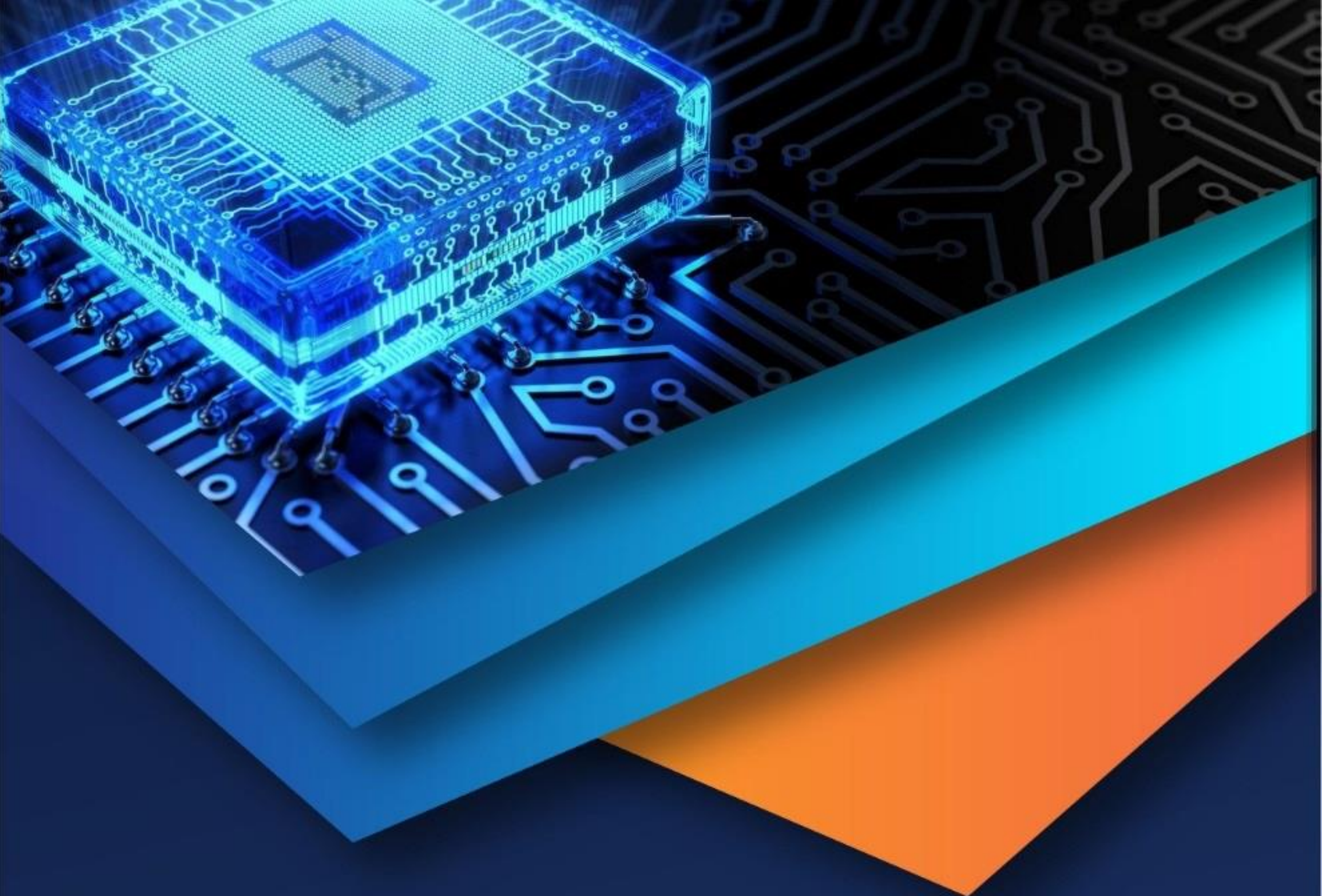

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