Design and Fabrication of Portable Chair for Labours

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Abstract:*In the few six decades since researchers began to search and develop methods of creating them, exoskeletons have progressed from the stuff of science fiction to nearly commercialized products. While there are, still many challenges associated with labor working in companies and industrial area while standing work. A big issue of energy efficiency in robotics locomotion. Long hours of standing are often detrimental to health. The Portable Chair is like a mobile exoskeleton that allows people to essentially sit anywhere in this paper we are introducing portable chair the mechanism is actuated by a pneumatic cylinder which balances the weight of the worker and design overview of hardware, actuation and control systems for the mechanism.*

Keywords*: Exoskeleton1, Wearable2, Rehabilitation3, Robotic4, Locomotion5, Walking6 etc.*

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1. INTRODUCTION

Robotic exoskeletons that can enhance human power capabilities are no longer limited to the realm of science fiction. Engineers have been working on exoskeletons to augment human power since the 1970's [1] Lower-limb robotic exoskeletons could be a useful tool for conducting basic science research into the mechanics, energetic and control of human locomotion. Recent studies have begun to examine adaptations in electromyography and kinematics during walking with lower-limb powered assistance in both healthy and impaired populations [2] But, surprisingly, we found only a single study that has examined the metabolic cost of walking with powered exoskeletons (Norris et al., 2007). Experiments designed to address the biomechanics and energetic of humans walking with powered exoskeletons. Fundamental to designing a lower extremity exoskeletons selecting the overall structural architecture of the legs. Many different layouts of joints and limbs can combine to form a functioning leg we have calculating body parts weight and calculating force in Newton and selecting suitable gas spring operated cylinder and mechanism.

The control method has been implemented in a 1-Degree of Freedom (DOF) exoskeleton that is designed to assist the motion of the human knee by applying actuator forces in opposition to a specified muscle force profile. In this research, there is a discussion on the model of the human's lower body and how muscles are affected as a function of joint positions. Then it is discussed how to calculate for the forces needed by a pneumatic actuator to oppose the muscles to create the desired muscle force profile at a given joint angles. The proposed exoskeleton could be utilized either for rehabilitation purposes, to prevent muscle atrophy and bone loss of astronauts, or for muscle training in general. The proposed exoskeleton uses a dynamic model of the musculoskeletal system of the lower leg combined with the dynamics from a pneumatic actuator to provide resistive forces to the muscle forces. The exoskeleton will use a quasi-dynamic (useful for slow to moderate human movement speed) force-feedback control method to determine how the pneumatic actuators should apply forces at desired positions and times[4]

2. PROBLEM STATEMENT

In industries, the motivation behind this research involves helping workers to more effectively exercise to mitigate the effects of microgravity on bones and muscles. There is an unavailability of seat when we want to sit anywhere and anytime. It is often difficult to provide seating equipment for all workers in cramped spaces like warehouses and long hours of standing are often detrimental to health. Available robotics locomotion has big issue of energy efficiency. The Portable Chair is like a mobile exoskeleton that allows people to essentially sit anywhere. We have design the portable chair for 80kg person hence all calculations take by the reference of 80kg man

3. OBJECTIVES

To provide radical and effective solution to the problem faced by the workers when working in industry for hours and hours. The proposed Chair uses a dynamic model of the musculoskeletal system of the lower leg combined with the dynamics from a hydraulic actuator to provide resistive forces to the muscle forces. The exoskeleton will use a qSuasi-dynamic (useful for slow to moderate human movement speed) force-feedback control method to determine how the pneumatic actuators should apply forces at desired positions and times. Objective of this project into design the exoskeleton assistive device which allow for normal movement like walking and running when we wear it.

4. SCOPE

A control method is proposed for exercising specific muscles of a human's lower body. This is accomplished using an exoskeleton that imposes active force feedback control. The proposed method involves a combined dynamic model of the musculoskeletal system of the lower-body with the dynamics of hydraulic actuators. The exoskeleton is designed to allow for individual control of bi-particular muscles to be exercised while not inhibiting the subject's range of motion. The control method has been implemented in a 1-Degree of Freedom (DOF) exoskeleton that is designed to resist the motion of the human knee by applying actuator forces in opposition to a specified muscle force profile. Then it is discussed how to calculate for the forces needed by a pneumatic actuator to oppose the muscles to create the desired muscle force profile at a given joint angles. The two lower limbs will assist to sit a human being without any chair and back support. The Velcro strips will be provided so as to clamp the assembly with human limbs.

5. METHOD

- We started our work with literature survey and analysis.
- We have completed calculations parts.
- We have purchase standard components from market. shoe holder, gas spring cylinder, belts
- We will be done a rough 3D model of our project.
- First we collect a leather suitable shoe for which we will make a frame, which will use as shoe holder is done. The shoe holder is fixed to the heel of the shoe.
- Now a small square block one end of which is pivoted to shoe holder and another end is fixed to the bottom end of Piston connecting rod is which we are used.
- Here we will use 4 bar pressure spring operated cylinder, depends upon 80 kg weight of user. The cylinder has 40 mm bore diameter, 80 mm stroke length.
- Now, a leg holder is made which will hold the thigh and is made by taking 2mm MS sheet bended to the shape of thighs.
- The leg holder is pivoted to square block is fixed to cylinder.

6. DESIGN

6.1 mechanical design

To design a portable chair based on exoskeleton leg that can fit the labour's perfectly, the exoskeleton mechanical structure must accord with the Ergonomics' principles very well. In other words, the exoskeleton mechanical design will ensure that labour's will not feel any counterwork when they wear this device. [7]

6.2 Structure Design

Since the number and DOF of joints on the exoskeleton leg is defined, what should do next is to assign material, dimension to each part and determine the distribution of the cylinders. The exoskeleton should stand by other principles as below:

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1) It should be lightweight for the sake of the labour's comfort. Meanwhile, it should have enough strength. The high rigidity aluminum can meet this requirement.
2) It should be designed length adaptable for every different individual.
3) The positioning of actuators should make cylinders provide the maximum torque to drive the exoskeleton legs and cover the physiological space that human legs can reach to. The angle and of joints and the torques needed in the human walking cycle can be consulted in reference in order to meet this requirement, the kinematic model of mechanical joint must be analyzed. [5]

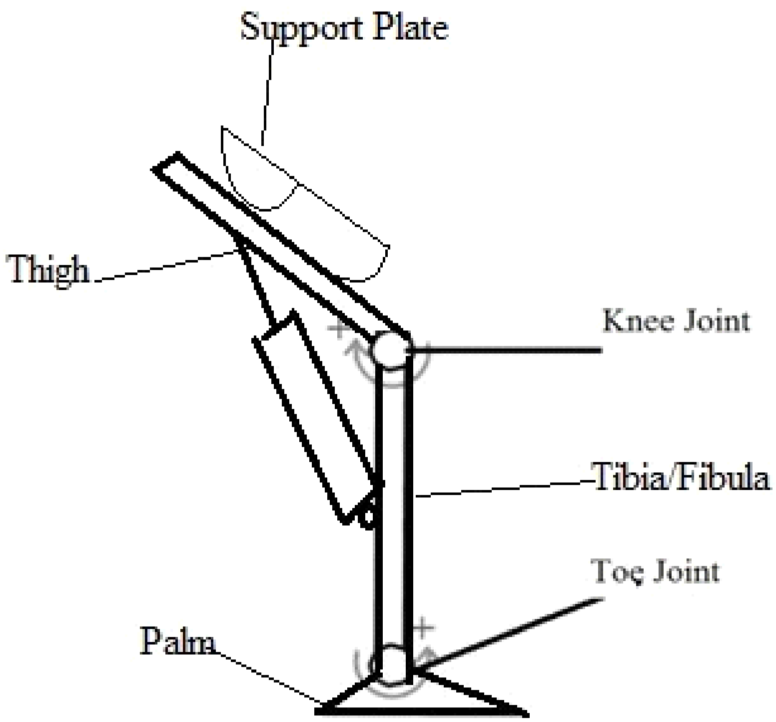
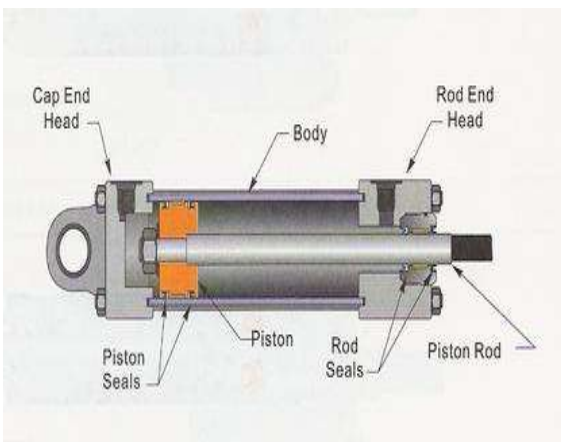


FIG. [1]

7. CALCULATIONS



[fig. 2]

3.2.1 Calculation for hydraulic cylinder:

For 80 kg weight of worker,

According to book of Human Body Dynamics: Classical mechanics and Human movement by Aydin Tozeren, the average percentage of weight for each body part is as follows;

Trunk (chest, back and abdomen) = 50.80% of total body weight $=\frac{50.80}{100} * 80 = 40.64$kg

Thigh = 9.88% of total body weight $=\frac{9.88}{100} * 80 = 7.904$kg

Head = 7.30% of total body weight = $\frac{7.30}{100} * 80 = 5.84$ kg

Lower leg = 4.65% of total body weight= $\frac{4.65}{100} * 80 = 3.72$ kg

Upper arm = 2.7% of total body weight= $\frac{2.7}{100} * 80 = 2.16$kg

Fore arm = 1.80% of total body weight= $\frac{1.80}{100} * 80 = 1.28$ kg

Foot = 1.45% of total body weight= $\frac{1.45}{100} * 80 = 1.16$ kg

Hand = 0.66% of total body weight= $\frac{0.66}{100} * 80 = 0.528$ kg

Total arm = $\frac{4.3}{100} * 80 = 3.44$ kg

3.2.2 Total effective weight on chair

Total effective weight of parts of body acting on chair = weight of head + weight of trunk (chest, back and abdomen) + weight of two thigh + weight of two arms + weight of hand

Therefore,

Total weight = 5.84+40.64+2*7.90+2*3.44+0.528

= 69.698 kg

We have use two Hydraulic cylinders

Therefore,

Force distributed in two cylinders = total weight/2 = 34.84 kg

By Newton’s second law of motion,

Weight force = Mass * Acceleration due to gravity

F = m * g

F = 34.84* 9.81

F = 341.85 N

We know that,

Pressure = Force/ Area

Force = pressure * Area

F = P * A

Calculating cylinder diameter subjected to given weight for different available hydraulic cylinder pressure.

For hydraulic cylinder of pressure 2 bar,

F = P * A

$341.85 = 2 \text{ x } e^5 \text{x} \frac{\pi}{4} D^2$

D = 46.65 mm

For hydraulic cylinder of pressure 3 bar,

F = P * A

$341.85 = 3 \text{ x } e^5 \text{x} \frac{\pi}{4} D^2$

D = 38.09 mm

For hydraulic cylinder of pressure 4 bar,

F = P * A

$341.85 = 4 \text{ x } e^5 \text{x} \frac{\pi}{4} D^2$

D = 32.98 mm

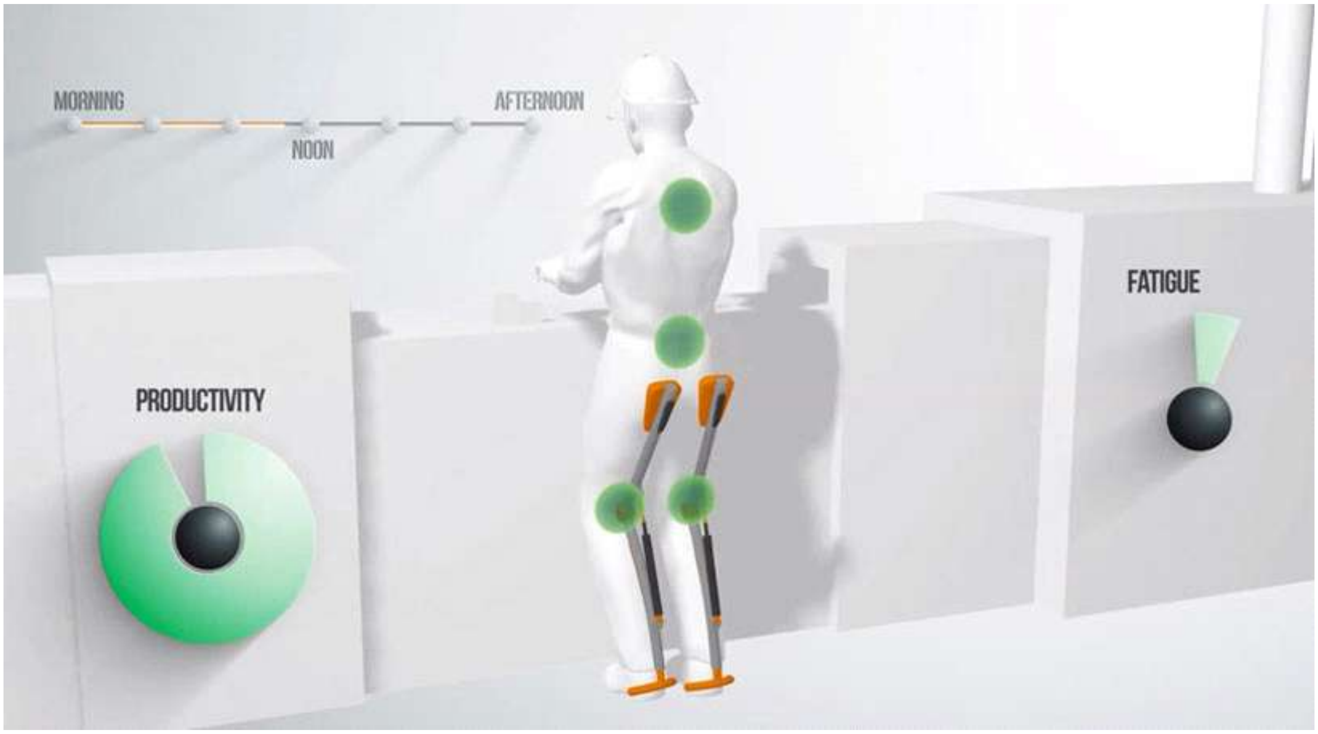
Approximately, D= 40.00mm (selecting standard)

Hence, stroke length (L) = 2D = 2 * 4

L = 80mm

8. ADVANTAGES

- Adjustable height as we want.
- Reduces human efforts and tired free work.
- Easy to operate and wear.
- .No frequent maintenance and service.
- .High efficiency and increases in production rate
- .Can used for seating and lifting.



[fig. 3]

9. DISADVANTAGES

1.Possibility of cramps due to long use.
2.incase failure if weight is high than 80 kg

10. APPLICATION

1. This portable chair would helpful to workers and anyone who needs to stand for long hours at stretch.
2. Once into mass production,a company can completely give up the usage of portable chairs and make maximize efficiency.
3.In food and manufacturing industries, for labours who work standing hours and hours. 4.Can be used by commuters standing in a crowded trains or metro to relax themselves without occupying much space.

11. CONCLUSION

The Exoskeleton Based on pneumatic gas spring operated cylinder fabricated and it was found to be suitably safe under the Load during walking as well as under Dead Load when the user sits/rests on it. We have only design model for 80kg weight person, we can also design to 80kg to required weight person. But design and calculation are varying with human weight**.**

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