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Design Chairless Chair-Exoskeleton System

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Abstract **– The 'chairless chair exoskeleton system' is a hydraulic based exoskeletal support which is basically a 'chair' that is like an exoskeleton, allowing users to walk or move at certain speed with the device while they work. It is a mechanical ergonomics device that is designed around the shape and function of the human body, with segments and joints corresponding to those of the person it is externally coupled with. This support helps users to rest their leg muscles by directing their body weight towards a variable damper attached to the frame and directs the weight to the ground. This exoskeleton system is designed to be appropriate mechanism with human lower extremity and it operates synchronously with the human realizes. It consists of two identical 'supports', one strapped to each of the wearer's legs. Simply bend the knees to a comfortable stance to activate its damper that supports the body weight. The overall weight of this exoskeleton chair is less so it doesn't burden the wearer. The exoskeletal support not just provides a comfort lower body support, but also has several other purposes with this being a skeleton for newer products.**

Keywords **– Assistive robotics, Impedance control, Stiffness augmentation.**

I. INTRODUCTION

The world is getting compact day by day & 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 "lower body 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 lower body 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 transfers 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 wraps around thighs, so it reduces fatigue and increases the productivity.

III. PROBLEM STATEMENT

1. In industries Problem is the standing operating condition of workers on the line. The aim is to, do not violated industrial policies, as we are providing support to legs.
2. Helping workers to more effectively exercise to mitigate the effects of microgravity on bones and muscles.

III. METHODOLOGY

In this case study, Solidworks 2017 was used to design the model of this project. First of all, 2 designs were produced. The first design is to use roller to move the rod when a person sitting and walking on the CCES. This design is rejected after a few analyses. The main reason to support the reason reject the first design is the roller tend to move beyond the tract when a person sit on the CCES.

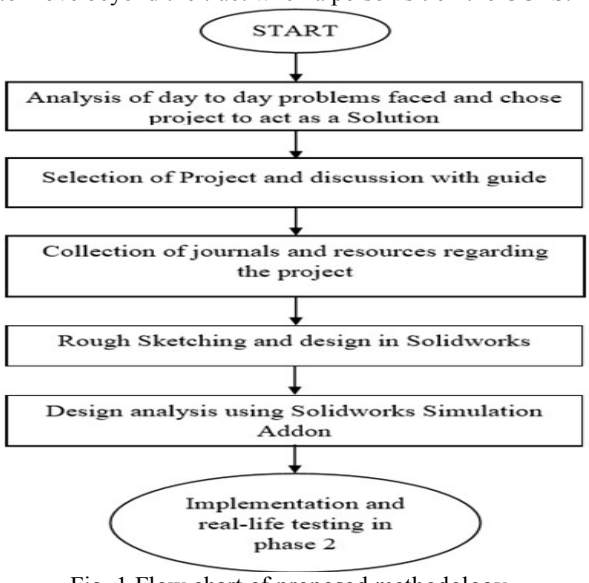

Fig. 1 Flow chart of proposed methodology.

The second design is to use hydraulic system at the rod that will control the movement of the it when a person sitting and walking on it. Here to apply hydraulic system, a power pack must be located near the piston to supply and store the hydraulic oil. This will make the chair less chair- exoskeleton system a bit complex since a power pack must always near the piston. The variation of this design is designed here which is using a ready stock damper as a piston to support the CCES. The design is started with designing the primary element is this project which is damper. The damper length during uncompressed state is 18" and 11" when compressed. Objective of this compressed and uncompressed length is to fit the design objective which is to prevent ergonomic problem occur during works. To achieve balanced seating, the angle between lumbar curve and humor bone must be 135 degrees. But since in variable model, we can adjust the damper to required position as per our comfort.

IV. COMPONENTS

- **Pneumatic Cylinder**

A Pneumatic cylinder (also called a linear hydraulic motor) is a mechanical actuator that is used to give a unidirectional force through a unidirectional stroke. It has many applications, notably in construction equipment (engineering vehicles), manufacturing machinery, and civil engineering.

Hydraulic cylinders get their power from pressurized hydraulic fluid, which is typically oil. The hydraulic cylinder consists of a cylinder barrel, in which a piston connected to a piston rod moves back and forth. The barrel is closed on one end by the cylinder bottom (also called the cap) and the other end by the cylinder head (also called the gland) where the piston rod comes out of the cylinder. The piston has sliding rings and seals. The piston divides the inside of the cylinder into two chambers, the bottom chamber (cap end) and the piston rod side chamber (rod end / head end). Flanges, trunnions, clevises, Lugs are common cylinder mounting options. The piston rod also has mounting attachments to connect the cylinder to the object or machine component that it is pushing / pulling.

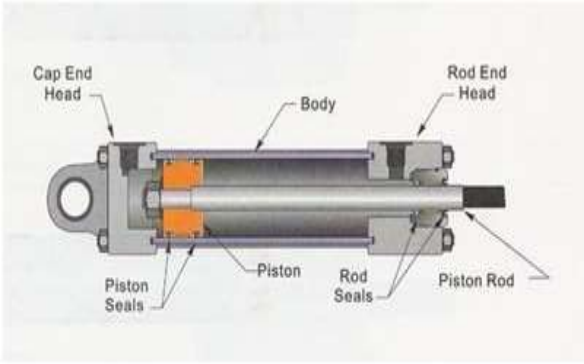

Fig.1. Pneumatic Cylinder.

- **Thigh Limb**

The femur or thighbone, is the most proximal (closest to the hip joint) bone of the leg in tetrapod vertebrates capable of walking or jumping, such as most land mammals, birds, many reptiles such as lizards, and amphibians such as frogs. In vertebrates with four legs such as dogs and horses, the femur is found only in the hind limbs. The head of the femur articulates with the acetabulum in the pelvic bone forming the hip joint, while the distal part of the femur articulates with the tibia and kneecap forming the knee joint. By most measures the femur is the strongest bone in the body. The femur is also the longest bone in the body. This femur bone i.e. thigh limb will be according to human ergonomics.

Fig.2. Thigh Limb.

- **Tibia/Fibula**

The tibia also known as the shinbone or shankbone, is the larger and stronger of the two bones in the leg below the knee in vertebrates (the other being the fibula), and it connects the knee with the ankle bones. The tibia is found on the medial side of the leg next to the fibula, and closer to the median plane or centre-line. The tibia is connected to the fibula by the interosseous membrane of the leg, forming a type of fibrous joint called a syndesmosis with very little movement. The tibia is named for the flute tibia. It is the second largest bone in the human body next to the femur. The leg bones are the strongest long bones as they support the rest of the body.

The fibula or calf bone is a leg bone located on the lateral side of the tibia, with which it is connected above and below. It is the smaller of the two bones, and, in proportion to its length, the slenderest of all the long bones. Its upper extremity is small, placed toward the back of the head of the tibia, below the level of the knee joint, and excluded from the formation of this joint. Its lower extremity inclines a little forward, so as to be on a plane anterior to that of the upper end; it projects below the tibia, and forms the lateral part of the ankle-joint.

These both bones will be replaced by a single solid link connected to thigh limb and palm.

Fig.3. Tibia/Fibula.

- **Palm /Toe/Foot**

The foot (plural feet) is an anatomical structure found in many vertebrates. It is the terminal portion of a limb which bears weight and allows locomotion. In many animals with feet, the foot is a separate organ at the terminal part of the leg made up of one or more segments or bones, generally including claws or nails. It is a cluster of seven articulating bones in each foot situated between the lower end of tibia and fibula of the lower leg and the metatarsus. The tarsus articulates with the bones of the metatarsus, which in turn articulate with the proximal phalanges of the toes. The joint between the tibia and fibula above and the tarsus below is referred to as the ankle joint.

- **Toe /Ankle Joint**

The ankle, or the talocrural region, is the region where the foot and the leg meet. The ankle includes three joints: the ankle joint proper or talocrural joint, the subtalar joint, and the Inferior tibiofibular joint. The movements produced at this joint are dorsiflexion and plantarflexion of the foot. In common usage, the term ankle refers exclusively to the ankle region. In medical terminology, "ankle" (without qualifiers) can refer broadly to the region or specifically to the talocrural joint.

The main bones of the ankle region are the talus (in the foot), and the tibia and fibula (in the leg). The talocrural joint is a synovial hinge joint that connects the distal ends of the tibia and fibula in the lower limb with the proximal end of the talus. The articulation between the tibia and the talus bears more weight than that between the smaller fibula and the talus.

- **Knee Joint**

The knee joint joins the thigh with the leg and consists of two articulations: one between the femur and tibia (tibiofemoral joint), and one between the femur and patella (patellofemoral joint). It is the largest joint in the human body. The knee is a modified hinge joint, which permits flexion and extension as well as slight internal and external rotation. The knee joint is vulnerable to injury and to the development of osteoarthritis.

Fig.5. Knee Joint.

- **Metal exoskeleton design**

The metal exoskeleton used to support people who carries high load. There are two applications can be possible for leg and hand applications. Exoskelton helps to reduce the impact of load in hand and leg.

In this design, the pneumatic cylinder movement helps the people move to different positions for the exo -skelton.

The design of pneumatic cylinder

We have to use two Hydraulic cylinders

V. ADVANTAGES

1. Adjustable height.
2. Reduces human efforts.
3. Auto controlled.
4. Easy to operate.
5. No frequent maintenance.
6. High efficiency.
7. Can used for seating and lifting.

VI. FUTURE SCOPE

The choice of material was limited due to its availability. In the future, carbon-fibrereinforced polymer (CFRP) can be used to further minimize the weight and increase the strength of the structure. In present work, no full attention is given to locking mechanism so different locking mechanisms can be used to involve providing better and smoothing functioning of the chair. The sensor can be attached to the body for locking of the mechanism by itself as per user needs. This chair is capable of relieving fatigue of lower body parts and needed further modification so that upper body parts are also free from MSD. The portability of the chair can be improved by converting it into a foldable flexible wearable chair.

With Additional links between the legs, we can convert it into a totally self-balancing chair.

1. With addons like, audio jack, water bottle holder, charging ports, it's a
2. complete exoskeleton with features.
3. With a focus on damper, electronically control, it could be a walking
4. assist device.
5. For military applications, it could be converted into a weaponry support, load distribution device and so on.

VII. CONCLUSION

The Chair Less Chair Exoskeleton system is successfully designed and analyzed. The aim of this project is to develop a lower body external skeletal structure to support sitting and partial standing posture. The finite element analysis is performed on the chair less chair, using Solid Works Simulation add-on to find total deformation. Maximum displacement, maximum stresses and deformations are analyzed and safe load is

determined. Future work will focus on making the design lighter and using high grade materials for greater strength at smaller dimensions and weight. Implementation of the design and testing in real world environment is to be done and effectiveness in daily scenarios is to be determined.

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