WEIGHT LIFT ASSIST EXOSKELETON

N.S.C.Chaitanya[1], G. Ramakrishna [2], P. Raja Naveen[3]

Associate Professor ,Mechanical Engineering, Raghu Engineering College(Autonomous),Vishakhapatnam[1,3]
Assistant Professor ,Mechanical Engineering,Raghu Engineering College(Autonomous),Vishakhapatnam[2]

ABSTRACT

For centuries now, humans have developed machines for tasks which are too labor intensive for species cannot do. So, creative imagination and subtle engineering has led to the development of the exoskeleton. It is a device which can be worn over the human body. An exoskeleton enables a human to perform tasks which are beyond the physical prowess by assisting the joint and muscular movements.

In this paper we investigate effects of the mass, kinematic constraints imposed by the joint, and assistance provided by the spring of a pair of quasi-passive knee exoskeletons on the motion of the human body center of mass during normal walking. The exoskeletons implement a spring in parallel with the knee joint in the weight acceptance phase of gait, and allow free rotation during all other phases. It was found that the exoskeleton mass is the main contributor to the changes in the motion of the center of mass, with more pronounced fluctuations of the center of mass in the mediolateral direction, while the exoskeleton joint and spring had negligible effects over and above those of the mass. Additionally, the exoskeleton mass and assistance conditions respectively resulted in a non significant increase and a non-significant decrease in the total mechanical work of the body.

Keywords: Exoskeleton, Springs, Actuators etc.

I.INTRODUCTION

One of the proposed main uses for an exoskeleton would be enabling a soldier to carry heavy objects (80–300 kg) while running or climbing stairs. Not only could a soldier potentially carry more weight, he could presumably wield heavier armor and weapons. The same is applicable for the labors at industries. The exoskeleton enables the labors to lift heavy tools and bare heavy loads while transporting them from one point to another. Most models use a hydraulic system controlled by an on-board computer. They could be powered by an internal combustion engine, batteries or fuel cells. Another area of application could be medical care, nursing in particular. Faced with the impending shortage of medical professionals and the increasing number of people in elderly care, several teams of Japanese engineers have developed exoskeletons designed to help nurses lift and carry patients.

Exoskeletons could also be applied in the area of rehabilitation of stroke or Spinal cord injury patients. Such exoskeletons are sometimes also called Step Rehabilitation Robots. An exoskeleton could reduce the number of therapists needed by allowing even the most impaired patient to be trained by one therapist, whereas several are currently needed. Also training could be more uniform, easier to analyze retrospectively and can be specifically customized for each patient. At this time there are several projects designing training aids for rehabilitation.

1.1METHODOLOGY:

The exoskeleton consists of both mechanical and pneumatic actuation which are springs and Mckibben muscle or pneumatic air muscle(PAM). The springs are used in lower limb parts and the PAMs are used in upper limb parts. When force is applied on one end of the spring, the spring length changes. As the spring is tensile in nature it stores the applied energy for reverse mechanism I.e., it restores its position which makes the spring to regain its original length. This displacement of the spring is utilized to form a linear motion between two links.

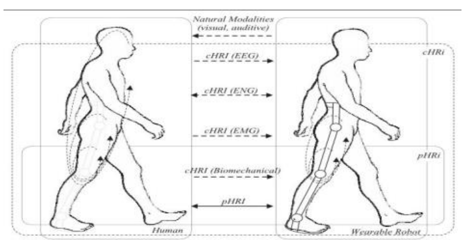

Figure 1.1Schematic representation of dual cognitive and physical interaction in wearable robots

The PAM has a thin-walled, rubber bladder placed inside an axially stiff but radically compliant braided sleeve. As the rubber bladder expands due to an increase in pressure, the diameter of the combined sleeve and bladder assembly easily changes in the radial direction and the PAM shortens in the axial direction. As the consequence of this interaction, a large contraction force produced can perform external work at rapid rate. However, non-linearity exists as the pressure changes in the bladder because its area expands proportionally to the square of the diameter.Also as the outer sheath material moves, its length is dependent on trigonometric relationships involving the outer sheath material, which are non-linear. Thus this displacement is used to actuate a link.

II. DESIGN OF EXOSKELETON IN CATIA:

2.1 ARM:

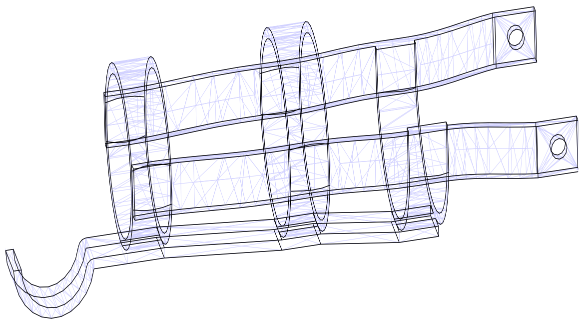

Fig 1.2 Arm design

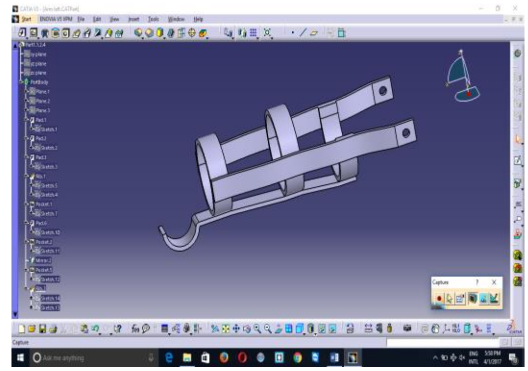

Fig 1.3 CATIA design

2.2 SHOULDER:

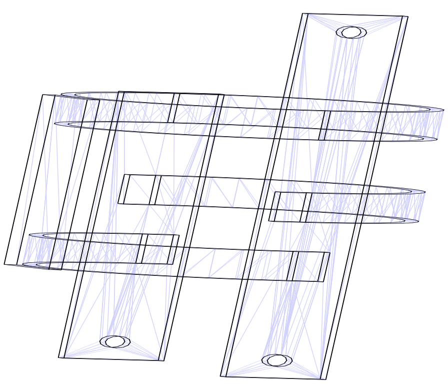

Fig 1.4 Shoulder Design

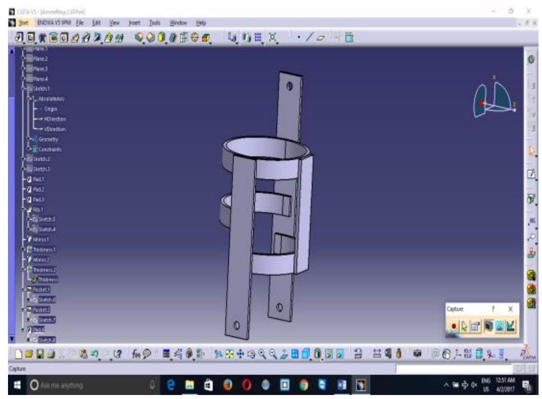

Fig 1.5 CATIA Design

2.3DESIGN OF BACK SUPPORT:

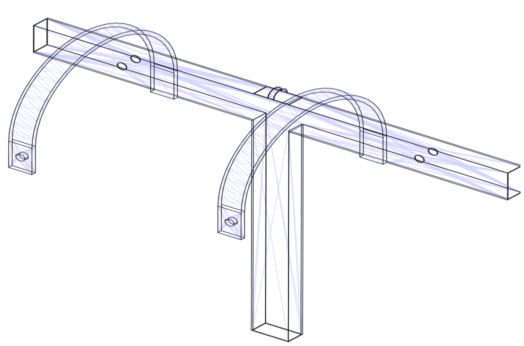

Fig 1.6 Design Of Back Support

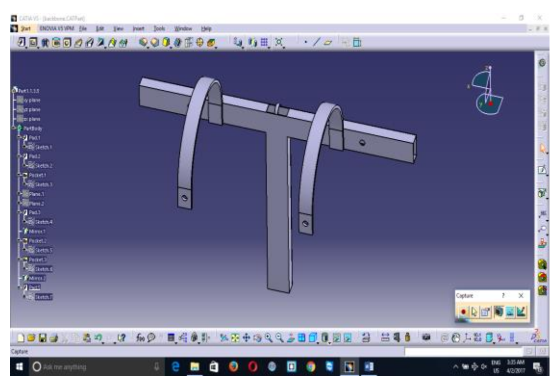

Fig 1.7 CATIA Design

2.4 DESIGN OF HIP SUPPORT:

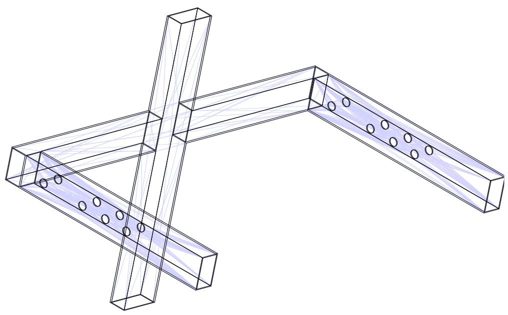

Fig 1.8 Design Of Hip Support

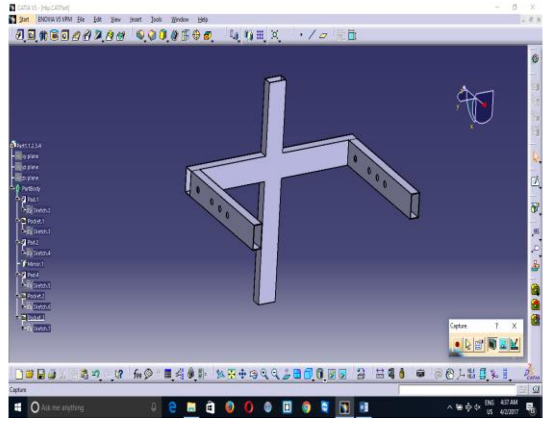

Fig 1.9 CATIA Design

2.5. DESIGN OF LOWER LIMBS:

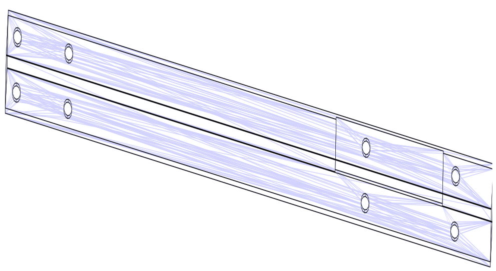

Fig 2.0 DESIGN OF LOWER LIMBS

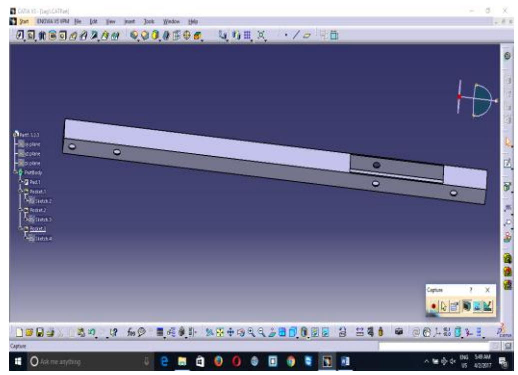

Fig 2.1 CATIA Design

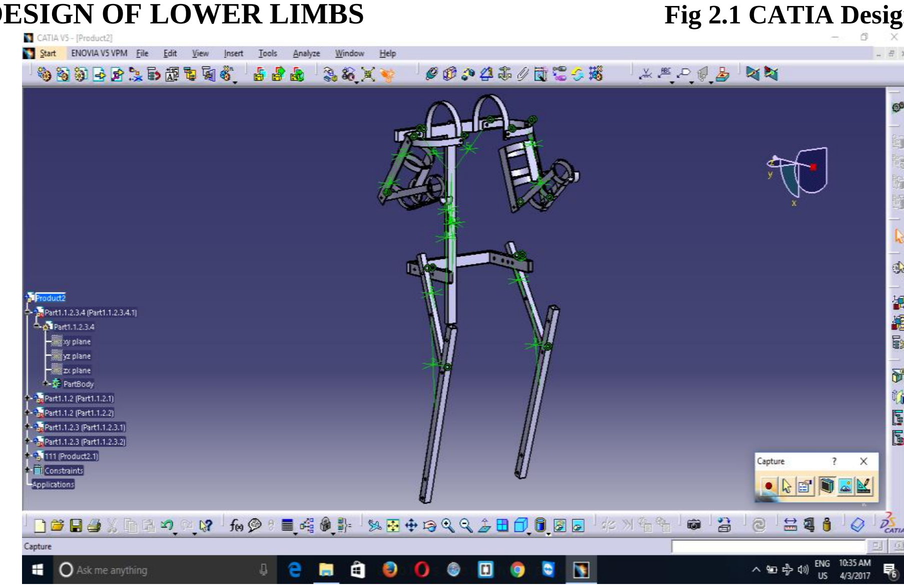

Fig 2.2 Design Of Exoskeleton In CATIA

III ACTUATION:

An actuator is a component of a machine that is responsible for moving or controlling a mechanism or system. An actuator requires a control signal and a source of energy. The control signal is relatively low energy and may be electric voltage or current, pneumatic or hydraulic pressure, or even human power. The supplied main energy source may be electric current, hydraulic fluid pressure, or pneumatic pressure. When the control signal is received, the actuator responds by converting the energy into mechanical motion.

An actuator is the mechanism by which a control system acts upon an environment. The control system can be simple (a fixed mechanical or electronic system), software-based (e.g. a printer driver, robot control system), a human, or any other input.

3.1 TYPES OF ACTUATIONS

3.1.1 Mechanical

A mechanical actuator functions to execute movement by converting one kind of motion, such as rotary motion, into another kind, such as linear motion. An example is a rack and pinion. The operation of mechanical actuators is based on combinations of structural components, such as gears and rails, or pulleys and chains.

3.1.2 Electrical

An electric actuator is powered by a motor that converts electrical energy into mechanical torque. The electrical energy is used to actuate equipment such as multi-turn valves. It is one of the cleanest and most readily available forms of actuator because it does not directly involve oil or other fossil fuels.

3.1.3 Pneumatic

A pneumatic actuator converts energy formed by vacuum or compressed air at high pressure into either linear or rotary motion. Pneumatic energy is desirable for main engine controls because it can quickly respond in starting and stopping as the power source does not need to be stored in reserve for operation.
Pneumatic actuators enable considerable forces to be produced from relatively small pressure changes. These forces are often used with valves to move diaphragms to affect the flow of liquid through the valve.

3.1.4 PAM (Pneumatic air muscle)

Figure 3.1.4 Robotic Arm with PAM actuation

McKibben air muscles were invented for orthotics in the 1950s. They have the advantages of being lightweight, easy tofabricate, are self limiting (have a maximum contraction) and have load-length curves similar to human muscle. The muscles consist of an silicon inner tube/bladder inside a braided mesh, clamped at the ends. When the inner bladder ispressurized and expands, the geometry of the mesh acts like a scissor linkage and translates this radial expansion into linear contraction. Standard McKibbens contract in a linear motion up to a maximum of typically 25%, though different materials andconstruction may yield contractions around 40% . Though they can technically be designed to lengthen as well, this is notuseful as the soft muscles buckle.

3.2 Methodology:

An air muscle is a simple pneumatic device developed in the 1950's by J.L. McKibben. Like biological muscles, air muscles contract when activated. Robotists find it interesting that air muscles provide a reasonable working copy of biological muscles. So much so that researchers can use a human skeleton with air muscles attached to the skeleton at primary biological muscle locations to study biomechanics and low level neural properties of biological muscles. (See Internet sources)

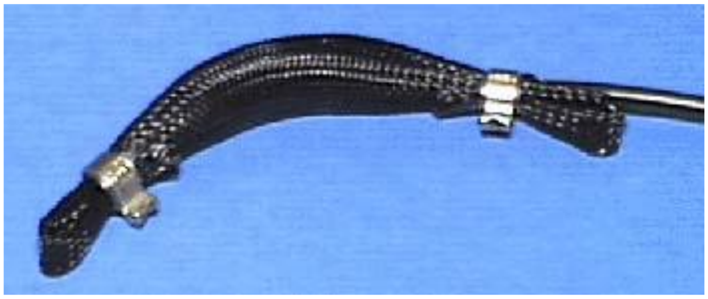

Figure 3.2 Pneumatic Air Muscle

This feature is utilized by the research in many "Bio-Robotics" projects institute by numerous researchers. In published papers air muscles are also referred to as;McKibben Air Muscles, McKibben Pneumatic Artificial Muscle, Rubbertuator and as I refer to them simply as air muscle(s).

IV FABRICATION:

Metal Fabrication is the building of metal structures by cutting, bending, and assembling processes. It is a value added process that involves the construction of machines and structures from various raw materials. A fab shop will bid on a job, usually based on the engineering drawings, and if awarded the contract will build the product. Large fab shops will employ a multitude of value added processes in one plant or facility including welding, cutting, forming and machining. These large fab shops offer additional value to their customers by limiting the need for purchasing personnel to locate multiple vendors for different services. Metal fabrication jobs usually start with shop drawings including precise measurements then move to the fabrication stage and finally to the installation of the final project. Fabrication shops are employed by contractors, OEMs and VARs. Typical projects include loose parts, structural frames for buildings and heavy equipment, and stairs and hand railings for buildings.

4.1FINAL ASSEMBLY:

After the weldment has cooled it is generally sand blasted, primed and painted. Any additional manufacturing specified by the customer is then completed. The finished product is then inspected and shipped.*Assembling* (joining of the pieces) is done by welding, binding with adhesives, riveting, threaded fasteners, or even yet more bending in the form of a crimped seam. Structural steel and sheet metal are the usual starting materials for fabrication, along with the welding wire, flux, and fasteners that will join the cut pieces. As with other manufacturing processes, both human labor and automation are commonly used. The product resulting from fabrication may be called a fabrication. Shops that specialize in this type of metal work are called *fab shops*. The end products of other common types of metalworking, such as machining, metal stamping, forging, and casting, may be similar in shape and function, but those processes are not classified as fabrication**.**

V CONCLUSION:

Wearable robotics is the next logical step after service robots and personal robots, the difference being the closer cognitive and physical interaction between wearable robots and humans. Given the intrinsic combined operation of humans and robots in wearable robotics, a systemic biomechatronic approach is required in order to develop this scientific area fully. The direction of modern biomechatronics, in particular in the area of wearable robot design, must exploit four research avenues:

• Increasing miniaturization, chiefly in component design, so that more compact sensor, actuator and energy storage technologies can be adopted. Miniaturization will pave the way for lower Conclusions and Outlook 331 energy consumption by these technologies. This in turn will make it possible to establish wireless communication networks from which wearable robotics can benefit.

• Increasing intelligence, mainly in the areas of intelligent cognitive and physical human–robot interaction. Cognitive interaction should naturally detect user intention as an input to control the robot. It needs to be two-way in order to allow proprioceptive feedback. Safety and dependability of physical interaction should be a priority in cooperative human–robot systems.

• More compact solutions based on multifunctional components are to be developed. This falls into the first avenue of research, since sharing several functions, e.g. actuation, sensing and control, in the same component also contributes to miniaturization of designs.

• Integration of hybrid (artificial and biological) systems. This will foreseeably result in systems where the borderline between artificial and biological components eventually disappears and the biological and artificial components are closely interfaced.

Wearable robots were first proposed in the military arena. Currently they are being successfully proposed in rehabilitation, functional compensation of physical impairment, empowering (in general assistance), telemanipulation and space. Applications will foreseeably be extended and the coming years will probably see closer-knit and hybrid human–robot systems. If this development is to be successful, special attention must be paid to safety, dependability and ethics.

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