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Research Paper on Paralysis Exo-skeleton

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Abstract: Exoskeleton is a combination of human intelligence and mechanical power device of the mechanical energy of a combination of human and robot, it can help people bearing by load, effectively strengthen the load ability, help people walk in a variety of complex terrain. The exoskeleton robot is essentially a wearable robot, it will be the person's intelligence and the external mechanical equipment of mechanical energy together, which can give a person the power and provide additional capabilities, enhance the human body function. In this paper we discuss the stroke rehabilitation by robotic device and a novel exoskeleton, which is based on the patient's self-guided control will be presented. This work presents the design of exoskeleton made up of mechanical links and control by mechatronics system using Artificial Pneumatic Muscles (PAM). The exoskeleton robot is essentially a wearable robot, it will be the person's intelligence and the external mechanical equipment of mechanical energy together, which can give a person the power and provide additional capabilities, enhance the human body function. The proposed method involves a combined dynamic model of the musculoskeletal system of the lower-body with the dynamics of pneumatic actuators.
Keywords: Stroke Rehabilitation, the man-machine combination, Exoskeleton, Pneumatic Artificial Muscles (PAM), Mechanical energy, Pneumatic Actuators, physiotherapeutic treatment.

I. INTRODUCTION

Paralysis exoskeleton, also known as powered exoskeleton, exo frame, is a mobile machine consisting primarily of an outer framework worn by a person, which is powered by a pneumatic system that delivers at least part of the energy for limb movement. Modern robots have mechanical power device which makes the robot can easily complete many difficult tasks, such as lifting, handling the heavy load, etc.

The requirements on a social, well-functioning, and modern health care system—including elderly care—are demanding: it must be flexible enough to encounter the increasing process of change and the related challenges. These changes and challenges are triggered, among other things, by the demographic changes, the increase in chronic diseases, the rising costs, and the impending skills shortage [1].

These could be systems like powered exoskeletons, active orthoses, or special end-effector-based therapy robots [2]. The World Health Organization (WHO) estimates that about 15 million individuals suffer from stroke every year around the world.

At least one-third of them will require rehabilitation from disabilities after a stroke while another five million of these people will die. It is the third leading cause of death and the leading cause of serious long term disability in the world. Our focus is more on exoskeletons for the one side of the body and exoskeleton as an assistive device for rehabilitation.

As we researched further, we came to know that; Now-a-days even small accidents may cause serious damage such as fractures, brain injury, spinal cord injury or at times even death. In worst conditions, person may get a victim of paraplegia, which may lead to eliminate the ability of a person to move from one place to another.

Due to the aging society and probably significant increase in chronic diseases of the musculoskeletal and the nervous system, the need for innovation in assistive technologies for everyday activities and rehabilitation is judged as very hig [3]. In general, independent living and acting are strongly connected with the motor skills of the individual.

The proper function of the arm and hand in everyday activities—at work or at home—are of vital importance [4]. cutting kinematics and cutting conditions [5].

Measurement of surface roughness is used to determine surface quality of machined surfaces. . Every manufacturing industry is trying to achieve the high quality products in a very short period with less input. In milling machine, there are many process parameters like spindle speed, feed rate, depth of cut, coolant, tool geometry, etc. which affected on required quality parameters. So, selections of such process parameters are important for any quality parameters.

II. CONSTRUCTION OF THE PNEUMATIC POWERED EXO SKELETON

The construction of a simple pneumatically powered paralysis exo skeleton is as follows:

A. Skeleton

Skeleton are usually made up of common materials which can be easily moulded, machined and are cheaper in price such Aluminium, stainless steel, plastic etc. As steel is a heavy metal, the exo skeleton must work harder to overcome it's own weight and to assist the person who is wearing the exo skeleton in order that wearing efficiency should not be decreased. In assistance to steel aluminium alloys can be used but they fail through fatigue quickly, it is not acceptable that the exo skeleton failed during actuation on its own in high load conditions and injuring the wearer. As time passed, an option arises to replace steel or aluminium with a material which is light in weight, expensive and has high strength such as Titanium and use more complex component construction methods, such as molded carbon-fiber plates. The carbon fiber has a huge difference in terms of weight with mild steel i.e. 10kg of steel is 10gms of carbon fiber.

B. Actuator

It is a device which converts the power of pressurized fluid into useful mechanical work. The useful work is obtained through force and motion.

For the purposes of this study, pneumatic actuators were chosen to create the resistive forces against the muscle forces due to their active stiffness characteristics that allow the forces they produce to be altered whenever desired. A wealth of research has been produced to dynamically model the pneumatic actuators as well as to control the dynamic characteristics of the actuator such as force and stiffness. The work of Shen et al. shows how using two 3-way proportional valves rather than one 4-way valve can be used to independently control the force and stiffness characteristics of a pneumatic actuator.

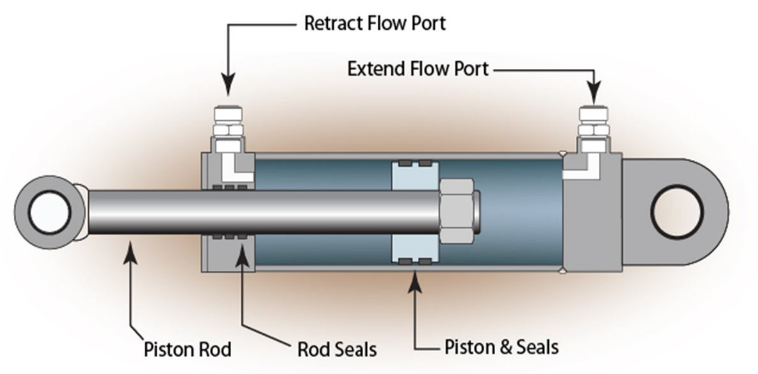

Fig. 1. Schematic of Pneumatic Actuator

It accomplishes this by changing the equilibrium point of the actuator (point of zero force) or pressurizing both chamber sides of the actuator to modify the "spring" stiffness [5]. A pneumatic actuator is modeled in Fig. 1.

1) 5/3 Direction control valve: Direction control valve is a valve which directs the stream of pressurized air coming from the compressor into the actuator. It is located in between the pump and the actuator.

5/3 DCV is as shown in figure, it consists of 5 ports inlet port, outlet port and actuator port i.e. T,B,P,A,T and three positions i.e. forward, reverse and neutral position.

When the lever is operated port P(inlet port) gets connected to port B(actuator port) and port A(actuator port) gets connected to port T(outlet port).

Pressurize air flows from port P to port B and at the same time the air which is already present in the actuator gets discharged from port P to port T.

When the lever is operated in other direction the pressurize air will flow from port P to port A and port B gets connected to port T.

When the lever is operated in neutral position the port T,P,T gets blocked due to spool in reverse direction; no operation is performed inside the DCV.

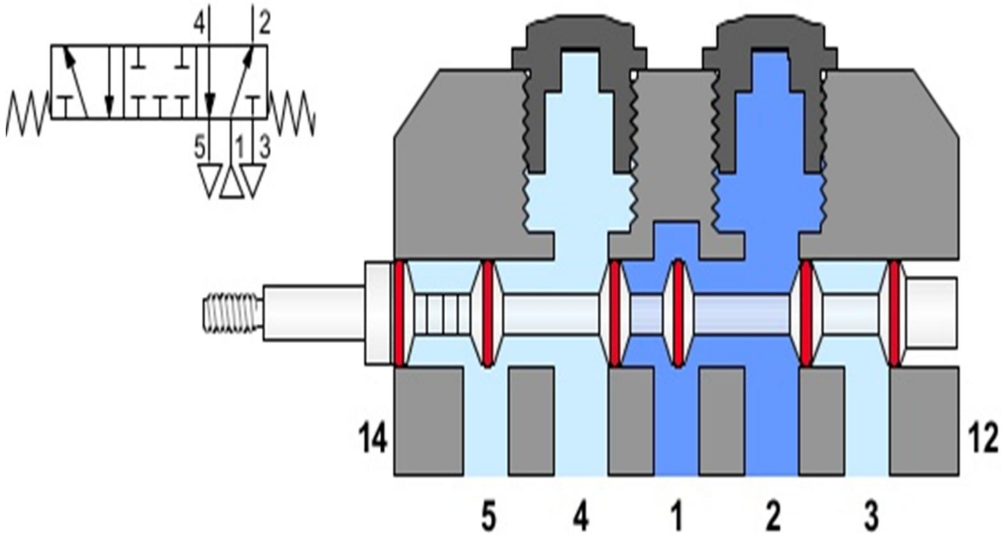

Fig. 2. Schematic of 5/3 D.C.V.

2) *Hoses:* It is the flexible pipe which can be easily bent to any shape in a pneumatic system; these flexible pipes are known as PNEUMATIC HOSES.

III. WORKING

Paralysis Exoskeleton works on the principle of pneumatic power. The main motive for building up a "PARALYSIS EXOSKELETON" is to assist and rehabilitate a person who is suffering from stroke. The exoskeleton can be made by Stainless Steel, Aluminium, Carbon Fiber etc. In this case we are considering stainless steel angles which are joint by bolted joints and welded joints as per requirement. After developing the skeleton now the task is to select a proper method for actuation i.e. pneumatic or hydraulics. We are opting out for pneumatic system, in which we need a compressor to increase the pressure of the atmospheric air and DCV to direct the flow of compressed air. A Flow regulator is used to regulate the rate of flow of compressed air into the system and to control the speed of the actuator. Fittings are used, through which air passes throughout the system.

A. Hand

When the lever is operated of the direction control valve in the forward direction the air flows from the DCV to the inlet of the actuator i.e. on the piston face side. The pressurized air applies pressure on the piston face side and pushes the piston towards the piston rod end side i.e. from left to right, thus completing the forward stroke of the actuator which results in the bending motion of the arm from the elbow.

When the lever is operated of the direction control valve in the reverse direction the air flows from the DCV to the inlet of the actuator i.e. on the piston rod side. The pressurized air applies pressure on the piston rod side and pushes the piston towards the piston face side i.e. from right to left, thus completing the reverse stroke of the actuator which results in the straighting motion of the arm.

B. LEG

When the lever is operated of the direction control valve in the forward direction the air flows from the DCV to the inlet of the actuator i.e. on the piston face side. The pressurized air applies pressure on the piston face side and pushes the piston towards the piston rod end side i.e. from left to right, thus completing the forward stroke of the actuator which results in the bending motion of the leg from the knee.

When the lever is operated of the direction control valve in the reverse direction the air flows from the DCV to the inlet of the actuator i.e. on the piston rod side. The pressurized air applies pressure on the piston rod side and pushes the piston towards the piston face side i.e. from right to left, thus completing the reverse stroke of the actuator which results in the straighting motion of the leg.

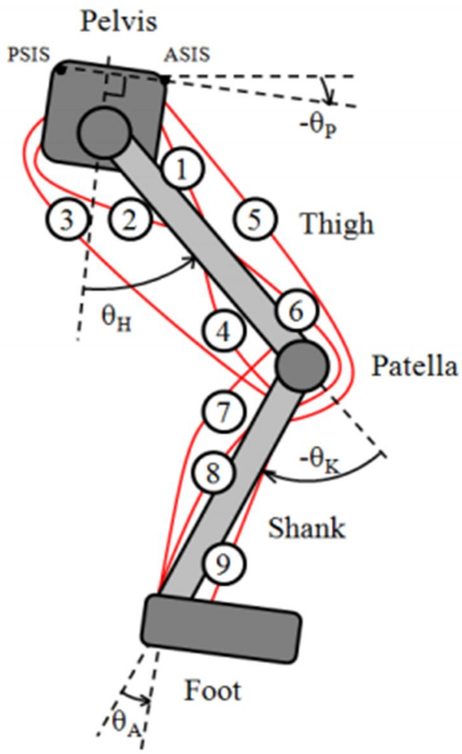

Fig. 3. Working Diagram

IV. CONCLUSION

The development of exoskeleton benefits the human which includes weaknesses or healthy people. In this paper, rehabilitation and power assist robots have been reviewed. The robotic exoskeleton can help physical weak or motor function reduced patient to regain their movement. In additional, it can help healthy people to train up their strength or to distribute out the weight gained by the users.

Pneumatic actuator, pneumatic muscle, motor actuator and hydraulic actuator are found to be commonly used in research study about actuator among exoskeletons. The motor actuator has the advantages of easy control and good accuracy while pneumatic actuator has the advantage of spend zero power in holding the position of robot. Furthermore, the pneumatic muscle mimics the human muscle perfectly while the hydraulic actuator gives high power output.

In the review, it is found that some researchers only focus on a single DOF at a single joint while some researchers look at the system design of whole upper extremity and even a few of the researchers carry out a whole body suit exoskeleton. No matter how many DOFs are included in the exoskeleton, their researches are benefiting human. Further review on the exoskeleton control system might help to understand more about the exoskeleton.

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