THE EXCELLENCES OF EXOSKELETONS FOR MEDICAL EQUIPMENT

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Abstracts

This paper is aimed to inform the advantages of exohand as device that is used in industry and medical treatment on literature review. The exohand is manufactured by Festo, Inc. It has many advantages such as design is more comfortable to human or in the other words is ergonomic than the others design. Not only using the latest technology but also consent about the product method alike using selective laser sintering. This model of exoskeletons can be applied in many fields, such as industry and medical treatment for stroke patients.

Keywords: *exoskeletons, stroke patient, robotic*

Abstrak

Tulisan ini bertujuan untuk memberikan keunggulan dari exohand sebagai alat yang digunakan di industry dan untuk alat kesehatan yang berdasarkan tinjauan pustaka. Exohand ini dibuat oleh Festo, Inc. Alat ini mempunyai banyak keunggulan seperti disainnya yang dapat membuat nyaman orang yang menggunakannyadibandingkan dengan alat yang lain. Alat ini bukan hanya menggunakan teknologi yang terkini tetapi juga dibuat dengan metode selektif laser sintering. Model ini dapat digunakan di banyak tempat, seperti di Industri dan untuk alat kesehatan bagi penderita sakit stroke.

1. INTRODUCTION

In recent years, there has been an increasing interest in the development of different kinds of exoskeletons. This is made promising now by many technological advancements: some as well as diminution in sizes of actuators such that exoskeletons can be worn by a human user, improvements in diminution of size of power supplies and lifetime, better control techniques, etc.

One area where exoskeleton development could show useful is in use as the equipment for therapy which has the purpose to recover partially or totally the motor abilities of a stroke patient. And the last one, the Exoskeletons can be used in manufacturing as interaction human machine is like the activity represents a challenge, especially to older workers. In addition, the exoskeletons is used for remote manipulation of a robotic hand in an industrial setting, complex tasks in dangerous or hazardous environments for example can be performed from a safe distance. As a force feedback system, the artificial hand can greatly extend the human operator's scope of activity in a production environment.

2. THEORETICAL BACKGROUND

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For daily tasks, many motions involve the arm. Motions involving grasping and the wrist (such as pronation and supination of the wrist) are weakest in comparison to other motions such as lifting by stronger forearm and bicep muscles.

The physical exoskeleton structure is designed to wrap around the fingers of the hand and not to lie on top of the fingers to reduce the size of the exoskeleton on the glove and increase portability and wear ability.

The design of the exoskeleton is broken down into 3 main subsections as shown in Fig.1.

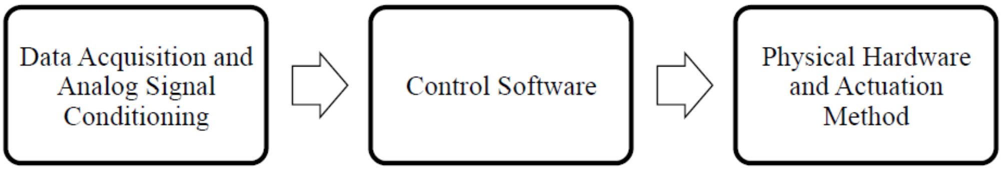

Figure 1. Flow chart of general design components of exoskeleton

The design concept of development of exoskeleton can be seen in picture below:

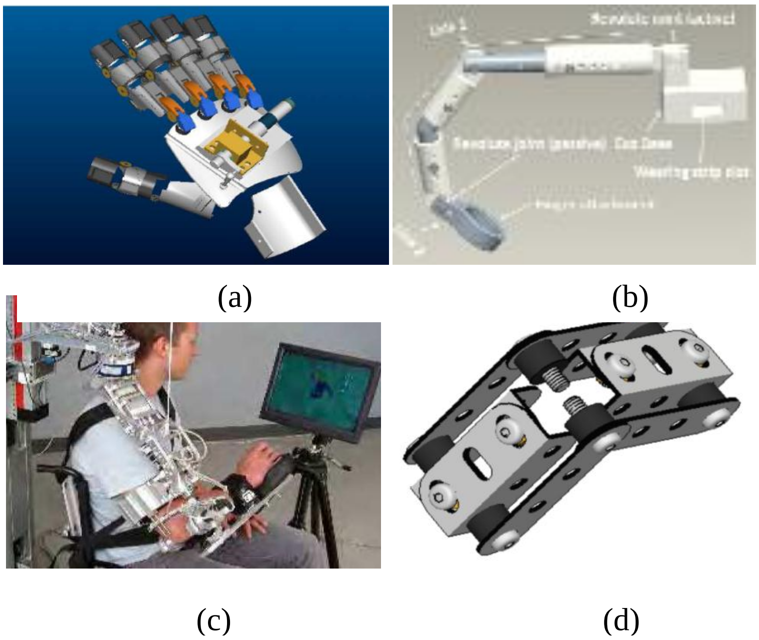

Figure 2. Design of exoskeleton (a) by Chiri, F. et al. , (b) By A. Jamshed I.et al. , (c) Mihelj et al. , (d) By Regina Leung

The development of a hand exoskeleton device is a very challenging endeavor, which has been targeted by many research professionals.

The applications of the exoskeleton is geared towards specific professions (military, industrial workers) and special purposes (rehabilitation) making them not very useable for the average person.

The kinematics of the exoskeleton follows that of the human hand as closely as possible. A critical fact that must be accounted for in the development of a hand exoskeleton is that the phalanges of the finger rotate about a point located inside their respective joints. For the exoskeleton joints to mimic the motion of the fingers their centers of rotation should coincide with the centers of rotation of the actual fingers.

For example, in the case of military and industrial workers, the exoskeletons are usually made for the lower extremity or even full body exoskeletons that allow the user to perform “super human” abilities that would not be used and worn by a normal person daily.

The latest product of exoskeleton is developed by festo and called ExoHand. The ExoHand from Festo is an exoskeleton that can be worn like a glove. The fingers can be actively moved and their strength amplified; the operator’s hand movements are registered and transmitted to the robotic hand in real time.

2. DESCRIPTION OF EXOHAND

The exoskeleton hand has all the principal physiological degrees of freedom of its human counterpart. It thus supports the human hand’s diverse techniques for grasping and handling objects. The objectives are to enhance the strength and endurance of the human hand, to extend humans’ scope of action and to secure them

an independent lifestyle even at an advanced age.
Since all the joints and their drive units are positioned outside the actual hand in the appearance of the exoskeleton, this manual orthosis can be fitted not only over the human hand, but also over a synthetic handmade of silicone. Using alike hardware, this enables a scenario that creates a link between robotics and orthotics in a completely new way.
The practical advantages for Festo lie in extending the scope of human-machine cooperation for automation technology with the accumulation of know-how in the fields of remote exploitation and force amplification. In this form of direct human-machine interaction, the ExoHand represents a potential technical solution to the challenges that will be faced by production and working environments of the future – both real and virtual.
The medical advantages, along with an immense interest in assistance systems for automation technology, have collaboration between Festo's engineers with the Tübingen University Hospital as part of the Bionic Learning Network.
The ExoHand, Festo can be used in many places not only for older workers but also used for remote manipulation of a robotic hand in an industrial setting, complex tasks in dangerous or hazardous environments for example can be performed from a safe distance.
This allows forces to be transferred from a different environment to the operator's own hand in the form of force feedback; the operator has the sensation of feeling the shape of the remote object. The human sense of touch can thus be implemented over long distances and can even be applied at the interface of the real to the virtual world.
In medical rehabilitation, the ExoHand can be used as an active manual orthosis. It is combined with a brain-computer interface (BCI), the ExoHand from Festo allows a closed feedback loop to be established. The active manual orthosis can help stroke patients suffering from paralysis to regenerate the damaged connection from the brain to the hand.

(a) (b)

Figure 3. (a) The ExoHand in combination with a brain-computer interface
(b) The ExoHand in the rehabilitation of stroke patients

Performance Indicator

The Exohand is moved by mechatronics system which combines the traditional disciplines of mechanical, electrical and computer engineering and use eight (8) double-acting pneumatic actuators – DFK-10 cylinders. It is manufactured from polyamide in the selective laser sintering (SLS) process and produced on the basis of a 3D scan of the user's hand.
Linear potentiometers register both the positions of the fingers and the force applied by each individual drive unit. The corresponding pressure in the various chambers is regulated by means of piezo proportional valves. Pressure sensors on the valve terminal serve to regulate the pressure and give an indication of the forces exerted by the cylinder.
In control position precisely is used A CoDeSys-compliant controller that is used registers and processes the positional and force parameters.

Technical data

1. Pneumatic actuators: 8 DFK-10 cylinders per hand
2. Piezo proportional valves:
   a. Orthosis: 16 piezo proportional valves
   b. Robotic hand: 8 MPYE proportional valves
3. Sensors: 8 linear potentiometers per hand as displacement sensors, 16

pressure sensors per hand; in the orthosis: integrated into the valve terminals

4. Control: CoDeSys-compliant control
5. Exoskeleton material: polyamide
6. Production method: selective laser sintering (SLS)

Discussion

It can be seen, the exohand product by Festo has many excellence such as design is more comfortable to human or in the other words is ergonomic than the others design. Not only using the latest technology but also consent about the product method alike using selective laser sintering.

4. CONCLUSION

Base on description and performance indicator of the exohand can be concluded as follows:

1. The design more ergonomic than the others.
2. Using the latest equipment such as 8 linear potentiometers, CoDeSys-compliant control, and polyamide.
3. In production method use selective laser sintering.

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