DESIGN AND ANALYSIS OF CONTROLLED HAND EXOSKELETON FOR REHABILITATION

[1]Eswaramoorthy.C, [2]Hariharan.K, [3]Jeffri Immanuel.N, [4]Karthikeyan.S, [5]Pratheek Nair.U

[1]Assistant Professor, Department Of Mechanical Engineering, knowledge Institute of Technology, Tamilnadu, India.

[2]UG Scholar,Department of Mechanical Engineering, knowledge Institute of Technology, Tamilnadu, India.

[3]UG Scholar,Department of Mechanical Engineering, knowledge Institute of Technology, Tamilnadu, India.

[4]UG Scholar,Department of Mechanical Engineering, knowledge Institute of Technology, Tamilnadu, India.

[5]UG Scholar,Department of Mechanical Engineering, knowledge Institute of Technology, Tamilnadu, India.

ABSTRACT

Exoskeleton have evolved as leading tools for augmenting able-bodied performance which is assisting human mobility and restoring lost limb function exploiting biomimetic design, the device may be worn in close proximity to the body and transmits torques via powered revolute joints and structural limbs. In the present work a comprehensive design and fabrication of hand exoskeleton technologies for rehabilitation and assistive engineering were made from the basic hand biomechanics to actuator technology with the involvement of pneumatic power. The designed suit reviews the state of the art of active hand exoskeletons for the applications in the areas of rehabilitation and assistive robots.

INTRODUCTION

Exoskeleton arm is an anthropomorphic external mechanical structure that allows for the transfer of mechanical power from the exoskeleton structure to the human arm. Excelsior's exoskeleton suit, also known as powered exoskeleton, exoframe or exosuit, is a mobile machine consisting primarily of an outer framework worn by a person, and a powered system of pneumatic artificial muscles (fluidic muscles) that delivers at least part of the energy for limb movement. Thanks to this device the user will no longer feel any fatigue in carrying heavy loads for long periods of time. Recyclable, light and enduring materials are used in this project in order to fulfill safety and environmental concerns. The main function of the exoskeleton suit is to assist the wearer by boosting their strength, endurance and durability. They are commonly designed for military use, to help soldiers carry heavy loads both in and out of war. In civilian areas, similar exoskeletons could be used to help firefighters and other rescue workers survive dangerous environments. The medical field is another prime area for the exoskeleton technology, where it can be used for enhanced precision during surgery or as an assist to allow nurses to move heavy patients. Because of their inherent motor and sensory requirements, hand exoskeleton technologies for rehabilitation and assistive engineering have not progressed as rapidly as the exoskeleton robots and devices for lower and upper limbs that have become popular over the last decade. These requirements have inspired considerable developments in robotic hands in terms of their degrees of freedom, weight, size and dexterous manipulation capabilities. At the same time, enhancement of hand functions using exoskeleton technologies for those who have lost or weakened hand capabilities because of neuromuscular diseases or aging has become an important issue, because hand functionality is a dominant factor in living an independent and healthy life.

LITERATURE REVIEW

"Design, Analysis and Experiment of A Non-humanoid Arm Exoskeleton for Lifting Load",Xin Li, Zhengwei Jia, Xiang Cui, Lijian Zhang Research Center of Human Performance Modification Technology Beijing Institute of Mechanical Equipment Beijing, China Published in: 2018 The International Conference of Intelligent Robotic and Control Engineering.

Arm exoskeleton is widely used in medical and industrial areas because of its assistant ability. Many universities and institutes do some relevant works describes a bio-inspired arm exoskeleton that uses a parallel mechanism inspired by the human forearm to allow naturalistic shoulder movements. The patients with musculoskeletal disorder or elderly who do not have enough strength to move their limbs freely presents the development of the exoskeleton system for amplifying human strength.

"The RETRAINER Light-Weight Arm Exoskeleton: Effect of Adjustable Compliance Passive Assistance and Forces", Markus Puchinger, Nithin Babu Rajendra Kurup, Thomas Keck, Johannes Zajc, Michael Friedrich Russold and Margit Gföhler 2018Published in:2018 7th IEEE International Conference on Biomedical Robotics and Biomechatronics (Biorob) Enschede, The Netherlands, August 26-29, 2018

The recovery of arm movements is one of the most important goals in the processs of

Also, people whose work requires the exertion of forceful and repetitive hand gripping action are exposed to a high likelihood of developing a musculoskeletal disorder. Therefore, to prevent such work-related musculoskeletal disorders, it is important to reduce the physical burden on these workers. Hand exoskeletons can be used to assist the hand function by amplifying the hand gripping force or automating the motion. Applicable areas include heavy industry, construction, military, and logistics.

rehabilitation in order to avoid long-term disability.. In this study, the reduction of
muscle activities and muscle forces with the gravity compensated RETRAINER
upper limb exoskeleton were analyzed carrying out defined movements with healthy
subjects.

"Design of Exoskeleton Arm for Enhancing Human Limb Movement ",
Thunyanoot Prasertsakul, Teerapong Sookjit, and Warakorn Charoensuk
Published in: Proceedings of the 2011 IEEE International Conference on
Robotics and Biomimetics December 7-11, 2011, Phuket, Thailand.

Human motion is an important function which is related to the movement of the limbs.
Patients who have injured or damaged of brain will be lost the movement function.
The designed exoskeleton arm has degrees-of-freedom. Three degrees-of-freedom are
at the shoulder joint, i.e. flexion/extension. The elbow joint has two degrees-of
freedom that are flexion/extension and supination / pronation. Controlling the
exoskeleton arm can be performed by the signals and a set of controller which
composes of the electromyography amplifier, analog to digital convertor, motor
control and motor driver.

DESCRIPTION OF EQUIPMENT

GLASSMOTOR

Another toll-booth, another mile--or at least it seems as if the tollbooths come every mile on this road, with a half mile of traffic idling its leisurely way up to the token monster. Within an arm's length of the bin, you toggle the power window switch with one hand while the other hand fingers a token, preparing to whip it into the basket just as you floor the throttle. All goes as planned--except the window doesn't move, the token bounces back into your face, and you have to jam on the brakes, crack the door and pitch a second token backhanded to keep from getting a ticket as a toll evader, all to the tune of horns blaring from the cars behind you.

Fortunately, power windows are usually one of the more reliable systems on a late model car. And diagnosis and repair are usually pretty straightforward.

PROOF POSITIVE

As an absolute proof that the problem is electrical, try running a jumper wire direct from the battery positive terminal to the positive side of the motor to see if it comes alive. Be aware that a few window regulator systems supply 12v constantly, and switch the ground side of the circuit. Check the schematic. Also, most vehicles have the ability to lock--and deactivate--the rear windows. Check this switch if only the rears are balky. Occasionally, the true problem is a duff motor. You'll have to replace it. Otherwise, you can simply trace the wires until you find the problem. Severe misalignment caused by loose fasteners can jam gear-type regulators.

ARDUINO DUEMILANOV

The Arduino Duemilanove ("2009") is a microcontroller board based on the ATmega168 or ATmega328It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to getstarted.

"Duemilanove" means 2009 in Italian and is named after the year of its release.

The Duemilanove is the latest in a series of USB Arduinoboards.

POWER

The Arduino Duemilanov can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wallwart) or battery. The adapter can be connected by plugging a 2.1mm centerpositive plug into the board's power jack. Leads from a battery can be inserted In the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12volts

MEMORY

The ATmega168 has 16 KB of flash memory for storing code (of which 2 KB is used for the boot loader); the ATmega328has 32 KB, (also with 2 KB used for the boot loader). The ATmega168 has 1 KB of SRAM and 512 bytes of EEPROM (which can be read and written with the EEPROM library; the ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

COMPONENTS

The fabrication of Controlled hand exoskeleton for rehabilitation consists of the following components to full fill the requirements of complete operation of the machine.

The project consist the following parts

- Glass motor
- Proof positive
- Arduino Duemilanov
- Power
- Memory

WORKING PRINCIPLE

The world today is spellbound by the surreal realm of superheroes and their ability to defy the laws of physics. Although they are fictitious, they have inspired the modern homo-sapiens to incorporate certain concepts of superhuman abilities into current technology. This idea conceived by the humans has been realised with the birth of the "Human Exoskeleton." The term "Exoskeleton" refers to an external wearable robot that is worn by the user to extend muscle strength and enhance body stability. It is designed in a skeletal manner i.e., the joints of the exoskeleton line up correspondingly with the joints of the human limb on which it is worn. The force exerted by the exoskeleton is thus exerted on the joints of the human to create poweraugmented motion. In recent years, there has been an increasing interest in the development of different kinds of exoskeletons.

MERITS

- Easy to operate.
- Less maintenance.
- It occupies less space.
- No physical instructor is required.
- It is portable.

DEMERITS

- Need to recharge the batteries to use.
- Only carries vertical motion of the arm upto 120 degrees.

APPLICATIONS

- It can be used for stroke patients to activate their muscle function.
- Applicable in hospitals, etc,…
- This project is mainly used in areas where people seek rehabilitation of their inability
- Project to use this in efficient way to regain joint movements.

CONCLUSION

The integration of human and robot into a single system offers remarkable opportunities for a new generation of assistive technology. Despite the recent prominence of upper limb exoskeletons in assistive applications, the human arm kinematics and dynamics are usually described in single or multiple arm movements that are not associated with any concrete activity of daily living Moreover, the design of an exoskeleton, which is physically linked to the human body, must have a workspace that matches as close as possible with the workspace of the human body, while at the same time avoid singular configurations of the exoskeleton within the human workspace. The aims of the research reported in this manuscript are to study the kinematics and the dynamics of the human arm during daily activities in a free and unconstrained environment, to study the manipulability of a 7-degree-of-freedom powered exoskeleton arm given the kinematics and the dynamics of the human arm.

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