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Exoskeleton for knee replacement

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Abstract - Robotics will play an important role in therapy activities within rehabilitation treatment. Lately the interest in robotics has grown highly in the medical field due to the success of it. Exoskeletons are wearable, powered devices intended to support and augment limb function. With the aging population and patients undergoing rehabilitation therapy thus increasing demand for total knee arthroplasty, or other surgeries exoskeletons could prove a valuable tool for regaining function.

An automated exoskeleton leg helps patients to move around with dysfunctional leg even with the other leg being amputated by flex sensor. With the use of electromechanical devices and sensors, the movement the patient is controlled based on the motion of the functional leg

The objective is to design a exoskeleton leg that is basically sensors with high degrees of repeatability, precision, and reliability

Flex sensor is such a device, which accomplish the above task with great degree of accuracy. hardware and software co design of robotic limb controlled using flex sensor and ardino controller. Micro controller programming can be done with an ease to suit the requirements.

Key Words: Exoskeleton, rehabilitation, knee surgeries, sensors, accuracy, microcontroller

1.INTRODUCTION

In 2010, approximately 4.7 million Americans were living with knee replacements

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 power-augmented motion

In recent years, there has been an increasing interest in the development of different kinds of exoskeletons. This is made possible now by many technological advancements some including reduction in weight such that exoskeletons can be worn by a human user, improvements in reduction of size of power supplies and longer lifetime, better control techniques, etc. The exoskeleton is a classification under wearable robots that describes a robotic field which studies the interaction between the human body and robotics.

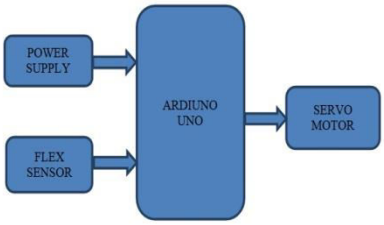
In these systems, a mechatronics structure is attached to different parts of the human body, and while the wearer commands the mechanical system using physical signals (like electronic sensors, controllers and motors) the mechanical system does the hard work, like carrying heavier objects or helping the movement of handicapped parts of the body. Since its conception in the sixties, the bibliography written by Crawshaw speaks about two models of wearable robots - the prosthetics and the orthotics. The first group replaces the lost body members, while the second one assists the body movements or enhances the body capabilities.

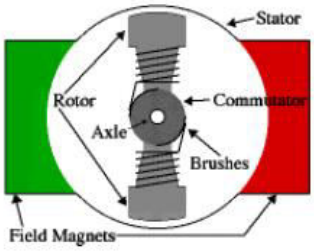
2. MATERIALS AND METHODS

This is a case study and customized design in the development of economic automated exoskeleton add on whose application is real time.

The electronics consists of two 5A relays, microcontroller, the motion of the femur is sensed by a flex sensor, placed at the pelvic joint. The resistance of the flex sensor changes with the angle bent by the femur. The flex sensor resistance increases with increase in the bending angle thereby decreasing the output voltage. The change in the output voltage of the flex sensor is detected by the microcontroller.

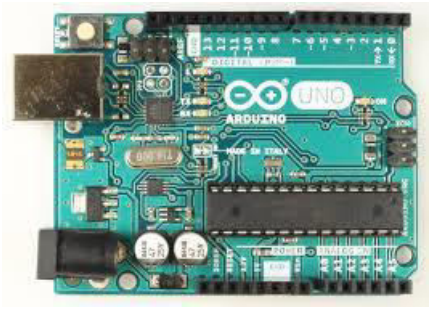
The DC motor of the linear actuator is controlled by the microcontroller through a pair relays based on the voltage output of the flex sensor. When the voltage ranges from 0 to 1.85V, the microcontroller produces clockwise direction of the motor thereby retracting the leg front movement. If the voltage is above 1.85V, the direction of the motor is reversed hence, the leg moves in opposite direction.





Main components used

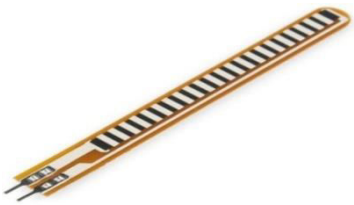
Ardino uno:



Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

Flex sensor:

Flex sensor is also called as bend sensor. That is capable of sensing any kind of minute bend in its structure. Flex sensor is designed in a thin plastic strip type material. This flex sensor is a variable resistor, the resistance of the flex sensor increases as the body of the component bends



Dc motor:

A DC motor is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore so is its current. In any electric motor, operation is based on simple electromagnetism

Battery

Battery is the main power source for the exoskeleton to run. Therefore more voltage gives longer run

Knee Joint:

The knee joint is the movable joint which is connected to the connector by three links. One end of the knee joint is connected to the connected and the other end hinged to the links.

Table: The angles and displacements tabulated

TESTING

Sl no	Angle (degrees)	' X' coordinate	'Y' coordinate	Displacement (degrees)
1	90	25	-20	30
2	20	25	-20	18
3	30	25	-20	25
4	40	25	-20	20
5	50	25	-20	20
6	90	20	-25	18
7	20	20	-25	20
8	30	20	-25	18
9	40	20	-25	17
10	50	20	-25	15

Table 9.1 upper and lower gripper position

The position angle plays an important role, help in achieving maximum displacement and improve in ergonomics of the prosthetic. The optimum angle and maximum displacement achieved is tabulated

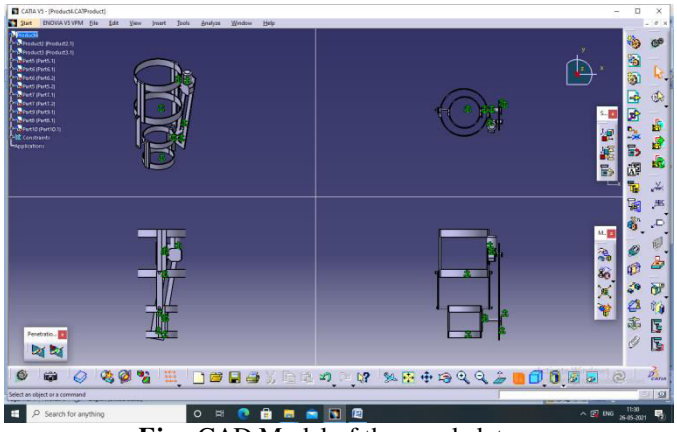


Fig : CAD Model of the exoskeleton

3. CONCLUSIONS

The exoskeleton leg proves to be an excellent assist tool for the people who have difficulty in walking. The exoskeleton limb is just the beginning of a potential power enhancing exoskeleton suit which is the technology of the future. The results highlighted the importance of principles of legged mechanics for understanding human motor control, as well as of neuromuscular controllers for improving the functionality of powered leg exoskeleton. Eventually, these results might change how we understood human locomotion and engineered artificial legs, improving the quality of life of people who face difficulty.

Automated exoskeleton has a greater advantage, adaptability, reduction in complexity is achieved. Thus,

Automation of this system can be achieved without tapping neural signal Automated exoskeleton is more cost efficient

The frames were designed keeping in mind the average dimensions obtained from a survey of various human leg sizes

ACKNOWLEDGEMENT

The collected information in the paper is true.

Scope for future work

The exoskeleton can be improved by working on some parameters,

Duty cycle: stepper motor to operate for a longer period thereby helping the patient to walk for a longer time.

Battery: The battery should be more durable, by equipping the prosthetic with higher voltage battery higher speed can be obtained, use of different type of batteries which are lighter enables reduction in weight and net power consumption

Adaptability: The exoskeleton can be made adaptable by having variable dimension adjustable, by doing so, the requirements of different cases are satisfied.

Stair climbing and sitting condition: The step angle needs to be increased and with the suitable addition of electronics stair climbing and sitting process can be achieved.

Sensor: The delay in the response can reduce by introducing new sensor like myoware, Gyroscope etc. A myoware sensor which is sensitive compared to other sensor and is more reliable.

REFERENCES

1. Abdulla Almomani, Faisal Miqdadi, Mustafa Hassanin, Mustafa Samy, and Mohammed Awadallah, “The 1st Pneumatic Fluidic Muscles Based Exoskeleton Suit in The U.A.E,” IEEE, 2014.

2. Kwok-Hong Chay, Jer-Vui Lee, Yea-Dat Chuah and Yu-Zheng Chong, “Upper Extremity Robotics Exoskeleton: Application Structure and Actuation,” International Journal of Biomedical Engineering and Science (IJBES), Vol. 1, Issue No. 1, pp 35-45, April 2014.

3. Joel C. Perry, Jacob Rosen and Stephen Burns, “Upper-Limb Powered Exoskeleton Design,” IEEE/ASME Transactions on Mechatronics, Vol. 12, Issue No. 4, pp 408-417, August 2007, Publisher: IEEE.

4. Boris Jobbágy, Dušan Šimšík, Jiří Marek, Ján Karchňák and Daniela Onofrejová, “Robotic Exoskeleton for Rehabilitation of the Upper Limb,” American Journal of Mechanical Engineering, Vol. 2, Issue No. 7, pp 299-302, 2014, Publisher: Science and Education Publishing.

5. Gregory Clark Henderson and Jun Ueda, “Pneumatically-Powered Robotic Exoskeleton to Exercise Specific Lower Extremity Muscle Groups in Humans,” Biomedical Robotics and Biomechatronics (BioRob), 4th IEEE RAS & EMBS International Conference on IEEE, pp 1506-1511, 2012, Publisher: IEEE.

6. Younkoo Jeong, Yongseon Lee, Kyunghwan Kim, Yeh-Sun Hong and Jong-Oh Park, “A 7 DOF Wearable Robotic Arm Using Pneumatic Actuators,” Proceedings of the 32nd ISR (International Symposium on Robotics), Vol. 19, pp 21, April 2001.

7. Zhichuan Tang, Kejun Zhang, Shouqian Sun, Zenggui Gao, Lekai Zhang and Zhongliang Yang, “An Upper-Limb Power-Assist Exoskeleton Using Proportional Myoelectric Control,” Sensors, Vol. 14, Issue No. 4, pp 6677-6694; DOI: 10.3390/s140406677, Publisher: Multidisciplinary

Digital Publishing Institute, 2014.

8. Hugh Herr, "Exoskeletons and orthoses: classification, design challenges and future directions," Journal of Neuroengineering and Rehabilitation, Vol. 6, Issue No. 1, pp 21, DOI: 10.1186/1743-0003-6-21, Publisher: BioMed Central, 2009.

9. Evangelos Papadopoulos and Georgios Patsianis, "Design of an Exoskeleton Mechanism for the Shoulder Joint," 12th IFToMM World Congress, Besançon (France), pp 18-21, 2007.