Elbow Assistive Orthosis for Monoplegia Using 3D Print Design Model

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ABSTRACT - The Monoplegia is a one type of paralysis. The Monoplegia patients do not do the regular Elbow Extension and Flexion activities, because weakens muscle movements, mainly due to nerve damage. This orthosis is used to externally assist patients elbow extension and flexion movements. An elbow extension and flexion assist orthosis is automatic functioning system. When the patient is shaking the fingers, vibration sensor detects the vibration and the device is extending the hand by using Linear actuator and flexion is also done by a same procedure. The prototype is design in 3d printing model which was a make the design lightweight as much possible. Consider incorporating a user-friendly control interface that allows the patient to adjust the level of assistance or control the device based on their comfort and needs. Implement safety features to prevent sudden or unintended movements that could cause discomfort or injury .Design the orthosis to be easily adjustable to accommodate different arm sizes and shapes. Allow for customization based on the individual's specific range of motion and strength. efficient and lightweight power source, considering the need for mobility and comfort. Optimize the battery life to ensure the device can be used throughout the day without frequent recharging. Ensure that the materials used in the 3D printing model are durable, hypoallergenic, and lightweight .Pay attention to the ergonomic design to maximize comfort during prolonged use. Develop a comprehensive user training program to help patients become familiar with the device and optimize its use. Ensure that the design complies with relevant medical device regulations and standards to guarantee safety and efficacy. Collaborate with healthcare professionals, therapists, and end-users to gather feedback and make continuous improvements to the design. Thus the prototype will help to recover as soon as possible from the monoplegia condition.

I. INTRODUCTION

Monoplegia and hemiplegia are common neurological symptoms in patients presenting to the emergency department as well as outpatient department. Monnoplegia refers to weakness of one limb (either arm or leg) and hemiplegia refers to weakness of one arm and leg on the same side of body (either left or right side)..There are a variety of underlying causes for monoplegia and hemiplegia. The causes differ in different age groups. The causes also differ depending on the onset, progression and duration of weakness. Therefore, one needs to adopt a systematic approach during history taking and examination in order to arrive at the correct diagnosis. Appropriate

investigations after these would confirm the diagnosis. The aim of this chapter is to systematically look at the differential diagnosis of monoplegia and hemiplegia.

SOFTWARE COMPONENTS

ULTIMAKER CURA

SOFTWARE REQUIREMNETS:

Windows Operator :8/10/11
Bit Operator System: A 64-bit operating system updated to the latest version Graphics: An OpenGL 4.1 compatible graphics card for 3D layer view Display :A display resolution of 1920 x 1080
Processor: An Intel Core 2 or AMD Athlon 64 processor or higher Hard Disk:600 MB or More
Ram :4GB or More

TECHNICAL   SPECIFICATIONS

Ultimaker Cura works by slicing the user's model file into layers and generating a printer- specific g-code. Once finished, the g-code can be sent to the printer for the manufacture of the physical object. The open source software, compatible with most desktop 3D printers, can work with files in the most common 3D formats such as STL, OBJ, X3D, 3MF as well as image file formats such as BMP, GIF, JPG, and PNG.

DESIGN OF ELBOW MODEL:

In K-means algorithm, it is recommender to pick the optimal K, according to the Elbow Method. However all the tutorials explain the elbow method in these 4 steps:

    Run K-means for a range of K's
    Calculate the Sum of Squares of the distances from the cluster mean
    Plot a curve of the SSD over K's
    Visually pick the K at the elbow.
Elbow length in mm = Tan(Elbow Angle/2) X Elbow Radius in mm

For 90° Long Radius elbows, center to end dimension given in dimension tables of ASME B16.9 is same as radius of elbow. This is because Tan(90/2) i.e. Tan 45 is 1.Normally custom elbow angles from 45 degree to 90 are cut from 90 degree standard elbow. But for custom elbow angles smaller than 45 degree, elbow is normally cut from existing standard 45 degree elbow. Center to end dimension given in dimension tables for 45 degree elbow must be divided by Tan(22.5) to get elbow radius for standard 45 degree elbow. Then we can use above formula to get elbow angle for custom degrees.

AURDINO IDE

The latest IDE for Windows is bundled with Java Virtual Machine 8u32. Java 8 runs on the following Windows versions:

    Windows 8 (Desktop)
    Windows 7
    Windows Vista SP2
    Windows Server 2012 (64-bit)
    Windows Server 2008 R2 SP1 (64-bit)

Java 8 requires a Pentium 2 266 MHz processor and 128 MB of RAM. Hard Disk: 600 Mb of free disk space .

HARDWARE COMPONENTS

ARDUINO UNO

Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. This board can be interfaced with other Arduino boards, Arduino shields, Raspberry Pi boards and can control relays, LEDs, servos, and motors as an output.
RELAY

Flash Memory - 32 KB (of which 2KB used by bootloader)
SRAM - 2 KB
EEPROM - 1 KB
Clock Speed - 16 MHz

Relays are electrically operated switches that open and close the circuits by receiving electrical signals from outside sources.
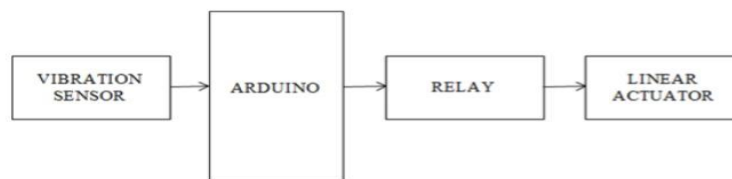
LINEAR ACTUATOR

A linear actuator changes the rotational motion of a motor into a straight line. Conventional electric motors move in a circle, while linear actuators move forward and backward. The push and pull action allows the device to slide, tip, and lift items with the push of a button.

EXPERIMENTAL SETUP AND PROCEDURE FOR PROPOSED SYSTEM
EXPERIMENTAL SETUP AND PROCEDURE

Here we are using ARDUINO as the controller. So, the input and output units are interfaced with the ARDUINO. The Vibration Sensor interfaced with Arduino. The Arduino is connected through the Relay.

Power supply is interfaced with the Relay. Linear actuator also connected in the Relay. Linear actuator is the output of the system. An elbow extension and flexion assist orthosis is automatic functioning system. When the patient is shake the fingers, vibration sensor detect the vibration and the device is extend the hand by using Linear actuator and flexion is also done by same procedure. This orthosis will help to recover the patients and do regular activities

as soon as possible.

In the diagram, it is shown that the sensors and modules are interfaced with the Arduino controller. The sensor is connected to Arduino as the input units and the output units are Linear actuator. An elbow extension and flexion assist orthosis is automatic functioning system. When the patient is shake the fingers, vibration sensor detect the vibration and the device is extend the hand by using Linear actuator and flexion is also done by same procedure. Vibration Sensor is used to sense the vibration of patient hand. Linear actuator works extension and flexion of elbow. This assist orthosis will help to recover the patients and do regular activities as soon as possible.

RESULT

This orthosis is used for monoplegia patients. To support for the Monoplegia patients Elbow Extension and Flexion movements, To provide regular activities for patients, To help the patient in Rehabilitation and when the patients continuously use the orthosis, will recover from the disease as soon as possible.

CONCLUSION

Fifteen million individuals worldwide experience a paralysis each year with 50,000 of these cases occurring in Canada. Monoplegia is a type of paralysis, It patients does not do the regular Elbow Extension and Flexion activities, because weakens muscle movements, mainly due to nerve damage. This orthosis is used to externally assist patients elbow extension and flexion movements. An elbow extension and flexion assist orthosis is automatic functioning system. The prototype is a lightweight, this orthosis which can be made relatively easily and is potentially concealed under clothing. The device is placed on the elbow of the patient. When the patient shakes their fingers or palm, the vibration sensor is sense the vibration. This vibration is taken to input of the device. Then the input is send to arduino and control the electronic switches. It provides elbow extension and flexion for the Monoplegia patients and also act as physiotherapy equipment. When the patient continuously use this device can be provides regular activities and recovery as soon as possible. In future will developed AI based orthosis. It consists of EEG systems and EMG systems.

In the next phase we will design the complete hardware output of this protype which was done now on the software design of the protype.

REFERENCES

[1] Mohammed Y Aalsalem, Wazir Zada Khan, Wajeb Gharibi, Nasrullah Armi "An intelligent oil and gas well monitoring system based on Internet of Things" International Conference on Radar, Antenna, Microwave, Electronics, and Telecommunications (ICRAMET),2017.

[2] Sayeda Islam Nahid, Mohammad Monirujjaman Khan " Toxic Gas Sensor and Temperature Monitoring in Industries using Internet of Things (IoT)" International Conference on Computer and Information Technology (ICCIT)2021

[3] S.Vivekanandan , Abhinav Koleti, M Devanand Autonomous industrial hazard monitoring robot with GSM integration International Conference on Engineering (NUiCONE)2013

[4] Meer Shadman Saeed, Nusrat Alim Design and Implementation of a Dual Mode Autonomous Gas Leakage Detecting Robot International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST)2019

[5] A.Sandeep Prabhakaran Mathan N Safety Robot for Flammable Gas and Fire Detection using Multisensor Technology International Conference on Smart Electronics and Communication (ICOSEC)2021.

[6] Ashutosh Mishra; Shiho Kim; N S Rajput" An Efficient Sensory System for Intelligent Gas Monitoring Accurate classification and precise quantification of gases/odors" International SoC Design Conference (ISOCC) 2020.

[7] Qiang Luo; Xiaoran Guo; Yahui Wang; Xufeng Wei "Design of wireless monitoring system for gas emergency repairing" Chinese Control and Decision Conference (CCDC) 2016.

[8] Mohammed Y Aalsalem; Wazir Zada Khan; Wajeb Gharibi; Nasrullah Armi "An intelligent oil and gas well monitoring system based on Internet of Things" International Conference on Radar, Antenna, Microwave, Electronics, and Telecommunications (ICRAMET) 2017.

[9] C.Nagarajan and M.Madheswaran - 'Experimental verification and stability state space analysis of CLL-T Series Parallel Resonant Converter' - Journal of ELECTRICAL ENGINEERING, Vol.63 (6), pp.365-372, Dec.2012.

[10] C.Nagarajan and M.Madheswaran - 'Performance Analysis of LCL-T Resonant Converter with Fuzzy/PID Using State Space Analysis'- Springer, Electrical Engineering, Vol.93 (3), pp.167-178, September 2011.

[11] C.Nagarajan and M.Madheswaran - 'Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques'- Taylor &; Francis, Electric Power Components and Systems, Vol.39 (8), pp.780-793, May 2011.

[12] C.Nagarajan and M.Madheswaran - 'Experimental Study and steady state stability analysis of CLL-T Series Parallel Resonant Converter with Fuzzy controller using State Space Analysis'- Iranian Journal of Electrical & Electronic Engineering, Vol.8 (3), pp.259-267, September 2012.

[13] Nagarajan C., Neelakrishnan G., Akila P., Fathima U., Sneha S. "Performance Analysis and Implementation of 89C51 Controller Based Solar Tracking System with Boost Converter" Journal of VLSI Design Tools & Technology. 2022; 12(2): 34–41p.

[14] C. Nagarajan, G.Neelakrishnan, R. Janani, S.Maithili, G. Ramya "Investigation on Fault Analysis for Power Transformers Using Adaptive Differential Relay" Asian Journal of Electrical Science, Vol.11 No.1, pp: 1-8, 2022.

[15] G.Neelakrishnan, K.Anandhakumar, A.Prathap, S.Prakash "Performance Estimation of cascaded h-bridge MLI for HEV using SVPWM" Suraj Punj Journal for Multidisciplinary Research, 2021, Volume 11, Issue 4, pp:750-756

[16] G.Neelakrishnan, S.N.Pruthika, P.T.Shalini, S.Soniya, "Perfromance Investigation of T-Source Inverter fed with Solar Cell" Suraj Punj Journal for Multidisciplinary Research, 2021, Volume 11, Issue 4, pp:744-749

[17] C.Nagarajan and M.Madheswaran, "Analysis and Simulation of LCL Series Resonant Full Bridge Converter Using PWM Technique with Load Independent Operation" has been presented in ICTES'08, a IEEE / IET International Conference organized by M.G.R.University, Chennai.Vol.no.1, pp.190-195, Dec.2007

[18] M Suganthi, N Ramesh, "Treatment of water using natural zeolite as membrane filter", Journal of Environmental Protection and Ecology, Volume 23, Issue 2, pp: 520-530,2022

[19] M Suganthi, N Ramesh, CT Sivakumar, K Vidhya, "Physiochemical Analysis of Ground Water used for Domestic needs in the Area of Perundurai in Erode District", International Research Journal of Multidisciplinary Technovation, pp: 630-635, 2019