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ANATOMICAL PLACEMENT OF AN ACCELEROMETER BASED HAND FRACTURE REHABILITATION/PARALYSED PERSON MONITORING DEVICE USING IoT

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ABSTRACT—

With the huge development and the latest technological advancement in mechatronics, prosthetic devices have acquired interest in many different fields such as medical and industrial fields. A prosthetic device can be an external wearable machine that covers the body or part of it. It is generated by electric motors. It can be installed on and elbow, wrist & finger. Moreover, it can be used for different purposes such as rehabilitation, power assistance, diagnostics, monitoring, ergonomics, etc. Most of the existing wearable devices face different problems in terms of size, cost and weight; they are huge, expensive and heavy. Therefore, the goal of this project is to design a portable, lightweight and low-cost rehabilitation system for people with a fracture/ paralyzed based on accelerometer sensor. In this project, we are using PIC microcontroller to monitor and control the hand, wrist & finger. The wearable device allows a user to perform specific movements and exercises to train the patient's impaired hand using IoT communication. Thus, the user gradually starts to restore the functionality of his hand and also alert the care takers/doctor though IoT module based on the hand gesture movement.

Keywords- rehabilitation, IoT communication.

1. INTRODUCTION

Amputation due to accidents or diseases profoundly impacts individuals physically and psychologically. Rehabilitation often involves dummy limbs made of materials like wood and plastic. Recent advancements in mechatronics have led to the development of prosthetic devices aimed at improving mobility and independence for amputees, including those with spinal cord injuries or strokes. These devices, which can be installed on various limbs, offer rehabilitation, power assistance, and diagnostics. However, current prosthetics are often bulky, expensive, and heavy. This project aims to design a portable, lightweight, and cost-effective rehabilitation system for paralyzed hands using the Internet of Things. Accurate gait event detection is crucial for the control of lower limb prosthetics, which can significantly enhance the quality of life for lower limb amputees. Wearable sensors, such as gyroscopes and accelerometers, play a key role in these advanced prosthetic systems.

Types of Joints & Movements

Joints are the connections between bones that enable various types of movement essential for daily activities. Key joint types include synovial (most movable, e.g., shoulder and knee), fibrous (minimal movement, e.g., skull sutures), and cartilaginous (limited movement, e.g., intervertebral discs). Movements facilitated by joints include flexion, extension, abduction, adduction, rotation, and circumduction. These movements are crucial for actions such as walking, running, lifting, and twisting, contributing to overall mobility and functionality. Understanding joint mechanics is vital in fields like medicine, physiotherapy, and sports science.

IoT in Medical & Healthcare

The Internet of Things (IoT) has revolutionized medical and healthcare fields by enabling real-time monitoring and data collection. Wearable devices like smartwatches and fitness trackers continuously monitor vital signs such as heart rate, blood pressure, and glucose levels, allowing for proactive health management. IoT facilitates remote patient monitoring, reducing hospital visits and enabling timely interventions, especially for chronic disease management. Smart medical devices, such as connected inhalers and insulin pumps, ensure medication adherence and precise dosage delivery. IoT enhances telemedicine services by

2. LITERATURE REVIEW

1. Nikhil Sawake, Santosh Gupta et al. EMG-based Prosthetic Leg for Above-knee Amputee – IEEE, 2017

This system uses EMG signals from the healthy leg's calf muscles to control the prosthetic knee joint, enhancing the user's gait. The EMG signals are processed and interfaced with a microcontroller to actuate the prosthetic leg's motor.

2.Robert D. Gregg, Anne E. Martin Prosthetic Leg Control in the Nullspace of Human Interaction – IEEE, 2016

The proposed method projects virtual constraints into the nullspace of human interaction forces, maintaining output dynamics invariant to these forces. Simulations illustrate the method's effectiveness for transfemoral amputees using a powered knee-ankle prosthesis.

3. Lobes Herdiman et al. Improvement in Walking Efficiency of Transtibial Amputee using Prosthetic Leg with Multi-Axis Joint and Energy Store Return Ankle – IEEE, 2015

The study assessed walking balance and gait efficiency in 14 transtibial amputees using a prosthetic leg with a multiaxis joint and energy store return ankle. Participants walked a 10-meter track at 1.2 m/s, with data collected to evaluate walking efficiency.

4. Rashmi Vashisth, Akshit Sharma et al. Gesture Control Robot Using Accelerometer – IEEE, 2017

This paper introduces a gesture-controlled robot using a 3axis accelerometer (ADXL335) and ATmega16 microcontroller. The robot interprets human gestures through mathematical algorithms, enabling a communication bridge between humans and machines.

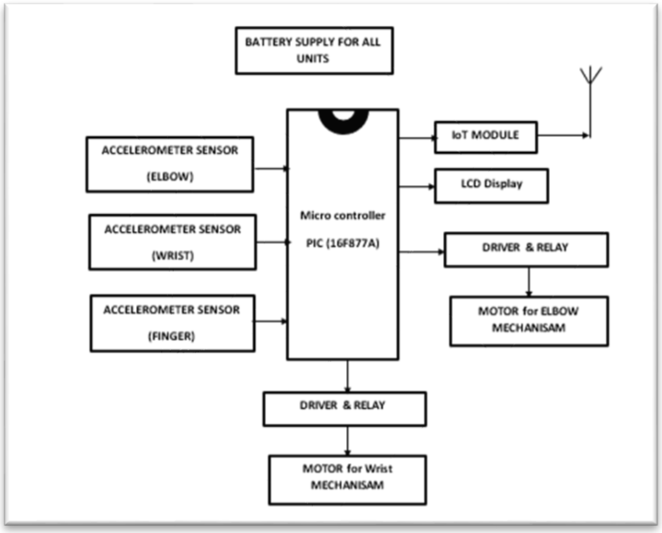
PROBLEM STATEMENT

Traditional prosthetic legs for above-knee amputees lack automatic knee joint actuation, often requiring exaggerated movements or remote controls, resulting in unnatural and inefficient gait patterns. These prosthetics are typically passive, heavy, and expensive, making them inaccessible for many, especially in rural areas. Current systems also struggle with accuracy and dependency issues, making it difficult to synchronize the prosthesis with the user's natural movements. Consequently, there is a need for a more robust, costeffective, and adaptive prosthetic leg that can reliably use EMG signals from the healthy leg to control the prosthetic knee joint, enhancing mobility and reducing the physical effort required by the user.

3. Proposed System Architecture

Without advanced systems, paralyzed individuals face significant challenges, including mobility limitations that necessitate caregiver dependence, discomfort from loss of sensation, and susceptibility to secondary health issues like pressure sores and muscle atrophy. These physical limitations can also negatively impact mental health, leading to frustration, isolation, and depression. Limited access to rehabilitation further hinders recovery and adaptation. The proposed system integrates a prosthetic hand with IoT connectivity for remote-controlled hand exercises, using an accelerometer to monitor leg position and provide real-time feedback. A control interface allows users or caregivers to select exercises and adjust parameters, while healthcare providers remotely monitor progress and customize therapy. Data logging tracks improvements, optimizing rehabilitation, and safety mechanisms prevent injury by monitoring vital signs. This system enhances therapeutic engagement and personalized therapy management, alleviating many challenges associated with paralysis. The platform extends modular gesture movement acquisition using IoT modules, offering new applications for rehabilitation and motion evaluation. Users and healthcare providers can control the prosthetic hand remotely via smart devices, with data managed by a PIC (16F877A) microcontroller.

Block Diagram



4.Hardware and Software Requirements

Hardware Requirements

Power Supply

A power supply unit (PSU) is a device that provides electrical energy to an output load. Power supplies for electronic devices are broadly classified into linear and switching types. Linear power supplies are simple but bulky and less efficient, whereas switched-mode power supplies are more complex but efficient and compact.

Linear Power Supply

A linear power supply converts AC voltage from a wall outlet to a lower voltage using a transformer. It includes a rectifier to convert AC to DC and a capacitor to smooth the pulsating current, though some ripple remains. Voltage regulation is necessary to stabilize output, often using linear regulators which also limit current and reduce noise.

Transformer

Transformers convert AC electricity from one voltage to another. Step-down transformers are commonly used in power supplies to reduce high mains voltage to a safer level. They operate through electromagnetic induction between primary and secondary coils, with the turns ratio determining the voltage conversion.

Bridge Rectifier

A bridge rectifier, made from four diodes, converts AC to DC using both halves of the AC waveform. It is more efficient than a single diode rectifier but incurs a
voltage drop of 1.4V. Bridge rectifiers are rated by their current capacity and maximum reverse voltage.

Voltage Regulator

Voltage regulators, such as the LM78XX series, provide fixed or variable output voltages and protect against overcurrent and overheating. They are essential for stabilizing voltage in electronic circuits and can be used in various applications, including logic systems and instrumentation.

Battery Cells

Battery cells are the fundamental components of a battery, consisting of electrolyte and lead plates. Lead-acid batteries, commonly used due to their robustness and costeffectiveness, store energy through reversible chemical reactions. Despite being heavy and having a shorter cycle life, they remain prevalent in automotive applications.

Lead Acid Battery Characteristics

Lead-acid batteries have lead dioxide cathodes, sponge lead anodes, and sulfuric acid electrolytes. They are prone to issues like gassing, sulphation, and shedding, which can affect performance and longevity. Proper maintenance and regular self-tests are recommended to prevent failures.

Accelerometer

An accelerometer measures proper acceleration relative to free fall, useful in various applications from inertial navigation to vibration monitoring. Modern accelerometers are often MEMS devices, operating on principles like capacitive sensing and the piezoelectric effect. Capacitive accelerometers offer high accuracy and stability, while piezoelectric accelerometers are ideal for measuring dynamic phenomena like vibration.

Software Requirements MPLAB IDE Software

MPLAB is a proprietary, freeware integrated development environment (IDE) for developing embedded applications on PIC and dsPIC microcontrollers by Microchip Technology. The latest version, MPLAB X, built on the NetBeans platform, supports 8-bit, 16-bit, and 32-bit PIC microcontrollers. It runs on Windows, Mac OS X, and Linux, offering features like project management, code editing, debugging, and programming. MPLAB X supports various compilers, including MPLAB XC8, XC16, and XC32. It is compatible with Microchip's hardware tools like environment for writing and uploading code. Arduino boards read inputs (e.g., light on a sensor) and convert them into outputs (e.g., turning on an LED). They are popular for educational and hobby projects due to their affordability, cross-platform software, and open-source nature.

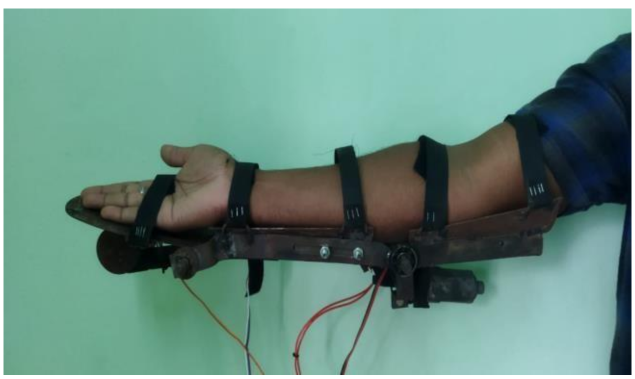
Arduino UNO

Arduino UNO is a widely used microcontroller board based on the ATmega328P, part of the open-source Arduino platform. It features 14 digital I/O pins, 6 analog inputs, and a USB connection for programming. It is used for prototyping and building digital devices, with a strong community supporting a variety of applications. The Arduino software is easy to use for beginners yet flexible enough for advanced users. Its open-source hardware and software make it a versatile tool for learning and development in electronics and programming.

Sketch

A sketch is the program code uploaded to an Arduino board. Arduino is an open-source platform designed for building digital devices and interactive objects. It uses a simplified version of C++ and provides a development

OUTPUT



5. CONCLUSION

The proposed wearable robotic device leverages state-ofthe-art technology, IoT, and cloud communication for controlling lower limb prosthetics and orthotics (P/O) during activities of daily living. This technology aids orthopedic physical therapy by visualizing patient data for better clinical decision-making. A study deploying this device in patient homes showed promising results but highlighted the need for larger sample sizes. Future work will expand to more body regions and complex exercises, enhancing PT customization capabilities with compound joint motions for comprehensive rehabilitation.

6. FUTURE ENHANCEMENTS

1. Extended Body Region Analysis: Expanding the device's applicability to monitor and assist additional body regions, such as upper limbs, torso, and neck.
2. Complex Exercise Customization: Enabling physical therapists (PTs) to prescribe and customize more complex, functional exercises like jumping jacks and compound-joint motions such as pushing and pulling.
3. Enhanced Motion Widgets: Introducing new motion widgets for compound movements, facilitating the specification of exercises that involve multiple joints working simultaneously.
4. Adaptive Algorithms: Developing adaptive algorithms to tailor the device's functionality to individual patient needs and progress, ensuring personalized rehabilitation plans.
5. Integration with Other Healthcare Technologies: Connecting the wearable device with other healthcare technologies, such as telemedicine platforms and electronic health records (EHR), for comprehensive patient management..

REFERENCES

1. F. Sup, A. Bohara, and M. Goldfarb, "Design and control of a powered transfemoralprosthesis," Int. J. Robot. Res., vol. 27, no. 2, pp. 263– 273, 2008.
2. F. Sup, H. Varol, and M. Goldfarb, "Upslope walking with a powered knee and ankle prosthesis: Initial results with an amputee subject," IEEE Trans Neural Sys Rehab Eng, vol. 19, no. 1, pp. 71–78, 2011.
3. M. R. Tucker, J. Olivier, A. Pagel, H. Bleuler, M. Bouri, O. Lambercy, J. del R Millan, R. Riener, H. Vallery, and R. Gassert, "Control ´ strategies for active lower extremity prosthetics and orthotics: a review," J. Neuroengineering and Rehabilitation, vol. 12, no. 1, 2015.
4. Nanjangud and R. D. Gregg, "Simultaneous control of an anklefoot prosthesis model using a virtual constraint," in ASME Dynamic Systems Control Conf., San Antonio, TX, 2014.
5. K. A. Hamed and R. D. Gregg, "Decentralized feedback controllers for exponential stabilization of hybrid periodic orbits: Application to robotic walking," in American Control Conference, 2016.
6. Isidori, Nonlinear Control Systems: An Introduction, 3rd ed. Berlin, Germany: Springer-Verlag, 1995.
7. R. D. Gregg, T. Lenzi, L. J. Hargrove, and J. W. Sensinger, "Virtual constraint control of a powered prosthetic leg: From simulation to experiments with transfemoral amputees," IEEE Trans. Robotics, vol. 30, no. 6, pp. 1455–1471, 2014.
8. E. Martin and R. D. Gregg, "Hybrid invariance and stability of a feedback linearizing controller for powered prostheses," in American Control Conference, 2015, pp. 4670–4676.
9. E. Westervelt, J. Grizzle, C. Chevallereau, J. Choi, and B. Morris, Feedback Control of Dynamic Bipedal Robot Locomotion. New York, NY: CRC Press, 2007.
10. E. R. Westervelt, J. W. Grizzle, and D. E. Koditschek, "Hybrid zero dynamics of planar biped walkers," IEEE Trans. Automat. Contr., vol. 48, no. 1, pp. 42–56, 2003.
11. K. Sreenath, H. W. Park, I. Poulakakis, and J. W. Grizzle, "A compliant hybrid zero dynamics controller for stable, efficient and fast bipedal walking on MABEL," Int. J. Robot. Res., vol. 30, no. 9, pp. 1170– 1193, 2011
12. Poulakakis and J. W. Grizzle, "The spring loaded inverted pendulum as the hybrid zero dynamics of an asymmetric hopper," Automatic Control, IEEE Transactions on, vol. 54, no. 8, pp. 1779–1793, 2009.
13. S. Kolathaya and A. D. Ames, "Achieving bipedal locomotion on rough terrain through human-inspired control," in IEEE Int. Sym. Safety Security Rescue Robot., College Station, TX, 2012.
14. Martin, D. Post, and J. Schmiedeler, "Design and experimental implementation of a hybrid zero dynamics controller for planar bipeds with curved feet," Int. J. Robot. Res., vol. 33, no. 7, pp. 988–1005, 2014.

15. Ramezani, J. W. Hurst, K. A. Hamed, and J. W. Grizzle, "Performance analysis and feedback control of ATRIAS, a 3D bipedal robot," ASME J. Dyn. Sys. Meas. Control, vol. 136, no. 2, p. 021012, 2013.

16. K. AkbariHamed, B. Buss, and J. Grizzle, "Continuous-time controllers for stabilizing periodic orbits of hybrid systems: Application to an underactuated 3D bipedal robot," in IEEE Conf. Decision & Control, 2014, pp. 1507–1513.

17. K. A. Hamed, B. G. Buss, and J. W. Grizzle, "Exponentially stabilizing continuous-time controllers for periodic orbits of hybrid systems: Application to bipedal locomotion with ground height variations," Int. J. Robotics Research, 2015, OnlineFirst.

18. Martin and J. Schmiedeler, "Predicting human walking gaits with a simple planar model," J. Biomech., vol. 47, no. 6, pp. 1416–1421, 2014.

19. G. Lv and R. D. Gregg, "Orthotic body-weight support through underactuated potential energy shaping with contact constraints," in IEEE Conf. Decision & Control, 2015.

20. R. M. Murray, Z. Li, and S. S. Sastry, A Mathematical Introduction to Robotic Manipulation. Boca Raton, FL: CRC Press, 1994.

21. H. K. Khalil, Nonlinear Systems, 3rd ed. Upper Saddle River, NJ: Prentice Hall, 2002. [22] C. D. Meyer, Matrix Analysis and Applied Linear Algebra. Philadelphia, PA: Siam, 2000.