WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Automatic Lower Limb Rehabilitation Device Using IOT

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ABSTRACT

Physiotherapy is vital for treating neurological and musculoskeletal disorders, and advances in mechatronics have sparked interest in orthotic devices, powered by electric motors. These devices, worn externally, serve various purposes like rehabilitation and monitoring but often suffer from size, cost, and weight tissues. This project aims to address these drawbacks by designing a portable, light weight,and cost-effective rehabilitation system for paralyzed legs, leveraging IoT. Utilizinga PIC microcontroller, the wearable device will monitor and controlthe lower limb and toes, with added accelerometer and EMGsensors for precise movement and muscle activity detection. IoT integration enables remote training tailored to the patient's needs, bridging traditional rehabilitation with modern technology. The device's accessibility due to its portability and affordability has the potential to revolutionize physiotherapy and rehabilitation

Keywords: Sign language recognition, Gesture based control

1. Introduction:

The integration of mechatronics in orthotic devices has expanded their application in neurological and musculoskeletal disorder treatment. However, existingdevices often face issues of size, cost, and weight. To address this, a project aims to develop a portable, lightweight, and cost-effective rehabilitation system forparalyzed legs, utilizing IoT technology. This wearable device, powered by a PIC microcontroller, monitors and controls lower limb and toe movements.Accelerometer and EMG sensors enhance functionality, enabling precise movement monitoring and muscle activity detection. With IoT integration, users canremotelyperform tailored exercises to rehabilitate theimpaired leg, bridging traditional methods with modern technology. The device’s lightweight, portability, and affordability aim to widen accessibility, potentially transforming physiotherapy and rehabilitation practices.

2. Literature Survey:

Nikhil Sawake[1]"Nikhil Sawake,Santosh Gupta et all EMG-based Prosthetic Leg for Above-knee Amputee"

In this existing system, a prosthetic leg based on Electromyography (EMG) signals, for above knee amputees. The surface EMG signals picked upfrom the calf muscles of a healthy leg during the muscle activity are interfaced with a microcontroller using EMGacquisition system.

RobertD.Gregg, Anne E. Martin [2]"ProstheticLegControlintheNullspaceofHumanInteraction"

This exsiting paper proposed a method for projecting virtual constraints into the nullspace of the human interaction terms in the outputdynamics.Theprojected virtual constraints naturally render the output dynamics invariant with respect to the human interaction forces, which instead enter into theinternal dynamics of the partially linearized prosthetic system. This method is illustrated with simulations of a transfemoral amputee model walkingwith a powered knee-ankle prosthesis that is controlled via virtual constraints with and without the proposed projection.

Lobes Herdiman[3]"Improvementin WalkingEfficiencyof TranstibialAmputeeusingProstheticLegwithMulti-Axis JointandEnergyStoreReturnAnkle"

This study uses 14 male transtibial amputees as subjects. The subjects were requested to walk on the flat surface along 10 meters (4 times back andforth) walking track for about 6 minutes (6 minutes walking test) and with normal walking speed for about 1.2 m/s.We set 3minutes rest when thesubject achieving 40m. We also treat nutrient intake as 273 calories for all the subjects. From the test, we collect their walking balance and gaitefficiency data as two main parameters for walking efficiency. A crossover design was used for the experiments, which separate the subject into 2treatment groups and 2 testing periods.

3. Existing system:

The existing work presented in this paper is the first step in the development of a prosthetic leg based on Electromyography(EMG) signals, for aboveknee amputees. The surface EMGsignals picked up from thecalf muscles of a healthyleg duringthe muscle activityare interfaced with a microcontrollerusing

EMG acquisition system. These signals are processed, analysed and used to actuate the knee joint of the prosthetic leg.During the course of thepresent work, it was possible to control the rotation of a motor of prosthetic knee joint using EMG signals from the healthy leg. The completely designedprosthesiswillallowuserstowalk with abettergait.The human history has been accompanied by accidental trauma, war and congenital anomalies.Consequently, amputation and deformity have been dealt with one way or the other throughout these ages. Our motivation behindthis project is the factthat in India, there are nearly 80 lakh people living with limbloss and around 6 lakh people require prosthetic leg every year. Around 70 percent of theseare from rural areas. Being engineers, it is our responsibility to develop technology that can improve the life of such people. Our project aims to provideprostheses for above-knee amputees in which the important part is to acquire EMG signals from the calf muscles of the healthy leg and analyze them toprovide the control signals toactuate the knee joint of the prosthetic leg using a microcontroller. We intend todesign a prosthetic leg which isinexpensive, water resistant and easy to fit.

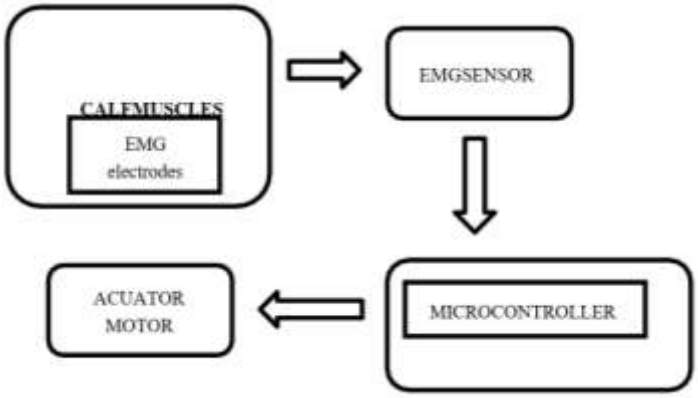

FIG3.1: BLOCK DIAGRAM OF EXISTINGSYSTEM

Disadvantage:

- It is not accuracy.
- If we want to use this,we want todepend other.
- Difficult tofind the position of the leg.

4. Proposed system:

The proposed rehabilitation system is a portable, lightweight, and cost-effective orthotic device designed specifically for individuals with paralyzed legs.Leveraging advancements in mechatronics and IoT technology, it aims to bridge the gap between traditional physiotherapy methods and modernrehabilitation techniques. The wearable device, powered by electric motors and controlled by a PIC microcontroller, assists with lower limb and toemovement, facilitating rehabilitation exercises. Integration of an accelerometer enables real-time monitoring of leg movement and orientation, whileelectromyography (EMG) sensors detect muscle activity, allowing for precise feedback and adjustment of assistance levels. Additionally, IoT capabilitie senable remote monitoring and control of the device, empowering users to access personalized rehabilitation programs and receive supervision from healthcare professionals. The system's portability, affordability, and customizable features make it accessible to a wider demographic, potentially revolutionizing the field of physiotherapy and rehabilitation.

Block Diagram

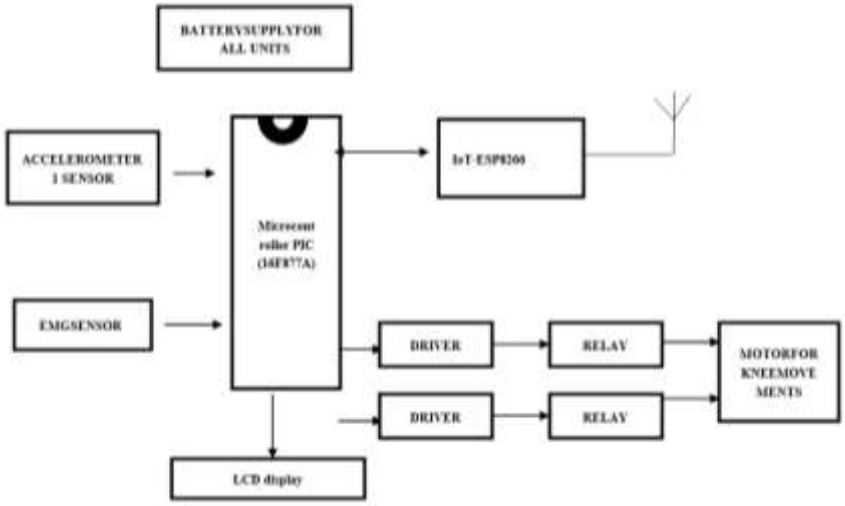

FIG4.1: BLOCK DIAGRAM OF PROPOSED SYSTEM

5. System Architecture:

Lead Acid Battery

A lead-acid battery is an electrical storage device that uses are versibl echemical reaction to store energy.It uses a combination of l ead plates or grids and an electrolyte consisting of a diluted sulphuric acid to convert electrical energy into potential chemical energy and back again. The electrolyte oflead-acid batteries is hazardous to your health and may produce burns and other permanent damage if you come into contact with it.

Accelerometer

An **accelerometer** is a device that measures proper acceleration; proper acceleration is not the same as coordinate acceleration (rate of change ofvelocity).Accelerometer shave multiple applications in industry and science.Highly sensitive accelerometers are components of inertia lnavigation systems for aircraft and missiles. Accelerometers are used to detect and monitor vibration in rotating machinery. Accelerometers are used in tablet computers and digital cameras so that images on screens are always displayed upright. Accelerometers are used in drones for flight stabilisation.

Coordinated accelerometers can be used to measure d ifferences in proper acceleration, particularly gravity,over their separation in space

Emg Sensor:

The electrical source is the muscle membrane potential of about -90 mV. Measured EMG potentials range between less than 50 µV and up to 20 to 30mV, depending on the muscle under observation.Typical repetition rate of muscle motor unit firing is about 7–20 Hz, depending on the size of themuscle (eye muscles versus seat (gluteal) muscles), previous axonal damage and other factors. Damage to motor units can be expected at rangesbetween 450 and 780 mV.

Pic Microcontroller:

PIC is a family of Harvard architecturemicrocontrollers made by Microchip Technology, derived from the PIC1640. Originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "**Programmable Interface Controller**".PICs are popular with both industrial developers and hobbyists a like due to their lowcost, wide availability, large user base, extensive collection of application notes,availabilityof low cost or free development tools, and serial programming (and re-programming with flash memory) capability.Microchip announced on February2008 the shipment of its six billionth PIC processor.

LCD Display:

Liquidcrystal cell displays (LCDs) are use dinsimilar applications where LEDs are used.These applicationsare display of display of numeric and alphanumeric characters in dot matrix and segmental displays.

Relay

A relay is an **electrically operated switch**. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes theswitch contacts. The coil current can be on or off so relays have two switch positions and most have **double throw** (**changeover**) switch contacts asshown in the diagram.

DC motor

A**DCmotor** is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most commontypes relyon the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, toperiodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force andmotion in a straight line

6. Software details:

Arduino software(IDE)

Arduino Software (IDE) Arduino Integrated Development Environment - or Arduino Software (IDE) - includes a text editor for writing code, a messagearea, a text console, a toolbar with common function buttons and a set of menus. It connects to Arduino and Genuino hardware to download and interactwith programs.

MATLAB

MATLAB is a high-level language and interactive environment for numerical computing, visualization and programming. With MATLAB, you cananalyze data, develop algorithms, and create models and applications. The language, tools, and built-in math functions allow you to explore differentapproaches and arrive ata solution faster than using spreadsheets or traditional programming languageslike C/C++ or Java. You can use MATLABfor many applications, including signal processing. and communications, image and video processing, control systems, test and measurement, computationalfinance and computational biology

7. Result:

The goal of the LLR Authoring Tool was to create and customize a device assistant that a PT could use to instruct patients in a prescribed exercise andrecord the correct and incorrect movements. The tool is intended to be used without requiring the PT to have programming expertise; PTs should be ableto use their familiar anatomical language. The system should translate this language into virtual assistant behavior for monitoring and recording thespecified exercise movements and instructing the patient in the exercise. Ultimately, the tool could be extended to act as an in-home coaching aide thatwould include not just instructions, but also encouragement, corrections if needed, and visualizations for the PT, customizedto the PT's specifications.This thesis covers the first steps in the process—the monitoring and instruction module. myDevices LaunchesCayenne, the World's First Drag-and-DropIoT Project Builder.myDevicesdeveloped a robust IoT platform that allows companies to efficientlyconnect devices, visualize data, applysophisticatedrules and interact withtheirconnectedcustomers. Cayenne IoTproject builderthat empowers developers toquicklycreateandhost theirconnecteddeviceprojects. Cayenne was designed for the Internet of Things.

8.Conclusion and Future work:

The proposed arm hosts state-of-the art technological advancement, communication protocols, control systems, and human interfacing. Technologicaladvancements have led to the development of numerous wearable robotic devices for the physical assistance and restoration of human locomotion usinginternet of things. While many challenges remain with respect to the mechanical design of such devices, it is at least equally challenging and important todevelop strategies to control them in concert with the intentions of the user. This work reviews the state-of-the-art techniques for controlling portableactive lower limb prosthetic and orthotic (P/O) devices in the context of locomotive activities of daily living (ADL) through cloud communication.Orthopedic physical therapytreats injuries to the muscles, bones and other tissues in the body. Patients might have been injured from accidents or playingsports, or they might have difficulties resulting from surgery or a chronic disease. Orthopedic physical therapy treats many types of musculoskeletalinjuries, including knee and hip injuries, which result in restrictions in mobility for 20 million patients.In addition to analyzing more body regions, theauthoring cloud tool should also be expanded beyond isolation exercises to allow PTs to customize more complex, functional exercises, such as jumpingjacks, leaping from side to side, lifting boxes over shoulders, and so forth. PTs expressed that these complex exercises would be difficult to prescribethrough thetool in itscurrent form. One possibilityistoexpand the set ofmotion widgetsbeyond just those based on joints; newones could beadded thatare based on common compound-joint motions, such as pushing, pulling and jumping. These motions typically involve at least two joints - for example,pushing usually72 involves the elbowand shoulderjointsworking simultaneously, and jumping requires theknee and hip jointsworkingin tandem. So inthe example of authoring of a jumping jacks exercise, the primary motion may be "jumping" and the additional rule may be "include shoulder abduction"to indicate that the jumps should be accompanied by side-to-side swaying of the arms. Overall, more research is need to explore how the specificationinterface and motion analysis implementation might have to change to allow PTs to specify compound exercises in an intuitive manner.

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