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Walker in Conjunction with Haptic Feedback System for Muscle Relief

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Abstract

The goal of clinical reasoning in physical therapy during the past ten years has been to provide mechanisms that enable physiotherapists to respond to the increasingly complicated demands of healthcare and rehabilitation facilities with clinical decisions that are made quickly, effectively, and efficiently. Studies have demonstrated the value of walking aids in the aged population following arthroplasty surgery, during the rehabilitation process from various diseases, and for elderly individuals experiencing muscle weakness and balance issues. Walkers are useful tools that support the healing process. For gait abnormalities and imbalance brought on by a variety of conditions, including lower limb surgery or neurodegenerative alterations, the use of a walker is advised, particularly during the initial stages of recuperation.In this project, we designed a walker-using gadget that aids the patient in maintaining their right balance.

The core of the system is a network of carefully positioned sensors, such as pressure, accelerometer, and gyroscopes, which record information about the user's body posture and stride patterns. Using haptic feedback, this device will alert the user automatically when they exert greater pressure on one side. In addition, we integrated an automated fall detection system with a MEMS sensor. When the sensor hits a certain threshold, the system will automatically send the caregivers or doctors an emergency SMS with the patient's position. The internal lighting system of this walker is automated and is dependent on its surroundings. A network of carefully positioned sensors, such as pressure, accelerometer, and gyroscope sensors, forms the basis of the system and collects data on the user's body posture and walking patterns. The collected data is processed and evaluated in real-time using sophisticated algorithms to assess the user's alignment and spot any deviations from the ideal posture. Moreover, the system makes it easier to capture and analyze data, giving physiotherapists and medical experts access to insightful information on the performance and advancement of their patients. The gathered information is useful for creating individualized rehabilitation programs and monitoring the progress of the users over time.

Keywords: Microcontroller, Rehabilitation, Body posture, accelerometer, ultrasonic sensor GSM, GPS.

Introduction

In the 21st century, life has become more complex and more complicated with so little time left to watch and take care of people or those who have certain physical disabilities. Nowadays, the advancements in biology and technology are improving the quality of lives of elderly by creating and optimizing different solutions that not only will help with their daily life activities but also will make the targeted population useful members of the society The time spent with families is in gradual decrease, eldercare institutions have been always criticized due to their money consumption.

In a world were human beings designed and developed the basic core of their daily life activities depending on their physical abilities, elder people have managed a limited but realistic success to merge and make their lives active and connected with society. The traditional walker that the senior population usually uses is effective, but this may induce shoulder or elbow pain if more pressure is applied on single side. The objective is to create a system that will help the elderly and the other individuals move smoothly with confidence. This provides an effective and safe way for the user to fore see the dangers before taking place. The system is integrated on a walker tool, thus becoming the IoT Walker in conjunction with haptic feedback system for Muscle relief.
Movement disorders may significantly hinder one's capacity to perform daily tasks and raise the risk of falls for individuals with the neurological disorder Parkinson's. In accordance with data, 33% of adults over 60 have fallen at least once, despite the fact the majority of walkers on the market have been purchased by elders. We contend that since basic assistive devices, such walkers and rollators, are considerably more likely to break down, intelligence is necessary for an elderly walker to identify aberrant user behaviors and provide prompt safety support. Another strategy is the exoskeleton, which is an effective but less feasible everyday wear for elderly people due to its numerous robotic joints and linkages. Furthermore, older people require many forms of human-robot interaction for efficiency and convenience rather than just relying on gesture, voice or remote button. By providing a device that ensures their safety and enhancing their confidence and independence, all users' quality of life will be enhanced.

Need for the Project

The Main Purpose of this Project is to Provide Body Posture Management Based Assistance for People like Elderly, Accident Victims, Paralyzed People, especially abled people and provide them with Sensorial and Internet of Things Based Assistance which will help them recover or to avoid further damage to their joints. The intended use of the haptic feedback technology is to help users achieve and maintain good posture, which can improve their comfort, stability, and general physical well-being. It does this by providing real-time sensory signals and feedback. Consistently practicing proper posture with the help of the haptic feedback system can lead to improved muscle tone, reduced strain on joints, and better overall alignment. Over time, this can contribute to better physical health and comfort for the user.

Benefits of Implementation

This IoT based Integrated walker is perfect for seniors, people with limited mobility, and those at risk of falling. The walker can be used anywhere, from homes to hospitals and public spaces.

- An elderly person living alone can benefit from fall detection and haptic relief.
- Physical therapy and rehabilitation can be improved with analytics.
- Occupational therapy can increase independence and functionality.

The system can assist users in improving their gait and walking patterns, particularly important for individuals undergoing rehabilitation. The components used here promote independence and autonomy for users, particularly the elderly. It allows them to continue living in their own homes and pursuing their daily routines with greater confidence, knowing that they have support when needed.
In the long run, the project can potentially reduce healthcare costs by preventing serious muscle pains and hospitalizations resulting from falls and improper posture positions. It can also reduce the need for 24/7 caregiving assistance. The integration of multiple systems showcases technological advancements in healthcare and assistive devices, paving the way for further innovation in this field.

Existing System

Some studies showed the value of walking aids in the older population following arthroplasty surgery and during the rehabilitation process for certain conditions, but there are no proper solutions for the walking aid system. The people didn’t take that seriousness in this generally bought the walker and use it, due to the improper balances while using the walker their muscles are getting weaker.

Proposed system

Our proposal for this project is to use the sensors that are already included into the walker to extract pertinent data about its use during physiotherapy sessions, such as the forces applied to it. This device uses haptic feedback to automatically alert walkers when they exert more pressure on one side so that patients can correct them. We also added an automatic fall detection system with a MEMS sensor. If the sensor reaches a certain threshold, it will begin sending the caregiver and doctors an emergency SMS with the patient's current location. The caregiver and doctors with the use the Internet of Things can track the patient's real-time heart rate. The lighting system inside this walker is automated. The below figure is the integration of hardware modules.

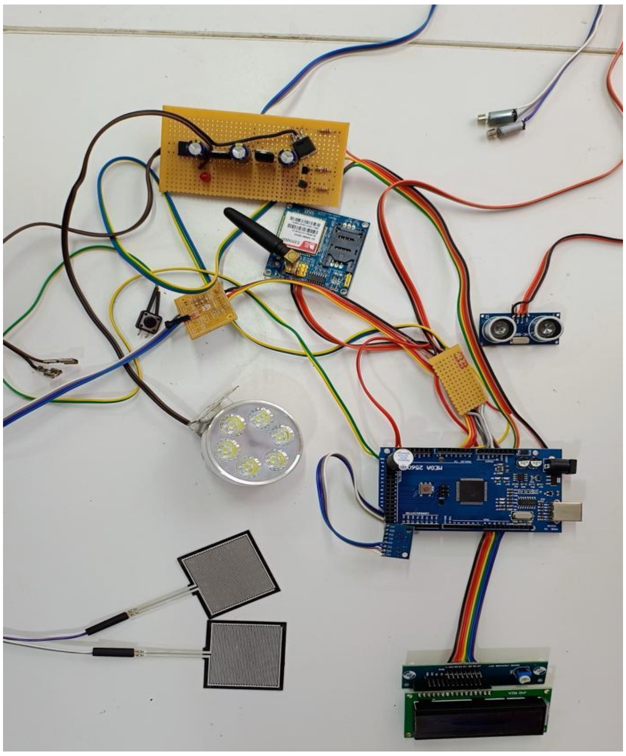

Fig 1: Integration of hardware modules

Execution Methodology

→ Defining Requirements
→ Hardware Selection
→ Microcontroller Selection
→ Power Source
→ Hardware Integration
→ Sensor Integration

→ Communication Protocols
→ Haptic Feedback System
→ Fall Detection
→ Automatic Internal Lighting System
→ Programming
→ Cloud Data Storage System
→ Testing and Validation
→ Results

Hardware Requirements

The required hardware components are mentioned in the below table

S.No	COMPONENT NAME	QTY
→	AT-Mega 2560 Microcontroller	1
→	Node-Microcontroller Unit	1
→	Liquid Crystal Display	1
→	Liquid Crystal Display Base	1
→	Accelerometer Sensor	1
→	Ultrasonic Sensor	1
→	Force Sensor BIG	2
→	Vibration Motor	2
→	Push Button	2
→	GSM	1
→	LDR Sensor	1
→	12V LED	1
→	Buzzer	1

Software Requirements

→ **Arduino IDE**

The Arduino Software (IDE) comprises a message section, a text console, a toolbar with buttons for frequently used tasks, a menu system, and a text editor for writing code. In order to upload and interact with programs, it establishes a connection with the Arduino hardware. Sketches are programs created with the Arduino Software (IDE). The text editor is used to write these sketches, which are then saved as files with the.ino extension. The editor offers tools for searching through and replacing text as well as cutting and pasting. In addition to displaying faults, the message box provides feedback during exporting and saving. Text output from the Arduino Software (IDE), including comprehensive error messages and other data, is shown on the console. In the lower right corner of the window, you can see the configured board and serial port. You may create, open, and save sketches, validate and upload programs, and start the serial monitor with the toolbar buttons.

Libraries include additional capability for use in sketching, such as interfacing with hardware or processing data. To incorporate a library into a drawing, select it from the Import Library menu. This can add one or more #include statements to the start of the sketch and compile the library alongside your

drawing. Libraries take up more space on the board because they are posted along with your sketch. One can simply remove the #include statements from the top of your code if a sketch no longer needs a library. The reference contains a list of libraries. The Arduino software comes with a few libraries. Others are available for download via the Library Manager or from a number of other sources. You can import a library from a zip file and use it in an open sketch starting with IDE version 1.0.5. Refer to these guidelines if there is a need to install a third-party library.
According to our design, a mobility aid that has been improved or expanded via the use of Arduino microcontrollers and sensors that have been programmed using the Arduino IDE is referred to as an Arduino IDE-based walker. Because of this connectivity, the walker can include intelligent functions that offer consumers convenience, safety, and support.
Additionally, the Arduino could interpret the heartbeat data and maybe send it to a website for medical experts to watch or notify them to. Through the Internet of Things, doctors and caregivers could be able to track the patient's real-time heart rate.

Results

The results of the deisgned walker project demonstrate significant advancements in enhancing the effectiveness and safety of physiotherapy sessions for patients. Through rigorous development and testing processes, the integration of sensors capable of capturing relevant data related to gait, balance, and exertion levels has enabled real-time feedback mechanisms, empowering users to make immediate adjustments and corrections. This functionality has been particularly beneficial in promoting proper usage of the walker and reducing the risk of injury or strain for patients.
Moreover, the implementation of a MEMS sensor for automatic fall detection has proven to be a critical safety feature, triggering timely alerts to caregivers or healthcare professionals in the event of a fall. This rapid response capability has enhanced patient safety, providing peace of mind to both patients and their caregivers.
Furthermore, the incorporation of IoT technology for remote monitoring of patients; heart rates has facilitated continuous assessment of physiological status during therapy sessions or daily activities. Healthcare practitioners can now act quickly in the event of any irregularities in heart rate thanks to this real-time monitoring capacity, thereby optimizing patient care and treatment outcomes. Additionally, the automatic internal lighting system based on the surrounding environment has enhanced user experience and safety, ensuring optimal visibility in various lighting conditions.
The collected health data, such as heart rate, pulse rate, and theforce applied while using the walker has been saved in an online web application where it can be viewed in real time and exported to other locations as needed. The web browser and application are very user-friendly and safe to use, ensuring that the users' health information is secure. The data are shown graphically, and both patients and medical professionals can access this website or web application. These health information of the user can be used, as needed, for future diagnosis.

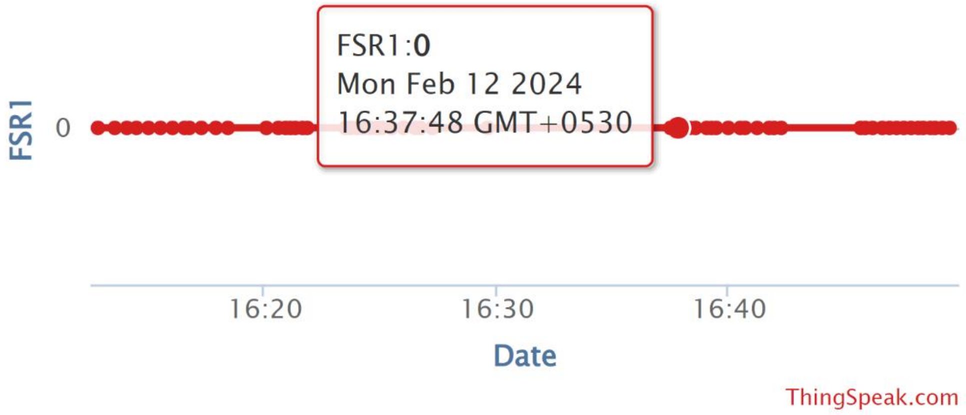

Fig 2: Graphical representation of fluctuations in FSR 1

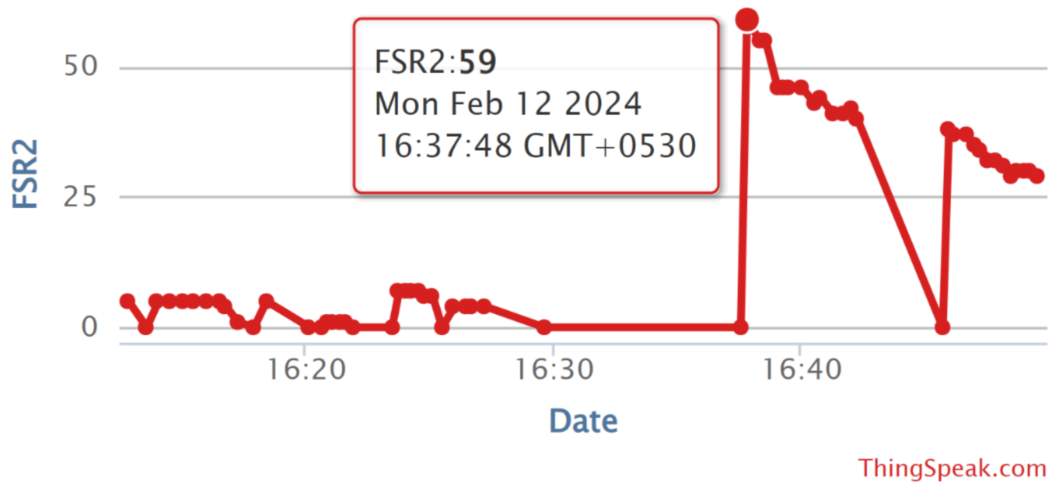

Fig 3: Graphical representation of fluctuations in FSR 2

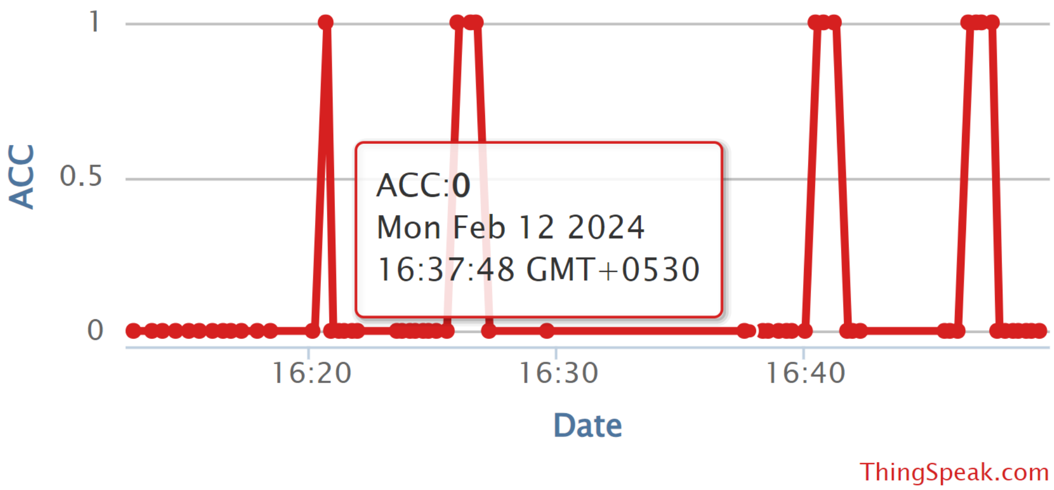

FIG 4: Graphical representation of accelerometer for fall detection

Discussion

The results emphasizes the transformative potential of smart walker technology in revolutionizing physiotherapy practices. By addressing key challenges such as proper usage, fall detection, and remote monitoring, the smart walker offers a comprehensive solution that not only improves patient outcomes but also enhances the overall efficiency and effectiveness of physiotherapy interventions. Moving forward, further refinements and advancements in smart walker technology have the potential to revolutionize rehabilitation practices and greatly raise the standard of living for patients undergoing physiotherapy. The development of a Walker Tool, which combines several technologies to offer patients a complete support system throughout their recovery process, is the suggested remedy. A number of cutting-edge features, like as sensors, GPS, and GSM modules, are included with this Walker Tool in an effort to enhance its usability and facilitate the healing process.

Overall, this project showcases the integration of technology and clinical reasoning in the realm of physical therapy. By combining sensors, haptic feedback, fall detection, and location-based communication, the designing Walker Tool functions as a thorough solution that not only aids in rehabilitation but also prioritizes patient safety and well-being. The project focuses on personalized care, immediate feedback, and real-time communication underscores the potential for technology to revolutionize the way patients experience rehabilitation and recovery by the use of walking aids.

In conclusion, the proposed project represents a groundbreaking advancement within the field of assistive mobility devices, specifically walkers. By strategically integrating cutting-edge sensor technology and intelligent systems, this project aims to address critical aspects of user safety, comfort, and therapy progress. The meticulous selection and embedding of sensors within the walker mark the foundation of this innovative system. These sensors have been thoughtfully placed to capture essential data related to the user's interaction with the walker during physiotherapy sessions. Particularly, the emphasis on monitoring applied forces on the walker offers valuable insights into the user's gait patterns and posture.

The device aims to aid patients during physiotherapy and walking sessions and provide safety features to enhance their rehabilitation process. The primary attributes and functionality of the project have been executed and tested to ensure their effectiveness and reliability. In essence, the project abstract introduces a multi-faceted walker system that integrates sensory insights, intelligent feedback mechanisms, fall detection capabilities, and health monitoring features. By encompassing these advancements, the project envisions a transformation in mobility assistance, fostering user empowerment, safety, and enhanced rehabilitation outcomes.

Future scope

The future scope of the smart walker project extends beyond its current capabilities, offering opportunities for further innovation and development. One avenue for future enhancement lies in the integration of additional sensors and artificial intelligence algorithms to provide more comprehensive insights into the users biomechanics and movement patterns. By analyzing data from a wider range of sensors, including accelerometers, gyroscopes, and pressure sensors, the desgned walker could offer personalized feedback and guidance tailored to the specific requirements of each patient. Moreover, advancements in machine learning and predictive analytics could enable the smart walker to anticipate potential issues or falls before they occur, further enhancing patient safety and reducing the risk of injuries.

Furthermore, there is potential for the smart walker to evolve into a multifunctional platform for remote healthcare monitoring and management. By integrating telemedicine capabilities, patients could have access to virtual consultations with physiotherapists and healthcare professionals, allowing for ongoing assessment and adjustment of treatment plans from the comfort of their homes. Additionally, the smart walker could serve as a hub for collecting and analyzing various health metrics, such as heart rate, activity levels, and sleep patterns, providing valuable insights into the patient's overall health and well-being. Another area of future development lies in improving the user interface and user experience of the smart walker. By incorporating intuitive controls, customizable settings, and seamless integration with mobile devices, the smart walker could become more user-friendly and accessible to a wider range of patients, including those with limited mobility or cognitive impairments. Moreover, Advancements in wearable technology and materials science could lead to lighter, more ergonomic designs that offer greater comfort and mobility for users.

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