Walker Integrated with IOT Based Fall Detection, Emergency Response System with Haptic Feedback System for Muscle Relief

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ABSTRACT

In the last decade, the clinical reasoning in physical therapy has been to develop systems for physiotherapists to make clinical decisions rapidly, effectively and efficiently, in response to the increasingly complex needs of health and rehabilitation units. Some studies show the importance of walking aids during rehabilitation from some diseases, and after surgery for arthroplasty in the elderly population, and elderly patients with balance disorders, muscle weakness. Walkers are important devices that aid the rehabilitation process. The use of a walker is recommended for gait changes and imbalance due to various factors, such as surgery of the lower limbs or neurodegenerative changes, especially in the early recovery period. In this project we design a solution for the patient using walkers, this device helps them to maintain the proper balance. The system's foundation lies in a network of strategically placed sensors, including gyroscopes, accelerometers, and pressure sensors, meticulously capturing data on the user's body posture and gait patterns. Employing advanced algorithms, the gathered data is processed and analyzed in real-time to evaluate the user's alignment and identify any deviations from the ideal posture. Furthermore, the system facilitates seamless data recording and analysis, enabling healthcare professionals and physiotherapists to access valuable insights on

the user's progress and performance. The accumulated data assists in developing personalized rehabilitation plans and tracking the user's improvements over time.

Index Terms— Microcontroller, LCD, Movement Detection, Accelerometer sensor, 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 life of the elderly and the blind 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 instead of a burden by constructing a new life design, thus, probably saving their lives or at least improving it. The time spent with families is in gradual decrease; eldercare institutions have been always criticized due to their money consumption.

The blind however, faces bigger challenges. In a world where human beings designed and developed the basic core of their daily life activities depending on their sense of vision, blind people have managed a limited but realistic success to merge and make their lives active and connected with society. But unfortunately, all methods used by the blind from Braille reading to moving around using their cane and/or adopting a trained dog to facilitate movement as well has have yet reached a level of success where other aid and assistance is needed. The traditional cane that the blind population usually uses is effective but sometimes fails to detect what should be avoided while moving around. The objective is to create a system that will help the elderly move around and be supervised at the same time. This provides an effective and safe way for the user to be able to foresee the dangers before taking place. The system is integrated on a crutch tool, thus, becoming the Smart Crutch Tool.

BACKGROUND:

The implementation of the Smart Walker Tool represents a novel and innovative approach to improve the quality and efficacy of rehabilitation in physical therapy. By leveraging advanced sensor technology and real-time communication features, this smart device empowers physiotherapists and caretakers with comprehensive insights into patients' gait patterns and recovery progress. Additionally, patients benefit from increased safety, reduced fall risks, and enhanced balance throughout their rehabilitation journey, ultimately leading to improved overall outcomes and better quality of life.

OBJECTIVE:

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 This research seeks to bridge the gap in current mobility assistance technologies for the elderly and visually impaired. By integrating cutting-edge sensor technology and real-time monitoring features into the Smart Crutch Tool, we aspire to enhance the users' confidence and independence while ensuring their safety during movement. The system's ability to foresee and respond to potential risks effectively will not only empower the elderly and the blind but also alleviate concerns among their families and caregivers.

The subsequent sections will delve into the design, features, and implementation of the Smart Crutch Tool. Through this project, we aspire to create a transformative solution that not only addresses mobility challenges but also paves the way for a more inclusive and supportive society for individuals with physical disabilities. By promoting active engagement and safety, this innovation has the potential to significantly impact the lives of its users, improving their overall well-being and fostering a sense of belonging within the community.

LITERATURE REVIEW:

TITLE: Evaluation of Existing Walking Sticks and Recommendations for Modified Walking Stick

AUTHOR: Piyali Sengupta, Kiran Mondal, Hiranmoy Mahata, Sujaya De, Prakash C Dhara

DESCRIPTION:

The present study concluded that the elderly population needs modification in existing walking sticks. The slipping rate of the stick could be minimized by adapting some modifications in the stick. Cane is preferred as the stick material in the studied population. Keywords: Designing approach, Elderly, Subjective evaluation, Viewpoints of ergonomics, Walking stick.

EXISTING SYSTEM:

Some of the existing systems are;

Rollators: Rollators are walking aids equipped with wheels and handbrakes, providing stability and support for users during walking. Some advanced rollators may include features like built-in seats, storage compartments, and height-adjustable handles.

Gait Rehabilitation Systems: These systems are designed to aid individuals in gait training and rehabilitation. They often include virtual reality components, treadmills, and real-time feedback to improve walking patterns and balance.

Powered Wheelchairs: Powered wheelchairs are motorized mobility devices that allow individuals with limited mobility to move around independently. They offer different driving mechanisms, such as joystick control or head-controlled systems.

PROPOSED METHODOLOGY:

In this project, we propose the sensors embedded in the walker were chosen to extract the relevant information related to the walker's use during the physiotherapy sessions like applied forces on the walker. This device will automatically warn the walkers when they apply more pressure on a single side using haptic feedback so that the patients can be able to correct them. Along with this, we included the automatic fall detection system using MEMS Sensor, if the sensor reaches its threshold value, it will automatically send an Emergency SMS along with their current location to the caretaker/doctors, along with that doctor's and caretaker can be able to monitor the patient's real-time heart rate via Internet of Things. This walker has an automatic internal Lighting system based on the Surrounding Environment.

Algorithm:

Fuzzy Logic Algorithm:

Fuzzy logic is a type of mathematical logic that is used to deal with uncertain or vague information. In a fuzzy logic system, variables can take on any value between 0 and 1, which represents the degree of membership of a particular set. Fuzzy logic can be used in a wide range of applications, including control systems, pattern recognition, and decision-making. In Arduino, fuzzy logic can be implemented using a library called Fuzzy Logic Controller (FLC). This library provides a set of functions and tools that can be used to create fuzzy logic systems for various applications.

The basic steps involved in implementing fuzzy logic in Arduino using the FLC library are:

- In fuzzy logic, the input and output variables are defined in terms of membership functions, which specify the degree of membership of a particular input or output to a particular set. For example, if we are designing a fuzzy logic system to control the speed of a motor, the input variable could be the error between the desired speed and the actual speed, and the output variable could be the motor speed. We would need to define membership functions for both these variables, such as slow, medium, and fast.

- The rules in a fuzzy logic system are used to map the input variables to the output variables. For example, if the error is small, the motor speed should be slow. These rules are defined using if-then statements, such as "if the error is small, then the motor speed should be slow".

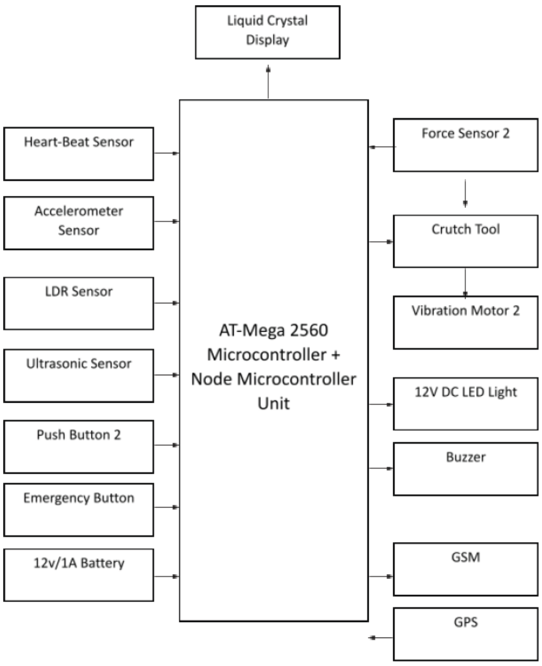
- Once the input and output variables and the rules are defined, we can implement the fuzzy logic system using the FLC library. The library provides functions for defining the membership functions, rules, and input-output mappings, as well as tools for simulating and testing the system.

- Finally, we need to tune the system to get the desired performance. This involves adjusting the membership functions and the rules to optimize the system for a particular application.

SOFTWARE REQUIREMENTS:

- Arduino IDE

BLOCK DIAGRAM



Block diagram of hardware

HARDWARE REQUIREMENTS:

S.No	Component Name	Qty
1.	AT-Mega 2560 Microcontroller	1
2.	Node-Microcontroller Unit	1
3.	Liquid Crystal Display	1
4.	Liquid Crystal Display Base	1
5.	Accelerometer Sensor	1
6.	Ultrasonic Sensor	1
7.	Force Sensor BIG	2
8.	Vibration Motor	2
9.	Push Button	2
10.	GSM	1
11.	LDR Sensor	1
12.	12V LED	1
13.	Buzzer	1
14.	12v/1A battery	1
15.	Walker	1

FUTURE SCOPE:

Consider integrating additional sensors, such as gait analysis sensors or pressure-sensitive footplates, to gather more comprehensive data about the patient's walking patterns and balance. Implement machine learning algorithms to enhance fall detection accuracy and reduce false positives. Training the system with a diverse dataset of fall and non-fall events can improve its performance. Implement machine learning algorithms to enhance fall detection accuracy and reduce false positives. Training the system with a diverse dataset of fall and non-fall events can improve its performance. Utilize the collected heart rate data to analyze the patient's cardiovascular health and provide insights for personalized rehabilitation programs. Explore integration possibilities with electronic health record systems and telemedicine platforms for seamless information exchange and enhanced patient care.

CONCLUSION:

The Smart Walker Tool with embedded sensors, haptic feedback, automatic fall detection, and real-time heart rate monitoring via the Internet of Things (IoT) has been successfully designed and developed. The device aims to aid patients during physiotherapy and walking sessions and provide safety features to enhance their rehabilitation process. The project's main features and functionalities have been implemented and tested to ensure their effectiveness and reliability. The automatic fall detection system, powered by MEMS sensors, can promptly detect sudden changes in orientation or acceleration, which may indicate a fall. When a fall is detected, the device automatically sends an emergency SMS to the designated caretaker and doctors, along with the patient's current location. This swift response enables quick assistance and medical attention, potentially saving lives and reducing the severity of injuries. The automatic fall detection system, powered by MEMS sensors, can promptly detect sudden changes in orientation or acceleration, which may indicate a fall. When a fall is detected, the device automatically sends an emergency SMS to the designated caretaker and doctors, along with the patient's current location. This swift response enables quick assistance and medical attention, potentially saving lives and reducing the severity of injuries. Furthermore, the automatic internal lighting system, which adjusts based on the surrounding environment, enhances safety during low-light conditions or in dimly lit areas. This feature ensures better visibility for patients, reducing the likelihood of accidents caused by inadequate lighting.

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