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INTELLIGENT CRUTCH TOOL FOR BODY POSTURE MANAGEMENT SYSTEM TO AVOID INJURIES

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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. This Smart Walker Tool is equipped with sensors, GPS, and GSM Modules. 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 walker's when they apply more pressure on a single side using haptic feedback. Along with this, we included the automatic fall detection system using MEMS Sensor, if the sensor reaches its threshold value, it'll automatically send an Emergency SMS along with their current location to the care-taker/doctors. This walker has an automatic internal Lighting system based on the Surrounding Environment.

Keywords:. *Microcontroller, LCD, Movement Detection, Accelerometer sensor, ultrasonic sensor, GSM, GPS.*

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I. INTRODUCTION

The World Health Organization (WHO) has defined rehabilitation as "a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions, in interaction with their environment". Rehabilitation interventions optimize well-being by addressing impairments, limitations, and restrictions in many areas (areas as disparate as mobility, vision, and cognition), as well as by considering personal and environmental factors. Individuals with health conditions or injuries may require rehabilitation across the course of their lifespan. The timing and type of intervention that a rehabilitation provider selects depend greatly on several factors. These include the etiology and severity of the person's health condition, the prognosis, the way in which the person's condition affects the person's ability to function in the environment, as well as the individual's identified personal goals. Rehabilitation services may be delivered in any setting (including in hospitals and in communities), depending on individuals' needs and situation. In hospitals, acute rehabilitation is particularly important in facilitating recovery, maximizing the effect of emergency and surgical services, preventing complications, and ensuring that the optimal functional outcome is achieved. Rehabilitation in the community similarly aims to optimize functioning in those who are not in the hospital system, to identify needs, and to provide services in a person's typical environment. Community rehabilitation services frequently are accessed by those with chronic health conditions or sensory impairment, as well as children with developmental conditions. Walking aids are sometimes also referred to as ambulatory assistive devices. A walking aid is one of several devices a patient may be issued in order to improve their walking pattern, balance or safety while mobilizing independently. They can also be a means of transferring weight from the upper limb to the ground, in cases where reducing weight bearing the lower limb is desired. 2 Walking aids fall into multiple categories and include the following: Canes or walking sticks: The distal tip of canes and crutches should have a rubber ferrule to prevent the walking aid from slipping, with some ferrules being depressed to form a vacuum when it comes into contact with the ground. The ferrule should not be worn or cracked and should fit well onto the point of the walking aid). Crutches, Standing Aids: To assist with manual handling often used with in rehabilitation. Although often a solution to mobility issues, walking aids do come with their own mix of benefits and challenges to the individual using them. A 2005 study reported that these devices can improve balance and mobility but also can interfere with balance in certain situations, and the strength and metabolic demands can be excessive. They hoped for improved designs and guidelines for safer use of canes and walkers. Prescription of walking aids should ideally be done by a physiotherapist or occupational therapist after a thorough assessment of gait, balance, cognition and the cardiovascular, musculoskeletal and neurological systems. Assessment should also take into account any clinically significant co-morbidity and the individual's day to day mobility requirements for example. Thresholds in their home, community ambulation, navigating steps or public transport. Thought needs to be given to whether the walking aid is a temporary requirement For example, post fracture or a more long-term option for example a walking frame for an elderly adult with reduced mobility post stroke. Therapists should also be aware of the perceptions of walking aids can be negative at times as individuals may feel like they are giving up their independence or fear they will look frail. In such instances, the Therapists needs to balance the individual's concerns with

safety, encouraging the individual to consider the walking aid as keeping them mobile and able to participate in their activities of daily activities. A neurodegenerative disorder like Parkinson's disease (PD) causes tremor, rigidity, postural instability and gait problems in early stages and thus poses an undetermined threat to the social and personal lives of the elderly in developing countries due to insufficient survey and research activities.

II. OBJECTIVE

To introduce the automated ambulation tool for and encouraging results set path for extending this work to be implemented in more aids to improve the overall health and well being of old and Mobility impaired people. The main aim of the project is to avoid sports injury,accident patients and cerebral palsy.

III. SCOPE

The elderly population is highly prone to falling. These falls can result in hip, pelvis, femur, and spine fractures thereby hampering the physical movement or walking of an individual. Furthermore, falling is considered the second leading cause of accidental and unintentional injury deaths globally. Approximately 424,000 individuals die due to falls every year. Falling, among the elderly population can be prevented by the appropriate use of assistive devices. This segment is anticipated to witness lucrative growth over the forecasted period due to the high prevalence of osteoporosis & arthritis, increasing awareness, and increasing adoption of crutches. Moreover, the addition of advanced features to crutches, such as sensor technology and digital software, that allows the person to navigate properly and with a internal lighting systemis supporting advancements in the product.

IV. LITERATURE SURVEY

Zheng Wang have propose a novel smart robotic walker that targets a convenient-to-use indoor walking safety aid for the elderly. Present-day assistant devices require attentive control of the user while moving (Di et al., 2015; Xu et al., 2018), which could raise safety issues for many elderly people with executive dysfunction or dementia. Although a few studies have investigated the task enabling the walker to follow behind the user (Moustris and Tzafestas, 2016), the problem is simplified since the human intention is known a posteriori by inspection of his/her trajectory.

Prof. Dr.Damla Turgut have described and studied several prototypes for a smart walker specialized for people with both visual and mobility impairments. As a first conclusion, we found that there are multiple, very different choices of sensors that can ultimately ensure a similar user experience. Active sensors such as ultrasonic distance sensors or infrared depth cameras achieve the best accuracy in localizing obstacles. However, recent advances in computer vision, in particular object detection and recognition, allow passive, inexpensive cameras to achieve accuracy that is sufficient for the purposes of such a walker. In addition, computer vision systems can provide additional functionality such as identifying and naming the type of obstacle encounter by user.

M.E.Harikumar focuses on proposing an idea to enhance the living standard of an elderly, who needs a walking aid to perform their daily activities, and also for a caretaker to be able to monitor their health status. This can be done by developing a model which focuses the critical parameters like temperature, heart rate, location, etc., by using various sensors embedded inside the walking aid. The main focus of this paper is to design a module that includes a mobile application, through which the caretakers and doctors

can monitor the patient while the patient performs their daily routine.

Ms.Vaishali B.Niranjanee have executed the idea to avoid accidents while walking, we have used obstacle detectors using ultrasonic sensors, so in case they are unable to see an obstacle, the robot will detect it for them. From the point of view of robot control system, the user's walking will occur with the help of the keys provided on the keypad install LED on the walker. The keypad will have keys for forward and sideways motion and a panic button to send the location of the user. The motor used in the walker will also play an important role as far as the motion of the walker is concerned and will also prevent falling on slopes/ramp.

Lim Wei Liong have addressed the problems associated with existing mobility devices were discussed and the detailed presentation of the new smart walker design was presented. The use of smart features such as distance sensing, rehabilitation activity monitoring and telecommunication as well as the hardware involved were also explained. This smart walker is the first of its kind to be developed and is in line with the development of today's smart ward in a new hospital setting.

Kabalan Chaccour have introduced the body vital signals can also be conveyed through the walker'shandlebars. In fact,the microcontroller has extra analog inputs for heart pulse and oxygen sensors. The board has also an LCD for the accelerometer calibration and an offline battery charger. Future work will consider online charging with small solar panels. Body vital signals can also be conveyed through the walker's handlebars. In fact, the microcontroller has extra analog inputs for heart 6 pulse and oxygen sensors. The board has also an LCD for the accelerometer calibration and an offline battery charger. Future work will consider online charging with small solar panels. Body vital signals can also be conveyed through the walker's handlebars.

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SUMMARY

As per the literature survey the Some studies showed the importance of walking aids during rehabilitation from some diseases, and after surgery for Arthroplasty in the elderly population, but there are no proper solutions for the walking aid system. The peoples 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.

V. METHODOLOGY

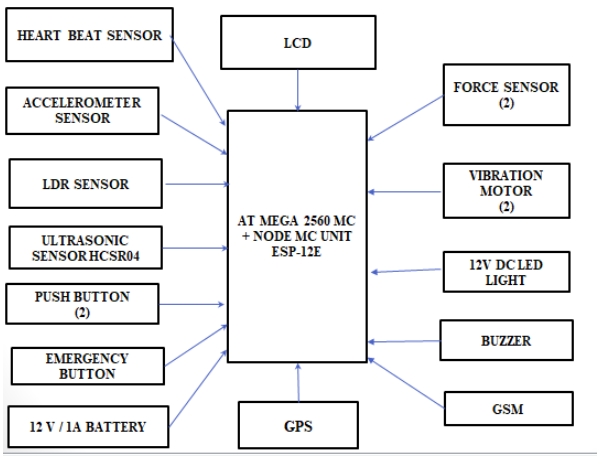

Figure 1. Block diagram of Crutch Tool

Crutch tools are important devices that aid the rehabilitation process. The use of a

crutch tool 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. This Smart Crutch Tool is equipped with sensors, GPS, and GSM Modules. 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 MEMS Sensor, if the sensor reaches its threshold walker's when they apply more pressure on a single side using haptic feedback. Along with this, we included the automatic fall detection system using value, it'll automatically send an Emergency SMS along with their current location to the care-taker/doctors. This walker has an automatic internal Lighting system based on the Surrounding Environment.

VI. COMPONENTS USED

1. ARDUINO AT MEGA 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila.

Figure 2.1 Arduino ATMEGA 2560

2. NODE MCU ESP8266

The ESP8266 is a System on a Chip (SoC), manufactured by the Chinese company Espressif. It consists of a Tensilica L106 32-bit micro controller unit (MCU) and a Wi-Fi transceiver. It has 11 GPIO pins* (General Purpose Input/Output pins), and an analog input as well. This means that you can program it like any normal Arduino or other microcontroller. And on top of that, you get Wi-Fi communication, so you can use it to connect to your Wi-Fi network, connect to the Internet, host a web server with real web pages, let your smartphone connect to it.

Figure 2.2 Node MCU ESP8266E

3. LIQUID CRYSTYAL DISPLAY

Liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light- modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly,[1] instead using a backlight or reflector to

produce images in color or monochrome.[2] LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden. For instance: preset words, digits, and seven-segment displays, as in a digital clock, are all good examples of devices with these displays. They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement.

Figure 2.3 LCD Display

4. LED BASE LCD

LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smartphones, televisions, computer monitors and instrument panels. LCDs were a big leap in terms of the technology they replaced, which include lightemitting diode (LED) and gas- plasma displays. LCDs allowed displays to be much thinner than cathode ray tube (CRT) technology. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it. Where an LED emits light, the liquid crystals in an LCD produces an image using a backlight.

5. ACCELEROMETER SENSOR

An accelerometer sensor is a tool that measures the acceleration of any body or object in its instantaneous rest frame. It is not a coordinate acceleration. Accelerometer sensors are used in many ways, such as in many electronic devices, smartphones, and wearable devices, etc. Accelerometers are used in biomedical applications, and biomedical field accelerometer sensors are mainly operated instep counting, activity monitoring [5], or motion artwork and suppression. Accelerometer sensors are easy to apply to all subjects, without much emphasis on sensor placement. These sensors are used to monitor vital signals, even for the problematic cases surrounding cardiac arrest.

Figure 2.5 Accelerometer sensor

6. ULTRASONIC SENSOR

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after ithas travelled to and from the target). In order to calculate the distance between the sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver.

Figure 2.6 Ultrasonic Sensor

7. FORCE SENSOR

Force sensor is a type of transducer, specifically a force transducer. It converts an input mechanical force such as load, weight, tension, compression or pressure into another physical variable, in this case, into an electrical output signal that can be measured, converted and standardized. As the force applied to the force sensor increases, the electrical signal changes proportionally. Force Transducers became an essential element in many industries from Automotive, High precision manufacturing, Aerospace & Defense, Industrial Automation, Medical & Pharmaceuticals and Robotics where reliable and high precision measurement is paramount. Most recently, with the advancements in Collaborative Robots (Cobots) and Surgical Robotics, many novel force measurement applications are emerging

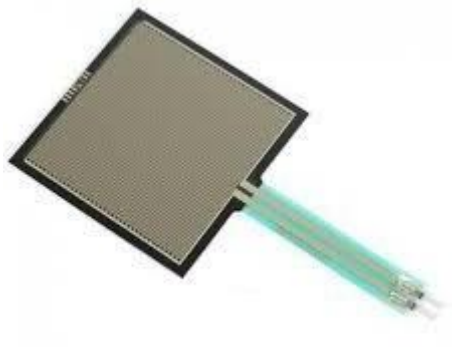

Figure 2.7 Force sensor

8. VIBRATION MOTOR

Vibration motors are a type of motor that provides vibration by operating electrical energy or pneumatic (air) energy. Vibration motors are used in all industrial machines where vibration energy is required, in food, feed, flour factories, in the construction industry in the forced water tunnels of subways, highways, hydroelectric power plants, in steel and wooden concrete molds producing concrete prefabricated elements, in mining, asphalt plants and crusher machines in concrete plants, sand dewatering machines, recycling facilities, flour, feed, cement and similar steel silos, sieves, feeders, vibratory discharge channels, vibration motors for compaction, pouring, execution, separation and placement processes. Vibration motors, also called vibro, vibro motor, vibration motor, vibrator motor, vibration motor or vibrator motor, generate vibration energy by the rotation of the rotor of the energized motor, thanks to the eccentric weights fixed on the rotor shaft.

Figure 2.8 Vibration Motor

9. PUSH BUTTONS

Push buttons can be explained as simple power controlling switches of a machine or appliance. These are generally metal or thermoplastic switches that are intended to grant easy access to the user. The idea of electric circuits is that the electricity should be able to flow uninterrupted through multiple wires and components. However, circuits that are always complete aren't as useful as the ones that work only when required. The design of the push button is such that it can accommodate a human finger to control the system easily. For machinery with complicated operations and various buttons, there are donations for separate

colours of the push button. This enables users to identify what function the switch is bound to perform. For our daily applications, there are scarce guidelines for the colour of the button, since only a few of them are common across multiple industries. For example, the red button frequently functions as the power button, while yellow indicates a pause. For industrial applications like machinery, the colour meanings are more firmly defined in international standards.

Figure 2.9 Push Button

10. GLOBAL SYSTEM FOR MOBILE COMMUNICATION

GSM (Global System for Mobile communication) is a digital mobile network that is widely used by mobile phone users in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies: TDMA, GSM and code-division multiple access (CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 megahertz (MHz) or 1,800 MHz frequency band. GSM, together with other technologies, is part of the evolution of wireless mobile telecommunications that includes High-Speed Circuit- Switched Data (HSCSD), General Packet Radio Service (GPRS), Enhanced Data GSM Environment (EDGE) and Universal Mobile Telecommunications Service (UMTS).

Figure 2.10 GSM module

11. LDR SENSOR

There are some applications of LDR which are given below. The LDR is used in the infrared astronomy. The LDR is used in light failure alarm circuits and used in light meter. The LDR used in smoke detectors.

Figure 2.11 LDR sensor

12. 12V LED LIGHT

12V DC LED system is a common voltage platform. Many electrical systems operate on 12V DC, and you are probably already familiar with several of these. Many batteries for vehicles including boats and RVs operate on 12V DC, which makes using a 12V LED system a no-brainer for these applications, as there is no need for any additional transformers or power supplies to convert the voltage - your LED lights can be plugged in directly. On the other hand, even if you are not going to be using batteries, you will still need to rely on power supply units. 12V is a very common voltage level primarily due to its

common use in desktop computing. This makes power supplies readily and cheaply available and can help reduce your purchase costs.

*It is used for automatic contrast and brightness control intelevision receivers.

*It is used in photosensitive relay *It is used in opticalcoding.

*It is used in street light control circuits.

13. BUZZER

Figure 2.12 LED Light

*It is used in camera light meters.

*It is used in the security alarm.

*It is used as a proximity switch.

*It is used in light activated control circuits.

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, train and confirmation of user input such as amouse click or keystroke.

Figure 2.13 Buzzer

14. 12V 1AH BATTERY CHARGER

The 12 Volt 1 Amp battery charger is best suited for charging any 12 volt battery rated between 5 – 18 ampere hours. The 12 Volt 1 Amp battery charger can also be used for charging batteries for mobility applications such as scooters and wheelchairs. The 12 Volt 1 Amp battery charger has thefollowing characteristics:

*Overload Protection

*Short Circuit Protection Enable

*Reversed Polarity Protection Enable

*Operating temperature 0°C(32°F) to 40°C(104°F)

*Storage temperature -30°C(-22°F) to 85°C(185°F)

*Operating Relative Humidity: 8% to 90%
*Storage RelativeHumidity: 5% to 95%

*Indicator Status Green LED On: Empty Load or Float Charge

*Indicator Status Red LED On: Bulk Charge

Figure 2.14 12 V Battery

15. HEART RATE SENSOR

A person's heartbeat is the sound of the valves in his/her's heart contracting or expanding as they force blood from one region to another. The number of times the heart beats per minute (BPM), is the heartbeat rate and the beat of the heart that can be felt in any artery that lies close to the skin is the pulse.The basic heartbeat sensor consists of a light-emitting diode and a detector like a light detecting resistor or a photodiode. The heartbeat pulses cause a variation in the flow of blood to different regions of the body. When tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in the form of the electrical signal and is proportional to the heartbeat rate.

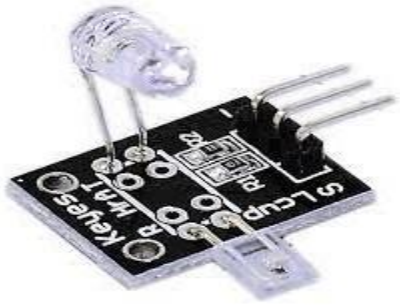

Figure 2.15 Herat Rate Sensor

16. WALKER

A walker (North American English) or walking frame (British English) is a device that gives support to maintain balance or stability while walking, most commonly due to agerelated mobility disability, including frailty. Another common equivalent term for a walker is a Zimmer (frame), a genericised trademark from Zimmer Biomet, a major manufacturer of such devices and joint replacement parts. Walking frames have two front wheels, and there are also wheeled walkers available having three or four wheels, also known as rollators.

Figure 2.16 Walker

VII. RESULTS AND DISCUSSION:

1. HARDWARE SETUP OF THEPROTOTYPE:

Figure 3.1. Prototype of Crutch Tool

Figure 3.2. Indication of parameters shown by sensors

2. CONCLUSION AND FUTURE SCOPES:

we described and studied several prototypes for a smart walker specialized for people with both visual and mobility impairments. As a first conclusion, we found that there are multiple, very different choices of sensors that can ultimately ensure a similar user experience. IOT embedded C programming language is used to implement the proposed system. Since there are so many deep learning algorithms are available NEUROFUZZY system plays an important role in the E-assisting human health devices. Fuzzy logic is an approach to variable processing that allows for multiple possible truth values to be processed through the same variable. Fuzzy logic attempts to solve problems with an open, imprecise spectrum of data and heuristics that makes it possible to obtain an array of accurate conclusions.

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