Smart Walker Instrumentation Using Hand Gestures for Lower Limb Impaired People

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***Abstract**: Nowadays, passive walking aids may autonomously steer or brake, needing the user to push them forward. In order to provide better support and assistance, this project develops a smart walker system with sensors and actuators. Here, hand gestures are used by the user to steer the walker. The main advantages include improved physical assistance, sensory support, cognitive support, health monitoring, and human-machine interface. Gyroscopes are used in the technique to detect the angles of hand motions and launch the smart walker in the user's selected directions. To assess health variables including temperature, heart rate, leg position angles, and hand angles, a gyroscope, temperature sensor, and heart rate sensor are employed. Arduino serves as the control system. Senior citizens and those with lower limb problems typically use it during the rehabilitation period.*

Key Words : **Smart Walker, Hand Gestures, Gyroscope, EMG Sensor, Rehabilitation.**

1.INTRODUCTION

By 2050, there will be 21% of individuals in the world who are 60 or older, a figure that has been quickly increasing. It is crucial that people continue to be active and move around as the population ages. Age-related impairments in mobility are associated with a rise in mortality risk, institutionalisation, loss of independence, and a decline in quality of life. Unfortunately, 44% of older persons report having reduced mobility. Therefore, maintaining the elderly's mobility is essential for our aging society. Mobility aids include everything from straightforward external devices like canes to mobile vehicles like wheelchairs.

Canes provide only a small amount of weight support, but they can help patients fall less because they stabilize their stride. People who are unable to move independently can be transported in wheelchairs, but prolonged sitting can harm one's health. among the two lie walkers. Walkers help patients maintain their weight and balance but force them to move independently, preventing mobility loss. The practicality and support for natural gait patterns of rollators, or wheeled walkers, are two of their most appealing qualities.

People who are healing from lower-body or hip replacement surgery, as well as those who can't put their entire weight on one leg, may want to use walkers. With the aid of a walker, one can transfer weight from one leg to the other while remaining upright. patients with limited movement, poor balance, or lower extremity impairment are stabilised with it more frequently. It improves social connections, has broad physiological effects, increases self-assurance, and relieves the stress associated with taking care of others.

A smart walker system has sensors and actuators for enhanced support and assistance. Better physical support, sensory help, cognitive assistance, health monitoring, and human-machine interface are the key benefits of our system. Here, we've created a smart walker system that can be controlled with hand gestures because active devices can actively control movement, whereas passive ones must be pushed forward in order to move. Our system also monitors the user's temperature, heart rate, and leg movement before analysing and sending the results to a mobile device.

2. LITERATURE SURVEY

2.1 A Smart Walker for People with Both Visual and Mobility Impairment

Nafisa Mostofa et al., studied four alternative configurations of smart walkers that are precisely geared to the demands of the community. They investigated different sensing technologies (ultrasound-based, infrared depth cameras and RGB cameras with advanced computer vision processing), software configurations, and user interface modalities (haptic and audio signal based).Furthermore, they discovered that a holistic evaluation of the systems' end-to-end performance is required, as the quality of the user interface often has a greater impact on overall performance than increases in sensing accuracy beyond a certain point.

2.2 Ultrasound-Based Smart Walker with Data-Sharing System

Selshiya S et al., makes use of the advanced technologies to upgrade the walker to monitor the physiological parameters measured from the elderly people andalert the care taker or family member using alarm and the GPS. In detail to support elders, they introduced the automated ambulation walker entitled 'smart walker' by using ultrasonic sensor for obstacles detection, if ultrasonic sensor detects any obstacles in front of the user buzzer will give sound to alertthe user. The heart rate and body temperature of the elderly must be monitoreddaily, so sensors are used to assess them. Since there is no provision in the conventional walker to improve visibility at night, elderly people cannot use it at night. GPS is also used to track the location of the user and finally all these data will be shared to their caretaker or physician if they are in emergency by sending amessage using GSM module.

2.3 Semi-Remote Gait Assistance Interface: A Joystick withVisual Feedback Capabilities for Therapists

Daniel E. Garcia A et al., designed a Smart walker which is a particular typeof devices since they integrate navigation systems, path-following algorithms, and user interaction modules to ensure natural and intuitive interaction. Although these functionalities are often implemented in rehabilitation scenarios, there is a need to actively involve healthcare professionals in the interaction loop while guaranteeing safety for them and patients.

2.4 ROS-Based Smart Walker with Fuzzy Posture Judgementand Power Assistance

Chang, Y et al., studied that in recent years the increased rate of the aging population has become more serious. The elderly suffers a variety of issues as they age, including delayed walking, unstable or weak limbs, and even fall-related injuries. As a result, developing an assistive aid de vice is critical. A fuzzy controller based smart walker with a distributed robot operating system (ROS) framework is built in this study to aid in independent walking. The combination of Raspberry Pi and PIC microcontroller acts as the control kernel of the proposed device. Furthermore, with sensor integration, the environment mental information and user postures can be recognized. The sensing data includes the road grade, the walker's velocity, and the user's grip forces, among other things. The fuzzy controller can generate an assistive force based on the sensing data to make the walker move more smoothly and safely. A smartphone application (App) is also built, which allows the user's guardian to check the smart walker's current state as well as track the user's whereabouts.

2.5 Monitoring Walker Assistive Devices: A Novel Approach Based on Load Cells and Optical Distance Measurements

Vítor Viegas et al., present a measurement system for tracking walker assistance device utilization. Load cells mounted to the walker legs monitor force unbalance, whereas motor incoordination is calculated by synchronizing force readings with distance data provided by an optical sensor. The measurement system is equipped with a Bluetooth link that enables local supervision on a computer or tablet. The measurement system is equipped with a Bluetooth link that enableslocal supervision on a computer or tablet.

2.6 A Review on Smart Walker for Antalgic and Ataxic Gait Population

Gokul M et al., investigated this. Clinical reasoning in physical therapy has focused on developing smart and automated tools for physiotherapists to make clinical judgements quickly and efficiently in response to the complicated impending needs of health and rehabilitation units throughout the previous decade. The primary issue addressed in this review paper concerns the antalgic and ataxic gait group. Both subjects share a problem with improper body weight balance while walking. This imbalance gives them additional agony in their shoulders and joints, potentially leading to asphyxia. Creating an automated smart walker with a balance management system, a fall management system, and a light assistance system can help them avoid unnecessary pain while also correcting their gait pattern.

2.7 Assistive Devices Regaining Mobility in Myositis

Davalbhakta et al., proposed that assistive devices (ADs) are external devices that have been modified to improve tasks and function. In inflammatory myositis, ADs are of utility in combating weakness, improving mobility, preventing, and treating contractures, preventing falls, and assisting in daily chores. This narrative review looks at the evidence for the use of ADs in myositis and disorders with a similar pattern of muscle weakness (e.g., muscular dystrophy) subsequent to a literature search. The majority of the evidence for their use in inflammatory myositis comes from inclusion body myositis, where progression is common and distal mobility loss also impacts functionality.

2.8 Multimodal Human–Robot Interaction for Walker-Assisted Gait

C. A. Cifuentes et.al., proposed a smart walker that offer important benefits for human assisted-gait in rehabilitation and functional compensation scenarios. The purpose of this work is to offer a new interaction technique for human-walker cooperation. This work provides the controller's mathematical formulation, simulations, and practical experiments with the interaction method. Finally, the controller keeps the walker in front of the human gait at all times, and it is demonstrated how the walker orientation follows the human orientation during real-world trials.

2.9 Smart Walker

G. A. Haidar et al., G. A. Haidar et al., proposed a system for elderlies, blind or visually impaired people recur to a cane as a traditional ambulation aid. The goal of this research is to create a revolutionary automated ambulation tool called "Smart Walker" that addresses the drawbacks listed above. The Smart Walker is outfitted with an Android application that wirelessly collects and analyses pertinent data (blood pressure, heart rate, obstacle position, etc.) via sensors. The processing is done in real-time via a pre-programmed Arduino board, the results are relayed back to the application installed on the smart phone.

2.10 Smart Walker Solutions for Physical Rehabilitation

O. Postolache et al., proposed a system the elderly population, and in elderly patients with balance disorders, muscle weakness or in people with diabetes mellitus. 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.

3. METHODOLOGY

3.1 PROPOSED METHODOLOGY

In this circuit, an Arduino microcontroller is utilized. The entire circuit receives electricity from the 12V battery. Since Arduino only needs a 5V power supply, the buck converter converts the 12V battery power supply to a 5V power supply. People with lower limb impairments can use the gyroscope to measure the angles of their hand gestures. The gyroscope turns the measured angles into a signal. The technology in the smart walker is driven by this signal. The DC motors are controlled by the H-bridge. The gloves that are part of our system are fastened to the gyroscope. The person with lower limb impairment can wear the gloves. After wearing, the user can support themselves by keeping their hands on the arm resting pad.

As a result, the blind individual with damaged lower limbs is supported by the smart walker. As a result, substantially less pressure is placed on the lower leg. The H-bridge activates and powers the DC motors when the hand glove attached to the gyroscope is moved. The motors in the smart walker's wheels cause movement. Now, the intelligent walker reverses direction when the hand is raised. The intelligent walker moves forward when the hand is lowered. The intelligent walker advances to the right when the hand is pushed in that direction. The intelligent

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walker advances to the left when the hand is moved in that direction.

People using the smart walker are warned of impending obstacles by the ultrasonic sensor. The walker halts its motion when it encounters an obstruction. Through the ESP8266 Wi-Fi module, the measured values from the Heart rate sensor, Temperature Sensor, and Ultrasonic Sensor are sent to the cloud. Doctors or attendees present in the mobile system can review the graph-based depiction of the transmitted data created by utilizing software programs.

3.2 BLOCK DIAGRAM

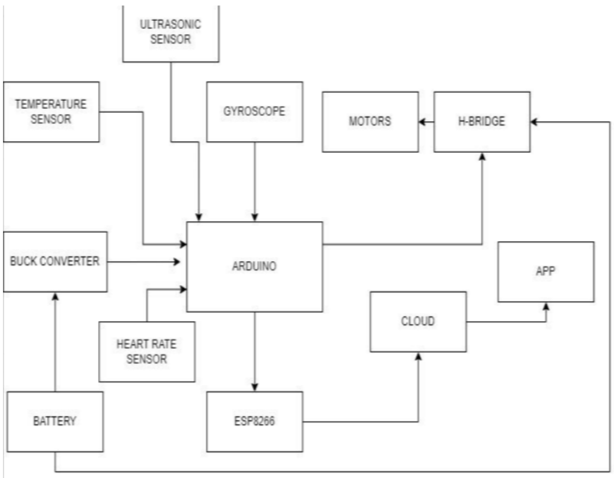

Fig 1 BLOCK DIAGRAM

3.3 INTERFACING ARDUINO WITH GYROSCOPE

The MPU6050sensor chip has several different uses. This module is incredibly accurate in converting analogue data to digital data because it has a 16bit analogue to digital converter for each channel. It has a MEMS gyro, an accelerometer, and a temperature sensor. The x, y, and z channels can all be recorded at once by this module. It has an I2C interface for communicating with the host controller. The MPU6050 module is a small semiconductor featuring an accelerometer and gyro. This is a very useful device for a variety of uses, such as robots, drones, and motion sensors. It is sometimes referred to as a gyroscope or a triple-axis accelerometer. The MPU-6050 chip combines an accelerometer and an 8-pin, 6-axis gyro. This module connects through I2C serial by default, but it can be configured to use an SPI interface by altering a register. I2C lines SDA and SCL are present here. We are only using the I2C mode pins in this case, despite the fact that nearly all of the pins are multipurpose. Your Arduino needs four wires attached in order to function with a gyroscope sensor. The gyroscope's VCC pin must be connected to the Arduino's 5v pin via two wires, and its Gnd pin must be connected to ground (Gnd). Two more wires must be connected to the Arduino's two analogue inputs. These two wires are connected to the gyroscope by its SCL and SDA pins, respectively.

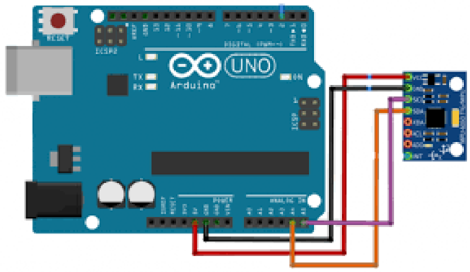

Fig 2 Interfacing Arduino With Gyroscope

3.4 INTERFACING ARDUINO WITH ESP8266

The ESP8266 wifi module is a cheap standalone wireless transceiver that can be used to improve end-point Internet of Things applications. The ESP8266 wifi module can be used by applications for embedded devices to connect to the internet. Using the TCP/UDP communication protocol, it establishes a connection with the server or client. Connect the ESP8266's TX to the Arduino Uno's TX.RX on the ESP8266 should be linked to RX on the Arduino Uno. Connect the ESP8266's EN pin to the Arduino Uno's 3.3V. Connect the 3v3 (or VCC) of the ESP8266 to the 3.3V of the Arduino Uno. GND on the Arduino Uno should be connected to GND on the ESP8266.

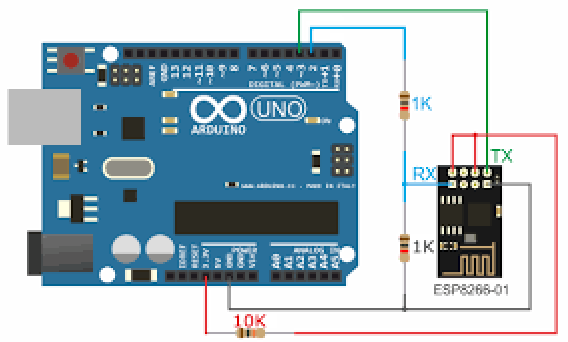

Fig 3 INTERFACING ARDUINO WITH ESP8266

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3.5 INTERFACING ARDUINO WITH DHT11

When using the DHT11 humidity and temperature sensor, it is very easy to add humidity and temperature data to your DIY electronics projects. It is perfect for systems that monitor farms or gardens, indoor climate control systems, and outdoor weather stations. The DHT11 measures relative humidity. Relative humidity is the distance between the amount of water vapour in the air and its saturation point. At the saturation point, water vapour starts to condense and accumulates on surfaces to form dew. The saturation point changes along with the temperature of the air. In contrast to cold air, which can store less water vapour before being saturated, hot air can hold more before this happens.

A percentage is used to represent relative humidity. Condensation occurs at 100% RH, and the air is entirely dry at 0% RH. Data is transmitted from the DHT11 to the Arduino using a single signal line. Independent lines supply ground and 5V. A 10K Ohm pull-up resistor is needed between the signal line and the 5V line in order to guarantee that the signal level remains high by default. The +3V supply of the Arduino is connected to the VCC pin of the DHT11. The Analogue Pin A0 of the UNO is connected to the DATA pin of the DHT11. The Ground Pin (GND) of the UNO is connected to the DHT11's GND pin.

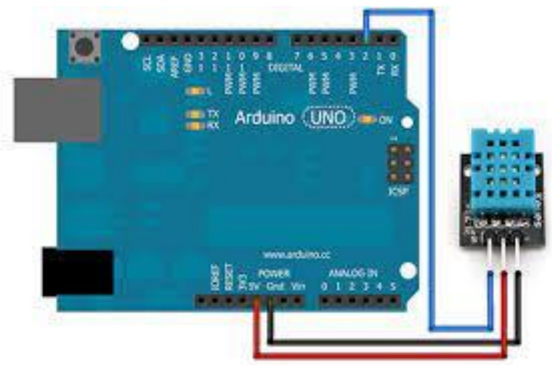

Fig 4 INTERFACING ARDUINO WITH DHT11

3.6 INTERFACING ARDUINO WITH HEART RATE SENSOR

Blood is pumped through the body during a heartbeat and squeezed into the capillary tissues. The volume of these capillary tissues consequently grows. But this volume within the capillary tissues decreases between the two subsequent heartbeats. The amount of light that will pass through these tissues will vary depending on the volume change that occurs between heartbeats. It can be measured with the help of microcontroller.
A light on the pulse sensor module aids in determining the pulse rate. The amount of blood inside the capillary blood vessels changes how much light is reflected when the finger is placed on the pulse sensor. From the pulse sensor's output, this fluctuation in light transmission and reflection can be derived as a pulse. Then, using Arduino, this pulse can be programmed to read as a heartbeat count after being trained to measure heartbeat.

Fig 5 INTERFACING ARDUINO WITH HEART RATE SENSOR

4.HARDWARE AND SOFTWARE SPECIFICATIONS

4.1 HARDWARE REQUIREMENTS

A. Arduino Uno
B. Gyroscope
C. Heart rate Sensor
D. Temperature Sensor
E. Ultrasonic Sensor
F. H-Bridge
G. ESP8266 – Wifi Module
H. DC Motor

4.2 CIRCUIT CONNECTION

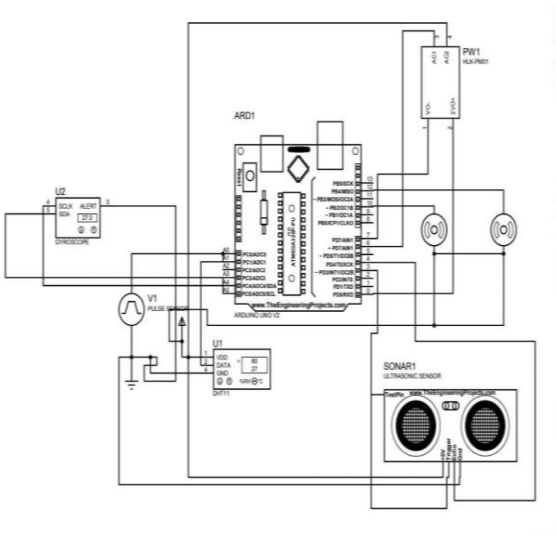

Fig 6 CIRCUIT CONNECTION

4.3 EXPLANATION OF CONNECTION

Arduino acts as the control unit for the whole circuit. The Power Supply given is 3.3V. The H-Bridge acts as the motor drive and is connected to PIN 4,5,6,7 of Arduino. Then the Ultrasonic Sensor consists of 4 Pins in which the power supply is given and Echo emits the Ultrasonic Sound which is not hearable then the trigger is used as the reflector from the object by which the obstacle is detected. These two pins Echo and Trigger are connected to PIN 8,9 of Arduino. The Temperature sensor is found inbuilt into the Gyroscope where the temperaturecan be sensed. All these parameters like Temperature and EMG Signal valuescan be seen in the cloud with the help of the Wifi-Module. The pins of the Module are Transmitter and Receiver Pins which are connected to PIN 2,3 of Arduino. The Server used in the proposed system is Thing speak as it is a freeserver.

4.4 SOFTWARE SPECIFICATION

- Operating system: Windows family
- Tool : Arduino

5. RESULTS AND DISCUSSION

Smart walkers play an essential part in the study field of healthcare for the elderly. Physical therapy assessments are implemented in networks based on smart walker nodes that measure angular velocity, and physical rehabilitation sessions are monitored utilizing Internet connectivity via sensed data and analyses via mobile applications. Based on client-server architecture, the applications may also allow sensors to store and evaluate data. The results clearly demonstrated that the proposed technologies can make significant contributions to improving the quality of life of walker users, which is critical for monitoring imbalance and instability circumstancesthat can result in user falls and hazardous injuries.

Here the below graph shows the application result of Temperature Parameter. The result will refresh each 30 seconds. It will be displayed with time and temperature result will be in Celsius.

Fig 7 RESULT OF TEMPERATURE PARAMETER IN SOFTWARE

Fig 8 OVERALL RESULT

5.CONCLUSION

Age-related increases in healthcare needs make smart walkers a key research topic. By adopting physical rehabilitation assessment networks based on smart walker nodes that measure force, acceleration, and motion, physical treatment sessions can be remotely monitored via the Internet and mobile applications. The client-server architecture-based storage and processing of sensor data may also be made possible by the apps. The results made it abundantly clear that the suggested technologies, which detect unbalance and instability, can greatly enhance the quality of life of walkers.

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