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SMART BLIND STICK FOR VISUALLY IMPAIRED PERSON

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Abstract. People with vision impairments encounter numerous challenges in getting around either indoors or outdoors. They have to be on guard at all times to prevent from hazardous circumstances like running into moving or stationary objects, staircases, or skidding on wet surfaces. They can also be in difficulty and want to inform their friends or family about their predicament. Blind individuals' problems can be resolved using this technology. The "Visibly Impaired Smart Blind Stick" is specially created to give people those who lack vision or are blind greater information as well mobility recording capabilities. With an array of sensors and modules, the smart blind stick prototype on display is a simple, useful, and reasonably priced gadget. The option to message others who are worried about the user's whereabouts is another feature of this system. The device incorporates recording the voice commands placed in the SD card previously and then indicates the person when there is any type of obstacle, GPS navigation for orientation, and an integrated audio recorder for capturing verbal notes and descriptions. Real-time audio and haptic feedback ensure obstacle awareness, while the GPS module assists in navigation and location tracking. It enhances mobility, safety, location awareness, information recording, and accessibility. This innovation intends to enhance the independence as well safety of those with visual impairments through merging traditional mobility aids with modern IoT technology.
Keywords: Obstacle detection, enhanced mobility, GPS navigation, user customisation.

Introduction

Several individuals alongside significant visual deficiencies are unable to travel on their own. As a result, they must employ a wide range of instruments and methods in order to use them when traveling. Among these methods is the orientation and high-quality professional, who assists the blind and visually challenged and teaches them how to navigate around on their own using their many residual senses. Typically, they rely on their hearing for navigating daily tasks, but relying solely on this sense can pose safety risks, Therefore, it was necessary to create a smart stick that would help impaired-vision people and warn them of potential hazards through voice commands and provide details regarding their whereabouts. The blind stick's design is made with ultrasonic detector, water sensor and other electronic modules that are compatible with the nearest relative's Android smartphone.

As technology progresses into the modern era of automation, the traditional wooden cane utilized by people with vision impairments has been supplanted with aluminum alternatives. However, these canes no longer offer the same level of independence. In response, a variety aiding technology use has been developed, such as the smart stick, Mowat sensor, Sens Cap, Laser Cane, Embedded Glove, and Nav Belt. The smart stick, in particular, has become a prevalent early aiding technologies, designed to lower incidents affecting people who are blind or visually challenged. Unlike devices like the NAV Belt and Sens Cap, which pose risks of neural damage, the smart stick provides a safer solution. Equipped with various sensors, it detects obstacles and notifies users through beeps, vibrations, and voice alerts, facilitating greater mobility and independence for those who are blind.

Despite the existence of numerous current solutions, challenges persist regarding precise location tracking, user-friendliness, and emergency response capabilities. The smart stick design integrates Internet of Things (IoT) technology, incorporating a range of sensors including ultrasound, water sensor, and GPS/GSM sensor. It operates in two modes: one utilizes ultrasound to detect obstacles and communicates their direction to the user through vibration motors, while the other mode detects and recognizes obstacles, providing voice feedback. These modes can be switched based on user preferences. Additionally, a water sensor is integrated to identify wet surfaces as well as prevent falls. Moreover, To find the user's precise location, GPS and GSM are employed with latitude and longitude. Finally, the smart stick incorporates a panic button that users can press to summon emergency assistance when needed. Notably, the innovation of this smart stick lies in its custom-designed adjustable stick to accommodate visually impaired individuals of varying heights, as well as the use of waterproof sensors and control box, ensuring durability in challenging conditions. Additionally, a specially designed water sensor with strategic placement ensures accurate detection of puddles, while vibration motors guide users around obstacles and earphones deliver relevant audio alerts, enhancing ease of use.

1. Related Methodology

Existing System:

When traveling, those with visual impairments typically utilize an assistance dog or a standard white cane by automatically. While the traditional white stick provides a warning approximately 1 meter before encountering an obstacle, at a typical walking speed 1m/s, the moment available to respond is exceedingly brief. Additionally, since the stick primarily scans the floor, it may overlook certain obstacles. Safety and assurance could be increased using devices that Send an indicator to determine the obstacle's path – free path in odd or shifting environments. Travel aids with electronic components are those that emit a warning by acoustic or /and physical signals when an obstacle is in the manner in which those with visual impairments and allow the user to elude it. Several gadgets were originally

created to enhance the mobility of visually impaired people. An active optic pioneer with a photosensitive and LED is used as an electronic travel aid to increase blind people's movement. The improved version of LED and Photodiode is electronic travel aids: a clever directing tool shaped like a pair of spectacles that these people can inventively and safely. Different from existing A brand-new multi-sensor fusion based obstacle avoidance technique is put forth that makes use of both the optical depth sensor as well as the ultrasonic sensor to address the issues with miniature barrier detection along with
translucent obstacles.

Limitation of the existing system:

The system which was developed before was a moderate budget navigational aid for visually impaired people. Following were the limitations of the project:

- Requirement of power source.
- Bulky to carry.
- Does not offer face and torso protection from obstructions.
- Due to use of electronic components, any malfunction will be difficult for a blind person to identify or repair on the spot.

Proposed system:

The Ultrasonic Sensor detects obstacles by emitting continuous ultrasonic waves, which are then reflected back to the system upon encountering any obstruction. The received ultrasonic waves are interpreted by sensor and relayed to the Microcontroller. This data triggers the Microcontroller to issue alerts via voice messages. The proposed design for the smart stick harnesses the power of the Internet of Things (IoT) by integrating various sensors such as ultrasonic, water, and GPS/GSM sensors. The device incorporates by recording the voice commands beforehand in the bluetooth module and then indicates the person when there is any type of obstacle, GPS navigation for orientation, and an integrated audio recorder for capturing verbal notes and descriptions.

2. Methods

Arduino uno: The comprehensive microcontroller board known as the Arduino Uno R3 is according to the ATmega328 (datasheet). The board consists of several components, such includes six analog inputs, 14 digital input/output pins, six of which may provide PWM outputs, and a 16 MHz crystal oscillator. It also has a reset button, ICSP header, power jack, and USB connector for ease of use and enhanced functionality. This integrated design ensures that it is fully equipped to facilitate the functions of the microcontroller effectively. All it takes to start using it is a USB connection to a computer or the utilization of a battery or AC-to-DC adaptor to power it. One major way that the Uno is different from its predecessors is that it uses the Atmega16U2, a USB to serial converter, a role previously filled by the Atmega8U2 up to version R2. This technological advancement enhances the Uno's compatibility and functionality, making it an adaptable and simple-to-use choice for a variety of tasks and uses. In Revision 2, To bring the 8U2 HWB connection to earth, a resistor is used, simplifying DFU mode activation. Revision 3 introduces several new features:

A 1.0 pinout adds two extra pins close to the RESET pin, two extra SDA and SCL pins close to the AREF pin, IOREF, which enables shields to adapt to the board's voltage, and a pin reserved for future use.

A reinforced RESET circuit.

Replacement of the 8U2 with the Atmega16U2.

Fig.1 Arduino uno

Known as "Uno" (which translates to "one" in the language of Italy), it denotes the approaching the Arduino 1.0 release (version 1.0) and moving forward, Uno will be the arduino standard reference board. The most recent model in the USB arduino board family, is the platform standard. For comparisons with previous versions, refer to the Arduino boards index.

GPS Unit NEO-6MV2:

Fig.2 GPS Unit NEO-6MV2

A GPS unit used for navigation is called the NEO-6MV2.

After determining its position on Earth, this module outputs coordinates for longitude and latitude. It is a part of a range of standalone GPS receivers with the popular u-blox 6 positioning engine. These versatile and compact receivers offer several connectivity options and are housed in a small package (16 x 12.2 x 2.4 mm). Because of their small size, low power consumption, and recollection possibilities, The modules of NEO-6 are a good fit for mobile devices that run on batteries and have limited resources and space. Superior navigation performance is guaranteed by the innovative design of the Neo-6MV2, even under challenging conditions.

Overview of the GPS Unit NEO-6MV2:

GPS Unit NEO-6MV2 provides accurate location data and is widely recognized as one of the leading options available, offering affordability as well. Its precision meets the requirements of most applications, and its integration into smartphone and tablet designs enhances its efficiency. This module is popular among enthusiasts and developers alike, particularly those working on navigation-related applications.

Using the GPS Unit NEO-6MV2 is straightforward. The board in the application circuit below is powered on, and functionality is enabled by connecting the microcontroller's UART interface output.

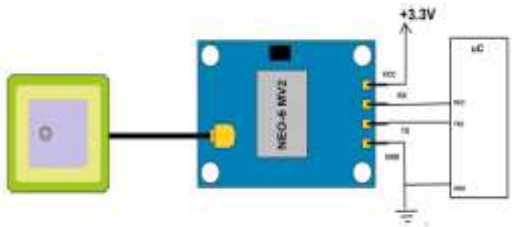

Fig.3 ckt diagram of NEO-6MV2

Pin Configuration for GPS Unit:

Pin Name	Description
VCC	+ve power pin
Receiver	UART receiver pin
Transmitter	UART transmitter pin
GND	Ground

Table.1 GPS Module Pin Configuration for NEO-6MV2

For correct connection with the module, after the equipment has been set up, the controller's baud rate must be configured. Failure to do so

may result in errors. Once the baud rate is configured, The serial data is immediately readable from the module. Typically, users can change the longitude and latitude values that make up this data as needed. Simple decimal computations can be used in software to create easily legible values, while the module's raw values can be challenging to grasp.

Global Systems for Mobile Communication:
The Worldwide Mobile Communication System, in Europe and other parts of the world, GSM is a commonly used electronic mobile phone system. By utilizing Time Division Multiple Access (TDMA) technology, GSM stands as the majority of widespread among the trio of digital wireless mobile technologies (GSM, CDMA, and TDMA). It employs data digitization and compression before transmission using a conduit alongside two additional user data streams, each with a specific time frame. With frequencies between the 900 MHz and 1,800 MHz range, GSM is the most widely used wireless phone system in Europe. With a user base exceeding one billion worldwide, GSM extends its coverage to 190 countries. Leveraging roaming agreements between numerous GSM network operators and foreign counterparts, users frequently retain mobile phone usage capabilities when traveling abroad.

Fig.4 GSM

Mobile Frequency Range	Rx: 925-960; Tx: 880-915
Multiple Access Method	TDMA/FDM
Duplex Method	FDD
Number of Channels	124 (Eight people each channel)
Channel Space	200kHz
Modulation	GMSK (0.3 Gaussian Filter)
Channel Bit Rate	270.833Kb

Table.2 Specifications of GSM

GSM network architecture:

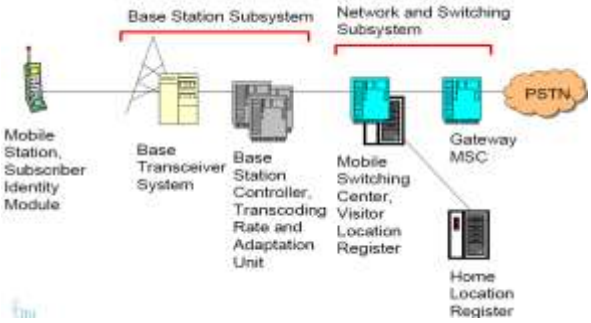

Fig.5 GSM network architecture

Different functional entities, each with specific functions and interfaces, make up a GSM network. A typical GSM network's configuration is shown in Figure. The GSM network is often divided into three sections. The Mobile Station is carried by the Subscriber, and the Base Station Subsystem is responsible for managing the radio link with the Mobile Station. Call switching between mobile users and between mobile and fixed network users is handled by the Network Subsystem, which is mostly composed of the Mobile Services Switching Center (MSC). The MSC also oversees operations related to mobility management. The Operations Maintenance Center, which manages the network's correct configuration and functioning, is not shown. The Um interface, sometimes referred to as the radio link or air interface, is used for communication between the Subsystem of Base Station and the Mobile Station. The Base Station Subsystem connects to the Mobile Services Switching Center via the A interface.

Ultrasonic Sensor:

Similar to radar or sonar, When ultrasonic sensors are able to transmit and receive data, they are also called transceivers, work with this idea, analyzing sound waves or radio echoes, respectively, to assess attributes of a target. These sensors produce high-frequency sound waves, then examine the reflected waves that they receive. Sensors measure the distance to an object by calculating the time gap between signal emission and echo reception.

Fig.6 Ultrasonic Sensor

This technology is used in many different fields, including anemometry (the measurement of wind speed and direction), tank filling, and air or water speed measurement. Multiple detectors are used in devices that measure direction or speed, and the computation of speed is dependent on the proportional separations between the medium's particles. For liquid level measurement, sensors gauge the distance to the fluid surface. Sonar, medical ultrasonography, burglar alarms, humidifiers, and non-destructive testing are some other uses. Above 18,000 Hz, or the ultrasonic range, sound waves are often produced by devices that use transducers to transform electrical energy into sound. They convert the sound waves back into electrical energy when they receive the echo, allowing for measurement and display.
However, The density or uniformity of materials and surface forms affect the technology's efficacy. For example, readings in a tank of fluid may be distorted by foam on the fluid's surface.

Water Level Sensor:

The purpose of level sensors is to measure the concentrations of materials in motion, such as liquids, slurries, granular materials, and powders. Fluids and fluidized solids naturally settle to a level within their containers due to gravity, while most bulk solids form piles at an angle of repose. The substance being measured may be contained within a vessel or in its natural environment, such as a river or lake. Level measurements can be continuous, providing ongoing data within a defined range, or point values, indicating whether the substance is above or below a specific point. Point-level sensors typically identify extremely high or low levels.

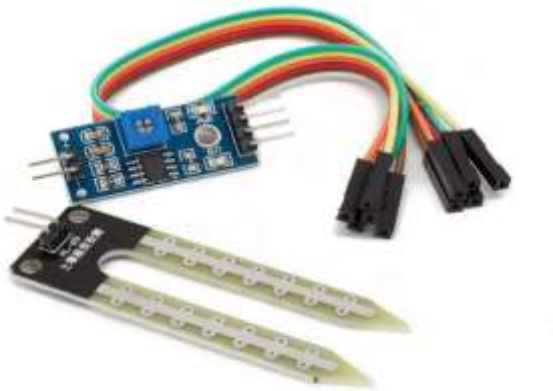

Fig.7 Water Level Sensor

Various physical and application criteria determine which level monitoring technology is best for industrial and commercial processes. Phase (liquid, solid, or slurry), temperature, pressure, vacuum, chemical composition, dielectric constant, density (specific gravity), agitation, vibration, mechanical shock, acoustical or electrical interference, and the size and shape of the tank or container are some examples of these physical characteristics.

Vibration Sensor:

In modern applications, electronic vibration sensors predominantly employ piezoelectric or piezoresistive technology, with piezoelectric variants being the prevalent choice. A vibration

sensor serves as a device to quantify the magnitude and frequency of vibration within a given system, machine, or equipment. These sensors play a crucial role in providing maintenance teams with insights into the conditions of critical assets, potentially preempting equipment failure and enabling predictive maintenance practices. By doing so, they contribute to reducing overall costs and enhancing machinery performance.

Fig.8 Vibration Sensor

Bluetooth, HC-05:

This module, which provides full-duplex, two-way wireless capabilities, is a great addition to projects. It permits Arduino and other microcontrollers to communicate with one another, as well as gadgets like laptops and phones that have Bluetooth built in. Numerous Android applications simplify this process further. With communication facilitated through USART with a 9600 baud rate, interfacing with any USART-supporting microcontroller is straightforward. Additionally, command mode can be used to configure the default values for the module. If you require wireless data transfer between a microcontroller and your computer or smartphone, this module is a suitable choice. However, It's crucial to remember that the HC-05 isn't designed for multimedia transfer such as photos or songs; for such tasks, the CSR8645 module would be more appropriate.

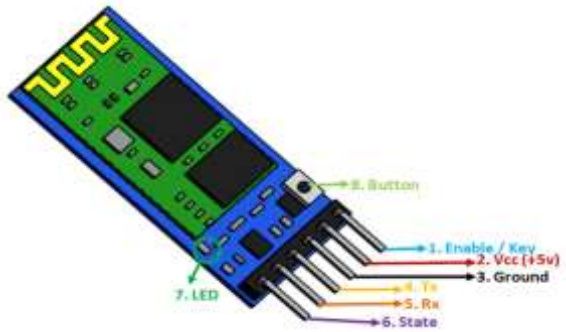

Fig.9 Bluetooth module Pinout

The module has two different modes of operation: AT Command mode, which permits changing of default device settings, and Data mode, which permits data exchange with other Bluetooth devices. The pin description explains how to use the key pin to switch between different modes. Because the HC05 module uses Serial Port Protocol (SPP), It is easy to link it to microcontrollers. To activate the module, just give +5V power and as seen in the image below, connect the Rx pin to the MCU's Tx pin and the Tx pin to the MCU's Rx pin. Grounding the key pin during power-up enables access to Command mode, while leaving it unconnected results in default entry into Data mode. Upon powering up the module, it should appear as the discoverable Bluetooth device HC-05. The default password '1234' can then be used to establish a connection, enabling communication.

Buzzer:

Fig.10 Buzzer

A gadget for audible signaling is a buzzer or beeper that can be made of electrical, automated, or electro-technological parts. Common applications include alarms, timers, and giving feedback on keystrokes or mouse clicks made by the user. Early versions of these devices resembled electric bells but lacked the metal gong. Some featured relays connected to interrupt their own actuating current, resulting in a buzzing sound. Often, these units were affixed to walls or ceilings to amplify the sound. The term "buzzer" originates from the rasping noise produced by electromechanical buzzers. When powered by an oscillating electrical circuit or another source of audio signals, piezoelectric elements, produce sounds like clicks, rings, or beeps to indicate button presses

Panic Button:

Fig.10 Panic Button

The prompt emphasizes the critical function of Panic Buttons, which are specifically designated for use during active threats or emergencies. When activated, these buttons immediately transmit an SOS message containing the user's location to their guardian, highlighting the importance of a swift response to ensure timely assistance reaches the distressed individual.

4.Proposed Model

4.1 Block Diagram:

Fig.11 Block Diagram of Visibly Impaired Smart Blind Stick

The block diagram illustrates the fundamental components and connections of Visibly Impaired Smart Blind Stick. Arduino, an ultrasonic sensor, a water sensor, a battery, a vibration sensor, a GPS and GSM module, a Bluetooth module, and a panic button are among the parts. The smart blind stick uses an Arduino microcontroller-controlled combination of sensors and communication modules to improve the safety and navigation for those with vision impairments. At its core, to identify obstructions in the user's route, the device uses an ultrasonic sensor, providing distance measurements to help navigate around them. A Water Sensor alerts the user to wet surfaces or puddles, while a Vibration Sensor detects ground vibrations that could indicate potential hazards like construction work or approaching vehicles. Additionally, a Panic Button enables the user to trigger emergency alerts if needed. The GSM Module allows the device to send SMS alerts or make calls in case of emergencies, while the GPS Module provides location tracking functionality, aiding in locating the user or sending location information during emergencies. A Bluetooth Module facilitates connectivity with smartphones or other devices for additional features or control. As the central processing unit, the Arduino collecting data from sensors,

processing it, and controlling other modules based on the input received.

4.2 Flow Chart

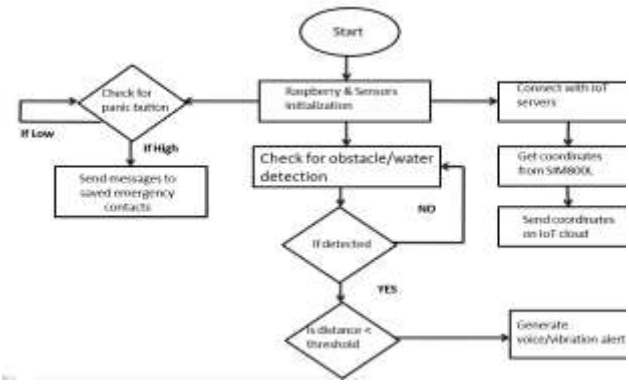

Fig.12 Flow Chart of Visibly Impaired Smart Blind Stick

This flowchart outlines the basic operation of the Visibly Impaired Smart Blind Stick. It continuously reads data through ultrasonic sensor to detect obstacles. If an impediment is found, it activates the vibrating sensor to alert the user and sends an alert via GSM if the panic button is pressed. It also sends obstacle alerts to a paired device via Bluetooth if available. Additionally, it monitors water levels and battery levels, sending alerts via GSM if water is detected or if the battery is low. Providing guidance to the user if water is detected and they are not in a safe location. Initiating a call to emergency services if a panic alert is triggered and confirmation is received from an emergency contact.

Results and Discussion:

The discussion above has demonstrated that improving the safety and independence of visually impaired people is a comprehensive solution. The ultrasonic sensor aids in the detection of roadblocks, while the water sensor alerts the user to any puddles or wet surfaces. The vibration sensor provides feedback about the terrain and any changes in elevation. The panic button can be pressed in case of emergencies to alert predefined contacts or authorities via the GSM module. Caregivers and loved ones can rest easy knowing where the user is thanks to the GPS module's tracking capabilities. Additionally, the Bluetooth module allows for connectivity with smartphones and enabling voice alerts through text to voice converter app. Overall, this smart blind stick combines various technologies to empower visually impaired individuals and improve their mobility and safety.

Fig.14 Voice alerts th converter app

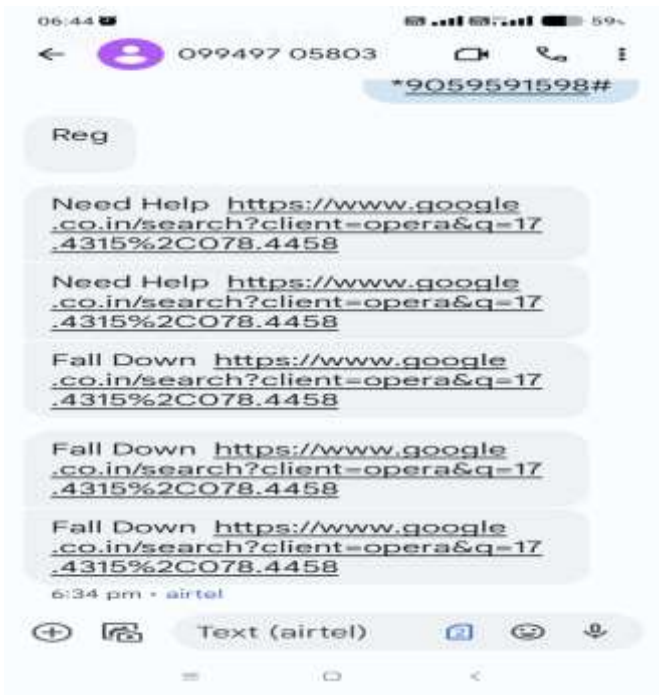

Fig.13 Location sharing SMS through GSM

Conclusion:

The project introduces the design and architecture of an innovative Arduino-based Virtual Eye, aimed at assisting blind individuals with a simple, affordable, and highly effective electronic guidance system. This system boasts numerous advantages, including portability,

configurability, and user-friendliness, making it an invaluable tool for the visually impaired. With its unique capability to accurately identify and measure the separation between obstacles in the blind person's environment, it offers comprehensive coverage in detecting obstacles from all directions, including left, right, and front, irrespective of their size or location. With meticulous construction, this system has the potential to empower the blind to navigate independently, eliminating the need for external assistance.

Conflicts of Interest

No conflict of interest is disclosed by the writers.

Author Contributions

Guidance and support by Devanna H, conceptualization by Sandeep RSV, Product design by Harsha Sri P, implementation and validation by Aravind Swamy V and Rakesh P.

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