Design and Development of IoT-powered Navigation Tool for Visually Impaired People

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ABSTRACT

Blindness is a condition resulting from physiological or neurological factors that causes a lack of vision, leading to visual disability. Blindness can be temporary or permanent, partial or complete, making individuals reliant on others for assistance. In today's world, people with disabilities seek independence and prefer not to depend on others for help. The Smart Blind Stick is an innovative device designed to address the daily challenges faced by blind individuals. This system incorporates various features, including obstacle detection, navigation, a panic button, and a moisture detector. Its primary objective is to enable blind individuals to walk independently and with confidence. The Smart Blind Stick features IR Sensor ultrasonic sensors, a water sensor, a navigation switch, and IOT connectivity, all integrated with an Arduino UNO. The device automatically detects obstacles in the user's path using ultrasonic sensors and provides real-time feedback. It also includes a moisture detector to assess ground conditions, ensuring the user is aware of safe walking surfaces.

Key Words: Smart Blink Stick, Internet of thongs, Obstacle detection.

1. OVERVIEW

Blindness is a common disability affecting people worldwide, with approximately 90% of visually impaired individuals residing in developing countries. Many blind individuals require assistance to perform everyday tasks, including walking. The Smart Blind Stick is a fully automated and manually operated device, designed to be affordable, easy to maintain, and comfortable to use. It employs innovative technology to enhance navigation and obstacle detection for visually impaired individuals. People who are visually challenged have trouble interacting with and sensing their surroundings. They don't interact much with their surroundings. Because it can be difficult for visually impaired people to differentiate obstacles that are in their path and because they are unable to go from one location to another, physical movement might be difficult for them. In the past, several systems were created with restrictions and a weak knowledge of nonvisual perception. Researchers have been working on creating an intelligent stick for decades in order to help visually impaired people and warn them about potential hazards as well as provide locational information. Research has been done over the past few decades on new gadgets to create a good and trustworthy system for visually impaired people to identify obstacles and notify them at danger spots. A walking stick is frequently used for navigating by people who are blind. Simple tactile-force feedback is employed in the basic walking stick to detect static obstructions on the ground, stairs, holes, and uneven surfaces. Although this device is small and light, it cannot include dynamic components because its range is constrained to its own size. Guide dogs are another option that offers blind people a means of transportation. In order to assist visually challenged people to be more self-reliant and to walk confidently, a Smart Walking Stick is proposed. The Smart Blind Stick is a tool designed to assist blind people in finding solutions to the issues they encounter on a daily basis if they prefer to be self-sufficient and do not wish to ask for aid from others… Through mobile, all detected obstructions are voiced instructions to the user. The visually handicapped can so

securely and conveniently overcome their daily mobility challenges by being given a sensation of artificial vision.

2. LITERATURE SURVEY

A lot of ideas are constantly being proposed in the field of walking aids for visually impaired people. Earlier visually impaired people have to rely on others for help in their day-to-day life. But nowadays, many devices are available to make them self-dependent. This research aims in the development of a visually challenged person's ultrasonic sensor-based walking stick. A buzzer is used to alert the visually impaired person while an ultrasonic sensor module, model HC-SR04, is utilized to identify obstacles in their route. The PIC microcontroller 16F877A is used to implement the suggested system. This walking stick can help the users navigate safely. Within a range of 5 to 35 cm, it can detect obstacles. This variant can't be extended to identify obstacles at a greater distance. It also lacks the GPS component that would normally provide spoken directions.

[1] This paper aids the visually impaired by operating in both indoor and outdoor settings. Ultrasonic sensor, buzzer, GPS and GSM module, vibratory motor, and Arduino as a micro-controller are some of the parts that make up this device. It accomplishes its goal of assisting the visually impaired people by locating impediments using an ultrasonic sensor, using GPS for navigation, and using GSM to transmit messages in an emergency to assist the users in receiving the necessary assistance. The main demerit with this model is that the SMS can provide inaccurate information if the GPS module does not receive a satellite signal. [2] This research aims to offer a technique that enables visually impaired people to avoid surrounding obstacles without grasping sticks or other heavy objects. The system used RGB data from a micro-controller and a smart phone to calculate the smoothness of the surface in both light and dark conditions. The system achieves the best level of surface smoothness in the day-night and dark conditions, respectively, at 96.341% and 98.683%. It creates and develops a system that consists of inexpensive, wearing, lightweight spectacles for the users so that they can receive assistance with walking and obstacle detection. This model's main drawback is that it can only calculate distances and object smoothness with a limited level of accuracy, which might lead to dangerous situations in some circumstances. [3] In this study, we suggest a smart stick based on infrared technology that is lightweight, affordable, user-friendly, quick to respond, and low power consuming. Within a two-meter range, a pair of infrared sensors can identify the existence of stairs and other obstacles in the user's route. Though, the experimental results are accurate, and the stick can find every barrier. The avoidance accuracy of this model only ranges from 75% to 90%, which is one of its shortcomings.

[4] The suggested approach alerts the user to identify and avoid every barrier so they can achieve their objective while being accurate in obstacle identification. This innovative prototype aids in energy conservation. This model does not have SOS mechanism to send the alert message in case of emergencies. [5] This paper, demonstrates a smart blind stick that uses ultrasonic sensors to recognize obstacles and an infrared camera to identify obstacles in front of the user within a 1 m range. The user will receive speech warning messages if the sensor detects any obstacles. The "Arduino Nano" micro-controller is used by this blind stick. The stick contains a feature that allows it to send an SOS message to the caregiver that was programmed into the system along with the caregiver's position and a link to a Google Map. The stick can detect objects up to one meter away and provide an alarm message to the user, causing the visually challenged person to move twice as quickly as usual. This smart stick lacks the developing technology to estimate the speed of impending obstacles.

[6] This research aims to create an image of opportunity, autonomy, and certainty with the help of an IoT stick. In order to do daily tasks swiftly, the proposed smart stick is designed with an obstacle identification module, a worldwide positioning system (GPS), pit and flight of stairs detection, water detection, and a global system for mobile communication (GSM). In order to separate the obstructions that suggest recognizing the obstacles and identifying the obstructions pattern, the impediment identification module makes use of an ultrasonic sensor combined with a water level sensor. The debilitated persons are informed about the barriers using an Arduino ATmega328, which also delivers notifications via buzzer and earphone. Using GPS and GSM modules, the users present location is determined. In the event of a loss, the stick initiates a warning system. [7] This paper proposes the addition of sensors, microcontrollers, and buzzers to the existing blind sticks. This study is suggested as a way to improve the subject's ability to move around and better navigate their surroundings. In the event of danger, the microcontroller activates a buzzer once the sensors detect hurdles and impediments from a safe distance. In emergency situations, the model uses a different device to use GPS and GSM to communicate location updates to the subject's family members. [8] The objective of this model is to develop an accessible, intelligent blind stick that will aid in navigation for the users. For the purpose of detecting obstructions in front of a blind user, the gadget consists of an ultrasonic sensor, an infrared sensor, and a vibration motor with a buzzer. Going up and down stairs is one of the major obstacles for individuals when they move indoors. By adding a feature that alerts the user when a staircase is present to our blind stick, we hope to address the problem. Additionally, this device contains a built-in GPS module and a GSM module that enable location tracking and display on a smartphone app, a feature that many family members of users find appealing.

3. EXISTING SYSTEM

In the current landscape, visually impaired individuals often rely on conventional tools like white canes or basic walking sticks to add them in navigation. These tools offer tactile feedback and allow users to detect obstacles or irregular terrain by physical touch. However, these methods have limitations, as they depend on the user's ability to interpret tactile cues. The existing technologies available, as discussed in our comparative analysis, are somewhat rudimentary. They include systems like the Smart Blind Walking Stick that uses ultrasonic sensors for obstacle detection, and the Smart Microcontroller-Based Blind Guidance System that employs infrared sensors. These systems lack advanced features and the precision required for precise navigation. To address these limitations, our proposed Smart Blind Stick integrates modern technology components such as ultrasonic sensors, a navigation for emergencies, and a water sensor detector to assess ground conditions. The device aims to provide more accurate obstacle detection and a comprehensive solution for visually impaired individuals, enhancing their mobility and independence in their daily lives.

4. PROPOSED SYSTEM

The goal of the proposed system is to design and develop a light weight, easily affordable Smart Walking Stick for the visually impaired that will provide constant assistance and aid them in better understanding their surroundings by frequently sounding different alerts on detection of obstacles, water, lowered and elevated surfaces, and guiding them to a specific location. As shown in fig 2.3 figure, we designed a block diagram to demonstrate the technique of our project. Several modules are connected to the Renesas microcontroller. The ultrasonic sensors linked to the Renesas, among which two are used for detecting obstructions and one for detecting potholes. The Water sensor which is also connected to the Renesas detects water, and buzzer provide tactile and audible feedback to the user. The system also sends emergency messages to the family members if the impaired person faces any problem.

BLOCK DIAGRAM

Fig. 1: Block diagram

SCHEMATIC DIAGRAM

Fig. 2: Schematic diagram

This is the pin diagram where all the hardware components are been connected components. This ARDUINO microcontroller having 28 pins. In which 14 GPIO pins as digital pins and 6 GPIO pins.

16MHz crystal oscillator connected internally. The step-down transformer, Bridge rectifier capacitor with 1000f Resisters and led are connected in Regulated power supply which provide the 5v to the Arduino and all input/output modules.

Schematic

- 16*2 LCD Monitor has connected with the Digital pins 2, 3, 4,5,6,7.

- IR sensors connected to A0, A1 pins of the Arduino micro controller.

- Ultrasonic sensor connected to A2, A3 pins of the Arduino micro controller.

- IoT Module connected to A4, A5 pins of the Arduino micro controller.

- Buzzer alarm connected to digital pin 9

FLOW DIAGRAM
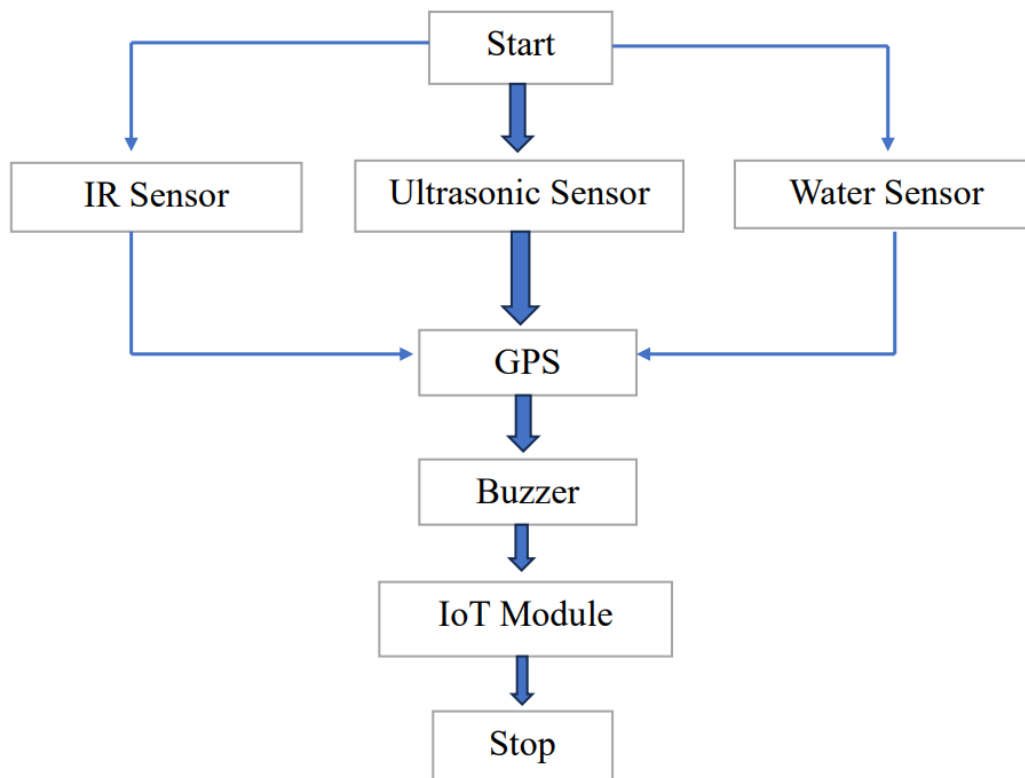
Fig. 3: Flow diagram

Logic Explanation

- Library and Pin Declarations: The code includes the Liquid Crystal and Software Serial libraries and declares pins for various components, including IR sensors (ir1 and ir2), an ultrasonic sensor (Trig Pin and Echo Pin), and a buzzer.

- beep () Function: This function is responsible for making the buzzer beep briefly by setting it to LOW and then HIGH after a delay.

- ultra_ dist () Function: This function uses an ultrasonic sensor to measure the distance to an object in front of it. It sends a trigger signal, measures the time it takes for the echo to return,

and calculates the distance in centimeters. The calculated distance is stored in the dist1 variable and returned.

- Setup Function: In the setup () function, various pins are configured as input or output. The IoT module is initialized using the IoT init () function, and the LCD displays a startup message.

- Loop Function: The loop () function continuously performs.

- IoT init () Function: This function initializes the IOT module by sending a series of AT commands. It sets up the module for sending SMS messages

- converts () and convert () Functions: These functions convert unsigned integers into characters and display them on either the serial monitors or the LCD.

WORKING

Including Arduino uno, LCD, ultrasonic sensor, water sensor, IR sensor, IoT module, buzzer, GPS module. When a power supply is given to the Arduino UNO board, all the components are activated then ultrasonic sensor will uses a transducer to send and receive the ultrasonic pulses that gives back information about the object's proximity then and to detect water, the water sensor is connected to the Renesas microcontroller, which is located at the bottom of the stick. Whenever the sensor detects the presence of water, it notifies the user through buzzer, The vibration sensors detect when the stick flows downward or when any vibrating object approaches the stick; they then relay the data through the IoT module, and the buzzer emits a sound, IR (Infrared) sensor works by emitting infrared light and measuring the reflection to detect obstacles in the user's path, when the light will not reflect than buzzer will be activate, then IoT module helps the stick share information with the internet. This way, someone, like a family member or caregiver, can check on the user's location, The GPS module is a wireless chip module combined on the mainboard of a mobile phone or machine. GPS module is used to detect the blind person location and sends the location information through IoT to their family members.
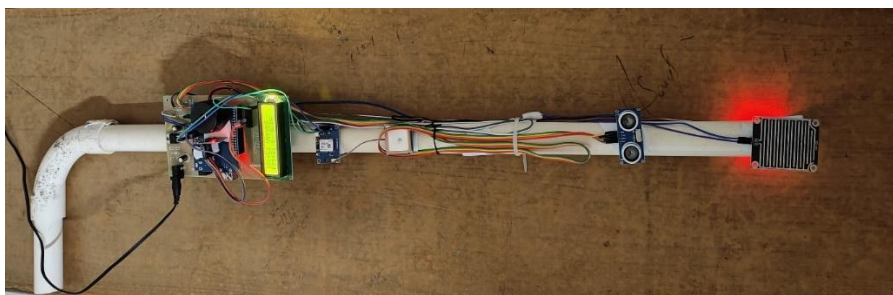
5.HARDWARE IMPLEMENTATION

Fig. 4: Smart Blind Stick

Fig 4 is the final result of the project what we did using different hardware components and with the use of the C language for the coding.
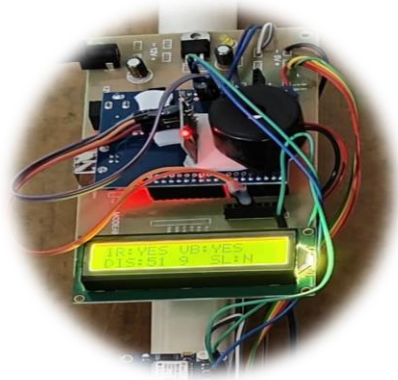
Fig. 5: Mother Board

Fig 5 is the motherboard for the model where we can see all the components in the above Fig. namely Ultrasonic Sensor, IR Sensor, water sensor, Vibration Sensor, Buzzer, which helps us to find any faults in the environments and alerts us in any situation.

Fig. 6: SMS

The location of the person can be known by this app to the relatives or care takers and also gets an alert message to the care takers if there is any disturbance in the vibration sensor.

6.CONCLUSIONS

In this paper design of a smart blind stick based on ultrasonic sensor is proposed and implemented successfully. It can be used as an effective navigation tool for blind persons. On the detection of obstacle in the path of the concerned person the smart blind stick sounds a buzzer to make an alert. The implemented system can detect any obstacle within the range of 5-30cm.This work can be extended to increase the range of obstacle detection and to send this information for further assistance along with

integrated Google mapping Assistance feature, which will provide voice directions on detection of obstacles in the path.

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