Smart Walking Stick for Visually Impaired

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Abstract **- Even without Sight, there is still Vision. In the world, there are about 4.3 crore people with blindness and 29.5 crore people with partial blindness. This latest eye health report is provided by the International Agency for the Prevention of Blindness's Vision Atlas. . People with visual disabilities are mostly dependent on external assistance or on designated systems for making every small decision. To overcome this limitation, the proposed system of a Smart Walking Stick is designed in a way to act like an artificial unit and an alarm unit. Using multiple sensors like ultrasonic sensors, LDR (Light Dependent Resistor), water sensor to detect every possible obstacle that can be overcome along with buzzer and vibration motor. The Stick is facilitated with a SOS (Save Our Souls) button for providing real time information of the person for quick response action by the user's guardian in case of an urgent situation.**

Index Terms **-** ***ESP32, Smart walking stick, Ultrasonic Sensors, LDR, GPS Module.***

I. INTRODUCTION

Around the world, at least 1 billion people have a near or distance vision impairment that is avoidable or is yet to be addressed, according to the World Health Organization (WHO). Vision impairment and blindness affect daily activities, and also career opportunities. One third of the world's blind population resides in India. It has about 1.2 crore people with visual disabilities as against the world's total of 3.9 crore, according to a report issued by the National Programme for Control of Blindness (NPCB). [1] Having a little contact with the surrounding, the visually impaired face adversities in interacting and understanding their environment. It becomes a major challenge to move around without the guidance of their family members or friends. Also, the jobs that they can do are limited to a greater extent because of their disability leaving around half of the legally blind population unemployed. In the past, many different systems were designed without any actual knowledge of the non-visual perception resulting in their ultimate failure. This system proposes to design and develop a stick for easy usage, correct input information for better analyzing the surrounding and reducing the dependency by large on external sources. The following system uses the ESP32 microcontroller to control and monitor the readings provided by various sensors that are integrated with the system. ESP32 is a microcontroller with integrated Wi-Fi and dual mode Bluetooth [2]. Sensors like ultrasonic sensor collect the data from the surrounding and when any obstacle is detected then the system acts accordingly. A circuit is designed, which acts like a water sensor in order to detect water surface on the path of the user. The system analyses the readings given by the inputs and accordingly the required signal is given to the user in form of sound and vibrations. Here the ultrasonic sensors are inputs. The values received from the sensors are analyzed if these values fall within a specified region, then the user is notified through buzzer along with a strong vibration at the handle for better sensation of the same. The SOS button sends a message to user' guardian through telegram asking for help while the GPS (Global Position System) module sends the users current location.

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II. LITERATURE REVIEW

Following are the works of individuals related to the Smart Walking Stick for Visually Impaired:

S Srinivasan, Rajesh M proposed a smart walking stick project which focuses on building better navigation systems and detecting falls. The proposed system made use of Arduino UNO board with ATmega328 along with multiple ultrasonic sensors, pressure sensor and Omni wheels for smooth movement. Multiple ultrasonic sensors attached at different places on stick detect presence of obstacles at different heights and accordingly the user is notified. [3].

Y Karuna, et al. devised a smart walking stick with an emergency navigation system. Raspberry pi has been used along with multiple ultrasonic sensors and a push button for sending SOS messages. The proposed system developed a mobile application which will help user's family and friends to communicate with user in case of any emergency. User's family can send voice message, text message and even could see the surrounding of the user through raspberry pi camera on mobile application. [4]

S Mohite, et al. proposed a solution to enable visually impaired people in detecting obstacles. The proposed system was integrated with ultrasonic sensor for obstacle detection, water sensor, LDR to notify the presence of user in the dark along with vibration motor, all connected to the microcontroller Arduino Uno R3. [5]

Pooja Mind, et al. concept of a smart electronic stick artificial is to provide vision and object detection. The system uses Raspberry Pi along with ultrasonic sensors, GPS module for real time assistance giving the exact location of the person and sending the same to the guardian person through a mobile application, and the feedback is received through audio along with a voice output for directions. [6]

Gia Haong Phan presented a design which detects obstacles, staircase and tracks location via smartphone. This device used the PIC16F90 microcontroller to ping proximity sensor, multiple ultrasonic sensors to detect the elevated surface and the GPS module is used to contact the user's guardian if there is any emergency [7].

Dr. K. M. Anandkumar, et al. developed a walking stick using echo-sounding and imaging. Along with ultrasonic sensor the object in front of the handler is identified along with the images captured at every instance and a mobile application is used to guide the user to reach his/her desired location using GPS. [8]

III. METHODOLOGY

1) Components

The proposed system has certain key components used in its design starting with a breadboard, which is used for testing and designing the prototype. ESP32 which is a microcontroller integrated with a Wi-Fi and Bluetooth is inserted into the breadboard. A network is created using ESP32 allowing other devices to connect to it. Two ultrasonic sensors are used to detect presence of object at different heights. Data collected from surrounding is sent to ESP32 for processing. Once the object is detected the buzzer starts beeping to alert the person himself and people in the close vicinity. In addition to buzzer a vibrating motor is fixed at the handle just in case the user has difficulty in hearing or is in a noisy place. The water sensor in general is a circuit designed to detect a water surface at the bottom of the stick where the circuit completes coming in contact with the water. LDR with a signaling LED (Light Emitting Diode) is particularly used to alarm the people around to make them aware of the user's presence in a dark environment to avoid any mishaps. Additionally, when the user presses the SOS button a message is sent to the user's guardian on telegram in response to any danger felt in the surrounding. Using the GPS module, a message can be sent notifying the location of the user to the user's guardian through telegram app.

2) Theory

An IOT system consists of smart devices which are web-enabled and also use embedded systems, in order to gather, send and process data they receive from their surroundings. [9]. Locally collected and analyzed sensor data is shared using IOT devices. In Ultrasonic sensor there is a transmitter and a receiver. Transmitter transmits ultrasonic sound waves which on hitting the object travels back towards the receiver of the ultrasonic sensor. This sensor is a 4-pin device which has VCC (Voltage Common Collector) pin for input power, GND (Ground), Trig pin and Echo pin. The Trig pin triggers ultrasonic pulses. On receiving a reflected signal Echo pin produces a HIGH pulse. The pulse duration is directly proportional to the total time taken to receive the signal which is transmitted. Time required for sound waves to comeback is calculated using pulseIn() function in the program, now the formula Distance = (s* t)/2 is used to calculate the distance between the ultrasonic sensor and the target where s is the speed of the sound(343m/s) and t is the time required for the sound wave to comeback from its target. When this distance falls within a particular range the microcontroller triggers the output devices. LDR is a type of resistor where its resistance is inversely proportional to the intensity of light falling on it. When light levels are low, the LDR senses the intensity and with the corresponding sensed input, the green LED attached to the LDR glows indicating the presence of darkness around. Thus, this gives the people around a fair idea about the user's presence. For detecting water, a simple circuit is designed in such a way that the two aluminum strips of opposite poles are attached to the bottom of the stick which complete the circuit on coming in contact with the water surface. As soon as the water surface is detected, the buzzer beeps thus alarming the user of the same. The data collected from the sensor are transferred to ESP32. The advantage of using ESP32 is that it retains the data even after the power is cut as it stores the data in its flash memory [10]. The program written for the proper

functioning of the system is edited through the Arduino IDE (Integrated Development Environment) in computer which is further transferred to the ESP32 via the micro USB port. According to the program and the input readings, the further steps of alarming and alerting the user are taken. This includes the activation of the buzzer along with the vibration felt at the handle of the stick. Vibration motor and Buzzer are used to alarm the user in case of danger. This system has an additional feature of an emergency SOS button to alert the user's acquaintances of any stressful situation. For generating a telegram message firstly, a new telegram private bot needs to be created. The new bot is created through 'Botfather' on telegram. After clicking start, making a new bot, and naming the bot, a unique username needs to be given. Now a bot token will be generated which can be used by anyone to control the bot created. This bot token is added to the program. To find the chat ID of a group or of an individual, 'myidbot' (IDBot) is used. Now after the SOS button is pressed the user's guardian will receive a message through telegram. The GPS module will allow the user to share his or her location with family members in case of any emergency. GPS module contains four pins namely VCC, RX, TX, GND. Telegram app will be used to share location of the user using GPS module.

As shown in Fig.1. the power supply is connected to the Vin pin of the ESP32.The Green and Red LED are connected to the D18 and D25 pins respectively. The buzzer is connected to the D19 pin and the Ultrasonic sensor1 is connected to the D4 pin (Trig pin) and to the D2 pin (echo pin). Ultrasonic sensor2 is connected to the D26 pin (trig pin) and to the D27 pin(echo pin). VCC and GND of both ultrasonic sensors are connected to VCC and GND of ESP32 respectively. LDR is connected to D5, VCC and GND (ground) of ESP32.SOS button is connected to D13, VCC of ESP32. The SOS push button is connected with the ESP32 board along with a red LED. The red LED is attached in series with the Push button. When the push button is pressed, the LED glows and the message of "###SOS Alert!!!##" is sent to the Telegram app bot via internet. The VCC pin of GPS module will be connected to the VCC of ESP32, RX pin will be connected to the TX of the ESP32, TX pin of GPS will be connected to the RX pin of the ESP32 and GND pin of GPS will be connected to the GND of ESP32.Whenever required location of the user can be shared through telegram app.

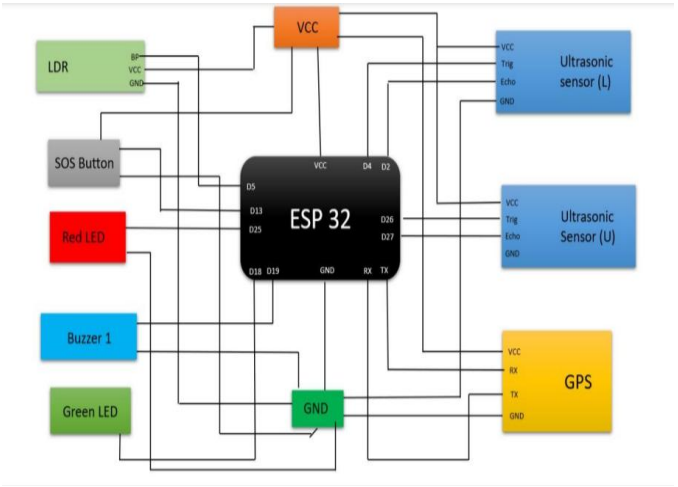

Fig.1 Block Diagram for Smart Walking Stick

Fig.2. gives us the overall idea of the functioning of the system.

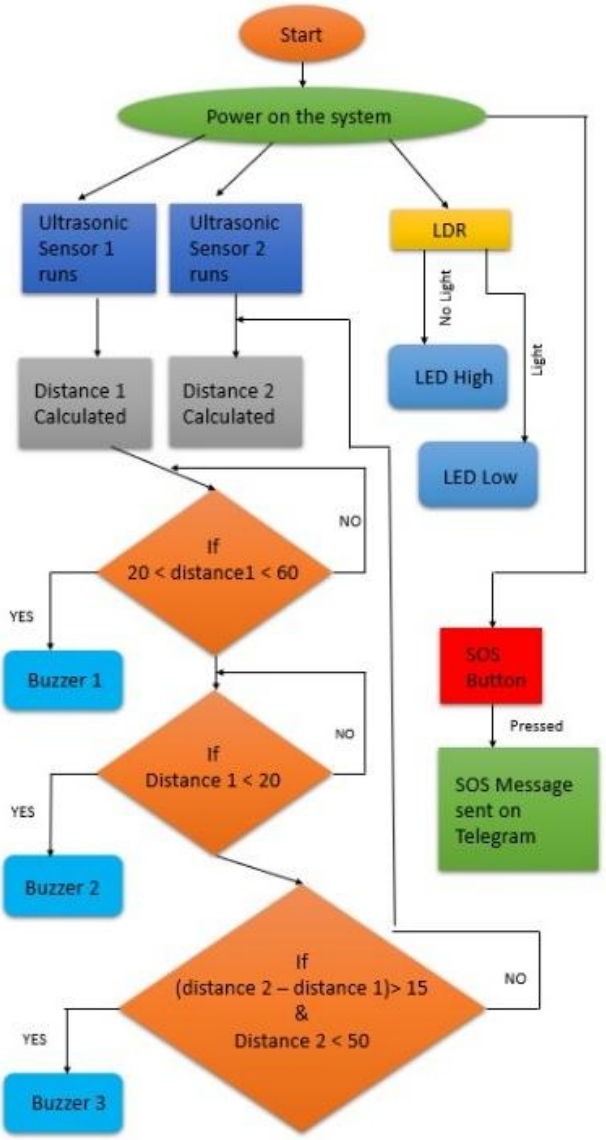

Fig.2 Flow of the system

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IV. TESTING

For the testing purpose of the system, the stick is moved across the surrounding region to come across obstacles in order to tackle them. If the ultrasonic sensor located at the bottom of the stick measures a distance below 20 cm it sets an alarm and sets the buzzer on. Also, If the other ultrasonic sensor situated in the middle of the stick along with the first ultrasonic sensor measures a particular value that is the difference between the two distances measured by the sensors, then the buzzer beeps in a continuous manner. This logic can be helpful to locate elevated surfaces. Along with the buzzer, the vibrating motor also vibrates which is beneficial if the user has some hearing disability or is present in a crowded area, As soon as the user walks in a dark region, the LDR comes into picture and after sensing the light intensity, the green LED glows marking its presence. If in case there comes a situation wherein the user needs to call someone for help, he can do so by pressing the SOS button. As shown in Fig.3., this message will immediately be sent to the person's guardian via the Telegram app along with the person's location and thus, the guardian can reach for help.

Fig.3 SOS Alert on Telegram.

V. RESULTS AND DISCUSSIONS

The proposed smart walking stick detects the presence of objects at different heights, water surfaces. The user can get a clear idea about the elevated surface through a different tone of the buzzer and a vibrating motor placed at the handle of the stick. It even sends an SOS message to the guardian through telegram in case of emergency. Location of the user is also made available thereby making it even more efficient.

The smart walking stick consists of only two ultrasonic sensors which detect objects only in front of the user. Also, the stick may feel a bit heavy to carry. Communication between the user and the user's guardian is minimal. In order to improve upon the results of the existing system, multiple ultrasonic sensors should be placed in different directions, so that the user can get a clear idea about the objects around him. Further, development of an android application which can help the user's guardian to communicate with the user and monitor its movement can be beneficial. Artificial intelligence can be introduced which will help the user to find the best path without human assistance.

V. CONCLUSION

The proposed project can ensure every visually impaired person doesn't have to depend on others to reach their destination. The smart walking stick can improve the lifestyle of visually impaired people by making them more independent. The project can detect the presence of obstacles and even send an emergency message and location of the user to the user's guardian through telegram application. By incorporating the design with advancements in technology, it can prove to be very reliable.

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