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Assistive Cane for Visually Challenged and Blind

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Abstract: **An effective reintegration of the disabled individuals in the family and society ought to be satisfied; it is necessary to help their lessened capacities or replace the lost functions. Recent progressions in embedded systems have opened an immense zone of innovative work for moderate and compact assistive gadgets for the outwardly impeded. Traditional walking canes help to detect obstacles on the ground, but what about higher or overhanging barriers. So, for a person with blindness, it is like walking on a minefield. The person may suddenly uncover such an obstacle and get hit by it, potentially leading to an injury. It could be avoided if one has spatial awareness and an early warning system that alerts possible contact with obstacles from a safer distance. This project aims to provide an efficient, affordable, and easy-to-carry solution in the form of an assistive cane to help the visually challenged and blind. The stick will act as a counterfeit vision and provide audio feedback to guide the user to reach one's destination. The cane is mounted with sensors that are interfaced with an embedded system. The undertaking utilizes the distance measurement property of the ultrasonic sensors and Global Positioning System tracking to locate the user's position and alert a pre-specified person in case of an emergency. Higher-order capabilities can be augmented by storing the user's data, securely making use of it to create comprehensive user profiles and accurately predict their needs. So, this could be like an intelligent walking blind stick giving instructions based on patterns analysis after its use over time.**

Keywords **— Blind Stick, GPS module, GSM module, Ultrasonic sensor, Water sensor**

I. INTRODUCTION

India has the largest population of visually impaired people, accounting for 20% of the world's blind population. The visually impaired are at a disadvantage due to losing their eyesight and cannot move freely. Along with the difficulties in their routine work, blind people may face new challenges every day. They need assistance for doing routine activities like moving, reading, traveling, etc. Visual deficiency may occur due to various reasons such as infection, injury, or different medical conditions. Legitimate visual deficit implies that a man has a vision that measures 20/200 or more regrettable. For instance, somebody with 20/200 vision sees an object from 20 feet that a man with perfect 20/20 vision can see from 200 feet. Knowing the difficulties of visual impairment, the present effort may help affected individuals live like an average person. Innovation presents a test for providing accessible technologies for visually impaired individuals. In most of the most recent years, issues identified with PC access for the visually impaired emerged. For instance, a visually impaired individual can't read the content on a website page. Browsing the web requires programming to read the data on a website. Individuals with limited vision may also experience issues with review sites, especially the petite textual styles, symbols, and screen hues utilized by many websites. Other innovations, for example, music players that need a visual determination of music, or instant messages, will likewise bring about difficulties for visually impaired individuals. Popular solutions are voice synthesizers, screen magnifiers, and other devices that have been developed over time to help the visually impaired. Many wearable assistive devices have been created as targeted solutions for tasks such as traveling and reading.

The safe mobility of a blind person remains one of the significant challenges. Due to lack of spatial awareness, moving around without external assistance could lead to loss of life. Several efforts have been made in this direction. The stereoscopic design was used to develop new hindrance detecting capacities [1]. Likewise, a navigation gadget that gives voice yields to hindrance and location awareness [2]. The device contains a Radio Frequency Identification (RFID) reader, an infrared sensor and runs the Android framework provided by Google, which enables connection with an Android-based phone through Bluetooth. To contribute to this field, we decided to know more about problems faced by blind people in their daily life.

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Table 1: Conditions for the actuation of sensor(s)

S. No.	Scenario	Sensors activated	Warning sound	Vibration motor activated?
1.	Wall	Ultrasonic sensor 1,2,3	Uninterrupted sound	-
2.	Step up	Ultrasonic sensor 2,3	Increasing T_{ON} with 1 sec T_{OFF}	-
3.	Step down	Ultrasonic sensor 4	Decreasing T_{ON} with 1 sec T_{OFF}	-
4.	Overhanging obstacle	Ultrasonic sensor 1	T_{ON} and T_{OFF} are 1 sec each	-
5.	Water detected	Water sensor	-	Yes
6.	Emergency button pressed	GPS & GSM module	-	-
7.	RF Transmitter remote pressed	RF module	Uninterrupted sound	-

We interacted with visually impaired people in hospitals and blind schools. After visiting them, we gained in-depth knowledge about their issues. It was concluded that there is a need for a low-cost device that can make these people's lives more accessible and comfortable. The target users were those visually challenged by birth or those who became so after a tragedy or disease and cannot get their eyesight back through any medical intervention. The end-users can be people from any class, community, gender, profession, age, etc. As these people need specific mobility assistive technologies to live a near-normal life, we came up with a solution that will help the person by object detection. It is one of the major features among other assistive solutions offered in this project. The project's primary purpose is to serve the needy people and contribute to advancing practical, easy, and accessible solutions in this field of research. We aim to help the disadvantaged person by providing a guiding tool to move around with a sense of safety and a mode of visual aid. The most crucial purpose is to serve humankind through the knowledge we have gained and the experience we have till now. Interested companies may utilize the outcome of this project for the further manufacturing of the product, which would help the affected subjects.

II. PRODUCT DESIGN & IMPLEMENTATION

For the development of smart cane, which detects obstacles from a distance, senses water, sends an emergency signal, and gives feedback for all the given cases, the components used were - Ultrasonic sensor HC-SR04, Water sensor, GSM Module – SIM900, The NEO-6M GPS module, Arduino Uno, radiofrequency (RF) module, Vibration motor. These components could be classified into four major categories: processing unit, sensors, feedback devices, and communication devices. The Arduino Uno is the processing unit of the cane. It was selected because of its low cost and relatively smaller size over another Microprocessor unit (MPUs). It is used toprocess all the raw data fed from the connected sensors. When the user switches ON the power, the system CPU-Arduino gets ON. The ultrasonic sensors could be used to find the object's distance. The sensor works on the principle of sound navigation and ranging. It sends an ultrasonic wave when the trigger pin is high, which upon striking an obstacle is reflected. An echo pin detects the reflected wave. It measures the time taken by the ultrasonic wave (342 m/s) to reach back to the sensor from when it was first transmitted. The following formula (1) calculates the distance between the obstacle and the user.

$$Distance = {(time(s) \times velocity(m/s))}/{2} \quad \ldots\ldots\ldots(1)$$

Suppose the distance of any obstacle is within its predefined range. In that case, the user is warned through audio and vibrational feedback depending upon the kind of obstacle and the corresponding case set in the Arduino. Four ultrasonic sensors were placed strategically on the cane to detect various scenarios, mainly- wall, step up, step down, and hanging obstacles as shown in Fig. 1. The ultrasonic sensors used remain active throughout, and it works independently of the other sensor in identifying the obstacle scenario as shown in table 1 and alerts the user depending on the distance as shown in table 2.

Table 2: Distance dependent actuation of ultrasonic sensor

S. No.	Scenario	Range
1.	No obstacle	>3m
2.	Obstacle detected	50cm to 3m

The water sensor is placed at the lower end of the stick, facing the ground. It will detect the presence of water. The sensor gives an output when the circuit meets water. However, it has been modified for a certain amount of water by decreasing the sensitivity. This modification has been done by chiseling down a few of the circuit lines. It will help to warn the user and save them from any accident like slipping. The Global Positioning System (GPS) and

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Global System for Mobile Communications (GSM) modules were also interfaced with Arduino. In case of an emergency, if the user wants to give a distress call to a concerned person, the emergency button can be pressed. The connected GPS module will fetch the location coordinates of the user and the GSM module will send a message containing the user's location to a preset mobile number. We also have considered the case in which the user is not able to locate the stick. To solve this, we have provided an RF Remote. The user can press the remote, and audio feedback is provided to help him locate the stick.

One can also use the vibration motors for the above scenarios where only audio feedback is provided to enhance the quality and audio feedback. The purpose of these motors is to give feedback even in a noisy environment. Since there might be cases when the user cannot listen to the changing beeps of the buzzer, in that case, the vibration motor can vibrate following the delay patterns given for different scenarios.

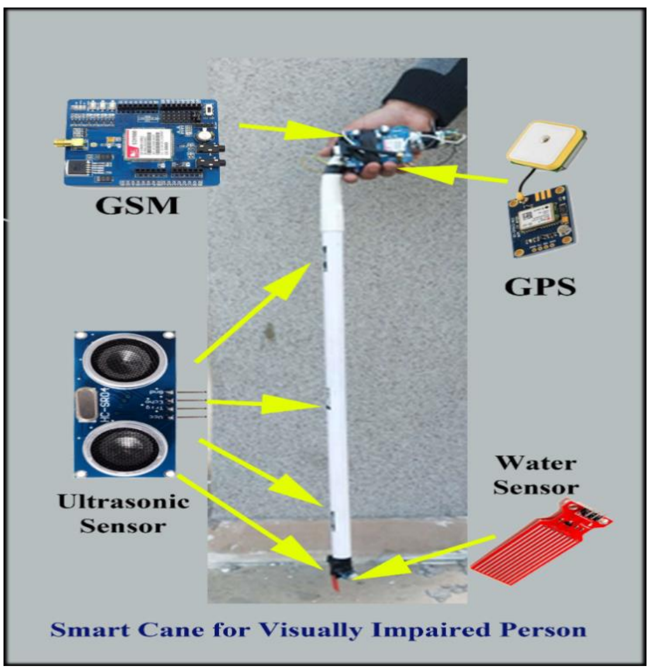

Figure 1:Developed cane equipped with sensors

III. Conclusion

The idea's conception was for one primary reason: to find an intelligent and cheaper solution to solve the problem of free mobility among the visually disabled. This was an attempt at making a change with the resources at our disposal. With millions affected by it, this project can help make a change at a nominal price. We completed the basic model and have developed upon that. Any person with semi or entirely visual impairment can efficiently operate the blind stick. The ease of operation and subsidized cost compared to other blind sticks in the market could be a budget buy for anyone who does not have enough money. With Arduino and ultrasonic sensors, the project is up to the mark with the technology. Any further modifications and developments can be made, and still, the device would stay up to date without any significant increase in cost. Such is the case of our humble project of creating something that's worth surviving. The stick has a very easy-to-use interface with a single power button and emergency button. The rest of the work viz-a-viz distance sensing for all the cases and water detection is done by the stick itself.

Upon pressing the emergency button, the user's location is sent to the contact in emergencies. If the user misplaces the stick, the stick can be relocated with an RF module's help. Though this system is hard-wired with sensors and other components, it is light in weight. The future aspect of the project includes the reduction in the size of the Arduino and GPS-GSM modules. Further, we can predict some of the pre-recorded daily routine distance patterns by using specific memories and interfacing them with Artificial Intelligence. Additionally, we can buffer some of the previous locations visited recently so that if there is a weak GPS link, just the last location can be sent. With the help of this blind stick, people can improve more than 15-20% travel speed, reduce minor collisions, and not lose their way and increase their safety compared to unaided equipment.

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