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Paper Authors
Ms. V. Somalaxmi, Mr. V. Chanikya Sai, Mr. CH. Krupakar Reddy, Mr. E. Kamal

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AN INTELLIGENT WALKING STICK FOR THE VISUALLY CHALLENGED PEOPLE USING IOT

Ms. V. Somalaxmi[1], Mr. V. Chanikya Sai[2], Mr. CH. Krupakar Reddy[3], Mr. E. Kamal[4]
[1]Assistant Professor, Department of ECE, CMR Institute of Technology, Medchal, Hyderabad.
[2,3,4]Bachelor's Student, Department of ECE, CMR Institute of Technology, Medchal, Hyderabad.

ABSTRACT-This paper presents the design, development, and testing of an IoT-enabled smart stick for visually impaired people to navigate the outside environment with the ability to detect and warn about obstacles. The proposed design employs ultrasonic sensors for obstacle detection, a water sensor for sensing the puddles and wet surfaces in the user's path, and a high-definition video camera integrated with object recognition. Furthermore, the user is signalled about various hindrances and objects using voice feedback through earphones after accurately detecting and identifying objects. The proposed smart stick has two modes; one uses ultrasonic sensors for detection and feedback through vibration motors to inform about the direction of the obstacle, and the second mode is the detection and recognition of obstacles and providing voice feedback. The proposed system allows for switching between the two modes depending on the environment and personal preference. Moreover, the latitude/longitude values of the user are captured and uploaded to the IoT platform for effective tracking via global positioning system (GPS)/global system for mobile communication (GSM) modules, which enable the live location of the user/stick to be monitored on the IoT dashboard. A panic button is also provided for emergency assistance by generating a request signal in the form of an SMS containing a Google maps link generated with latitude and longitude coordinates and sent through an IoT-enabled environment. The smart stick has been designed to be lightweight, waterproof, size adjustable, and has long battery life. The overall design ensures energy efficiency, portability, stability, ease of access, and robust features.

Keywords: IoT, Smart stick, Object recognition, Obstacle detection.

I. INTRODUCTION

Over 2.2 billion people globally are affected by vision impairment, impacting their education, employment, and overall quality of life. For children, it can hinder motor and emotional development, while adults may face reduced productivity and increased mental health challenges. The elderly are particularly vulnerable, with vision loss raising the risk of falls, social isolation, and dependency. Traditional aids like wooden and aluminium canes have been replaced by smart sticks, which utilize advanced sensors and IoT technology to enhance mobility and safety. These devices detect obstacles with ultrasound sensors, identify water puddles using custom waterproof sensors, and provide real-time GPS/GSM tracking for emergencies. Equipped with a panic button for urgent alerts and an ergonomic, adjustable design, smart sticks ensure ease of use and durability in all environments. Unlike earlier technologies like the Mowat Sensor and Nav Belt, the smart stick integrates vibration motors and audio feedback to offer intuitive navigation. By combining robust design with cutting-edge technology, these devices empower visually impaired individuals, enabling them to navigate the world with greater confidence, independence, and security.

II. LITERATURE REVIEW

Efforts to enhance the quality of life for Visually Impaired (VI) individuals are gaining global traction, with a significant focus on assistive technologies (AT) that address challenges in mobility, education, and daily living [7]. Malaysia, a nation witnessing a rising number of VI individuals, is making strides in integrating technology to cater to this community. With visual impairment among the most common disabilities in the country, targeted initiatives like Assistive Courseware (AC) and smart mobility aids are transforming accessibility and inclusivity for VI individuals [3]. However, gaps persist, as AT remains underutilized, costly, and largely inaccessible to low-income groups.

The government of Malaysia, through its emphasis on Information Technology and Communication (ICT) as part of its economic growth strategy, has recognized the potential of creative content and AT [8]. Despite these efforts, education for VI learners still lags, with limited resources and innovative tools available to bridge the gap between them and sighted peers. AC prototypes developed for VI children demonstrate that interactive features such as audio, graphics, easy navigation, and multimedia elements can significantly enhance learning outcomes and foster critical skills like self-motivation, interpersonal engagement, and adaptability. These tools not only expose VI learners to technology but also help to break down barriers to their participation in education and society [9].

On the mobility front, innovations like smart walking sticks and canes integrate advanced sensors, GPS, and feedback systems to provide real-time obstacle detection, navigation assistance, and safety alerts [5]. Devices such as the Smart Cane and ultrasonic sensor-based walking aids exemplify the potential of technology to empower VI individuals by enabling them to move independently and confidently in both indoor and outdoor environments [6]. These tools are designed to address practical needs, such as identifying stairs, water, and other potential hazards, while remaining lightweight and cost-effective [4].

Globally, the World Health Organization reports that over 285 million individuals are visually impaired, with 39 million categorized as blind [1]. Developing countries account for 90% of these individuals, underscoring the urgency of affordable and accessible solutions [2]. Research highlights the role of AT in bridging societal gaps, as seen in Malaysia, where the number of registered VI individuals rose from 14,738 in 2002 to 23,378 in 2009. Yet, limited resources and the high cost of AT continue to hinder its widespread adoption [5].

Malaysia's national plans, including the Ninth and Tenth Malaysia Plans, emphasize the development of creative content and AT as a means of fostering inclusive growth. Future efforts should prioritize affordability, scalability, and interactivity in AT solutions, enabling broader adoption across socioeconomic strata. By integrating multimedia elements, user-centric designs, and personalized learning approaches, AT can revolutionize access to education, mobility, and employment for VI individuals, contributing to a more inclusive society [10]. Furthermore, global collaboration in research, funding, and technological innovation is crucial to addressing the challenges faced by VI communities worldwide. Through these efforts, the vision of equitable access and participation for VI individuals can become a tangible reality.

III. SYSTEM MODEL

The Block Diagram of our prototype is as shown below,

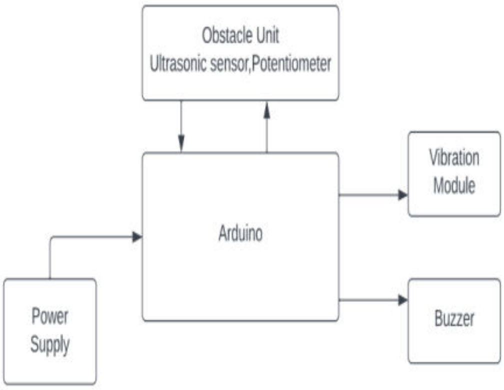

Figure1: Block diagram of the proposed system

The Arduino board serves as the central controller for the system. It processes data from sensors, communicates with the mobile app, and controls the watering mechanism.

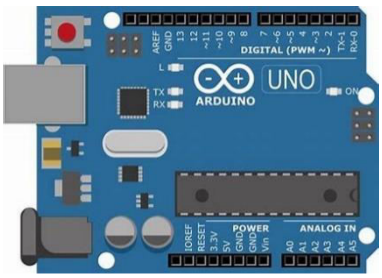

Figure 2: Arduino

A suitable power supply to provide power to the Arduino, water pump, and other components. Ensure it can provide the necessary voltage and current.

The LCD screen can display essential information about plant hydration levels, system status, and more.

Figure 3: LCD Display

An ultrasonic sensor is a device that measures distance by emitting ultrasonic sound waves and analyzing the time it takes for the echoes to return. These sensors are widely used in various technologies, including robotics, automotive systems, and assistive devices, due to their reliability and precision.

Figure 4: Ultrasonic Sensor

Buzzer is a small electronic component that generates sound as an alert or feedback mechanism. It is commonly used in assistive technologies for visually impaired (VI) individuals, providing audio cues to navigate safely and interact with their environment.

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Figure 5: Buzzer

Vibration Motor is a DC motor in a compact size that is used to inform the users by vibrating on receiving signals. It has no sound.

Figure 6: Vibration motor

Below is the design flow of the operation of the walking stick,

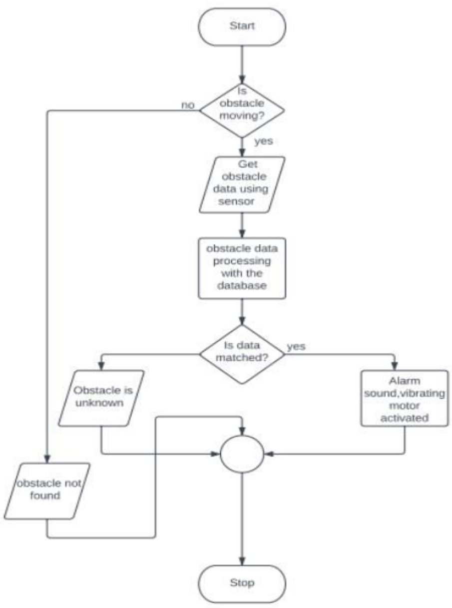

Figure 7: Design flow of the proposed system

The process begins. Check if the obstacle is moving. If no, proceed to "Obstacle not found". If yes, proceed to "Get obstacle data using sensor". Collect data about the obstacle using a sensor. Process the collected obstacle data with the database.

Check if the processed data matches the database. If yes, proceed to "Alarm sound, vibrating motor activated". If no, proceed to "Obstacle is unknown". The obstacle is not recognized. The obstacle is not detected. Then, move along. If object is detected Activate the alarm sound and vibrating motor. The process ends.

The system uses ultrasonic sensors to detect obstacles. These sensors emit ultrasonic waves and measure the time it takes for the echoes to return, determining the distance to the obstacle. An Arduino board or similar microcontroller processes the data from the sensors. It acts as the brain of the system, interpreting the sensor data and making decisions based on it. When an obstacle is detected within a certain range, the microcontroller processes this information and triggers the appropriate response.

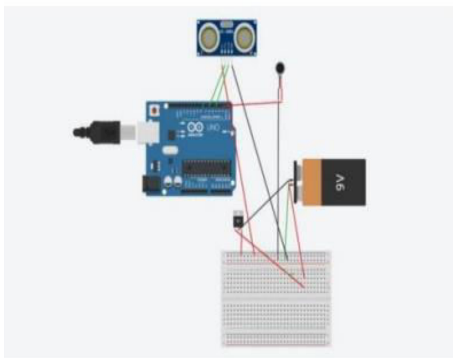

Figure 8: working model of the proposed system

Some advanced systems may include features like GPS for location tracking, Bluetooth for connectivity with mobile

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apps, and cameras for more detailed obstacle recognition.

IV. RESULT

Figure 9: Implemented Model of the proposed system

This paper was successfully tested and implemented in tinder cad and partially implemented in the hardware model. In the software model, whenever the object came nearby to the sensor it got detected by the distance (dist1 = dur1 * 0.034 / 2) which was the default. The potentiometer was provided to change the distance accordingly and it give successful results for detecting objects and the alarms the buzzer. The vibration motor was also implemented successfully according to their object's direction it vibrated. In the hardware model prototype of the stick was made and one side detection was successfully tested.

V. CONCLUSION

Visually impaired people need assistance to navigate safely for daily activities, and often a dog or stick is used for that purpose. With the advancements in technology, assistive sensors have been introduced in modern sticks for object detection and to guide the users to navigate on the outside. This study presents a smart stick that can both detect and identify obstacles and help visually impaired people. The blind population may go out into the world without any help from others while utilizing the proposed IoT-enabled intelligent stick with obstacle recognition because of its various features, including obstacle detection and recognition, water puddle detection, audio messages, haptic feedback, live location sharing and panic button for emergency contact through SMS.

Furthermore, the proposed smart stick is fully automated and does not need any input from the user, as it consists of ultrasonic sensors and camera modules that sense obstacles around the user and provide feedback to the user with the assistance of earphones and vibration motors connected to the controller. The two modes of obstacle detection and obstacle detection and recognition are useful in their own ways; the first has a longer battery life, but the latter has more accessibility features. The system continually operates so that the visually disabled person can obtain updates on the challenges up ahead at any point in the way.

Consequently, with the aid of this intelligent stick, the visually impaired can perform their daily tasks comfortably and go out in the world without any fear of getting lost or hitting someone or something.

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