

# TECH-ENABLED WALKING STICK FOR VISION IMPAIRED

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**Abstract:** This paper introduces a tech-enabled walking stick that supports visually impaired people by improving mobility and security. The gadget is prepared with diverse sensors, counting ESP32-based farther checking framework, Apr voice module, and GPS following. The stick provides a real-time language arm through the APR module to ensure that users receive immediate feedback from their surroundings. Additionally, Guardians can monitor sensor data via a web-based interface for improved safety and monitoring. The light and rechargeable design of the stick is extremely practical for everyday use. This innovation is aimed at providing greater independence and improved navigation to people with visual impairments.

**Keywords:** Arduino Uno, ESP32, GPS, Ultrasonic Sensor, ARP Voice Module, IOT, Remote Monitoring.

## I. INTRODUCTION

It's a day-to-day activity, and for a blind person, it would be out of the question to go around the world. For decades, white cane and guide dogs have been used as traditional mobility aids, which offer both tactile and auditory feedback to users. These methods have their limitations, such as the inability to detect large obstacles, moving objects, or alterations in environmental conditions like fire or water hazards. Also, the assistance relies on the user's sensory perception, which may not be adequate in complex environments.

Advancements in sensor technology, microcontrollers, and wireless communication make the reality of smart aids possible. By combining various sensors with an effective feedback system, aids have been revolutionized, resulting in improved navigation that is more secure for visually impaired individuals. By utilizing advanced built-in systems, the Smart Blind Stick provides immediate environmental awareness and minimizes the risk of mobility issues.

Rapid growth in the IoT has increased the potential for aids through remote monitoring and real-time data transfer.' The use of Wi-Fi connectivity in aids enables caregivers to monitor the user's actions and receive real-time sensor alerts while also providing additional security and assistance.

Smart Blind Stick is a pioneering initiative employing IoT- based tracking to enhance the safety and independence of the blind. A smart blind stick with a range of sensors, voice aid, and wireless surveillance capabilities is the focus of this research.

## II. LITERATURE SURVEY

Siddharth Bhorge *et al*<sup>6</sup> proposed the Object Detection Blind Stick (ODBS), a highly advanced blind aid device. With the incorporation of a GPS module, GSM module, ultrasonic sensor, and Arduino Uno microcontroller, the ODBS provides real-time detection of obstacles, location tracking, and navigation guidance.

With machine learning object classification, the system increases situational awareness and provides customized feedback. The inexpensive deployment and successful experimental validation render the ODBS a practical and beneficial device for the facilitation of blind mobility and safety.

P. Rajesh *et al*<sup>11</sup> suggested a Smart Blind Stick System with the addition of GPS, GSM, ultrasonic sensors, infrared sensors, ESP32, Arduino Uno, AI-based obstacle detection, IoT connectivity, and APR voice modules for aid. The system employs ultrasonic and infrared sensors for obstacle sensing, GPS and GSM modules for real-time positioning and emergency notification, and AI-based obstacle detection for greater situational awareness.

R. Kavitha *et al*<sup>8</sup> introduced a Smart Electronic Stick (Smart E- Stick) capable of improving the navigation of the blind through the integration of sensor technology and wireless communication. Obstacles and hazards from the surroundings are detected through ultrasonic, light, and water sensors and processed by a microprocessor to determine proximity and sound alarms. Buzzer and haptic vibration are used to provide immediate feedback for water, potholes, and obstacles and, therefore improve mobility safety. The stick is also fitted with a wireless RF remote that can locate itself if it gets lost. The incorporation of the "Speak for Me" Android app further improves it in terms of voice message creation for navigation by the user.

Ram Mude *et al*<sup>12</sup> created a blind walking stick with a first- person view live streaming system to assist visually impaired individuals in navigation and awareness of the environment. The system utilizes a camera-fitted eye-piece on glasses to stream live for object-detection-based audio feedback. Stick sensors detect obstructions and provide vibration feedback, and the GPS module senses the user's location in world coordinates, published and shown through a website.

This portable technology aims to improve mobility and freedom by enabling easier navigation of novel environments with more confidence.

Rajanish Kumar Kaushal *et al*<sup>13</sup> proposed an intelligent blind stick system based on IoT and AI technology to improve mobility and safety for the blind. The system utilizes ultrasonic sensors for detecting obstacles and an ESP32 camera to capture traffic signal images, which are processed with an Artificial Neural Network (ANN) model to identify signals. A speaker module provides voice alerts in real time for obstacles and traffic signals, which makes driving safer. Additionally, the system monitors the user's location and, if he/she ventures beyond a pre-defined area, sends an alert message to a registered mobile number. With the combination of different sensors, IoT connectivity, and AI-based recognition, the proposed solution offers an efficient, low- cost, and user-friendly assistive technology for visually impaired users.

Krupal Jivrajani *et al*<sup>1</sup> developed a smart cane integrating AIoT, ultrasonic sensor, object and currency detection-based deep learning-based camera, health monitoring with pulse sensor, navigation with Raspberry Pi, emergency alert notification with GPS, and Android application for Firebase interaction for use in real-time location and health monitoring. The system also provides live bus routes to aid in trip planning.

Prashik Chavan *et al*<sup>14</sup> proposed a smart blind stick with ultrasonic sensors, a servo motor, a buzzer, and a switch button for better obstacle detection. The system contains two modes: case 1, in which the ultrasonic sensor detects the obstacles directly ahead, and case 2, in which the servo motor turns the sensor to scan more area when crowds are around. A buzzer indicates the user upon obstacle detection, and a switch button makes switching modes easy. The stick provides the visually impaired person direction and sensitivity to the surroundings.

N. Loganathan *et al*<sup>15</sup> developed an intelligent blind stick using ultrasonic and infrared sensors, an RF transmitter and receiver module, a buzzer, a vibration motor, and an Arduino Uno board. It can sense obstructions to a distance of four meters, give vibration signals, and assist in locating the stick if misplaced by an RF-based buzzer system.

Arnesh Sen *et al*<sup>16</sup> proposed a walking stick using ultrasonic proximity sensors for pothole and obstacle detection, a GPS module for location tracking, and ultrasound reflection technology for enhanced navigation. The system is sensitive and can be worn on clothing, shoes, the body, or fixed on a walking stick for convenient usage. It is suitable for indoor and outdoor use, aiding visually impaired persons in independent mobility.

Apurv Shaha *et al*<sup>17</sup> proposed a smart walking stick using an ultrasonic sensor (range 5m) for obstacle detection, low-latency data sending protocols, a GPS module for location tracking in real time, and a mobile app for monitoring emergencies. It possesses different levels of alarm based on the closeness of the obstacles and possesses high power-saving capability to avoid battery replacement and charging events. Real-time tracking was tested in a blind school for experimental validation.

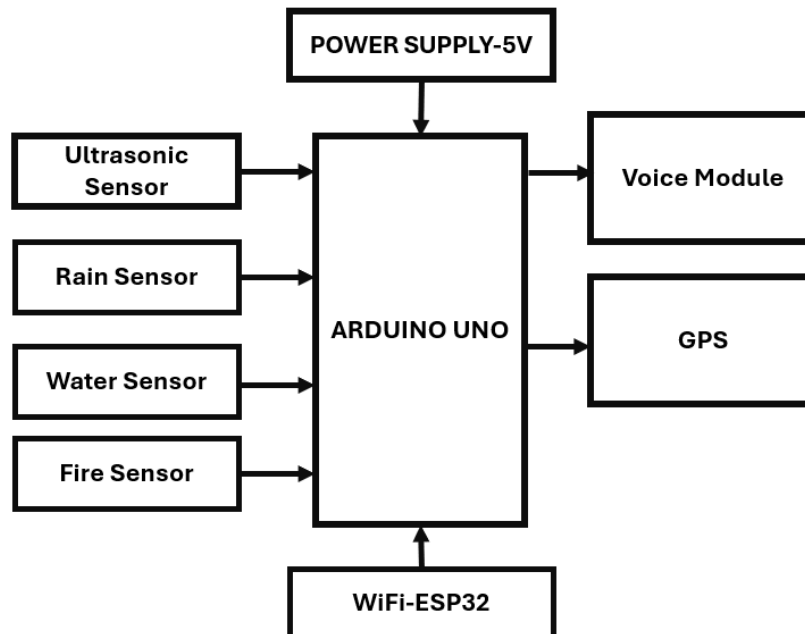
**III. PROPOSED METHOD BLOCK DIAGRAM**

Fig-1: Block diagram

The systems approach to be implemented is intended to provide an assistive real-time aid to the visually impaired individual by means of combining different sensors, wireless communication, and interactive alerting.

The system incorporates a processing unit, which is Arduino Uno, along with the ESP32 that provides wireless connection capabilities. The ESP32 hotspot is fully setup with a preset username and password, making it easy to pair the device and provide it with a static IP address. The assigned IP address gives guardians/caregivers the ability to remotely view data from the sensors via a web browser; thus, guardians/caregivers can experience monitoring or remote security as close to real-time as possible.

To design a comprehensive hazard detection system, an ultrasonic sensor will be integrated to create a barrier detection system, a rain sensor which detects the condition of wet road surfaces, and a water sensor that detects water-logging conditions.

A fire sensor will provide alerts for hazardous fire conditions but will also provide a supplemental layer of safety based on the multiple environmental conditions a user may find him or herself in.

A GPS Module will continuously track the user's location in real-time time with real-time coordinates, which can all be accessed remotely so a monitoring system can assess the user's conditions and assist when needed.

In connection to the built-in interface of user interaction, an APR voice module will provide audible alerts that the hazards identified may be hazardous, so a blind or visually impaired user will be able to identify and be cognizant of hazards or changes in their environment.

This small, affordable, and minimalistic system was developed to improve mobility, autonomy and safety for the blind, and enables an highly flexible and autonomous form of movement, allowing users to travel safely for the environment when they can still reasonably depend on assisted technologies that are detecting risks in real-time and location- based circumstances where they can still be monitored remotely.

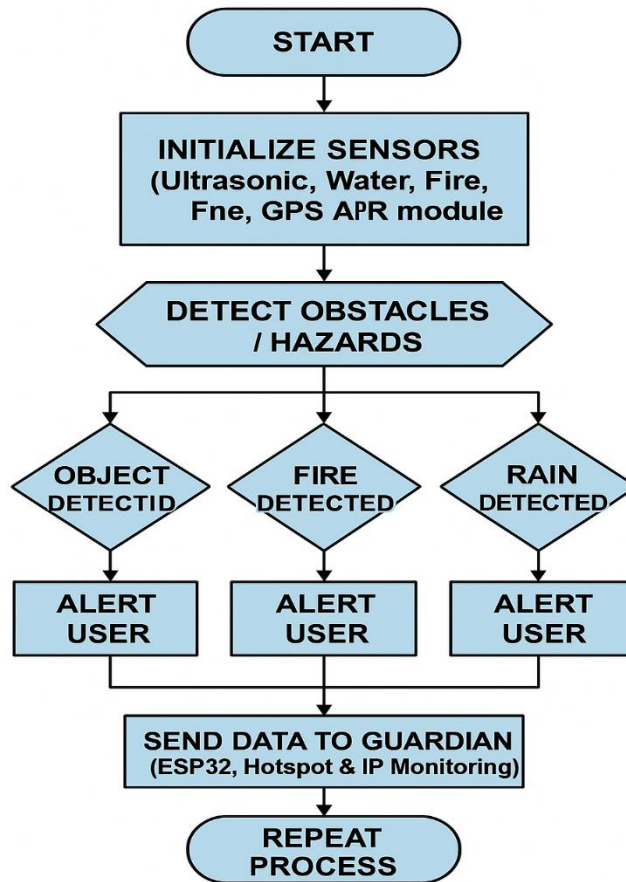
**Flow Chart:**

Fig-2: Flow chart of the system

### 3.1 HARDWARE IMPLEMENTATION



Fig-3: Setup

The hardware setup of the smart walking stick includes an Arduino Uno for sensor processing and a separate ESP32 for wireless connectivity. Hazards and obstacles are detected through ultrasonic, rain, water, and fire, while a GPS module is also used for location tracking. The APR9600 voice module provides real-time audio feedback. All hardware components are evaluated for maximum efficiency to ensure smooth operation and comfort for users who are visually impaired.

**Arduino Uno (ATmega328P):** The device acts as a principal microcontroller interfacing with multiple sensors used to gather data and provide live feedback. The microcontroller continuously polls for input signals, interprets detected hazards, and outputs responses based on that interpreted data. The equipment operates at 5 volts, which is sufficient power to operate each of the modules when not in fault.

**ESP32:** Enables wireless communication capability. Hotspot will automatically be created and connect with a stored configuration. The hotspot creates a non-shared IP address. The guardian can view live sensor data in a web browser while monitoring the user's environmental condition remotely.

**HC-SR04 ultrasonic sensor (2 cm – 400 cm range):**

To detect objects, the HC-SR04 ultrasonic sensor sends ultrasonic waves that return once they come in contact with an object. The duration of time that the echo returns indicates how far away a collision barrier is. It can then determine when an obstruction is approaching, indicating to the user that it is safe to pass.

**FC-37 rain sensor:** Rain sensor (0% – 100% moisture detection) senses rain and alerts the rider to remain dry. It is also very handy when slipping on wet floors is to be avoided.

**YL-83 water sensor:** The water sensor (water depth sensing in the range 0 mm to 5 mm) is positioned near the base of the stick to sense water-logged areas, warning When the user approaches puddles or flood areas, they are warned.

**NEO-6M GPS module:** It is included for enabling real-time location tracking. This enables the caregiver or guardian to monitor the movement of the user and protect them. The guardian can monitor the location of the user in detail if needed through the interface that is related to the system.

**APR9600 voice module:** For offering voice instructions, the APR9600 voice module (60-second recording capacity, 3V – 5V power supply) offers pre-recorded voice messages whenever a sensor identifies a hazard. Rather than vibrations or mere beeps, this system gives voice warnings so the user can easily hear what type of obstacle or threat is ahead.

**Power supply:** A 2200mAh lithium-ion battery drives the whole system, with the capability of supporting long usage without frequent recharging. The aluminum body with ABS plastic cover keeps it light and sturdy while being portable and easy to manage.

### 3.2 SOFTWARE IMPLEMENTATION

The software implementation of the tech-enabled walking stick is designed to process sensor data, detect obstacles and hazards, and provide real-time auditory feedback to visually impaired users. The system is programmed in Embedded C in the Arduino IDE, enabling seamless integration of microcontrollers, sensors, and the DFPlayer Mini module for voice notification.

Upon power-up, the Arduino Uno reads the attached sensors and sets up serial communications before activating the DFPlayer Mini to play sound.

The ESP32 is programmed separately to generate a Wi-Fi hotspot, allowing guardians to access real-time sensor data through a web interface.

The system continuously monitors inputs from the ultrasonic sensor for obstacle detection, the fire sensor for flame detection, and the rain and water sensors for environmental conditions. The rain and water sensor values are mapped to percentage levels to provide meaningful data representation.

When a hazard is identified, such as fire, heavy rain, high water level, or an obstacle in the vicinity, the system gives a sufficient audio warning using DFPlayer Mini.

The ultrasonic sensor continuously scans for objects, and if an obstacle is detected within a predefined range, the system plays a warning message. Each hazard has a designated audio track that notifies the user of the condition that has been

detected. The software ensures real-time processing, seamless sensor communication, and effective alert mechanisms, making the walking stick a trusted aid device for visually impaired individuals.

#### **IV. RESULT**

With the smart walking stick for the blind, users can receive real-time alerts as well as detect obstacles, environmental hazards, and sources of potential danger. By integrating various sensors with the Arduino Uno and ESP32, the system ensures that data processing is smooth and reliable.

The ultrasonic sensor is able to measure distances effectively and detect any obstacles in the environment. When an object is within a specific range, the DFPlayer Mini emits an audio alert and informs the user of its presence. This device's fire sensor detects and promptly activates a warning sound, making the user aware of any potential fire hazards.

Rain and water detection sensors can provide an accurate detection of the conditions of the environment. The rain sensor measures the amount of rainfall, and the water sensor detects logging. In case of an increase in rain or water levels, the system uses a suitable voice alert to notify the user.

The ESP32 will be programmed to create a Wi-Fi hotspot that will display when user-friendly username and password options are assigned. It connects and provides an IP address, which enables guardians to view live sensor information through their web browser. By allowing at-a-distance viewing functionality, the user can rest assured of additional security and independence.

During testing, the system consistently responded to sensor inputs, processed data with accuracy, and promptly activated voice alerts. Sensor-based hazard detection coupled with audio feedback and remote monitoring improves the mobility offered to a visually impaired individual, making a walking stick an effective assistive device.

## **Smart Blind Stick**

Fire : Normal

Rain : Rain Detected

Water: Water Detected

Ultrasonic: Object Detected

## **GPS Location**

Latitude: 17.6045673

Longitude: 78.4864816

[View on Google Maps](#)

Fig-4: Results

Feature	Tech-enabled walking stick	Existing Smart Walking Sticks
Microcontroller/Processor	Arduino Uno	ESP32, Raspberry Pi, Arduino
Obstacle Detection	Yes (Ultrasonic Sensor)	Ultrasonic / Infrared Sensors
Pothole Detection	Yes (Ultrasonic Sensor)	Not available
Fire Detection	Yes (Fire Sensor)	Not available
Weather Detection	Yes (Rain Sensor)	Rarely integrated
Water Detection	Yes (Water Sensor)	Not available
Voice Alerts	Yes (Voice Module)	Not available
GPS Tracking	Yes (Real-time tracking for guardians)	Not commonly available
Sensor Data Monitoring	Yes (Accessible via Web Browser)	some models via apps
Weight	Lightweight	Some are bulky
Cost Efficiency	Affordable	Expensive

Table-1: Comparison table

## 4.1 CONCLUSION AND FUTURE SCOPE

The tech-enabled walking stick for blind individuals integrates multiple sensors, microcontrollers, and auditory feedback capabilities designed to enhance mobility and safety. The system efficiently detects obstacles, fire, rain, and water levels, providing real-time alerts through the DFPlayer Mini module.

The ESP32 enables remote monitoring by generating a Wi-Fi hotspot, allowing guardians to access sensor data through a web browser. With accurate sensor readings and instant voice notifications, the device significantly improves the user's ability to navigate their surroundings independently.

### Future Scope:

The project has the potential for further enhancement by incorporating advanced features. Integrating AI-based object recognition using a camera module could help identify different obstacles, providing more specific guidance.

Adding real-time GPS tracking with a mobile application could enable guardians to monitor the user's location remotely. Improvements in power efficiency, such as solar-powered charging or energy-saving modes, could enhance battery life for extended usage. Additionally, integrating Bluetooth connectivity could allow seamless smartphone communication for navigation assistance.

By incorporating these advancements, the smart walking stick can evolve into a more sophisticated assistive device, offering enhanced safety, navigation, and independence for visually impaired individuals.

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