

**19CSE446  
IOT – INTERNET OF THINGS**

**SMART BLIND**

**STICK**

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**PROJECT REPORT**

*SMART BLIND STICK*

**1. Abstract:**

The Smart Blind Stick is an innovative IoT-based assistive device designed to enhance the mobility and safety of visually impaired individuals. The system integrates multiple sensors with an ESP32 microcontroller to detect obstacles, provide real-time alerts, and track location. Key components include an ultrasonic sensor for distance measurement, IR sensor for object detection, a touch sensor to monitor user interaction, and a GPS module for location tracking. The collected data is transmitted to a user-friendly interface that displays real-time sensor readings and location updates. A buzzer serves as an immediate feedback mechanism to alert the user of nearby obstacles. Powered by an 11.5V battery, the system is compact, reliable, and easily portable. This project demonstrates a practical application of IoT to address real-world challenges faced by visually impaired individuals, offering both increased autonomy and improved safety.

**2. Introduction**

Visually impaired individuals often face difficulties in navigating safely and independently. Traditional white canes offer basic assistance but lack features like obstacle alerts and location tracking. To address these limitations, this project presents a Smart Blind Stick using IoT technology.

The stick integrates an ultrasonic sensor for obstacle detection, an IR sensor for object proximity, a touch sensor for user interaction, and a GPS module for location tracking. An ESP32 microcontroller processes the data, while a buzzer provides audio alerts. A user interface displays real-time sensor readings and location, enhancing usability and monitoring.This compact, low-cost system aims to

improve the mobility and safety of visually impaired users through smart, real-time assistance.

**3. Project Objectives**

**3.1 Main Objective**

To develop an IoT-based Smart Blind Stick that assists visually impaired individuals by detecting obstacles, providing real-time alerts, and tracking location, thereby enhancing their safety and independence.

**3.2 Sub-objectives**

* To integrate and calibrate an ultrasonic sensor for accurate distance measurement from obstacles.
* To use an IR sensor for close-range object detection.
* To implement a touch sensor for detecting user interaction or usage.
* To incorporate a GPS module for real-time location tracking.
* To program the ESP32 microcontroller to collect and process sensor data efficiently.
* To trigger a buzzer for audio feedback when an obstacle is detected.
* To design a user interface that displays real-time sensor data and GPS location

**4. IoT System Architecture and Design**

**4.1 Problem Statement and Literature Survey**

Visually impaired individuals often rely on white canes, which lack features like obstacle detection and location tracking. Existing assistive devices using ultrasonic sensors or GPS offer limited IoT integration and often miss real-time feedback or ease of use.

This project proposes a Smart Blind Stick that combines multiple sensors with IoT technology to provide obstacle detection, location tracking, and real-time alerts through a user-friendly interface, offering a compact and affordable solution.

**4.2 Proposed System Overview**

The Smart Blind Stick is an IoT-enabled device designed to assist visually impaired users by detecting obstacles using sensors and alerting them via a buzzer. It uses an ESP32 microcontroller to read data from the ultrasonic sensor, IR sensor, touch sensor, and GPS module. The collected data is processed at the edge and displayed through a user interface. The device is powered by an 11.5V battery, making it fully portable.

**4.3 Hardware Components**

* ESP32: Acts as the central controller for processing sensor data and managing communication.
* Ultrasonic Sensor: Measures distance to detect obstacles ahead.
* IR Sensor: Detects nearby objects or surfaces.
* Touch Sensor: Detects user interaction or usage status.
* GPS Module: Provides the real-time geographic location of the stick.
* Buzzer: Alerts the user when obstacles are detected.
* Battery (11.5V): Powers all components.
* Breadboard & Wires: For temporary circuit assembly and testing.

**4.4 Software Architecture**

* Firmware: Written in Arduino C/C++ to interface sensors with the ESP32.
* Data Handling: Sensor readings are processed on the ESP32.
* Communication: Data sent via Wi-Fi to a local or cloud-based server.
* User Interface: A web/mobile-based dashboard displays real-time readings such as:

Distance to obstacles

Touch sensor status

Object presence

Live GPS location

**4.5 Edge and Cloud Integration**

The ESP32 acts as the edge device, handling real-time data collection and processing of sensor inputs to trigger immediate responses like buzzer alerts. For cloud integration, Firebase is used to store GPS data, obstacle detection events, and usage logs, enabling real-time monitoring and seamless synchronization with the user interface.

**4.6 Identification of Things**

Each smart blind stick can be assigned a unique device ID (e.g., MAC address of the ESP32) to differentiate between multiple users or devices in a cloud-based or networked setup.

**4.7 IoT Level Classification**

The system qualifies as a Level 2 IoT system, which includes:

* Data acquisition through sensors
* Local processing at the edge
* Real-time response (buzzer alerts)
* Optional cloud connectivity for visualization or long-term monitoring

**4.8 Intelligence at Edge and Cloud**

Edge intelligence enables immediate decision-making, such as triggering the buzzer when an obstacle is detected, and filters sensor data to reduce unnecessary communication. Cloud intelligence, via Firebase, allows for historical data storage, real-time visualization, and remote monitoring, with scope for future enhancements like AI-based navigation or voice guidance.

**5. Data Analytics and User Interface**

**5.1 Analytics Metrics**

The system collects and analyzes the following key metrics:

* Obstacle Detection Frequency: Number of times obstacles are detected via the ultrasonic or IR sensors.
* Distance Readings: Real-time distance measurements from the ultrasonic sensor to monitor proximity trends.
* Touch Sensor Activity: Tracks user interaction (pressed/not pressed) to determine stick usage patterns**.**

**5.2 UI Layout and Features**

The user interface is designed to be simple, accessible, and informative. Key features include:

* Live Sensor Data Display:
  + Ultrasonic sensor distance
  + Touch sensor status (Pressed/Not Pressed)
  + IR sensor status (Object detected/Not detected)
* Location Tracking:
  + Real-time GPS location display using map integration or coordinates.
* Alert Indicators:
  + Visual indicators when obstacles are detected or alerts are triggered.
* Cloud Sync (Firebase):
  + Displays synchronized data from Firebase for remote monitoring.
  + Option to view historical logs

**6. Implementation and Demo**

**6.1 Hardware Setup**

* ESP32 Microcontroller: Central controller for data processing and communication.
* Ultrasonic & IR Sensors: Detect obstacles and nearby objects.
* Touch Sensor: Detects user interaction on the handle.
* GPS Module: Tracks the user's real-time location.
* Buzzer: Provides audio alerts when obstacles are detected.
* 11.5V Battery: Powers the entire system.
* Breadboard & Wiring: Used for initial testing and connections.

**6.2 System Pictures and Screenshots**

**A screenshot of a smart blind stick dashboard

AI-generated content may be incorrect.**

**7. Challenges and Solutions**

* Sensor Calibration and Accuracy → Calibrated sensors and adjusted orientation
* Power Consumption → Implemented low-power modes and used a larger battery
* Real-time Data Syncing → Used local storage and sync when stable network available
* User Interface Accessibility → Designed simple UI with auditory cues and high contrast
* Multiple Sensor Integration → Applied efficient data management algorithm

**8. Conclusion**

The Smart Blind Stick integrates IoT technology and multiple sensors to help visually impaired individuals navigate safely. Using the ESP32 microcontroller, ultrasonic and IR sensors, GPS, and a simple interface, it provides real-time obstacle detection and location tracking.

Challenges like power consumption, calibration, and syncing were resolved, ensuring reliability. Cloud integration with Firebase allows for monitoring and future enhancements.

This project shows the potential of IoT to improve mobility and situational awareness for visually impaired users in a cost-effective and portable manner.

**9. References**

* ESP32 Documentation
* Ultrasonic & IR Sensor Data Sheets
* GPS Module Documentation
* Firebase Documentation

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