

# ***Development of an IoT-Based Navigation System for the Blind with Obstacle Detection, Emergency Button, and Real-time Location Tracking***

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## **ABSTRACT**

*Blind people often face difficulties in recognizing obstacles and determining direction while walking, especially in unfamiliar outdoor environments. Conventional aids such as white canes are unable to provide early warning of obstacles from various directions or real-time location information. Based on these problems, this study aims to design and develop an electronic navigation aid system equipped with ultrasonic sensor-based obstacle detection, voice notifications, and GPS integration for location tracking to improve user safety and independence. The method used is an engineering research approach with the stages of system design, implementation, and testing. The system is designed using an ESP32 microcontroller, an HC-SR04 ultrasonic sensor for obstacle detection, a DFPlayer Mini for voice notifications, a NEO-6M GPS module for location tracking, and a SIM800L module for sending data to the Firebase Realtime Database. An Android application was created using MIT App Inventor as an interface for location monitoring and emergency conditions. Test results show that the system is able to detect obstacles with a fast response, provide clear voice warnings in quiet environments, and send location coordinate data to Firebase with a delay that varies depending on the network signal strength. The emergency button worked effectively, triggering real-time notifications in the app. The overall system proved functional according to the research objectives, although improvements are still needed in terms of voice clarity in noisy areas and network connection stability.*

**Keywords:** *visual impairment aids, GPS, voice notifications, ultrasonic sensors*