IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

EchoLens:Vision Through Sound

Arti B.S[1], Muhammed Afraaz Faruk Patel[2], Abullais Iqbal Ahmed Katgeri[3], Amit Shivamurti Kamatagi[4], Mehfuzahmed N Sayyed[5]
Maratha Mandal's Engineering College, Belagavi, Karnataka, India
Department of Robotics & Artificial Intelligence

Abstract
This paper presents EchoLens: Vision Through Sound, an intelligent, low-cost assistive system designed to enhance mobility and safety for visually impaired individuals. The system integrates multiple sensors—ultrasonic, flame, water, temperature, and fall detection—interfaced with a PIC microcontroller. It provides real-time audio feedback through a voice processor and wireless monitoring via the Internet of Things (IoT) using an ESP8266 Wi-Fi module and the Blynk application. The stick detects obstacles, environmental hazards, and health conditions, issuing immediate alerts through both speech and remote notifications. Experimental results demonstrate accurate detection of obstacles up to 4 meters, fast response time, and reliable connectivity with mobile applications. By combining embedded control, sensor fusion, and IoT technologies, EchoLens improves user autonomy, reduces risk in unfamiliar environments, and bridges the gap between assistive hardware and smart communication systems. The project contributes toward inclusive innovation by transforming conventional mobility aids into interactive smart devices for social and health empowerment of the visually challenged.

Keywords:

Assistive technology, IoT, ultrasonic sensor, PIC microcontroller, visually impaired, embedded systems, voice feedback.

1. Introduction

Visual impairment significantly affects the independence and safety of millions of individuals worldwide. According to the World Health Organization, more than 285 million people are visually impaired, of which approximately 39 million are completely blind. Navigating public spaces or unfamiliar environments without assistance remains one of their greatest challenges. Traditional walking canes, though widely used, provide only limited tactile feedback and no information about dynamic or distant obstacles such as moving vehicles or overhead obstructions.

In recent years, rapid advances in embedded systems, sensor technologies, and wireless communication have enabled the development of smart assistive devices. These systems can detect environmental hazards, provide voice-based feedback, and enable remote monitoring through IoT integration. The EchoLens project is designed as a portable, intelligent solution that leverages these technologies to enhance situational awareness and independence for visually impaired users.

EchoLens: Vision Through Sound integrates multiple sensors into a single, ergonomic walking stick. The sensors continuously monitor the user's environment and physiological conditions. Detected events trigger context-specific voice alerts through a speaker and send notifications to caregivers via a mobile app. The system operates on embedded C code within a PIC microcontroller and communicates wirelessly using the ESP8266 Wi-Fi module.

This work aims to address key limitations of existing assistive systems—namely cost, complexity, and limited real-time interactivity—by offering a compact, energy-efficient, and user-friendly solution.

2. Literature Review

Extensive research has been conducted on assistive technologies for visually impaired individuals, utilizing sensors, computer vision, and wearable electronics.

Chaudhary and Choudhury [1] proposed an ultrasonic sensor–based smart blind stick that uses distance measurement for obstacle detection, offering effective short-range guidance. Similarly, Dagar et al. [2] designed a smart cane combining ultrasonic sensors and microcontrollers to provide vibration feedback. Kang et al. [3] introduced Raspberry Pi–based smart glasses for the blind, integrating a camera for object recognition; however, the system was expensive and power-intensive.

While these studies provide valuable foundations, most focus on either obstacle detection or IoT connectivity alone. The novelty of EchoLens lies in integrating multiple sensors— environmental, positional, and physiological—within a single embedded framework coupled with real-time voice feedback and IoT monitoring. This holistic design ensures user safety, health tracking, and social connectivity simultaneously.

3. Methodology

The methodology of EchoLens follows a systematic engineering process comprising design, development, and evaluation phases.

System Architecture: The architecture includes a PIC16F877A microcontroller as the core processing unit. Multiple sensors—ultrasonic, flame, water, temperature, and angular displacement (fall)—provide analog and digital data inputs. These inputs are processed in real-time to detect events and trigger appropriate actions. The ESP8266 Wi- Fi module handles wireless data transmission to the Blynk IoT platform, where caregivers can monitor alerts via smartphones or tablets.

Hardware Components include ultrasonic sensor, flame sensor, water detection sensor, fall detection sensor, body temperature sensor, emergency button, voice processor, and ESP8266 Wi-Fi module.

Software Design: Embedded C programming using MPLAB IDE was employed to control the PIC microcontroller. The software handles sensor data acquisition, event classification, voice playback control, and IoT data transmission.

Implementation and Testing: Hardware modules were first tested on a breadboard, then soldered onto a PCB for durability. Unit testing ensured each sensor's accuracy and stability.

4. Results and Discussion

The EchoLens system was evaluated based on detection accuracy, voice feedback response time, and IoT communication reliability.

Performance Analysis: The ultrasonic sensor reliably detected obstacles from 15 cm to 400 cm, with an average response delay of less than 200 ms. The IR sensor detected fire sources within 80 cm and maintained stable operation under variable light conditions.
Moisture detection worked accurately, and fall alerts were triggered within 100 ms.

Comparative Analysis: Compared with existing smart cane prototypes, EchoLens provides a more comprehensive multi-sensor suite with both environmental and physiological monitoring.

Discussion: The results affirm that low-cost microcontrollers and sensors can be effectively combined to create efficient assistive devices. Challenges identified included limited Wi-Fi range and occasional false triggering from reflective surfaces.

5. Conclusion and Future Work

This paper presented EchoLens: Vision Through Sound, an IoT-enabled, voice-assisted mobility aid for visually impaired individuals. By integrating multiple sensors with a PIC microcontroller and Wi-Fi communication, the system effectively detects environmental hazards and health conditions, providing immediate auditory and remote alerts.

Future work will focus on enhancing system intelligence through machine learning, implementing GPS-based tracking, and optimizing power management. Ultimately, EchoLens exemplifies how embedded IoT systems can transform traditional assistive tools into intelligent companions, contributing to inclusive technology for social well- being.

References

[1] Arati B. S. and Dr. Veena M. B. "Reconfigurable Single Precision Floating Point Multiplier using Reversible Logic", published in International Journal of Electronics Communication and Instrumentation Engineering Research and Development ISSN(Print):2294-684X: ISSN(Online):2249-7951: vol-4: DEC-2014; Impact Factor: 4.9467: Index Copernicus Value-2014:3.0

[2] Arati B.S. and Dr. Prashant P. Patavardhan. "Lesion Detection using Skin Biometric with Super Resolution", published in International Journal of Research and analytical Reviews. an international open access journal/approved by UGC (Journal No:43602). E-ISSN 2348-1269, P-ISSN 2349-5138. Impact factor 5.75, volume 7. Issue 4. October 2020