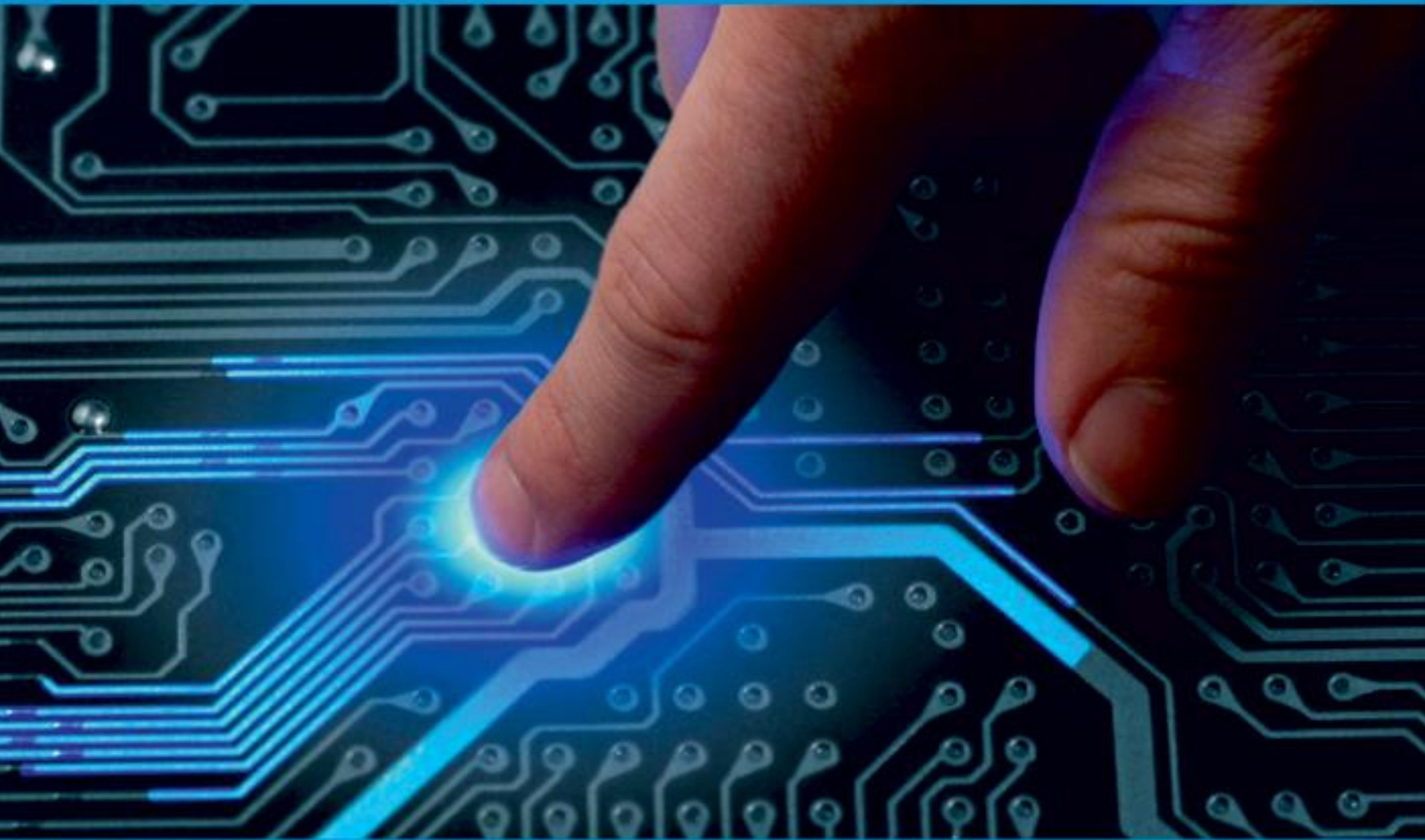
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 5, May 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 5, May 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1205254 |

Echo Sight-Vision for Blinds

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ABSTRACT: This project aims to develop an advanced assistive device designed specifically for visually impaired individuals, harnessing the capabilities of IoT technology. The main innovation involves incorporating ultrasonic sensors into a traditional blind cane, enabling it to detect obstacles in the user's path. This obstacle detection feature is critical for ensuring user safety and facilitating independent movement. Additionally, the device includes an ultrasonic soil moisture sensor, providing users with real-time information about soil moisture levels in their surroundings. With a NodeMCU ESP32 microcontroller serving as the central processing unit, the system can efficiently process sensor data and deliver prompt feedback to the user. This feedback can be customized to the user's preferences and accessibility needs, including auditory cues, vibration patterns, or tactile signals. Extensive user testing and feedback collection from visually impaired individuals guide the ongoing refinement of the device, ensuring its usability and effectiveness across various environments and situations. Ultimately, this innovative solution aims to empower visually impaired users by improving their mobility, enhancing environmental awareness, and fostering greater independence in their daily lives.

KEYWORDS: Blind cane, visually impaired individuals, NodeMCU ESP32 microcontroller, Real-time object identification and detection, Obstacle Detection, IOT technology.

I. INTRODUCTION

In today's world, where inclusivity and empowerment are key, assistive technologies are crucial for individuals with disabilities to navigate and interact with their surroundings. One such technology is the blind stick, a vital tool for visually impaired individuals that provides essential tactile feedback for safe movement. However, with the rapid advancements in IoT technology and sensors, there's a unique chance to enhance the blind stick with innovative features beyond just detecting obstacles. This project aims to utilize IoT by integrating ultrasonic sensors into the blind stick's design, improving its functionality to offer real-time insights into environmental conditions alongside obstacle detection. By adding an ultrasonic soil moisture sensor, this IoT-enabled blind stick becomes a comprehensive tool for confidently navigating environments and engaging in outdoor activities.

The core of this project involves blending traditional assistive technology with IoT innovation. Integrating ultrasonic sensors into the blind stick enhances its precision in obstacle detection, boosting user confidence in navigating complex spaces. Additionally, the soil moisture sensor provides valuable environmental information, facilitating activities like gardening or agriculture. A key aspect of this project is its user-centered design and iterative development. Input and feedback from visually impaired individuals guide device refinement, ensuring it meets their unique needs. From sensor placement to user interface design, every aspect is crafted for usability and accessibility. Real-world testing ensures continual improvement, striving for optimal functionality and reliability.

Ultimately, this project marks a transformative leap in assistive technology, using IoT to empower visually impaired individuals with confidence and independence. By merging tradition and innovation, it fosters a more inclusive society where everyone can thrive regardless of their abilities.

II. RELATED WORK

In [1], the author’s research focuses on assessing students understanding of IOT concepts. Author chosen project, “The Smart Stick Assistant for Visually Impaired People Using AI Image Recognition” aims to enhance accessibility for blind individuals during travel. This research seeks to improve responses for visually impaired individuals.

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In [2], an individual with vision impairment face challenges in communication and navigation their surroundings. The author develops an intelligent smart stick and alert system which aims to assist the blind individual by detecting the obstacles and providing location information through smart stick.

In [3], the smart device is highlighted as a crucial aid for the blind individuals, offering obstacle detection and location tracking capabilities through ultrasonic sensors. The technology enables the independent navigation and enhances user convenience with features like vibration feedback, compact design and ease of handling.

In [4], proposed a system that addresses the challenges faced by blind or partially sighted individuals in navigation. Utilizing sensors for detecting raised surfaces like staircases and ultrasonic sensor for object detection. In this system ISD1820 which enables the speech warnings when barriers are detected. This system provides an affordable, efficient, rapid, and lightweight solutions for impaired individuals.

In [5], a system is built around an Arduino Nano, interconnected with the wires to its digital and analogue pins. With an input voltage range of 9V/12V, the system offers a comprehensive range of features. It can detect various-sized obstacle and trigger appropriate vibratory and auditory alarms.

In [6], proposed system for blind individuals integrates a camera and microcontroller within a walking cane. When encounters obstacles, the camera captures image and then processed by the microcontroller for object detection. The system triggers the waring through an earpad, enhancing the safety during street crossings.

III. THE ECHOSIGHT SYSTEM

System requirement specification is a fundamental document, which forms the foundation of the software development process. It not only lists the requirements of a system but also has a description of its major feature. An SRS basically an organization's understanding (In writing) of customer or potential client's system requirements and dependencies at a particular point in time prior to any actual design or development work. It is two-way insurance policy that assures that the client and the organization understand other's requirements from that perspective at a given point in time.

The SRS also functions as blueprint for completing a project with as little cost growth as possible. The SRS is often referred to as the "parent" document because all subsequent project management documents, such as design specifications, statements of work, software architecture specifications, testing and validation plans, and documentation plans, are related to it. It is important to note that an SRS contains functional requirements only; it doesn't offer design suggestions, possible solutions to technology or business issues, or any other information other than what the development team understands the customer's system requirements to be.

Finally, the mixture of the software and hardware components enables the System model to achieve its intended design objective efficiently.

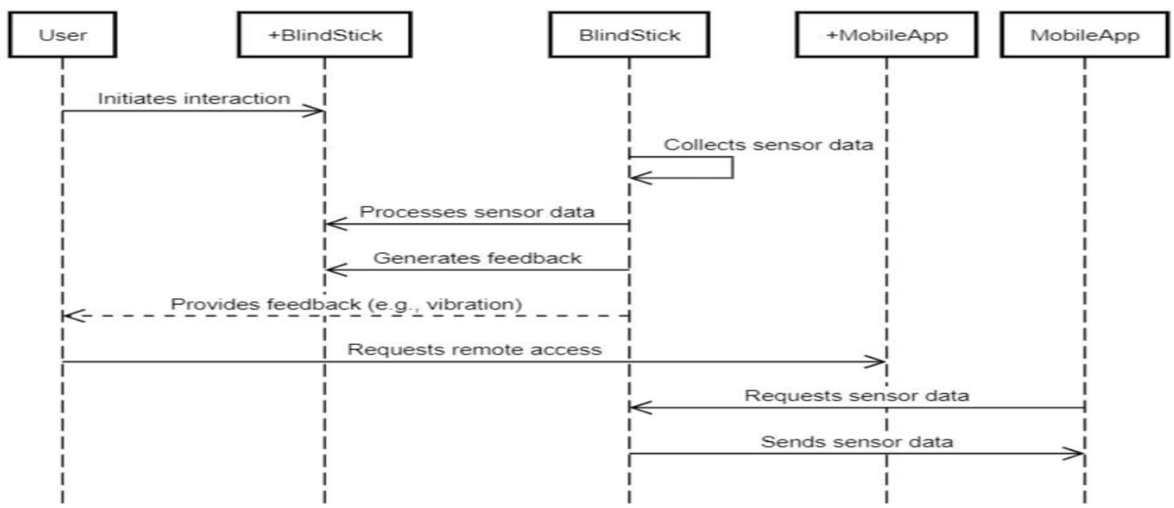

Figure 1: The system architecture of Echosight.

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IV. THE SYSTEM IMPLEMENTATION

A. *Hardware Requirements*

The fig below, fig 2. displays the hardware design, The proposed smart assistance system integrates ultrasonic sensors for obstacle detection and a soil moisture sensor for environmental assessment. Powered by the NodeMCU ESP32 microcontroller, the system processes data and communicates with the user interface. Haptic feedback through vibration motors enhances user interaction by providing tactile cues. User-friendly interface elements like tactile buttons or voice recognition ensure easy navigation and control for visually impaired individuals.

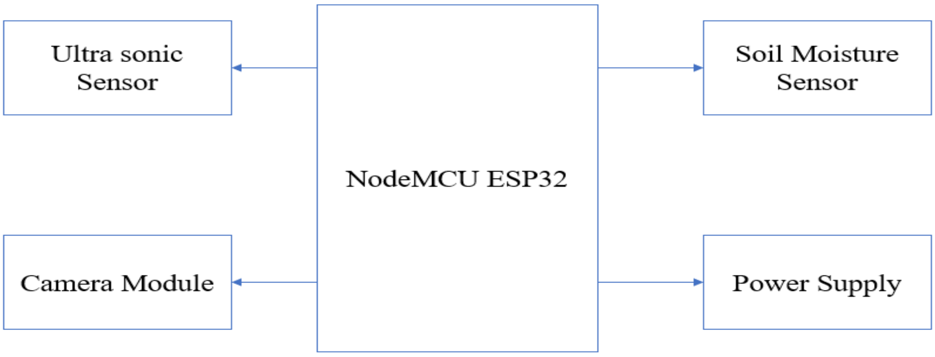

Fig. 2: Hardware design

1. NODE MCU

In the fig.3, Node MCU is an IoT framework that is open source. A micro-controller device is a compact machine operating on an integrated circuit board with single MOS. A micro-controller has one or more central processing units, with memory peripherals for input / output. The Node MCU board integrates the ESP32 microcontroller with additional features such as USB connectivity, Wi-Fi capabilities, and GPIO pins, making it suitable for a wide range of IoT projects. Its compact size and single MOS design make it a convenient and efficient choice for developers working on embedded systems and IoT solutions.

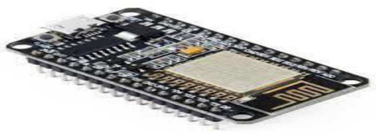

Fig. 3 Node MCU

2. Ultra-sonic Sensor

The fig 4, depicts an ultrasonic detector is a device that tests the distance to an object by taking sound waves. This detects distance by allowing a sound wave to return at a specific frequency and by waiting for that sound wave. ultrasonic sensor operates on the principle of emitting high-frequency sound waves, typically above the human hearing range, and then measuring the time it takes for the sound waves to bounce back after hitting an object.

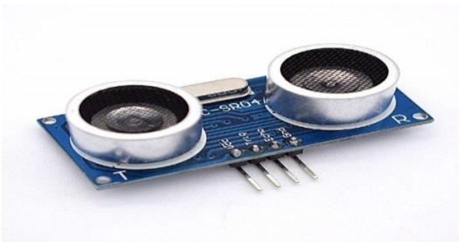

Fig 4. Ultra-sonic Sensor

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3. Soil Moisture Sensor

The below figure, fig5. shows the Soil Moisture Sensor. A soil moisture sensor is a vital tool used in agriculture and gardening to monitor the water content of soil. Consisting of electrodes inserted into the soil, these sensors measure changes in electrical conductivity as soil moisture levels fluctuate. This data helps farmers and gardeners make informed decisions about irrigation, ensuring plants receive adequate water without overwatering. By providing real-time insights into soil moisture, these sensors contribute to more efficient water usage, healthier plants, and sustainable agricultural practices.

Fig 5. Soil Moisture Sensor

4. ESP32-CAM

The below figure, fig6. Shows the ESP32-CAM. The ESP32-CAM is a compact and versatile development board that combines the ESP32 microcontroller with a camera module, making it ideal for projects requiring image capture and processing capabilities. It features built-in Wi-Fi and Bluetooth connectivity, allowing for seamless communication with other devices and the internet. The camera module on the ESP32-CAM supports various image resolutions and formats, enabling applications such as video streaming, surveillance, and facial recognition.

Fig 6: ESP32-CAM

5. Buzzer

The below figure, fig 7. Shows the buzzer. A buzzer is an electro-acoustic device that produces sound by vibrating a diaphragm or membrane in response to an electrical signal. It is commonly used in electronic circuits and devices to generate audible alerts, notifications, or alarms. Buzzer modules often come with adjustable frequency and volume settings, allowing for customization based on specific application requirements.

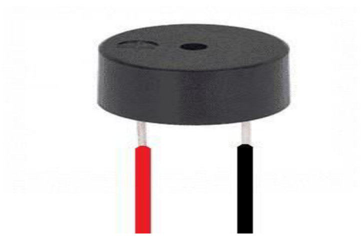

Fig 7: Buzzer

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B) Software Requirements

The software design diagram is shown below in fig 7. The project requires an operating system compatible with Windows 7/8/9/10/11. The coding language utilized is Embedded C, which is commonly used in embedded systems programming. The Integrated Development Environment (IDE) chosen for programming and development tasks is Arduino IDE, known for its user-friendly interface and compatibility with various microcontrollers and sensors. These software requirements are crucial for the successful implementation and functioning of the smart assistance system for visually impaired individuals.

The implementation process involves several steps:

a) Hardware Selection and Integration: Choose suitable ultrasonic sensors and soil moisture sensors compatible with NodeMCU ESP32.Integrate sensors and microcontroller onto the blind stick, considering size, weight, and power usage. Design a durable and ergonomic enclosure for user comfort.
b) Software Development: Develop firmware for sensor data management and communication.Implement algorithms for obstacle detection and soil moisture sensing. Create a user-friendly interface for device interaction and customization.
c) Connectivity Setup: Configure Wi-Fi connectivity for communication with external servers or apps. Implement reliable data transmission protocols ensuring security and compatibility.
d) User Testing and Feedback: Conduct usability testing with visually impaired users to assess functionality and accessibility. Gather feedback to refine hardware and software components.
e) Documentation and Deployment: Document system architecture, hardware setup, software implementation, and user interface. Prepare user manuals and instructional materials for effective device operation. Deploy the blind stick to users and provide training and support.
f) Monitoring and Maintenance: Establish monitoring mechanisms for device performance and connectivity. - Provide ongoing maintenance, updates, and technical support. Continuously optimize the system based on feedback and evolving needs.

V. ECHOSIGHT RESULTS

Auditory Feedback: Utilize sound signals with varying tones, pitches, or patterns to convey obstacle information effectively. Different tones can signify different types of obstacles or their proximity. Implement a voice synthesis module that can provide detailed spoken prompts about obstacle distances, directions, and potential hazards, ensuring clear and informative feedback for the user.

Tactile Feedback: Use vibration motors with different intensities or frequencies to provide nuanced feedback about obstacle presence and proximity. Varying vibration patterns can indicate the size, distance, and direction of obstacles. Design haptic cues such as textured surfaces or raised markings strategically placed on the device to offer non-visual feedback that is intuitive and easy to interpret for the user.

Voice Output: Utilize text-to-speech synthesis capabilities to convert textual information, such as obstacle descriptions or environmental data, into clear and natural-sounding spoken words. Ensure compatibility with multiple languages and accents for broader accessibility.

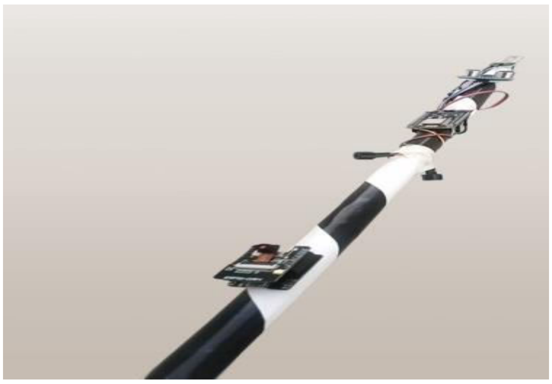

Fig 8: Blind Cane

Fig 9: Ultra-sonic and Moisture Sensors

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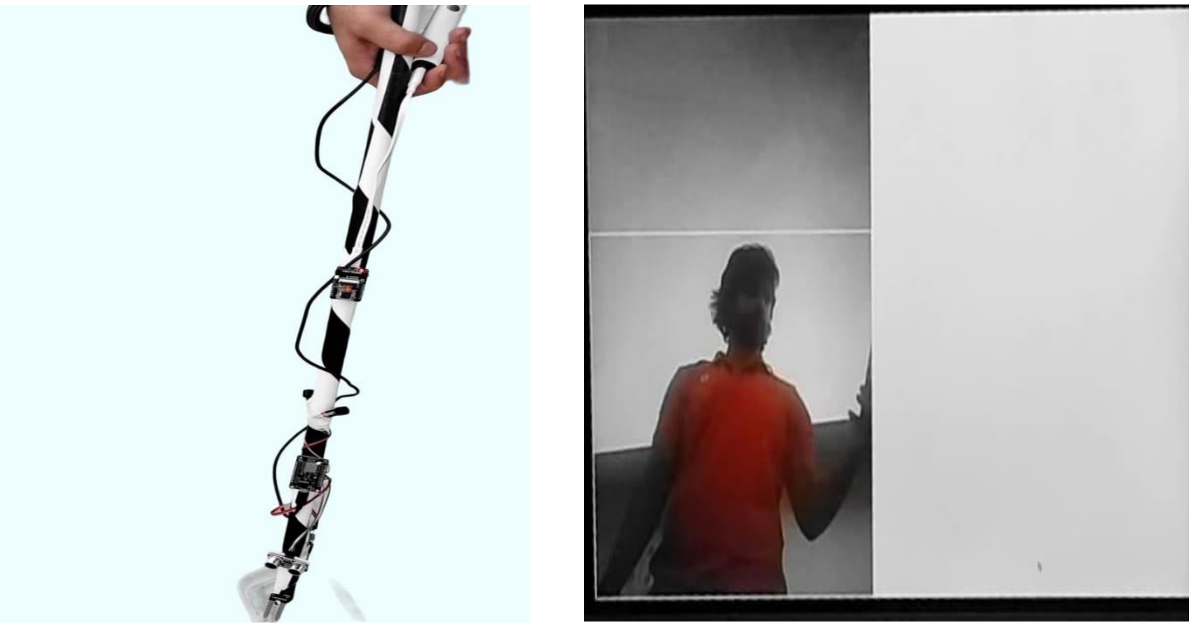

Fig 10: ESP32 CAM identify the person and Audio generate in system as output.

VI. CONCLUSION AND FUTURE WORK

In conclusion, this paper has ushered in the development of IoT-enabled blind stick with environmental sensing capabilities is poised to revolutionize the landscape of assistive technology for visually impaired individuals. This innovative device integrates ultrasonic sensors for obstacle detection and soil moisture sensing, offering a holistic solution to improve mobility, accessibility, and environmental awareness. With cutting-edge features such as real-time data transmission and user-centered design, the blind stick caters to the specific needs and preferences of visually impaired users. Moving forward, future work will focus on refining the device's functionality, enhancing its user interface, and expanding its compatibility with other assistive technologies. Collaboration with stakeholders, continuous user feedback, and advancements in sensor technology will drive ongoing improvements to ensure the device's effectiveness and impact in empowering visually impaired individuals to navigate their surroundings with confidence and independence.

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