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ECHO GUIDANCE VOICE-ACTIVATED APPLICATION FOR BLIND WITH SMART ASSISTIVE STICK USING ML AND IOT

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ABSTRACT

Navigating the world without sight presents profound challenges for millions of visually impaired individuals. Echo Guidance includes a pioneering application, addresses these obstacles by facilitating independence and mobility through voice-driven interaction and an IoT smart assistive device for obstacle detection by utilizing Ultrasonic, GPS and GSM modules powered by Arduino. This study explores the design and evaluation of Echo Guidance, highlighting its utilization of advanced algorithms like RGB888 conversion, matrix transformation, and Optical Character Recognition (OCR) for real-time object recognition. The application boasts a voice-centric interface tailored to the needs of the visually impaired, seamlessly integrating day-to-day functionalities such as weather forecasting, reminders, and a calculator accessible through voice commands. Central to Echo Guidance is its innovative object detection and recognition approach, employing the MobileNetObjDetector class powered by TensorFlow Lite for swift and accurate object detection. The OverlayView class visually represents detected objects, enhancing spatial awareness. Additionally, the integration of IoT devices, such as the smart stick with ultrasonic sensors for obstacle detection and head-level obstacle detection, coupled with SOS functionality in case of any emergency using GPS and GSM modules, further enhances Echo Guidance's capabilities. This research underscores Echo Guidance's transformative potential in improving the quality of life for visually impaired individuals, representing a significant advancement in assistive technology. Prioritizing accessibility and user experience, this paper empowers individuals worldwide with newfound independence and confidence in navigating their surroundings.

1.INTRODUCTION

Visually impaired people are often reluctant to use the resources of the visually impaired because of other factors such as social stigma and discrimination and lack of accessibility. They do find it extremely challenging to glimpse the outer world. On Earth, it is impossible to process real-time data using current equipment. In today's high-tech environment, the visually impaired need to be self-sufficient. The visually impaired cannot see, depend on others, and cannot use technology. Visually impaired people are at a disadvantage because they do not have access to important information about their surroundings. Therefore, we have implemented such a voice assistant app project for the visually impaired. Visually impaired people are at a disadvantage because they do not have access to important information about their surroundings. The gaps that we found in other research papers were the currency recognition module. The new type of settings we added in it like autofocus, use flash, and the OCR language. Echo Guidance emerges as a transformative solution, seeking to redefine the landscape of navigation assistance for the visually impaired through a novel voice-driven interface. This research paper focuses on investigating the efficacy of Echo Guidance in facilitating navigation for individuals with visual impairments, with meticulous attention to its integration with Internet of Things (IoT) technology, utilization of machine

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learning (ML) algorithms for enhanced object recognition, incorporation of Optical Character Recognition (OCR), and integration of an SOS functionality.

2.LITERATURE REVIEW

A) IoT-Based Shoe for Enhanced Mobility and Safety of Visually Impaired Individuals - This IoT-based shoe system is designed to address the unique challenges faced by visually impaired individuals when navigating through unfamiliar or crowded environments. The shoe integrates various sensors, such as ultrasonic sensors for obstacle detection, GPS for location tracking, and vibration motors to alert users about potential hazards. The microcontroller processes the sensor data and communicates with a companion mobile application via wireless communication, providing real-time feedback to the user. The mobile app also serves as an interface to customize settings, such as alert sensitivity or preferred walking routes. In addition to obstacle detection, the shoe system offers contextual information about the user's environment, such as proximity to specific landmarks or changes in walking direction. The combination of real-time environmental awareness and intuitive alerts helps users confidently navigate public spaces, reducing the risk of accidents and enhancing their overall safety. By integrating these technologies into a practical and wearable form factor, the shoe represents a significant advancement in assistive technology for the visually impaired. The evaluation of the system's performance was conducted through user trials, where participants tested the shoe in various scenarios, including busy streets, malls, and unfamiliar indoor environments. Feedback from these trials demonstrated that the IoT shoe system significantly improved participants' confidence and comfort while moving through these spaces. The combination of real-time feedback and adaptive features helped users navigate obstacles more effectively, making them feel more independent and safer. This research contributes to the growing field of assistive technology and demonstrates how IoT innovations can improve the quality of life for individuals with disabilities. The integration of embedded sensors and wireless communication in the proposed shoe system offers a promising solution that can be further expanded to include additional features such as emergency alerts, social integration, and enhanced navigation capabilities. Future developments of this system could also focus on reducing the size and cost of the components, making it more accessible for a wider range of users. Over the years, advancements in technology have significantly improved the quality of life for individuals with disabilities, providing new opportunities for increased independence and mobility. Among various challenges faced by people with disabilities, those who are visually impaired or blind encounter substantial difficulties when navigating through unfamiliar or complex environments. These challenges include the risk of collision with obstacles, difficulty in recognizing landmarks or changes in surroundings, and navigating through crowds or unfamiliar streets. In many instances, individuals with visual impairments rely on sighted companions, guide dogs, or canes to assist with their mobility. While these methods have proven effective to some extent, they are often limiting and do not provide a fully independent navigation experience. Moreover, current solutions may lack real-time environmental awareness and tailored assistance, which are crucial for safe navigation, especially in dynamic or crowded settings. The Internet of Things (IoT) has emerged as a transformative technology that connects various devices and systems through the internet, enabling real-time data exchange and interaction. In the context of mobility for visually impaired individuals, IoT has the potential to provide innovative solutions that offer real-time information, environmental sensing, and personalized assistance. These technologies can make everyday tasks more manageable and provide users with the ability to move independently, reducing the dependence on external aides while increasing confidence in navigating various environments. In particular, wearable technologies—such as smart shoes—integrating IoT and sensor-based systems have gained attention in recent years as an effective means to enhance mobility. These wearable devices can offer real-time feedback on the user's surroundings through various forms of interaction, such as vibrations, audio cues, or even haptic feedback, thus enabling visually impaired individuals to navigate more confidently and safely. The proposed IoT-based shoe system leverages embedded sensors, wireless communication, and a companion mobile application to provide real-time information to the user about obstacles, direction, and other environmental factors, offering a new and promising approach to assistive technology. Moreover, existing technologies, such as talking

GPS systems or smart cane devices, often fail to provide contextually relevant, real-time information about dynamic obstacles or environmental changes. These systems are typically limited to providing pre-recorded or mapped information, which may not be responsive to immediate hazards or variations in the environment. What is needed is an innovative and adaptive system that can detect a variety of obstacles and alert the user through an intuitive interface, providing continuous support throughout their journey. A wearable, IoT-based system that integrates sensors to detect obstacles, track location, and provide contextual alerts can enhance mobility while minimizing risks. This paper proposes the design and development of an IoT-based shoe system for visually impaired individuals, which will address these issues by providing real-time, location-aware feedback on obstacles and other environmental factors. The system aims to empower users to navigate independently and confidently, improving both their safety and overall quality of life.

B) Smart Walk: A Smart Stick for the Visually Impaired - It is estimated that globally, 285 million people in the world are visually impaired, while 39 million are completely blind. Visual impairment may cause difficulties for people to do their daily activities. There is a need for innovative, ambient, or active assisted living (IAAL) solution(s) to be designed, developed, and deployed for the visually impaired individuals. This paper presents a design of a smart stick for visually impaired individuals as an IAAL solution. The smart stick comprises ultrasonic sensors to detect objects and obstacles, a camera to capture the objects, a GPS module for location update and navigation, and a Raspberry Pi 3B+ which acts as a central unit for the whole system. The smart stick was tested in different environments and backgrounds. The image classification and object detection accuracy of the smart stick system was within the range of 59 per cent to 89 per cent (minimum and maximum range). The smart stick helped the visually impaired individuals to manage walking around their environment. The proposed system will improve the life of visually impaired people since it managed to accurately identify and detect objects with a 89 per cent accuracy level at a one meter distance. Visual impairment is a significant global health issue, with the World Health Organization estimating that approximately 285 million people worldwide are visually impaired, and 39 million individuals are completely blind. This condition poses severe challenges to individuals in performing routine tasks and activities, such as navigating through unfamiliar environments, avoiding obstacles, and ensuring personal safety. For many visually impaired individuals, everyday tasks such as walking, shopping, or commuting can become daunting and potentially hazardous. The absence of sight makes it difficult to detect obstacles, avoid collisions, or find accessible paths in both familiar and unfamiliar environments. As a result, mobility and independence are often greatly reduced, leading to a dependency on others, specialized equipment, or assistive devices like guide dogs and white canes. Despite the availability of some assistive devices like traditional canes, which help users detect objects at ground level, these solutions still have significant limitations. For instance, white canes only detect obstacles at the user's feet and do not offer a full-range assessment of the surroundings. Guide dogs, while extremely effective, are not always a practical or available option. There is a growing need for more advanced assistive technologies that can provide real-time, comprehensive assistance to visually impaired individuals, allowing them to move independently and safely while navigating complex and dynamic environments. Recent advancements in technology, particularly in the fields of Internet of Things (IoT), machine learning, and computer vision, offer promising solutions for addressing these challenges. Innovations such as smart canes, wearable devices, and integrated assistive systems can provide a more holistic approach to mobility. These systems can detect obstacles in real time, provide spatial awareness, and guide users safely by offering both auditory and haptic feedback. The integration of these technologies into a portable, wearable device, such as a smart stick, can greatly enhance the autonomy and quality of life for visually impaired individuals. This paper focuses on designing a smart stick as an innovative, ambient, or active assisted living (IAAL) solution for visually impaired individuals. The main objectives of this study are to develop a prototype of a smart stick that integrates multiple assistive technologies, including ultrasonic sensors for obstacle detection, a camera for object identification, a GPS module for navigation, and a Raspberry Pi 3B+ as the central processing unit. By combining these technologies, the smart stick aims to offer a comprehensive solution that not only detects obstacles but also assists with navigation and spatial awareness.

C) Smart stick for blind people with wireless emergency notification - This effort develops and uses a smart stick to help blind individuals walk more safely and avoid hazards. This research paper involved to develop smart stick for blind people to help them to walk safely by avoiding obstructions, and at emergency conditions sent their location to person in charge like a doctor or relatives to help them accordingly. Three ultrasonic sensors are used in the proposed device's architecture to detect obstructions at three different heights, low, mid, and high obstructions using speaker to alert the blind person. An emergency message with the location of the blind person's phone is sent through a mobile app to the doctor or person in charge whenever the designed smart stick's emergency button is touched, or the stick is dropped down. The Arduino Uno platform, Bluetooth model, MPU-6050 3-axis gyroscope as a position sensor, and microSd card module has been used to effectively implement the stick. At the testing stage, the device gave good results. The user received notifications in the form of voice messages and vibrations from the smart stick when it detects things or obstacles in front of them. Additionally, even though they cannot directly activate it, the automated emergency condition has been detection and activated. Globally, millions of people live with visual impairments, with estimates suggesting that over 285 million people are affected, including 39 million who are completely blind. For these individuals, navigating everyday environments can present significant challenges, including avoiding obstacles, crossing streets safely, and performing routine activities without assistance. Traditional mobility aids like white canes or guide dogs have been widely used to help blind individuals, but they still have limitations. White canes typically detect obstacles at the ground level and cannot alert the user to higher-level obstructions or environmental hazards, while guide dogs require extensive training and are not always practical for all users. As a result, there is a growing need for advanced assistive technologies that go beyond these conventional methods, offering more comprehensive solutions for improving the mobility and safety of blind individuals. Smart assistive technologies, particularly those incorporating sensors and IoT devices, have shown great promise in enhancing the independence and safety of visually impaired people. The integration of sensors like ultrasonic and infrared sensors, along with real-time feedback mechanisms such as audio or vibration alerts, has the potential to improve obstacle detection and offer greater spatial awareness. Additionally, by incorporating communication technologies like mobile applications, these systems can also provide emergency alerts and real-time location tracking, making it easier for caregivers, doctors, or family members to be notified in case of emergencies. Such advancements can significantly empower visually impaired individuals, allowing them to navigate with greater confidence and independence. This paper focuses on the design, development, and evaluation of a smart stick for blind individuals that integrates ultrasonic sensors, a position sensor, a gyroscope, and emergency alert functionality. The primary objective is to create a device that can detect obstacles at different heights—low, mid, and high levels—alerting the user through audio and vibration feedback. This comprehensive sensing and alerting system is aimed at enhancing the user's ability to detect obstacles and navigate more safely in various environments. Furthermore, the smart stick is designed to send emergency notifications, including the user's location, to a designated person such as a doctor, family member, or caregiver whenever an emergency condition is detected, such as when the stick is dropped or the emergency button is pressed. The smart stick proposed in this study incorporates several key components that work together to improve the mobility and safety of blind individuals. Three ultrasonic sensors are strategically placed at different heights on the stick to detect obstacles at low, mid, and high levels. This allows the system to provide comprehensive coverage of the user's surroundings, alerting them to obstacles in front of them regardless of their height. Additionally, an MPU-6050 3-axis gyroscope is used to detect the position and movement of the stick, helping to identify situations where the user may have fallen or the stick has been dropped. The microcontroller, an Arduino Uno, processes the sensor data and activates the appropriate alerts, including voice notifications through a speaker and vibration alerts to ensure that the user is aware of any obstacles or hazards in their path. The emergency functionality of the device is also a crucial feature. When the emergency button is pressed or the stick is dropped, the device automatically sends an emergency message along with the user's location to a pre-designated person via a mobile app. This allows family members, caregivers, or medical personnel to be immediately informed of the situation and take necessary action, such as providing assistance or dispatching help if needed. The system's use of Bluetooth communication ensures that the mobile app can seamlessly receive and display real-time data from the smart stick, enhancing its functionality and providing valuable support in critical situations. To evaluate the performance and effectiveness of the smart stick, a series of tests were conducted to assess its ability to detect obstacles and send emergency alerts. During testing, the device provided real-time feedback to the user in the form of voice messages and vibrations, accurately identifying objects in the user's environment and warning them in advance. The location tracking feature also worked effectively, sending the user's coordinates to the designated contacts when the emergency button was activated or when the stick was dropped. The results of these tests indicated that the device performed as expected, offering valuable assistance to the user and providing peace of mind to those responsible for their care. The success of the system highlights its potential to improve the safety and independence of blind individuals, allowing them to navigate more confidently and ensuring that they can quickly receive help in case of an emergency.

3.SYSTEM DESIGN

3.1. EXISTING SYSTEM

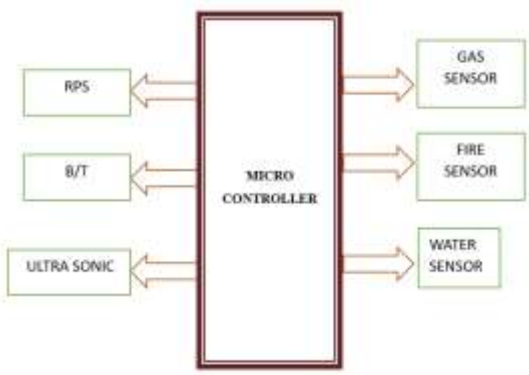
Previous research has extensively explored the fusion of object recognition algorithms with voice assistance systems to provide navigation aid for visually impaired individuals. Notably, studies by Lilhare et al., [7] limitations in recognizing a diverse range of objects, risks of technological obsolescence, and complexities in feature extraction have been noted, posing significant hurdles in achieving real-time performance and versatility in assistive technologies. Despite the advancements like a voice-based access system for visually impaired people [8] where users can open camera with voice command and camera will detect live objects and give result in the form of voice, reliance on traditional camera-based approaches may limit adaptability and realtime performance. Moreover, voice-only output may lack detailed information and potentially hindering user comprehension as well as interaction. Furthermore, IoTbased navigation devices, as investigated by Apu et al., [9] have gained attention for their potential to enhance navigation assistance for the visually impaired. These devices integrate sensors and connectivity modules to detect obstacles and provide real-time feedback. However, concerns regarding reliance on technology, effectiveness in complex environments, and maintenance issues have been raised, necessitating further optimization and development in IoTbased solutions

3.2. PROPOSED SYSTEM

The architecture of the Echo Guidance system comprises a mobile app [19]tailored for visually impaired users, seamlessly integrated with an IoT Smart Stick. The mobile app incorporates modules for OCR, object detection, utility features, location services, and user interaction, providing comprehensive navigation assistance and accessibility features. Through OCR integration, printed text is converted to speech, enhancing accessibility. Object detection algorithms and machine learning enable real-time detection of obstacles, while utility features like weather forecasting and a calculator further enrich the user experience. Integration with the IoT Smart Stick, equipped with Arduino microcontrollers, ultrasonic sensors, GPS, and GSM modules, enhances navigation with obstacle detection, precise geolocation, and emergency communication capabilities. Together, this architecture empowers visually impaired individuals to navigate with confidence, promoting independence and inclusivity in everyday life.

4.IMPLEMENTATION

4.1. BLOCK DIAGRAM



POWER SUPPLY

A **regulated power supply** transforms unregulated AC (Alternating Current) into a stable DC (Direct Current). It guarantees consistent output despite variations in input. A regulated DC power supply is also known as a linear power supply, it is an embedded circuit and consists of various blocks

- **Regulated Power Supply Definition**: A regulated power supply ensures a consistent DC output by converting fluctuating AC input.
- **Component Overview**: The primary components of a regulated power supply include a transformer, rectifier, filter, and regulator, each crucial for maintaining steady DC output.
- **Rectification Explained**: The process involves diodes converting AC to DC, typically using full wave rectification to enhance efficiency.
- **Filter Function**: Filters, such as capacitor and LC types, smooth the DC output to reduce ripple and provide a stable voltage.
- **Regulation Mechanism**: Regulators adjust and stabilize output voltage to protect against input changes or load variations, essential for reliable power supply

SENSORS

Sensors are used for sensing things and devices etc. A device that provides a usable output in response to a specified measurement. The sensor attains a physical parameter and converts it into a signal suitable for processing (e.g. electrical, mechanical, optical) the characteristics of any device or material to detect the presence of a particular physical quantity. The output of the sensor is a signal which is converted to a human-readable form like changes in characteristics, changes in resistance, capacitance, impedance, etc.

What is HC-SR04 Ultrasonic Sensor:

The HC-SR04 ultrasonic sensor includes a transmitter & a receiver. This sensor is used to find out the distance from the objective. Here the amount of time taken to transmit and receive the waves will decide the distance between the sensor and an object. This sensor uses sound waves by using non-contact technology. By using this sensor the distance which is required for the target can be measured without damage and provides accurate details. The range of this sensor available between 2cms to 400cms. The HC-SR04 is a type of ultrasonic sensor which uses sonar to find out the distance of the object from the sensor. It provides an outstanding range of non-contact detection with high accuracy & stable readings. It includes two modules like ultrasonic transmitter & receiver. This sensor is used in a variety of applications like measurement of direction and speed, burglar alarms, medical, sonar, humidifiers, wireless charging, non-destructive testing, and ultrasonography.

Fig: HCSR04-ultrasonic-sensor

FIRE SENSOR

Flame detector is a sensor designed to detect and respond to the presence of a flame or fire, allowing flame detection. Responses to a detected flame depend on the installation, but can include sounding an alarm, deactivating a fuel line (such as a propane or a natural gas line), and activating a fire suppression system. When used in applications such as industrial furnaces, their role is to provide confirmation that the furnace is properly; in these cases they take no direct action beyond notifying the operator or control system. A flame detector can often respond faster and more accurately than a smoke or heat detector due to the mechanisms it uses to detect the flame.

Description

The Fire sensor is used to detect fire flames . The module makes use of Fire sensor and comparator to detect fire up to a range of 1 meters.

Feature

- Allows your robot to detect flames from upto 1 M away
- Typical Maximum Range :1 m .
- Calibration preset for range adjustment.
- Indicator LED with 3 pin easy interface connector.

- Input Voltage +5VDC

FIG . Fire sensor

MQ2 GAS SENSOR WORKING AND ITS APPLICATIONS

Sensors are the electronic devices used for interaction with the outer environment. There are various types of sensors available that can detect light, noise, smoke, proximity etc… With the advent in technology, these are available as both analog and digital forms. Besides forming a communication with the outer environment, sensors are also a crucial part of safety systems. Fire sensors are used to detect the fire and take appropriate precautions on time. For smooth functioning of control systems and sensitive electronics, humidity sensors are used for maintaining humidity in the unit. One of such sensor used in safety systems to detect harmful gases is MQ2 Gas sensor.

What is an MQ2 Gas Sensor?

MQ2 gas sensor is an electronic sensor used for sensing the concentration of gases in the air such as LPG, propane, methane, hydrogen, alcohol, smoke and carbon monoxide.

MQ2 gas sensor is also known as chemiresistor. It contains a sensing material whose resistance changes when it comes in contact with the gas. This change in the value of resistance is used for the detection of gas.

Fig: MQ2 Gas Sensor

ARDUINO

The Arduino is a family of microcontroller boards to simplify electronic design, prototyping and experimenting for artists, hackers, hobbyists, but also many professionals. People use it as brains for their robots, to build new digital music instruments, or to build a system that lets your house plants tweet you when they're dry. Arduinos (we use the standard Arduino Uno) are built around an ATmega microcontroller — essentially a complete computer with CPU, RAM, Flash memory, and input/output pins, all on a single chip. Unlike, say, a Raspberry Pi, it's designed to attach all kinds of sensors, LEDs, small motors and speakers, servos, etc. directly to these pins, which can read in or output digital or analog voltages between 0 and 5 volts. The Arduino connects to your computer via USB, where you program it in a simple language (C/C++, similar to Java) from inside the free Arduino IDE by uploading your compiled code to the board. Once programmed, the Arduino can run with the USB link back to your computer, or stand-alone without it — no keyboard or screen needed, just power.

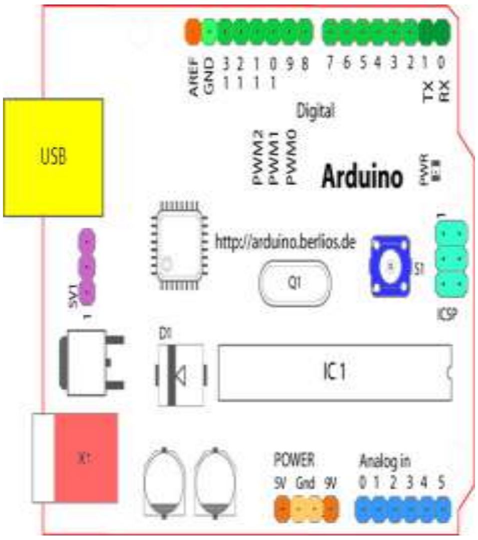


Fig: Structure of Arduino Board

5.WORKING

- Echo Guidance Voice-activated smart assistive stick is designed to help Blind users travel independently.
- Ultrasonic Sensors show obstacle detection and distance measuring and send alerts through audio if there is any danger.
- IR Sensors recognize potholes or slippery surfaces. There are two conditions: Active and Disactive. When the IR sensor is in the active state, it identifies only objects. When it is Disactive, it identifies potholes and slippery surfaces and detects them back to send alerts through audio to the User.

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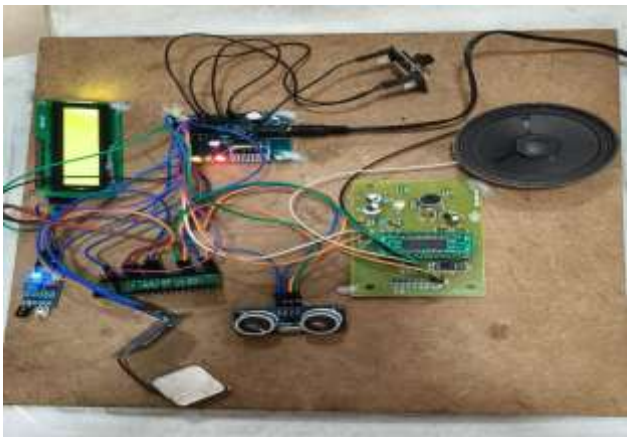
6.RESULTS



CONCLUSION

In conclusion, the findings of this paper shed light on the transformative potential of Echo Guidance in redefining navigation assistance for individuals with visual impairments. Through a comprehensive investigation and meticulous evaluation, the study has revealed the diverse capabilities of Echo Guidance. The integration of Echo Guidance with an IoT device, equipped with ultrasonic sensors, GPS, and GSM modules, represents a significant leap forward in navigation aid technology. The real-time feedback provided by the IoT component enhances spatial awareness and safety, enabling users to navigate independently in various environments. Furthermore, the incorporation of ML algorithms, particularly those based on the MobileNet architecture, empowers Echo Guidance to deliver precise object recognition capabilities. By translating visual data into intuitive auditory cues, users can navigate with confidence, surmounting obstacles with ease. Additionally, the integration of OCR capabilities promotes greater accessibility for users with visual impairments. The inclusion of an SOS functionality adds an extra layer of security, ensuring swift assistance during emergencies. In essence, Echo Guidance represents a paradigm shift in assistive technology, embodying a holistic approach to addressing the diverse needs of individuals with visual impairments. By emphasizing user-centric design principles and rigorous evaluation, Echo Guidance is poised to empower users to navigate their environments with newfound independence and safety.

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