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Smart Blind Stick with GPS module & ESP 32

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***Abstract*— Nowadays there are many cases of eye injuries and in certain injuries people suffer from long term recovery and in certain cases they suffer from permanent damage. In these situations they face a lot many problems in daily life and one of the major problems they face is moving around. So i tried to solve this problem by proposing a system consisting of ultrasonic sensors and ESP32 which detects and analyses the obstacles and generates the alarming signals according to the distance of the object. s, which includes an ESP32, an Ultrasonic sensor, a speech playback module, a GPS receiver module, and a GSM. Using an ultrasonic sensor, the Smart Stick locates impediments and feeds the information to an ESP32 for proximity calculation. The GSM module then determines the user's location and sends messages to their family based on sensor data, with the voice playback module providing vocal help to avoid collisions with obstructions. Because of its user-friendly control mechanism and ability to detect obstacles in all directions, the Smart Stick offers a comprehensive solution for those with vision impairment or blindness. The Smart Stick is a useful navigational aid. Using its GSM module, it can detect impediments in all directions, offer voice help, and give loved one's security. Anyone with a visual impairment can utilize it thanks to how simple it is to use.**

Keywords*— *ultrasonic sensor, ESP32, buzzer, haptic motor, GPS module

I. INTRODUCTION

The main aim of this project is to help blind persons without human need. Notably, the visually impaired person convey a hand that stays with them at whatever point they need help. Once in a while in any event, when they utilize this stick, there is no assurance that the visually impaired people are protected and get in arriving at their destination. There might be an obstacle in their way some people may get injured if obstacle is big or dangerous, however isn't experienced by the individual with the assistance of the stick. Thus, in this project a blind stick is designed and developed to assist the blind person and provide them a clear The smart blind stick is an innovative assistive device designed to enhance the mobility and safety of visually impaired individuals by incorporating modern technology such as the ESP32 microcontroller and a GPS module. This intelligent stick goes far beyond the traditional white cane by integrating advanced features that provide real-time feedback about the user's surroundings and location. At the heart of the system is the ESP32, a powerful and energy-efficient microcontroller with built-in Wi-Fi and Bluetooth capabilities, allowing for wireless communication and easy integration with smartphones or cloud-based services. The inclusion of a GPS module enables real-time location tracking, which is especially useful for navigation and for caregivers to monitor the user's whereabouts in case of emergencies. The stick can be equipped with ultrasonic sensors to detect obstacles in the path of the user and alert them through vibrations or voice commands, enhancing situational awareness and preventing collisions. Additionally, features like a panic button can be added to send immediate alerts along with the GPS coordinates to emergency contacts, thereby providing an extra layer of safety. Overall, the smart blind stick utilizing ESP32 and GPS technology represents a significant leap toward independent and confident movement for the visually impaired, merging accessibility with the power of embedded systems and IoT.

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II. LITERATURE SURVEY

A literature survey on smart blind sticks shows that many researchers are interested in using modern technology to help visually impaired people move around more safely and easily. In the beginning, smart sticks were designed using basic sensors like ultrasonic sensors, which could detect obstacles and alert the user through vibrations or sounds. Over time, these designs became more advanced by adding GPS modules to help with location tracking and navigation. The use of microcontrollers like the ESP32 has made it possible to add even more features, such as wireless communication and connection to mobile apps. Studies have found that combining sensors with GPS and GSM modules makes these sticks more useful both indoors and outdoors. Researchers have also pointed out the benefits of the ESP32, especially its ability to process data quickly and use less power. Some projects even use cameras and artificial intelligence to recognize objects, although these systems need more energy and stronger hardware. The research also highlights how these smart sticks can help visually impaired people feel more confident and independent. However, there are still some problems to solve, like making the devices affordable, strong, and easy to use. In conclusion, most studies agree that using ESP32, GPS, and sensors together can create a smart blind stick that gives real-time help and makes it easier for blind people to move around safely. Assistive technologies like the Guide Cane, Smart Cane, and Mechatronic Blind Stick are designed to help visually impaired people avoid obstacles and stay safe while moving around. These devices use tools like ultrasonic sensors to detect nearby objects, servo motors to help with movement, and RFID technology to recognize specific locations or objects. They often include small joysticks or control buttons for easier handling, and the programming for these devices is created using MPLAB software for a type of controller called a PIC microcontroller.

According to one source, although the Mechatronic Blind Stick uses sound and vibrations to help the user, it cannot be folded or detect water on the ground. Another design uses several sensors connected to a PIC16F90 microcontroller. It uses a Ping Sonar Sensor to detect obstacles and a GH311 Ultrasonic Sensor to detect changes in terrain. Electrodes are used to sense water or wet surfaces. The microcontroller takes in data from all the sensors and controls outputs like buzzers, LEDs, and motors. These outputs create different vibration patterns and sounds to alert the user about their surroundings. This setup is simple, user-friendly, and affordable.

Another research paper introduced a new idea for a smart walking stick that helps visually impaired people move around more easily. This system combines GPS, ultrasonic sensors, and RFID technology to locate the user and detect obstacles. It also uses voice and vibration alerts to warn the user about dangers. In emergencies, it can share the user's location with family members through a server. The device connects to an Android phone using Bluetooth, and an app provides voice directions based on RFID readings. Compared to older devices, this new solution is cheaper and works more efficiently.

III. METHODOLOGY

The development of a Smart Blind Stick involves a systematic approach to hardware integration, software programming, and testing to ensure reliable assistance for visually impaired individuals. The following methodology outlines the steps taken to design, implement, and evaluate the system. The system consists of an ultrasonic sensor fixed to the user's stick. While the user moves the stick in the forward direction, the ultrasonic sensor with Arduino mega fixed to the stick tries to detect the obstacle if any present in the path. If the sensor recognizes the obstacle, the output of the recipient triggers, and this change will be identified by the microcontroller since the output of the receiver is given as inputs to the microcontroller. This stick recognizes the article before the individual and offers a reaction to the client either by vibrating or through the order. In this way, the individual can walk with no fear. This gadget will be the best answer for defeat the troubles of the visually impaired individual.

❖ System Requirements and Component Selection

1) ESP32 microcontroller:

After comparing the Arduino Zero and ESP32 microcontrollers, we found that while both have similar features to other Arduino boards, there are some key differences between them. One of the biggest differences is that the ESP32 has built-in Wi-Fi and Bluetooth, which means it can connect to the internet or other devices wirelessly without needing any extra parts. On the other hand, the Arduino Zero does not have these features built-in, so you would need to buy and connect additional modules if you want it to connect wirelessly. Also, the main chip inside the Arduino Zero is called ATSAMD21G18 and it runs at 48 MHz, while the ESP32 has a much faster chip called Tensilica

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Xtensa LX6, which has two cores and runs at speeds between 160 MHz and 240 MHz. This means the ESP32 can perform tasks more quickly and handle more complex operations. Lastly, the ESP32 is much cheaper than the Arduino Zero, sometimes costing less than half the price, which makes it a more budget-friendly option for many projects

2) GPS module (e.g., NEO-6M)

The NEO-6M GPS module is a high-quality GPS receiver that can quickly and reliably find satellites to determine your location. It comes with a built-in ceramic antenna that helps it pick up signals clearly. There are also small lights on the module that show when it has power and whether it's working properly, so users can easily check its status. The module is made up of five main parts: the NEO-6M GPS chip itself, a small rechargeable battery, a memory chip called serial EEPROM, a voltage regulator known as an LDO, and a UFL connector that lets you connect an extra antenna if needed. The battery and memory chip help the module remember important information even when it's turned off, which makes it faster to find your location the next time you use it. The LDO allows the module to be powered safely using a regular 5V power supply.

3) Ultrasonic sensors (HC-SR04)

Using IR (infrared) sensors can be difficult in places that are very bright, like outdoors in sunlight, because the light can interfere with how the sensor works. Even in dark indoor areas, IR sensors may not always work properly due to reflections or other issues. On the other hand, ultrasonic sensors use sound waves to detect objects, so they are not as easily affected by light or darkness. This makes ultrasonic sensors more reliable and better for situations where accurate detection is very important. They are known for being both precise and dependable, which is why they are often chosen over IR sensors when accuracy really matters.

4) Buzzer & Haptic motor

This buzzer will be used to generate sound if any alert happens near the stick. The buzzer is a small device that makes sound when it gets electrical signals. It beeps when the sensor finds an obstacle and the ESP32 sends a signal to the buzzer. This sound helps alert the person about something in the way. The buzzer works even if the device is not connected to a phone.

5) Battery (power supply)

Most batteries don't give exactly 5 volts on their own. Instead, they usually give lower voltages like 1.5V, 3.7V, or

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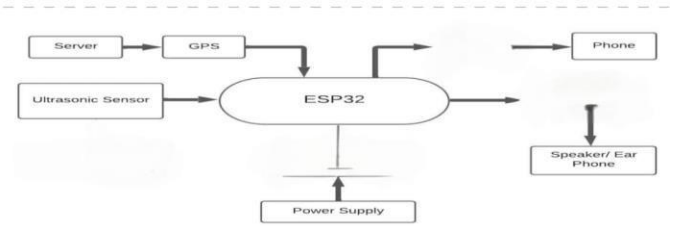
sometimes higher like 12V. To get 5 volts, we usually need to use special circuits called **voltage regulators** or **boost converters** that adjust the battery's voltage to the level we want

❖ **Block Diagram**



IV. APPLICATION & BENEFITS

A) Applications

Applications of a Smart Blind Stick with GPS & ESP32

1) *Navigation Assistance*

- **GPS module** provides real-time location tracking.
- The ESP32 can process location data to guide users via audio or haptic feedback.
- Can be paired with a mobile app or Google Maps API for route assistance.

2) *Obstacle Detection*

- Integrated sensors (e.g., ultrasonic) can detect obstacles ahead and alert the user using vibrations or sound.
- Useful for avoiding hazards in real-time.

3) *Emergency Features*

- Can include an **SOS button** to send location to emergency contacts.
- ESP32 can use Wi-Fi or GSM (via an external module) to send alerts.

4) *Remote Monitoring*

- GPS data can be sent to caregivers or family members for real-time tracking.
- Useful for ensuring the user's safety in unfamiliar areas.

5) *Voice Guidance*

- ESP32 can be integrated with a speaker or headphone module to provide verbal instructions or alerts.

B) Benefits

AIncreased Safety

- Real-time location tracking ensures the user doesn't get lost.
- Obstacle detection helps prevent falls or injuries.

□ *Improved Independence*

- Users can travel alone with confidence.
- Less reliance on others for navigation
- Connectivity

- ESP32's Wi-Fi & Bluetooth capabilities allow for app integration, cloud storage, or real-time updates.

□ *Smart Features*

- Can include AI or machine learning for smarter obstacle recognition.
- Location history can help track movement patterns for caregivers.

Low Power, High Efficiency

- ESP32 is energy-efficient, allowing for longer battery life and more portable designs.

Customizable & Expandable

- Open-source capabilities allow developers to add features like voice assistants, environmental sensors, or camera modules.

c) Specifications

- *Microcontroller:*
  - *ESP32*
    - Dual-core 32-bit processor
    - Wi-Fi and Bluetooth support
    - Low power consumption
    - Multiple GPIO pins for sensors and modules
    - Compatible with Arduino IDE

- *GPS Module:* Neo-6M GPS Module (or equivalent)
    - GPS tracking with location coordinates (latitude & longitude)
    - Baud Rate: 9600 bps
    - Position Accuracy: ~2.5 meters
    - Compatible with UART interface

- *Ultrasonic Sensors (for obstacle detection*
    - HC-SR04 or equivalent
        - Range: 2 cm to 400 cm
        - Accuracy: ~3 mm
        - Trigger + Echo pins for distance measurement

Vibration Motor (for haptic feedback):

- Notifies user about nearby obstacles

Buzzer (optional):

- Audio alerts for obstacles or navigation cues

Power Supply:

- Rechargeable Li-Ion Battery (e.g., 18650, 3.7V)
- Voltage Regulator (e.g., AMS1117 for 5V output)
- Charging Module (e.g., TP4056 for USB charging)

Switch / Push Button:

- To activate/deactivate modules or send location updates

LED Indicator(s):

- Status notifications (e.g., GPS lock, power on, obstacle detected)

GPS Functionality

- ***Real-time Tracking****:*
    - Fetches and sends location via Bluetooth or Wi-Fi
- ***Geofencing (optional)****:*
    - Alerts when user goes out of a predefined safe zone

Mechanical Design (Stick Frame)

- Foldable/Extendable Cane
- Sensor Mounts (top and front-facing for ultrasonic sensors)
- Waterproofing or Weather Resistance (if outdoor use)

V. FUTURE OUTLOOK

The device is designed to help visually impaired people move around more freely without always needing someone's help. It is small, lightweight, and simple to use because it uses only a few hardware parts and takes advantage of the features already available in mobile phones. This makes the device more affordable and easy to carry. One of the most useful features is that it can send the user's exact location to the cloud using GPS data from the mobile phone, which is very accurate. This way, family members can easily track and know where their loved one is at any time, which adds an extra layer of safety and peace of mind.

Conclusion

In summary, The smart blind stick is a simple, compact, and affordable device that helps visually impaired people move independently. It uses minimal hardware and mobile phone features to keep the design lightweight and cost-effective. The built-in GPS system allows family members to track the user's location accurately through the cloud, providing added safety and support.

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