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Design and Development of a Smart Foldable Aluminium Crutchwith IoT-Based Mobility and Fall Detection System

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ABSTRACT: For people with visual impairment, moving safely from one place to another is a daily challenge. Traditional walking sticks are helpful but limited, as they can only detect obstacles when they come into direct contact.

This often leads to unsafe situations, especially in crowded or unfamiliar environments. To overcome this issue, this paper presents a Smart Blind Stick that uses ultrasonic sensing along with IoT technology to improve navigation safety.

The system is built using an Arduino Uno, an ultrasonic sensor, and alert components such as a buzzer and vibration motor. It continuously checks for obstacles in front of the user and gives immediate feedback when something is detected within a certain distance.

This helps the user react quickly and avoid accidents.
In addition, the device can send information through the internet using a Wi-Fi module, allowing basic monitoring and emergency support. The overall design focuses on simplicity, affordability, and ease of use, making it suitable for real-life application and improving independence for visually impaired users.

KEYWORDS: Smart Blind Stick, Ultrasonic Sensor, IoT, Arduino, Assistive Device, Obstacle Detection

I. INTRODUCTION

Vision plays a major role in helping people understand and interact with their surroundings. When a person loses this ability, even simple tasks like walking safely become difficult. Many visually impaired individuals depend on traditional white canes, which are simple and easy to use but have certain limitations. These sticks can only detect obstacles when they touch them, which means the user gets very little time to react.

With the growth of technology, there is a need for smarter solutions that can provide better support. The idea of a smart blind stick comes from this need. By combining sensors and electronic components, it becomes possible to detect obstacles before physical contact happens.

In this work, an ultrasonic sensor is used to measure the distance of objects ahead. The information is processed using a microcontroller, which then alerts the user through sound or vibration. Along with this, IoT technology adds an extra layer by enabling basic communication and monitoring features.

This approach not only improves safety but also helps users feel more confident and independent in their daily movement.

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II. LITERATURE REVIEW

Over time, different methods have been developed to support visually impaired people in moving safely. The most common tool has been the white cane, which is simple and affordable but has clear limitations. It works only when it touches an object, so users often become aware of obstacles only at the last moment.

To improve this, researchers started using ultrasonic sensors that can detect objects from a distance and give early warnings. These systems made movement safer compared to traditional methods.

In many earlier designs, alerts were given only through sound, which was not always effective in crowded or noisy areas. Later, vibration-based feedback was added, making the system more reliable and easier to use. With the growth of technology, microcontrollers like Arduino became popular because they are easy to program and cost-effective.

Recently, IoT features have been included to allow tracking and emergency communication. Some advanced systems also use cameras, but they often increase cost and complexity. Overall, there is still a need for a solution that balances performance, simplicity, and affordability for everyday use.

III. RESEARCH METHODOLOGY

The methodology for this project was planned step by step to create a simple and useful solution. First, the main problem was understood, which is the difficulty faced by visually impaired people while walking independently. After identifying the need, suitable components were selected, including an Arduino board, ultrasonic sensor, buzzer, vibration motor, and a Wi-Fi module.

Next, the system was designed by connecting all the components in a proper way. The ultrasonic sensor was used to detect obstacles by measuring the distance. The Arduino acts as the main controller, processing the sensor data continuously. Whenever an object comes within a certain distance, the system responds immediately by giving alerts through sound and vibration. This helps the user react quickly and avoid danger.

Once the setup was ready, testing was carried out in different conditions to check how well the system performs. Important factors like detection range and response time were observed carefully. Based on the results, the system was found to work effectively. This approach ensures that the device is not only functional but also practical and easy to use in real-life situations.

IV. RESULTS AND DISCUSSION

The developed system was tested to check how well it detects obstacles and alerts the user. The ultrasonic sensor was able to detect objects within a range of about 2 to 3 meters. When an obstacle was detected within the set distance, the system quickly activated the buzzer and vibration motor.

The response time was fast enough to allow users to react and avoid collisions. The dual alert system worked effectively in both quiet and noisy environments. The Wi-Fi module was also tested and showed stable performance in sending data.

Compared to traditional sticks, this system provides better awareness and safety. The results show that the device performs reliably and can be used in real-world situations.

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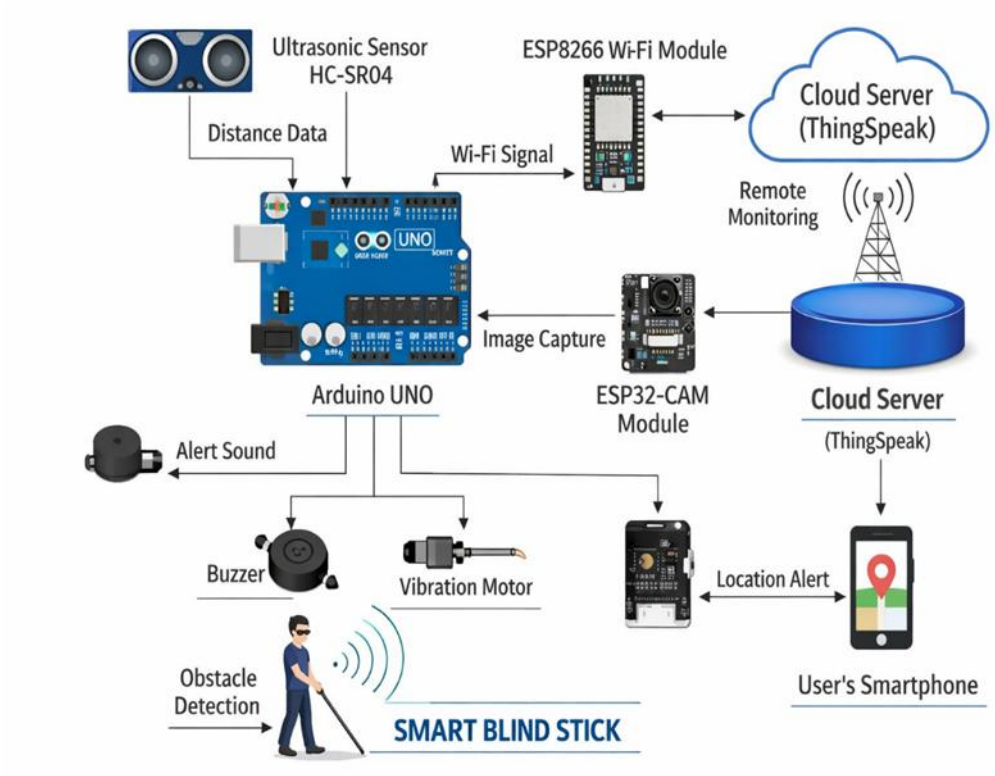

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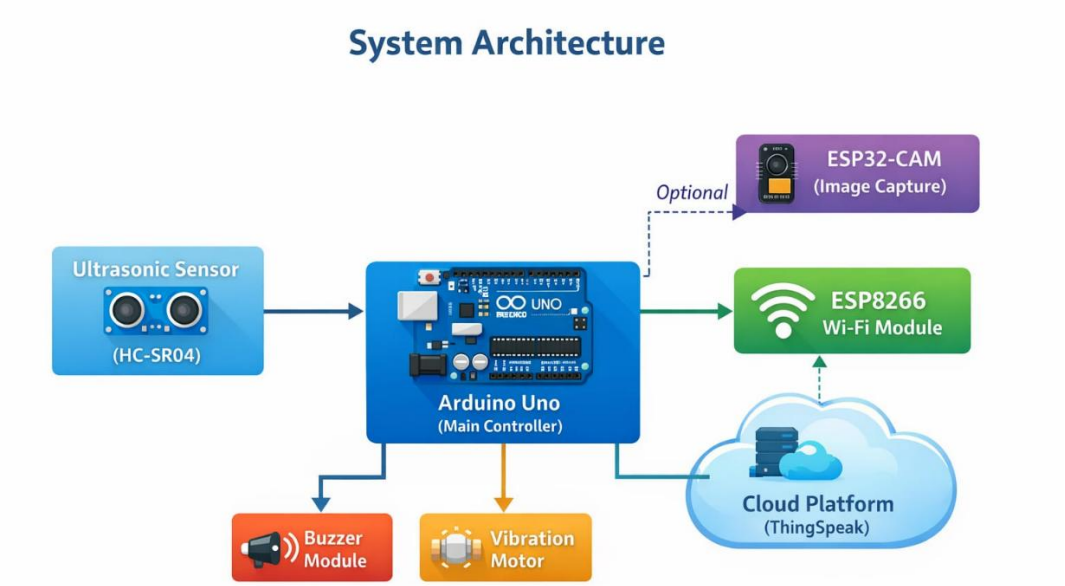

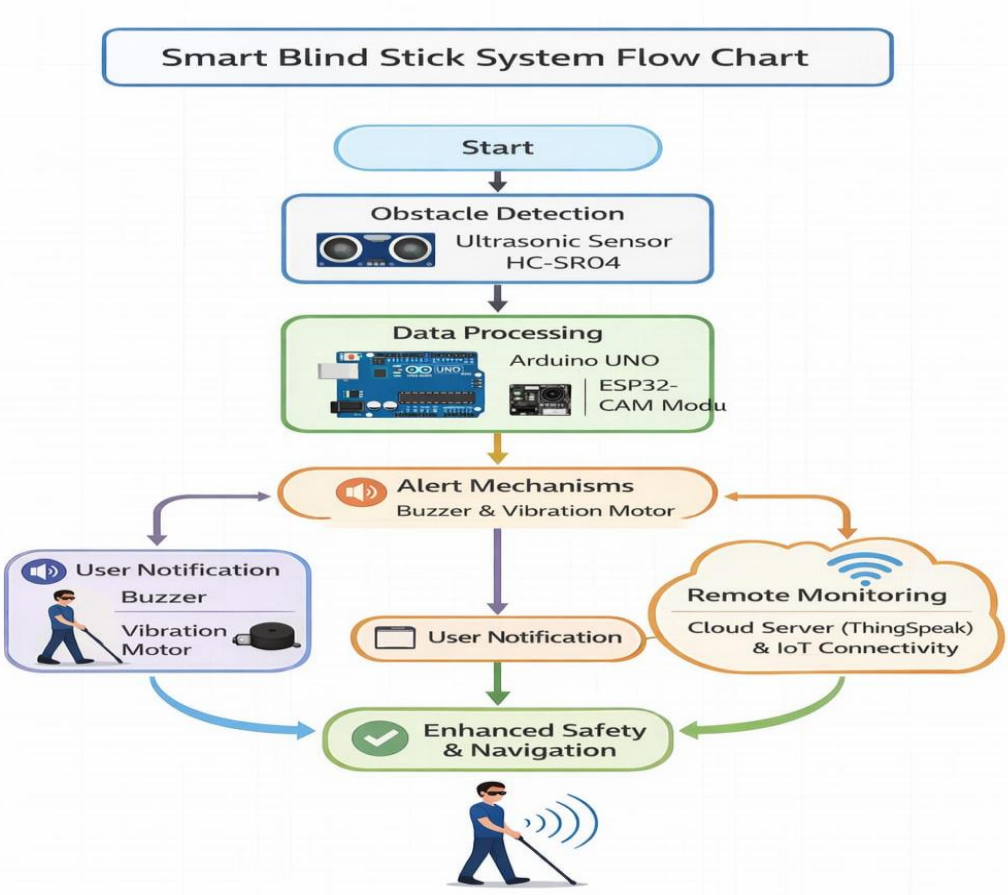

Flowchart of the Smart Blind Stick system showing obstacle detection, data processing, alert mechanisms, IoT communication, and safety outcomes.

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V. CONCLUSION

The Smart Blind Stick presented in this paper offers a practical improvement over traditional walking aids. By using ultrasonic sensing and simple alert systems, it helps users detect obstacles earlier and respond quickly.

The addition of IoT features makes the system more useful by allowing basic monitoring and support. The design focuses on being simple, low-cost, and easy to handle, which makes it suitable for everyday use.

Overall, the system improves safety and gives more confidence to visually impaired individuals while moving independently.

VI. FUTURE WORK

There are several ways to improve this system in the future. Adding a GPS module can help track the user's location during emergencies. A mobile application can also be developed for better interaction and monitoring.

Voice guidance can be introduced to provide clearer instructions instead of simple alerts. Camera-based object detection can further improve the system's intelligence.

Improving battery life and making the design more compact can also enhance usability. With these changes, the system can become more advanced and helpful for users.

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