Smart Helmet for Visually Impaired People using Arduino

Aditi M. Barde
det. of Electrical Engineering
Shri Sant Gajanan Maharaj College of Engineering
Shegaon, India
aditibarde03@gmail.com

Ankita V. Bharambe
dept. of Electrical Engineering
Shri Sant Gajanan Maharaj College of Engineering
Shegaon, India
ankitabharambe912@gmail.com

Sampada P. Palaskar
dept. of Electrical Engineering
Shri Sant Gajanan Maharaj College of Engineering
Shegaon, India
sampadapalaskar@gmail.com

Aseer S. Ahmed
dept. of Electrical Engineering
Shri Sant Gajanan Maharaj College of Engineering
Shegaon, India
aseerahmad916@gmail.com

Ashish T. Gosavi
dept. of Electrical Engineering
Shri Sant Gajanan Maharaj College of Engineering
Shegaon, India
gosaviashish390@gmail.com

Nirmal V. Shinde
dept. of Electrical Engineering
Shri Sant Gajanan Maharaj College of Engineering
Shegaon, India
nirmalshinde960@gmail.com

***Abstract*— Visually impaired people have great difficulties with independent and safe mobility in unfamiliar situations. Conventional mobility tools such as white canes and guide dogs provide some help but are generally not effective for detecting overhead or unexpected obstacles. In order to overcome these shortcomings, this project outlines the creation of a Smart Helmet that is specially made to help visually impaired users improve their spatial awareness and ability to detect obstacles.**

The suggested system is developed based on an Arduino Uno microcontroller interfaced with Sharp distance sensors and a vibration motor to offer real-time feedback. The helmet constantly scans the environment and warns the wearer through vibrations if an obstacle is detected in a pre-set range. This design offers intuitive and non-verbal feedback independent of sound, which is appropriate for noisy situations.

The equipment was tested in laboratory conditions and showed consistent obstacle detection, quick response, and comfort to users. The project is focused on low cost, simplicity, and modularity and hence is scalable for mass deployment and future modifications, such as audio feedback and pothole detection.

This intelligent assistive device is meant to enhance mobility, safety, and confidence in visually impaired individuals during their everyday lives. With today's hectic and infrastructure-driven life, visually impaired persons are presented with numerous challenges in terms of independent mobility. Simple activities like walking along congested streets, navigating around buildings, or overcoming obstacles prove difficult and, occasionally, perilous. Conventional mobility aids such as white canes and guide dogs provide some level of support but tend to lack in identifying head-level or approaching obstacles, which are outside their range of sensing. Such shortcomings can result in injuries, decreased independence, and reduced confidence among users.

I. INTRODUCTION

With the evolution of embedded systems, microcontrollers, and sensors, it becomes feasible to make smart, wearable devices that offer improved spatial perception and aid navigation. This work is concerned with the design and implementation of a Smart Helmet designed with visually impaired consumers in mind. The helmet uses the Arduino UNO microcontroller, together with Sharp distance sensors, vibration motors, and other electronic components, to identify obstacles in front of the user and give feedback in real time through vibrations.

The ultimate goal is to improve the mobility and safety of visually impaired individuals by outfitting them with a device that not only identifies obstacles at a range of distances and heights but also gives immediate, intuitive notice. The helmet should be lightweight, ergonomic, affordable, and easy to use, so that it can be comfortably worn for hours without inducing discomfort or fatigue.

In addition, the modular nature enables the system to be customized and scaled to suit user requirements or environmental factors. The components' simplicity makes it ideal for mass production and maintenance, and the open-source hardware such as Arduino facilitates further development and customization by developers and researchers.

II. PROBLEM DEFINITION

Visually impaired people have tremendous difficulties in traveling around independently, frequently being confronted with obstacles that are dangerous to their safety in their daily lives. Conventional mobility aids like canes or guide dogs provide some level of support, but they do not always give timely or adequate information regarding immediate threats, especially obstacles at head height. Blind people are, therefore, vulnerable to collisions with hanging objects, low-hanging branches, and other obstacles, which result in possible injuries and impaired mobility.

III. OBJECTIVES

The primary objective of this project is to design and develop an Smart Helmet for Visually Impaired People using Arduino, for real-time obstacle detection and simple feedback mechanisms. Specific goals include:

• Designing and prototyping a lightweight and ergonomic smart helmet integrated with Arduino.
• Implementing obstacle detection algorithms to accurately identify obstacles in the user's path.
• Developing a feedback system to provide intuitive alerts to the user about the presence and proximity of obstacles.
• Ensuring the device is customizable and adaptable to different environments and user preferences.
• Providing documentation and resources for users and developers to facilitate widespread adoption and further improvements.

IV. ANALYSIS

A. *Detailed Statement of the Problem*

Visually impaired individuals face serious challenges when moving around their environment on their own. In spite of the existence of traditional mobility aids such as canes and guide dogs, these individuals are still at risk from different obstacles that threaten their safety.

1. Poor situational awareness: Traditional mobility aids tend to lack timely and sufficient information regarding imminent threats, especially obstacles at head height.

2. Higher collision risk: Visually impaired persons have a high risk of collisions with suspended objects, low-hanging branches, and other obstructions, which can lead to physical injuries and mobility impairments.

3. Diminished autonomy: The absence of effective mobility aid can constrain the autonomy and self-confidence of the visually impaired, impacting their quality of life in general.

B. *Requirement Specifications*

In this section we will look towards the Hardware required for the implementation of the project.

1. Hardware Requirement
❖ Arduino Uno
❖ Sharp(IR) Sensor
❖ Vibration Motor
❖ Servo Motor
❖ Battery
❖ Helmet Frame
❖ Connecting Wire
❖

A. Hardware

Input: Here input is taken from the sharp sensors by detecting the object. with the help of microcontroller sensor data is process and actions are taken.

Output:
1. Real-Time Object detection.
2. Alert the user by vibration.

V. DESIGN

In this chapter, we provide the detail design of our project to showcase the structure and functionality of the project. This chapter includes System Architecture, flow diagram, technology stack.

Design means that planning the appearance, structure and functionality of the system before it is implemented. It represents a detailed view of system before it built so that we are able to identify its usability, feasibility, reliability and efficiency for improving and better performance of the system.

C. *System Architecture*

The architecture of the system contains a proper mounting of sharp sensor providing angular direction.

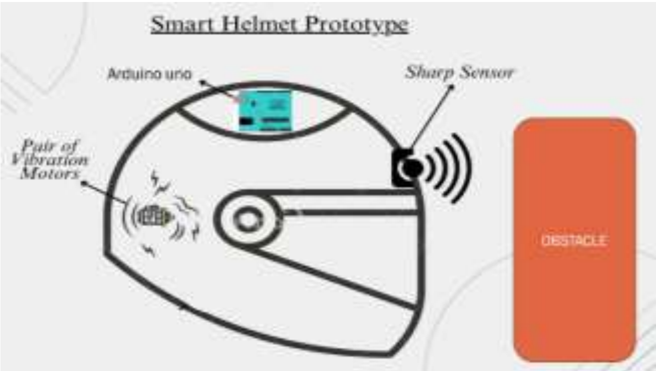

Fig.1 Concept Diagram

The envisioned smart helmet system combines components to support obstacle detection in angular directions. At its center is a Sharp IR sensor that detects obstacles. The interfaced servo motor gives angular direction to the Sharp IR sensor, which is positioned on the servo motor, to find the object's side. The IR sensor information is afterward processed by the microcontroller, which takes necessary action. The data is processed after which the signal is obtained by the vibration motor and then vibrated on the side where the object is placed by the sensor. Equipped with an electrical power source with a potential backup power source such as a battery, the system guarantees smooth operation. Overall, this model proposed here gives an end-to-end solution for visually impaired individuals.

1.Sharp IR Sensor: Sensing obstacles and providing data to the microcontroller.
2.Microcontroller: Interpreting data from the sensor and deciding on obstacle presence and location.
3.Servo Motor: Giving angular direction to the Sharp IR sensor for sensing obstacles.
4.Vibration Motor: Informing the user of obstacle presence via vibrations.

Key Functionality:
1.Obstacle Detection: System is detecting obstacles in the path of the user.
2. Directional Alert: System gives directional alerts regarding obstacles via vibration motors.
3.User Warning: System warns the user of potential dangers, allowing safe movement.

VI. PROPOSED METHODOLOGY

To achieve the objectives we developed a system that integrates the hardware components. The system development process involves the following important steps:

1. Sharp sensor integration
2. Servo motor operation
3. Data processing
4. Signal and alert
5. Continuous operation

A. Sharp sensor integration

The Sharp IR sensor is mounted on the servo motor and interfaces with the microcontroller. The sensor collects data at regular intervals, feeding it to the microcontroller for processing.

1. Infrared Technology: The Sharp IR sensor operates using infrared radiation to sense obstacles.
2. Distance Measurement: The sensor calculates the distance between the user and the obstacle.
3. Analog Output: The sensor gives an analog output signal that changes with distance.

a. Integration with Microcontroller

1. Signal Processing: The microcontroller processes the analog output signal from the Sharp IR sensor.
2. Distance Calculation: The microcontroller determines the distance to the obstacle using the sensor data.
3. Obstacle Detection: The microcontroller determines if there is an obstacle based on the calculated distance.

B. Servo motor operation

The servo motor rotates in angular directions - front, right, and left - to scan the surroundings for obstacles. This precise movement enables accurate detection.

1.Angular Movement: The servo motor allows for accurate angular movement, enabling the Sharp IR sensor to sweep around the environment.
2.Directional Control: The servo motor is made to turn in certain directions (e.g., left, right, front) to sense obstacles.
3.Positioning: The Sharp IR sensor is positioned by the servo motor at different angles to detect obstacles.
4.Accurate Movement: The servo motor's accurate movement allows the detection of obstacles precisely.

C. Data processing

The microcontroller processes the collected data, performing necessary actions.

1. Sensor Data Collection: Data is retrieved by the microcontroller from the Sharp IR sensor.
2. Calculation of Distance: The microcontroller computes the distance from the user to the obstacle.
3. Obstacle Detection: The presence of an obstacle is decided by the microcontroller based on the distance calculated.
4.Signal Generation: The microcontroller provides signals to notify the user using vibration motors.
5.Real-time Processing: The data is processed by the microcontroller in real-time, allowing prompt alerts and warnings.

D. Signal and alert

When an obstacle is detected, the microcontroller sends a signal to the vibration motors embedded in the helmet. These motors vibrate to alert the user, indicating the direction of the obstacle in front, right and left.

1.Tactile Feedback: Gives the user tactile feedback via vibrations.
2.Alert Mechanism: Informs the user of the presence of obstacles.
3.Directional Indication: The vibration motor gives directional indication by vibrating on the object's side or direction of the obstacle, warning the user of:

a. Left-side obstacles: Vibration motor located on the left side vibrates.
b. Right-side barriers: Vibration motor at the right side vibrates.
c. Front obstacles: Vibration motor gives clear pattern or both sides vibrate.

This directional cue assists the user in navigating safely.

E. Continuos operation

The smart helmet is powered by a battery, providing a reliable backup source. This ensures uninterrupted operation, allowing users to access from anywhere.

Fig 2:- Proposed Model

VOLUME: 09 ISSUE: 04 | APRIL - 2025 SJIF RATING: 8.586 ISSN: 2582-3930

VII. RESULT AND DISCUSSION

A. *Result*

Smart Helmet for the Visually Impaired was developed and tested successfully with the following results:

1. Accuracy in Obstacle Detection:

The Sharp distance sensor in the helmet proved to be a consistent tool in detecting obstacles between a few centimeters to a few meters. The analog output was taken to an Arduino Uno to measure obstacles' distances in real time.

2. Effective Feedback Mechanism

The vibration motor integrated into the helmet reacted precisely to blocks inside the threshold range (assuming an analog value of 500 units). On detecting an object in this area, the motor produced a vibration warning, thereby alerting the user to an obstacle.

3. Real-Time Processing:

The Arduino Uno constantly monitored sensor input, enabling instant reaction to changes in the environment. This provided users with timely warnings, improving navigation and minimizing the chances of collision.

4. Power Efficiency and Portability:

The device was powered economically with 5V DC, making it portable-friendly. Its small size and ergonomic shape ensured ease of wearing without interfering with movement or visibility.

B. *Analysis of working model*

We have use LED instead of vibration motor for visualization.

DIRECTION OF OBJECT DETECTED	LED BLINK	OUTPUT
Right	Red	
Left	Yellow	
Front	Blue	

C. *Discussion*

The Smart Helmet prototype was an effective low-cost, real-time assistive device for visually impaired users. Its key benefits are in its simplicity, reliability, and responsiveness:

Sensor Choice Justification:

The Sharp sensor was more desirable than the ultrasonic sensor because it provides greater accuracy in the detection of narrow and head-level objects, which are important for helmet-mounted systems.

User Safety and Comfort:

By warning users via vibration rather than audio, the helmet maintains privacy and prevents auditory distractions, especially in noisy situations.

Limitations and Challenges:

Sharp sensors have the tendency to misinterpret very reflective surfaces.

Detection angle is low; increased placement of sensors or multiple sensors would enhance coverage.

Pothole and terrain sensing are not currently implemented but referenced as future developments.

Expert Feedback and Industry Insights:

Industry response underscored modularity and customizability based on varied user requirements. Additional recommendation also involved integrating audio output with exact distance details to make the feedback more descriptive.

Additional Suggested Improvements:

Implementation of audio output to calculate distances approximated.

Development to incorporate improvement of the algorithm towards adaptive output.

Addition of pothole detection as ground-level safety enhancement.

VIII. CONCLUSION

The Smart Helmet for the Visually Impaired effectively showcases the use of embedded systems and sensor technology to improve mobility and safety for visually impaired individuals. Through the use of Arduino Uno, Sharp sensors, and vibration motors, the system offers real-time detection of obstacles and intuitive feedback in the form of vibrations, particularly for head-level obstacles that conventional aids such as canes tend to overlook.

The prototype has been found to be efficient, economic, and convenient, providing a feasible solution for everyday navigation problems of the visually impaired. The lightweight and modular architecture provides comfort and mobility, and the system's autonomy provides freedom from internet or external support while in use.

Overall, the project not only enhances visually impaired users' confidence and independence but also introduces the possibilities of technology in solving practical issues. Additional features like GPS compatibility, voice notification, and Bluetooth accessibility can further develop the device's function so that it becomes an even more useful aid.

REFERENCES

[1] Parihar, Vipul, Yogesh Rohilla, and Kusum Kumari. "Ultrasonic sensor based smart cap as electronic travel aid for blind people." 2020 Third International Conference on Smart Systems and Inventive Technology (ICSSIT). IEEE, 2020.

[2] Nishajith, A., et al. "Smart cap-wearable visual guidance system for blind." 2018 International Conference on Inventive Research in Computing Applications (ICIRCA). IEEE, 2018.

[3] Hengle, Amey, et al. "Smart cap: A deep learning and iot based assistant for the visually impaired." 2020 Third International Conference on Smart Systems and Inventive Technology (ICSSIT). IEEE, 2020.

[4] Aarthi, V., et al. "Smart alert and intimation system for VIP (visually impaired person)." 2021 5th International Conference on Computing Methodologies and Communication (ICCMC). IEEE, 2021.