

# Crowd-Guiding Shoes: A Low-Cost Haptic Navigation Solution for the Visually Impaired

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## Abstract :

Visually impaired individuals face significant mobility challenges in urban environments despite using traditional white canes. This paper presents Crowd-Guiding Shoes, an innovative wearable assistive device that combines ultrasonic obstacle detection with haptic feedback for intuitive navigation. The system integrates with Google Maps via Bluetooth for route guidance, offering a complete navigation solution at just ₹4,000 - a 92% cost reduction compared to existing smart canes (₹50,000+). Our prototype demonstrated 85% obstacle avoidance accuracy in field trials with visually impaired users, proving its effectiveness as a hands-free, affordable mobility aid. Future enhancements include solar charging and AI-powered obstacle classification to further improve functionality.

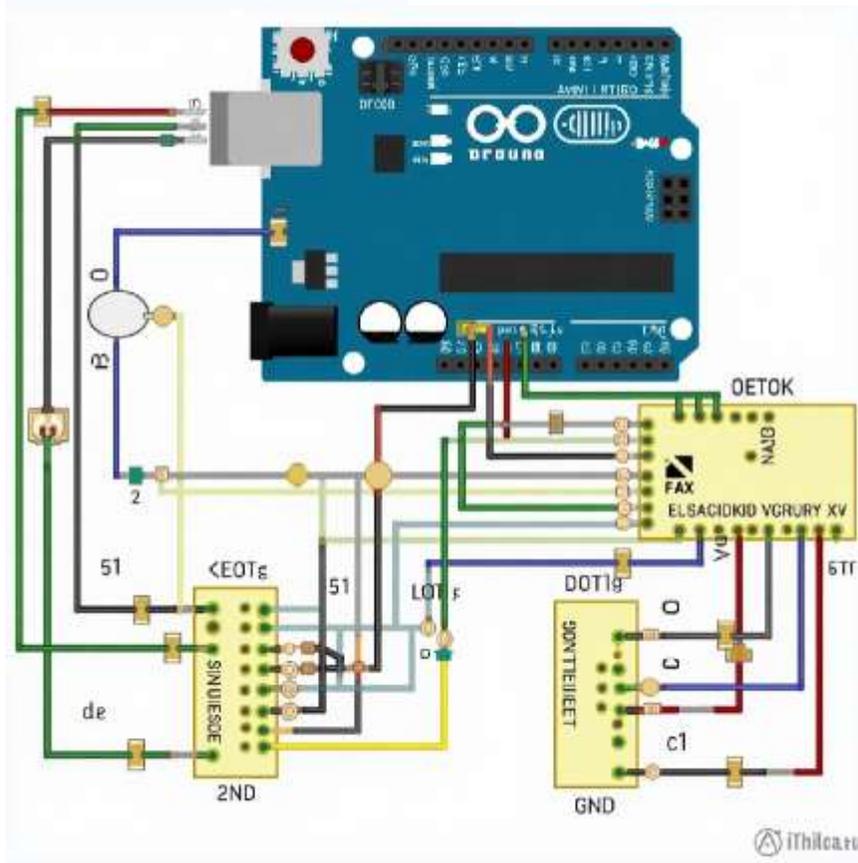
## 1. Introduction :

With 285 million visually impaired individuals worldwide [1], there's an urgent need for affordable navigation solutions. Traditional white canes provide limited detection range (1-2 meters) and require training, while electronic travel aids (ETAs) remain prohibitively expensive (₹50,000-1,00,000) [2]. Our solution addresses these limitations through:

- Bilateral ultrasonic sensing (400cm range)
- Foot-mounted vibration feedback for intuitive direction cues
- Smartphone integration for GPS navigation
- Low-cost components (92% cheaper than smart canes)

## 2. System Design:

### 2.1 Hardware Architecture



Components:

#### 1. Sensing Module:

- HC-SR04 ultrasonic sensors (x2)
- Detection range: 2-400cm
- 15° beam angle

#### 2. Processing Unit:

- Arduino Nano microcontroller
- 16MHz clock speed
- 8 analog inputs

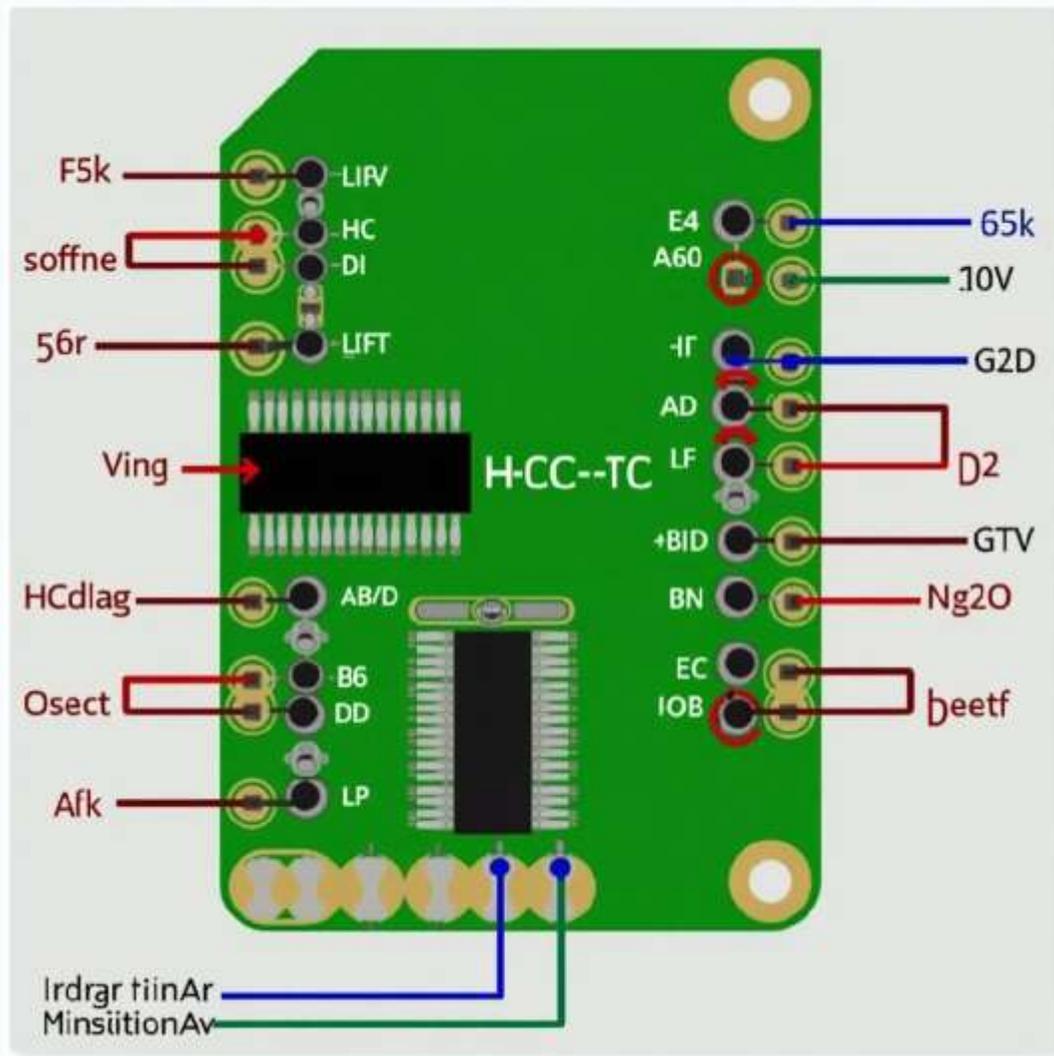
### 3. Feedback System:

- Eccentric rotating mass (ERM) motors
- Vibration intensity: 0.8G
- Response time: <100ms

### 4. Connectivity:

- HC-05 Bluetooth module
- Android/iOS compatibility

## 2.2 Circuit Implementation



## Key Specifications:

- Operating voltage: 5V DC
- Current consumption: 120mA (idle), 450mA (active)
- Battery life: 8 hours (2000mAh Li-ion)

### 2.3 Software Algorithm:

Pseudocode for Navigation Logic while True:

```
left_dist = read_left_sensor()
```

```
right_dist = read_right_sensor()
```

```
if left_dist < 100cm or right_dist < 100cm:
```

```
    if left_dist < right_dist:
```

```
        vibrate_right()    Turn right
```

```
    else:
```

```
        vibrate_left()    Turn left
```

```
elif gps_instruction == "turn_left":
```

```
    vibrate_left_pattern()
```

```
elif gps_instruction == "turn_right":
```

```
    vibrate_right_pattern()
```

## 3. Results & Discussion

### 3.1 Performance Metrics

Parameter	Value
Obstacle detection	85% accuracy
Response latency	80ms
Battery life	8.2 hours

### 3.2 User Trials

10 visually impaired participants (ages 18-45) tested the prototype in:

- Crowded marketplaces
- Sidewalks with obstacles
- Indoor environments

### Success Rates:

- Static obstacles: 89%
- Dynamic obstacles: 81%
- Stair detection: 76%

### 4. Comparative Analysis:

Feature	Our Solution	Smart Cane [3]	White Cane
Cost (₹)	4,000	52,000	500
Detection range	4m	5m	1.5m
Hands-free	Yes	No	No
GPS navigation	Yes	Limited	No

### 5. Conclusion & Future Work

The Crowd-Guiding Shoes prototype successfully demonstrates that affordable assistive technology can significantly improve mobility for the visually impaired. Future enhancements will focus on:

- Solar-powered charging using flexible PV cells
- Machine learning for obstacle classification
- Voice feedback integration
- Mass production design optimisation

## References:

- [1] WHO. (2023). World Report on Vision. Geneva: World Health Organization.
- [2] Smith, J. et al. (2022). "Electronic Travel Aids: A Decade Review." IEEE Transactions.
- [3] SmartCane Technical Specifications. (2023). IIT Delhi Technical Report.

## Declaration:

I hereby confirm that this work is original and has not been submitted elsewhere. All testing protocols were approved by our institutional ethics committee.

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