SMART BLIND STICK

Project Presentation

Under the guidance of,
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Contents

Problem definition

Traditional white canes can't detect obstacles in complex areas, which increases the chance of accidents and makes it harder for visually impaired people to move around easily. They need better support that gives them real-time help to navigate safely and efficiently.

Purpose and need

- The purpose of this project is to enhance mobility for visually impaired individuals by developing an advanced navigation aid that detects obstacles in complex environments.

- This technology aims to provide real-time assistance, improving safety and independence in their daily movements.

- By addressing these challenges, we hope to significantly improve their quality of life.

Project objective

- Develop a smart blind stick for safe and independent navigation for visually impaired individuals.
- Implement voice recognition for users to input commands and receive audio feedback.
- Utilize ultrasonic sensors to continuously monitor the environment for obstacles and provide real-time alerts.
- Incorporate a camera module for image processing to recognize objects and hazards.
- Implement location tracking and navigation to predefined locations.
- Design an emergency feature to send GPS coordinates to emergency contacts when activated.

Literature survey

PAPER	ADVANTAGES	DISADVANTAGES
U. Masud, T. Saeed, H. M. Malaikah, F. U. Islam and G. Abbas, "Smart Assistive System for Visually Impaired People Obstruction Avoidance Through Object Detection and Classification," in IEEE Access, vol. 10, pp. 13428-13441, 2022.	• Advanced object detection • Enhanced safety • scalability	• Hardware limitations • Real-time processing delays • Environmental constraints

PAPER	ADVANTAGES	DISADVANTAGES
B. Singh and M. Kapoor, "A Framework for the Generation of Obstacle Data for the Study of Obstacle Detection by Ultrasonic Sensors," in IEEE Sensors Journal, vol. 21, no. 7, pp. 9475-9483, 1 April 1, 2021.	● Improved accuracy ● Systematic data generation ● Real world application	● Narrow scope ● Environmental constraints ● Limited 3D information
R. A. Amin, M. Hasan, V. Wiese and R. Obermaisser, "FPGA-Based Real-Time Object Detection and Classification System Using YOLO for Edge Computing," in IEEE Access, vol. 12, pp. 73268-73278, 2024	● Real-time performance ● Low power consumption ● Edge device compatibility	● Complex hardware design ● Limited model flexibility ● High development effort

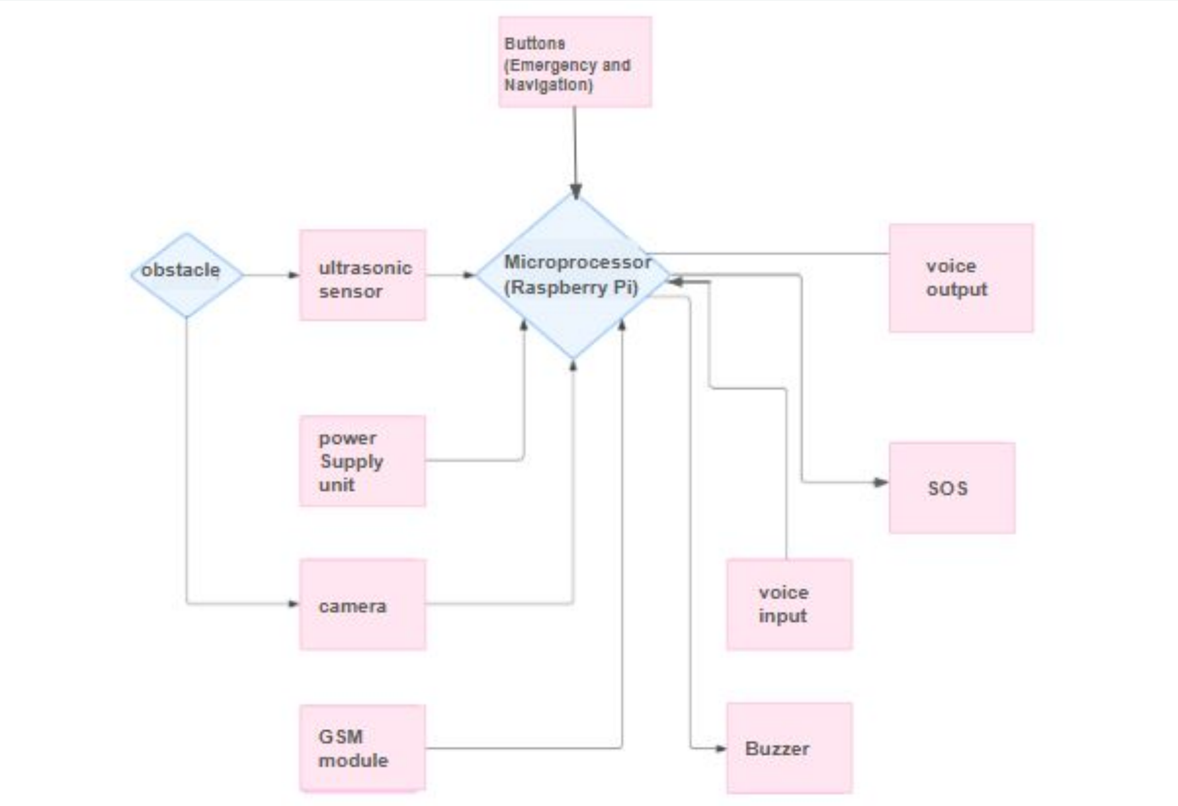
PAPER	ADVANTAGES	DISADVANTAGES
A. Thakur and P. Rajalakshmi, "L3D-OTVE: LiDAR-Based 3-D Object Tracking and Velocity Estimation Using LiDAR Odometry," in IEEE Sensors Letters, vol. 8, no. 7, pp. 1-4, July 2024.	• High precision tracking • 3D spatial awareness	• Limited object recognition • Cost of LiDAR systems
Stefanus Kurniawan 1,Dareen K. Halim 2, M.4“Multicore development environment for embedded processor in arduino IDE”TELKOMNIKA Telecommunication, Computing, Electronics and Control Vol. 18, No. 2, April 2020	• User-friendly platform • Multicore programming Support • Efficient resource usage	• Limited to Windows OS • Relies on external scripts • Performance variability

Proposed method

YOLO-v11 (You Only Look Once)

- **Description**: A real-time object detection system that divides images into a grid and predicts bounding boxes and class probabilities simultaneously.
- **Use Case**: Versatile for various object detection tasks in real-time applications (e.g., surveillance).
- **Pros**: Fast and efficient, good for detecting multiple objects in a single pass.
- **Cons**: Lower accuracy for small objects compared to some other methods.

Architecture Diagram


Buttons (Emergency and Navigation)
obstacle
ultrasonic sensor
Microprocessor (Raspberry Pi)
voice output
power Supply unit
SOS
camera
voice input
GSM module
Buzzer

Modules

- Obstacle Detection
- Navigation
- Image Processing
- Voice Output
- Emergency SOS

Each Module in Detail

- <u>**Obstacle Detection**</u> :

  Obstacle detection in a blind stick combines ultrasonic with a microcontroller to provide users with timely feedback, helping them avoid obstacles and navigate their environment more confidently.

- Ultrasonic Sensors Emits sound waves and measure the time it takes for the echoes to return. This helps determine the distance to nearby objects.

- We programmed Ultrasonic sensor in such a way that it gives a beeping sound when there is an obstacle along its path . A buzzer must be used for beeping sound.
- The system uses sound cues to indicate obstacle distance.
- When an obstacle is far away, it emits a beep sound with a longer delay.
- As the obstacle gets closer, the beep sound becomes more frequent, with a shorter delay.

- **Navigation**:
  - Navigation assistance in the blind stick uses location tracking.
  - Provides route guidance based on the user's location.
  - Helps users navigate their environment safely

- **Image Processing**:
  - Object detection in the blind stick uses a camera with image processing algorithms
  - Identifies and classifies objects in the user's environment.
  - Analyzes live video feed to recognize obstacles, signs, or important features.
  - Enhances user awareness and safety while navigating.

- Voice output:
    - The blind stick has voice output using text-to-speech technology.
    - Provides auditory feedback about surroundings and navigation.
    - Communicates information about obstacles, directions, and alerts.

- Emergency SOS:
    - The smart blind stick features an emergency SOS function.
    - When activated, it sends an email and SMS to pre-set contacts.
    - The message includes the user's real-time location for immediate assistance.

Assumptions

- Users will walk at a moderate pace, allowing sensors time to detect and alert about obstacles.
- Obstacles detected by the ultrasonic sensor will be at least 20-30 cm in height for the sensor to detect them effectively.
- Weight and Size: The stick must be lightweight and comfortable to carry for long periods. Consider the ergonomics and battery life.
- Durability: The stick should be durable enough to withstand occasional impacts and drops without affecting its functionality.
- The device will primarily be used in urban and semi-urban environments where internet-based location services are moderately reliable.

Work breakdown and responsibilities

- Beth Joseph Kollamala- Navigation Implementation.
- Amal Jose K- YOLO research and Image processing.
- C K Zaid-.Hardware Assembly and Fabrication, Emergency Communication Module.
- Benita Maria Eyoob- Implementation of Obstacle Detection using Ultrasonic Sensor.

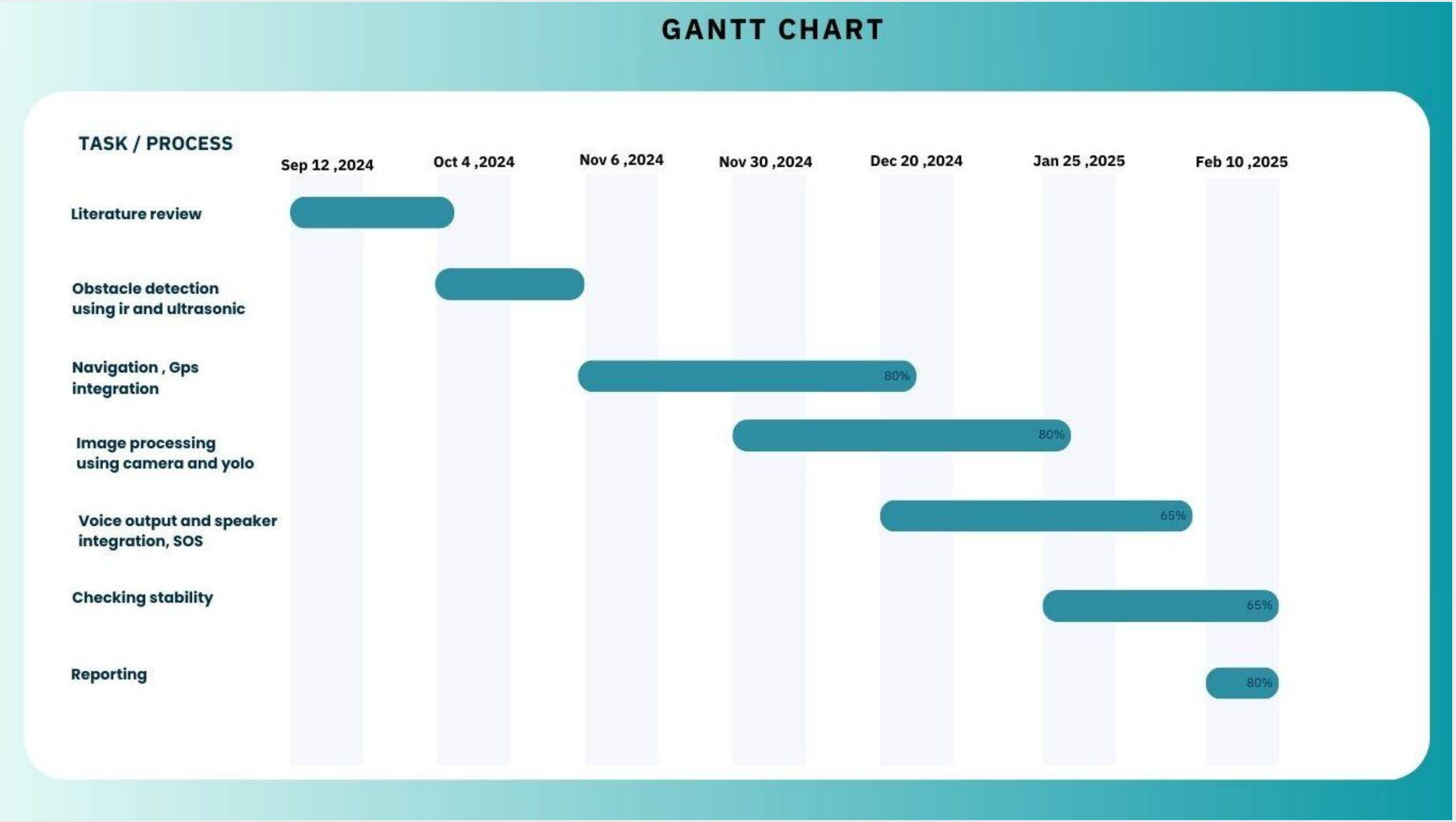
Hardware requirements

- Microcontroller: Raspberry pi
- Ultrasonic Sensor: HC-SR04 for obstacle detection.
- Camera Module: an appropriate USB camera for image processing.
- Voice Assistant Module:Speaker or audio output device (e.g., small speaker or buzzer).
- Power Supply:Rechargeable lithium-ion battery .
- Emergency button for user activation.
- Jumper wires and connectors for assembling the components.

Software Requirements

- Programming Environment: Python for programming the microcontroller.
- Voice Recognition Library: Libraries for voice recognition, such as Google Speech Recognition .
- Image Processing Library:YOLO for Object Detection.

Gantt chart


GANTT CHART
TASK / PROCESS
Sep 12 ,2024
Oct 4 ,2024
Nov 6 ,2024
Nov 30 ,2024
Dec 20 ,2024
Jan 25 ,2025
Feb 10 ,2025
Literature review
Obstacle detection using ir and ultrasonic
Navigation , Gps integration
80%
Image processing using camera and yolo
80%
Voice output and speaker integration, SOS
65%
Checking stability
65%
Reporting
80%

Budget

1. Microcontroller

- Raspberry Pi/ESP32: ₹800 - ₹6,200

2. Sensors

- Ultrasonic Sensor (e.g., HC-SR04): ₹150 - ₹400 (x2) = ₹300 - ₹800

3. Camera Module

- Raspberry Pi Camera or USB Camera: ₹2,000 - ₹4,000

4. Image Processing Software

- OpenCV: Free (open-source)

5. Voice Output

- Text-to-Speech Module/Speaker: ₹800 - ₹1,600
- Microphone: ₹400 - ₹1,200

6. Emergency SOS System

- GSM Module (e.g., SIM800L): ₹800 - ₹1,600
- SIM Card: ₹400 - ₹1,200 (for calls/SMS)

8. Power Supply

- Rechargeable Battery: ₹800 - ₹2,400
- Charging Module: ₹400 - ₹800

9. User Interface

- Buttons/Switches: ₹80 - ₹400

10. Enclosure

- Protective Case: ₹800 - ₹1,600

Total Estimated Budget

- Low-End Estimate: **₹6,170**
- High-End Estimate: **₹19,600**

Risk and challenges

<u>Sensor Limitations</u>: Ultrasonic sensor may struggle in certain environments (e.g., bright sunlight, reflective surfaces), leading to inaccurate readings.

<u>Battery Life</u>: Power consumption from multiple sensors and modules may lead to limited battery life, requiring frequent recharging.

<u>Cost</u>: Integrating multiple sensors and features can increase the overall cost, making it less accessible to users.

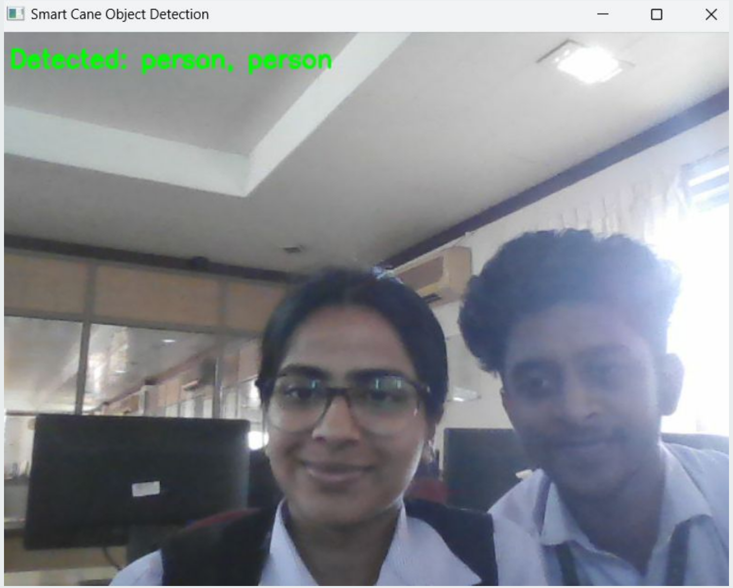
Over-reliance: Users might trust the stick too much and stop being cautious.

Connectivity Issues: GSM module may face connectivity problems in remote areas, hindering SOS functionality.

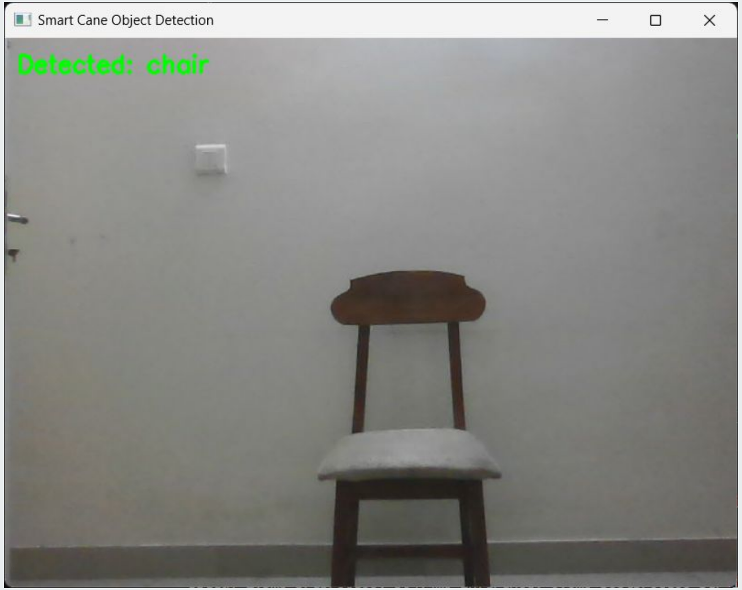
Processing Delays: Real-time image processing can introduce latency, potentially delaying important feedback to users.

Environmental Challenges: Moving obstacles, uneven terrain, and weather conditions like rain or fog can affect sensor performance or damage the electronics.

Output

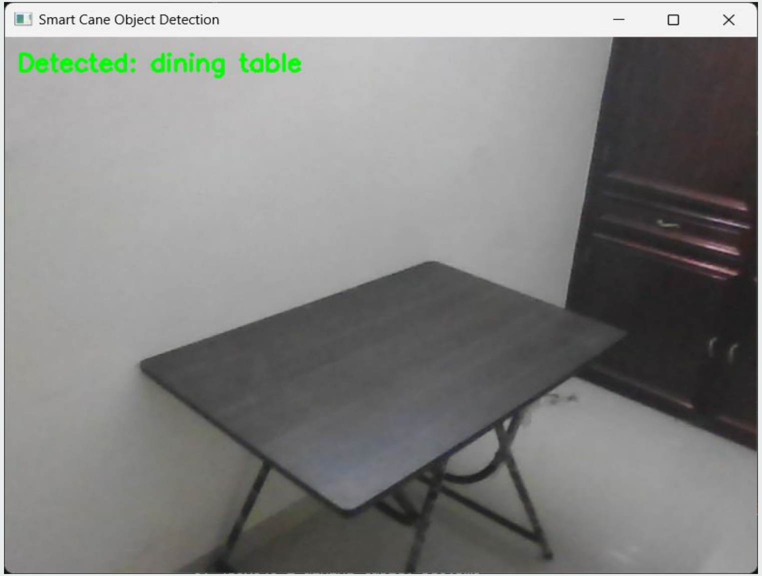


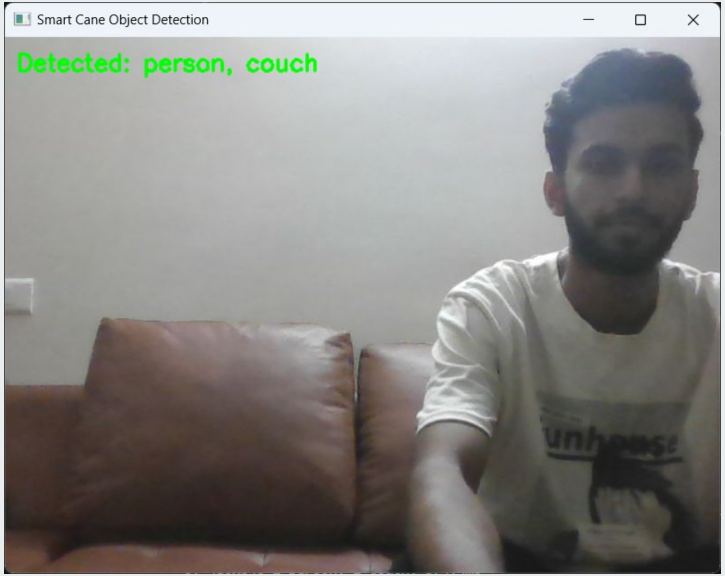
Smart Cane Object Detection
Detected: person, person



Smart Cane Object Detection
Detected: chair

Output

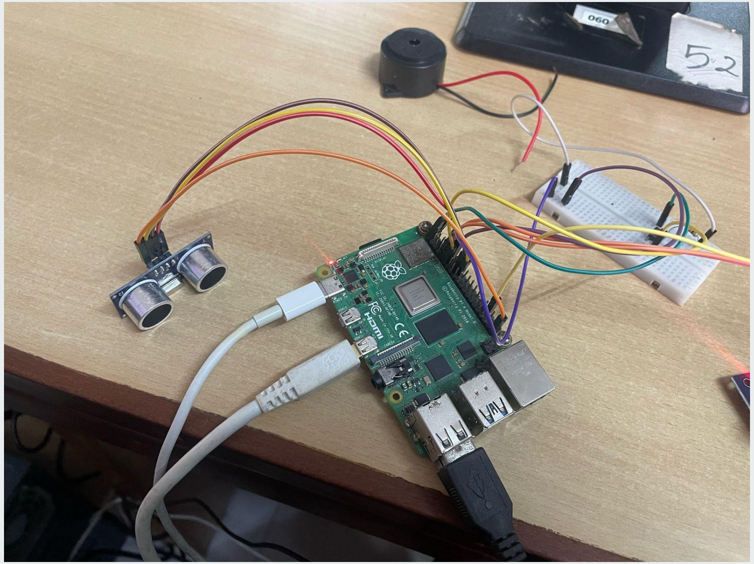

Smart Cane Object Detection
Detected: dining table

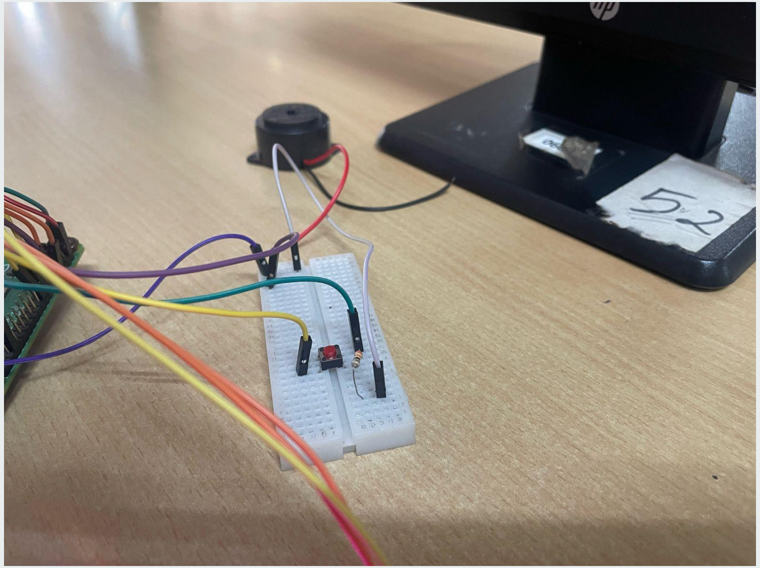

Smart Cane Object Detection
Detected: person, couch

Output

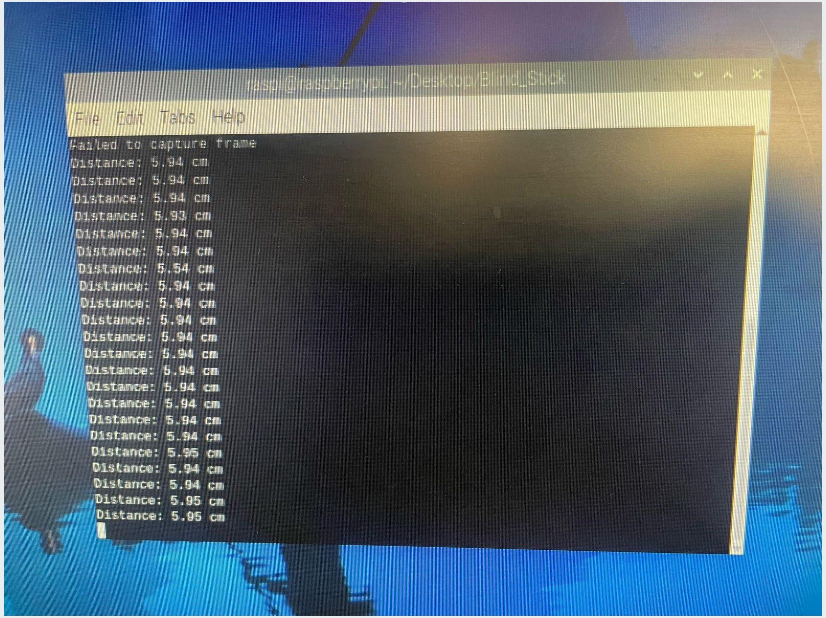
```
0: 480x640 2 persons, 1 handbag, 3 chairs, 2 tvs, 431.7ms
Speed: 3.2ms preprocess, 431.7ms inference, 0.0ms postprocess per image at shape (1, 3, 480, 640)
Detected: person, person, chair, chair, chair, tv, tv, handbag

0: 480x640 2 persons, 1 handbag, 2 chairs, 2 tvs, 405.6ms
Speed: 4.4ms preprocess, 405.6ms inference, 0.0ms postprocess per image at shape (1, 3, 480, 640)
Detected: person, person, chair, chair, tv, tv, handbag

0: 480x640 2 persons, 1 handbag, 3 chairs, 2 tvs, 1173.8ms
Speed: 0.0ms preprocess, 1173.8ms inference, 0.0ms postprocess per image at shape (1, 3, 480, 640
Detected: person, person, chair, chair, tv, chair, tv, handbag

0: 480x640 3 persons, 2 chairs, 1 tv, 1019.5ms
Speed: 8.0ms preprocess, 1019.5ms inference, 0.0ms postprocess per image at shape (1, 3, 480, 640
Detected: person, person, chair, chair, tv, person
```

Output





Output


raspi@raspberrypi: ~/Desktop/Blind_Stick
File Edit Tabs Help
Failed to capture frame
Distance: 5.94 cm
Distance: 5.94 cm
Distance: 5.94 cm
Distance: 5.93 cm
Distance: 5.94 cm
Distance: 5.94 cm
Distance: 5.54 cm
Distance: 5.94 cm
Distance: 5.94 cm
Distance: 5.94 cm
Distance: 5.94 cm
Distance: 5.94 cm
Distance: 5.94 cm
Distance: 5.94 cm
Distance: 5.94 cm
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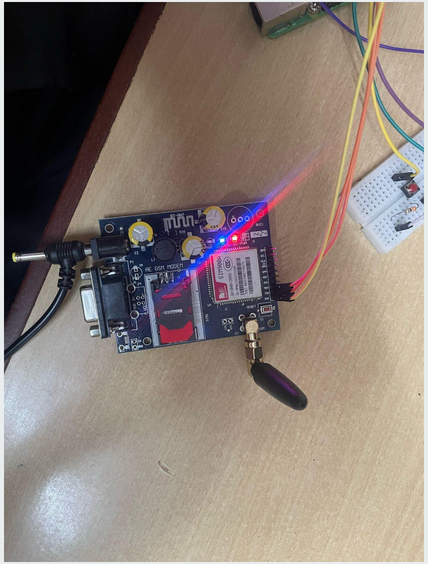
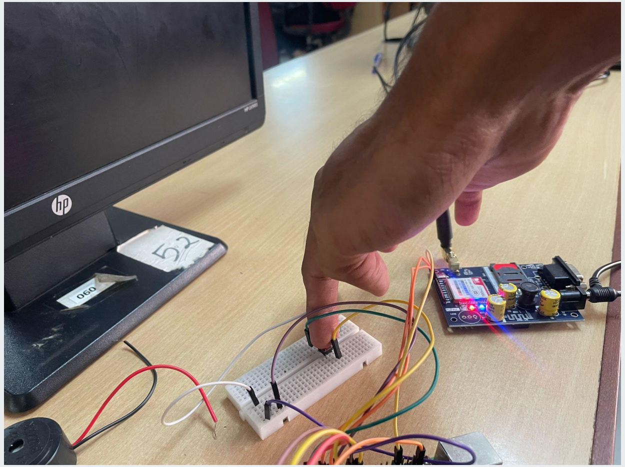
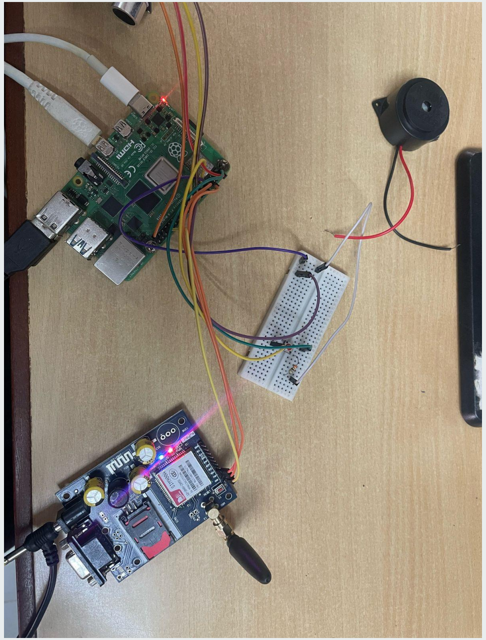
Distance: 5.95 cm

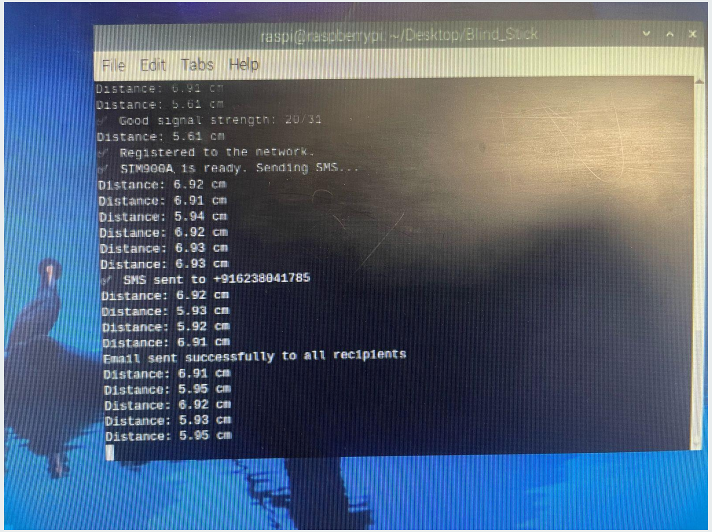
Output

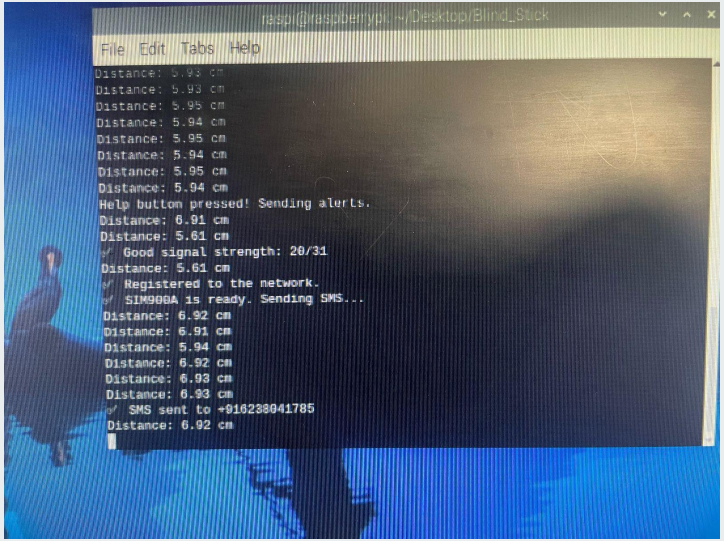




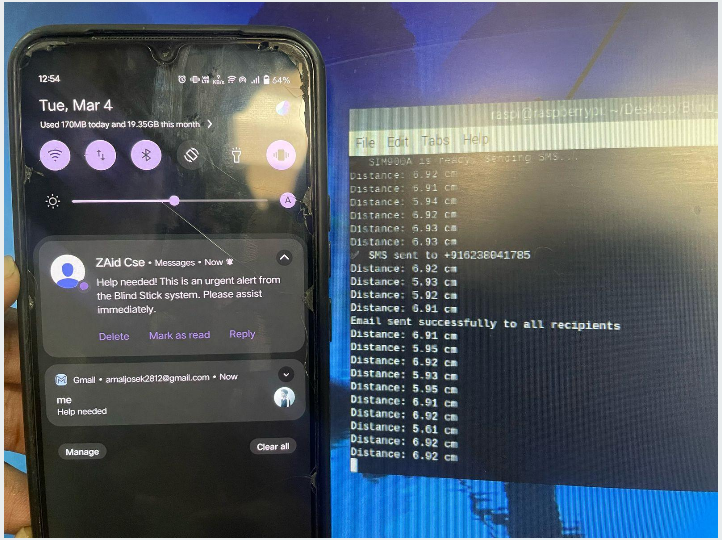


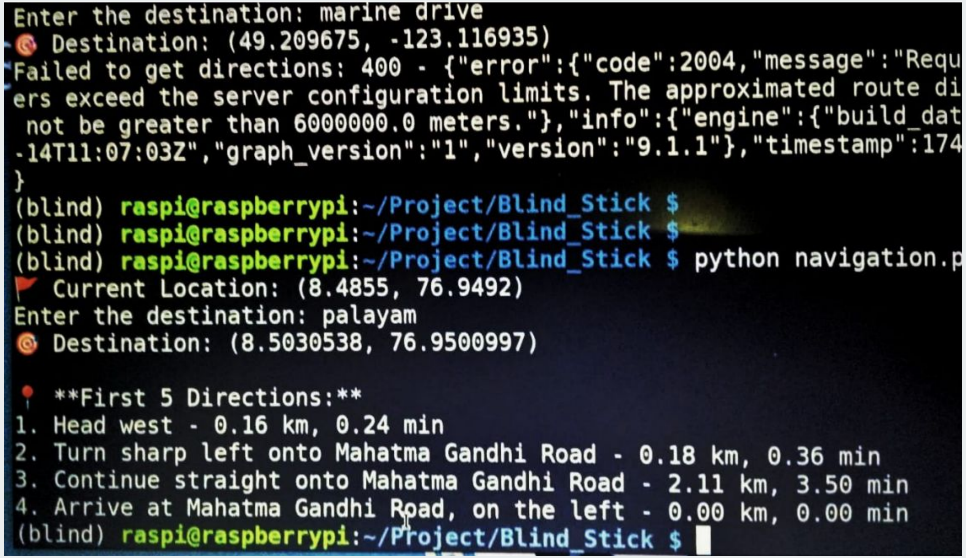
Output


raspi@raspberrypi: ~/Desktop/Blind_Stick
File Edit Tabs Help
Distance: 6.91 cm
Distance: 5.61 cm
Good signal strength: 20/31
Distance: 5.61 cm
Registered to the network.
SIM900A is ready. Sending SMS...
Distance: 6.92 cm
Distance: 6.91 cm
Distance: 5.94 cm
Distance: 6.92 cm
Distance: 6.93 cm
Distance: 6.93 cm
SMS sent to +916238041785
Distance: 6.92 cm
Distance: 5.93 cm
Distance: 5.92 cm
Distance: 6.91 cm
Email sent successfully to all recipients
Distance: 6.91 cm
Distance: 5.95 cm
Distance: 6.92 cm
Distance: 5.93 cm
Distance: 5.95 cm


raspi@raspberrypi: ~/Desktop/Blind_Stick
File Edit Tabs Help
Distance: 5.93 cm
Distance: 5.93 cm
Distance: 5.95 cm
Distance: 5.94 cm
Distance: 5.95 cm
Distance: 5.94 cm
Distance: 5.95 cm
Distance: 5.94 cm
Help button pressed! Sending alerts.
Distance: 6.91 cm
Distance: 5.61 cm
Good signal strength: 20/31
Distance: 5.61 cm
Registered to the network.
SIM900A is ready. Sending SMS...
Distance: 6.92 cm
Distance: 6.91 cm
Distance: 5.94 cm
Distance: 6.92 cm
Distance: 6.93 cm
Distance: 6.93 cm
SMS sent to +916238041785
Distance: 6.92 cm

Output


12:54
Tue, Mar 4
Used 170MB today and 19.35GB this month
ZAid Cse • Messages • Now
Help needed! This is an urgent alert from the Blind Stick system. Please assist immediately.
Delete
Mark as read
Reply
Gmail • amaljosek2812@gmail.com • Now
me
Help needed
Manage
Clear all
File Edit Tabs Help
SMS sent to +916238041785
Email sent successfully to all recipients
Distance: 6.92 cm


Enter the destination: marine drive
Destination: (49.209675, -123.116935)
Failed to get directions: 400 - {"error":{"code":2004,"message":"Requ
ers exceed the server configuration limits. The approximated route di
not be greater than 6000000.0 meters."},"info":{"engine":{"build_dat
-14T11:07:03Z","graph_version":"1","version":"9.1.1"},"timestamp":174
}
(blind) raspi@raspberrypi:~/Project/Blind_Stick $
(blind) raspi@raspberrypi:~/Project/Blind_Stick $
(blind) raspi@raspberrypi:~/Project/Blind_Stick $ python navigation.p
Current Location: (8.4855, 76.9492)
Enter the destination: palayam
Destination: (8.5030538, 76.9500997)
First 5 Directions:
1. Head west - 0.16 km, 0.24 min
2. Turn sharp left onto Mahatma Gandhi Road - 0.18 km, 0.36 min
3. Continue straight onto Mahatma Gandhi Road - 2.11 km, 3.50 min
4. Arrive at Mahatma Gandhi Road, on the left - 0.00 km, 0.00 min
(blind) raspi@raspberrypi:~/Project/Blind_Stick $

Output

Conclusion

The smart blind stick integrates voice assistance, ultrasonic sensors, image processing, and navigation to offer visually impaired individuals safe, real-time guidance. By incorporating emergency features, the system ensures independence while enhancing user safety and support.

References

1. U. Masud, T. Saeed, H. M. Malaikah, F. U. Islam and G. Abbas, "Smart Assistive System for Visually Impaired People Obstruction Avoidance Through Object Detection and Classification," in IEEE Access, vol. 10, pp. 13428-13441, 2022.

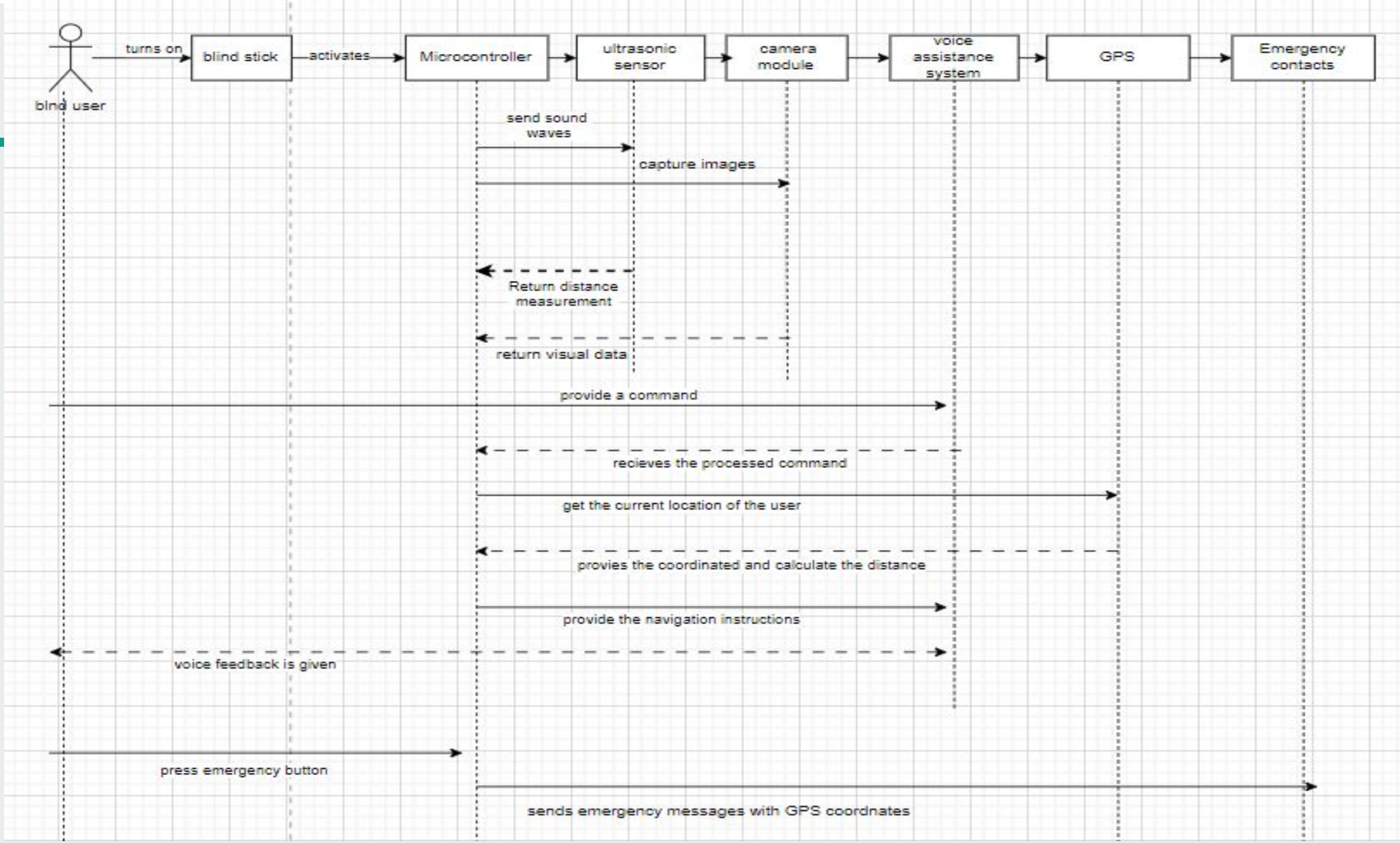
2. B. Singh and M. Kapoor, "A Framework for the Generation of Obstacle Data for the Study of Obstacle Detection by Ultrasonic Sensors," in IEEE Sensors Journal, vol. 21, no. 7, pp. 9475-9483, 1 April 1, 2021.

3. Y. Wu, H. Zhang, Y. Li, Y. Yang and D. Yuan, "Video Object Detection Guided by Object Blur Evaluation," in IEEE Access, vol. 8, pp. 208554-208565, 2020.

4. A. Thakur and P. Rajalakshmi, "L3D-OTVE: LiDAR-Based 3-D Object Tracking and Velocity Estimation Using LiDAR Odometry," in IEEE Sensors Letters, vol. 8, no. 7, pp. 1-4, July 2024.

THANK YOU

Sequence Diagram


blnd user
turns on
blind stick
activates
Microcontroller
ultrasonic sensor
camera module
voice assistance system
GPS
Emergency contacts
send sound waves
capture images
Return distance measurement
return visual data
provide a command
recieves the processed command
get the current location of the user
provies the coordinated and calculate the distance
provide the navigation instructions
voice feedback is given
press emergency button
sends emergency messages with GPS coordnates