UNIVERSITY OF ASIA PACIFIC

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CSE 316: MICROPROCESSOR AND MICROCONTROLLER LAB

BOD(Batwave Object Detective) Car

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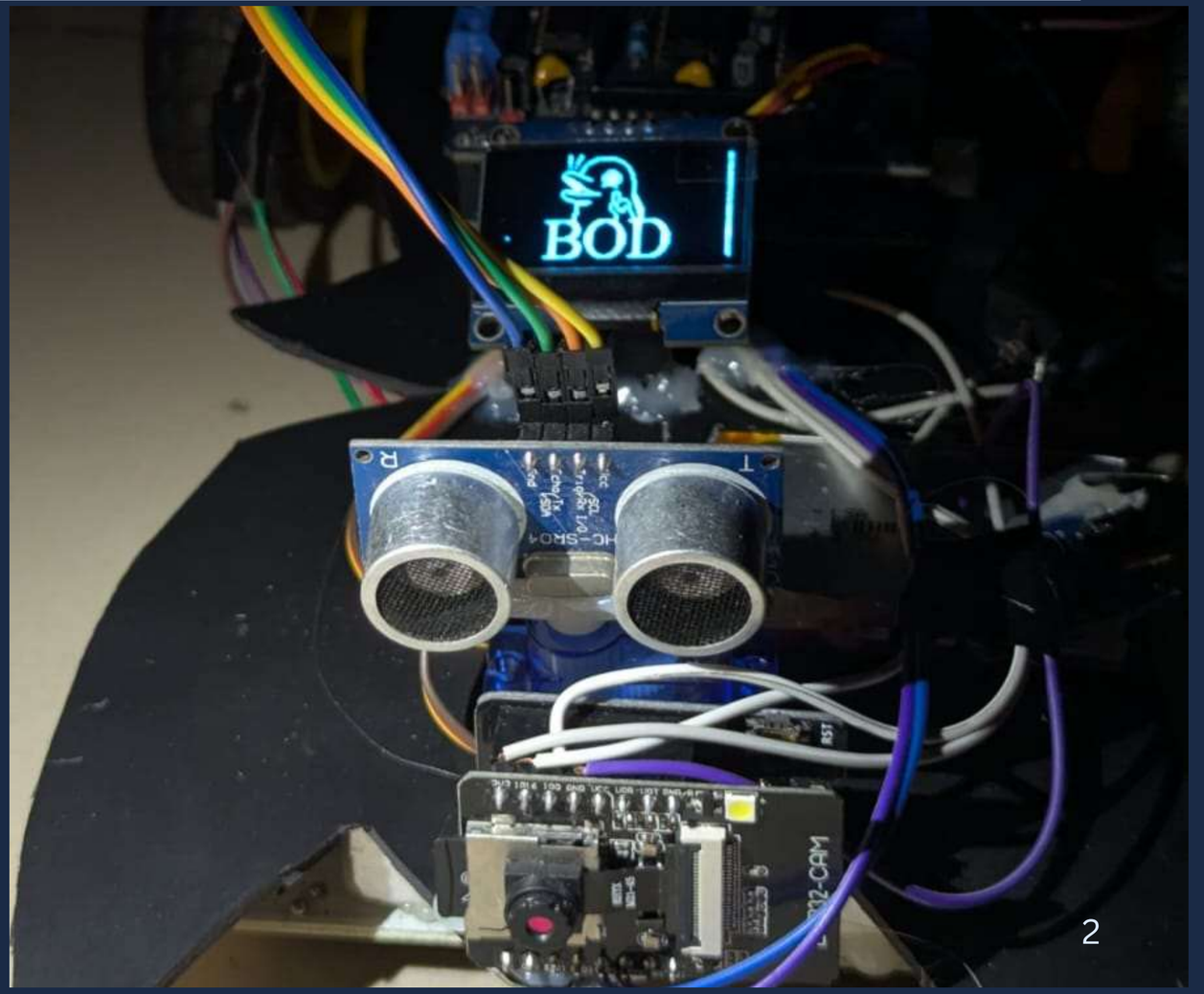
BOD

BOD(Batwave Object Detective) is an autonomous line-following and surveillance robot. It uses IR sensors to follow a path, an ultrasonic sensor and servo for obstacle detection, and an ESP32-CAM for live video streaming. The OLED display shows status updates, making it a smart, IoT-enabled system ideal for security and monitoring applications.



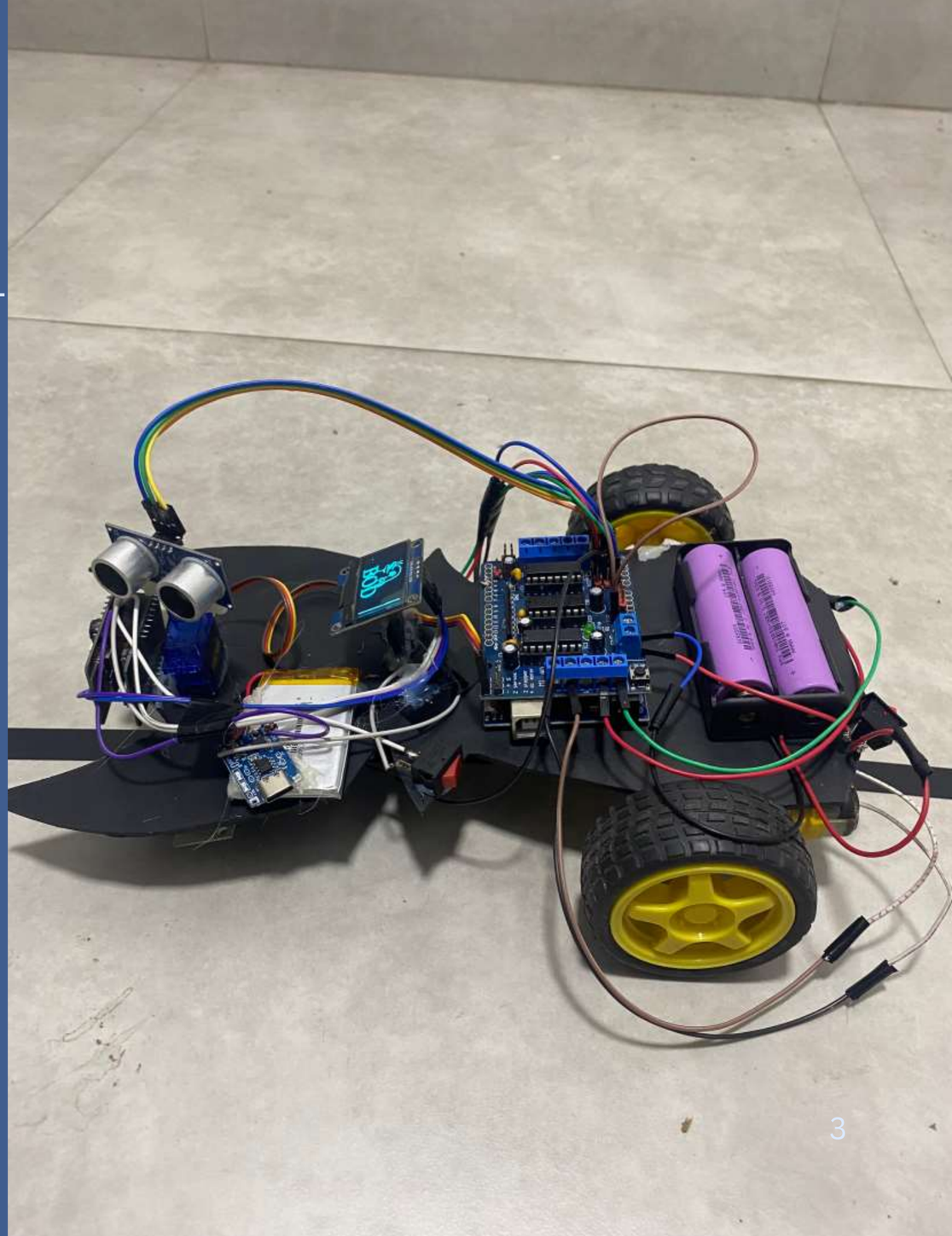
Project Objective

The objectives are:
(1) develop a line-following robot capable of autonomous patrolling

(2) integrate ultrasonic sensor for object/human detection

(3) implement alerts and recording via an onboard camera

(4) ensure safe, efficient power management with IoT-ready expansion.



Societal Impact and Motivation

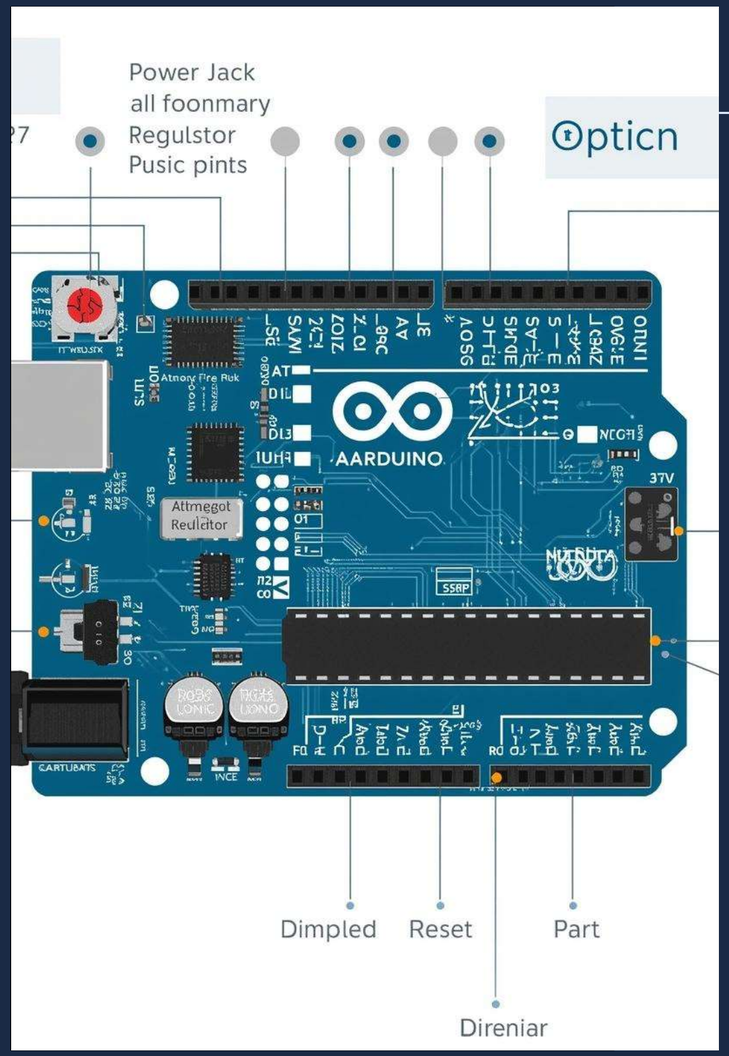
Motivation:

Security and monitoring systems increasingly combine robotics and IoT to offer mobile surveillance platforms that can patrol predefined paths and provide live or recorded visual evidence. The B.O.D. project aims to create an affordable, expandable platform.

Societal Impact :

- Enhances public and home security through automated surveillance and object detection.
- Encourages technological learning and innovation .
- Supports sustainable and energy-efficient smart monitoring systems.
- Developing intelligent infrastructure for safer communities.

Components of BOD Robot



1. **Arduino Uno R3** – Main microcontroller for processing sensor and motor data
2. **ESP32-CAM (with programming board)** – Captures and streams live video
3. **OLED Display (1.3")** – Shows system status and sensor readings
4. **3.7V 7000mAh Battery** – Powers Arduino, motors, and sensors
5. **3.7V Li-Po Battery** – Powers ESP32-CAM independently
6. **Gear Motors ×2 with Wheels** – Drive robot forward/backward and turns
7. **N20 Pololu Ball Wheel** – Supports smooth movement and balance
8. **TP4056 5V Charging Module** – Safely recharges batteries
9. **On/Off Switches ×2** – Control power separately for robot and camera
10. **6-Array IR Line Sensor** – Detects line path for navigation
11. **Ultrasonic Sensor (HC-SR04)** – Detects obstacles using sound waves
12. **L293D Motor Driver Module** – Controls motor speed and direction
13. **Servo Motor** – Rotates ultrasonic sensor for scanning surroundings

System Block Diagram

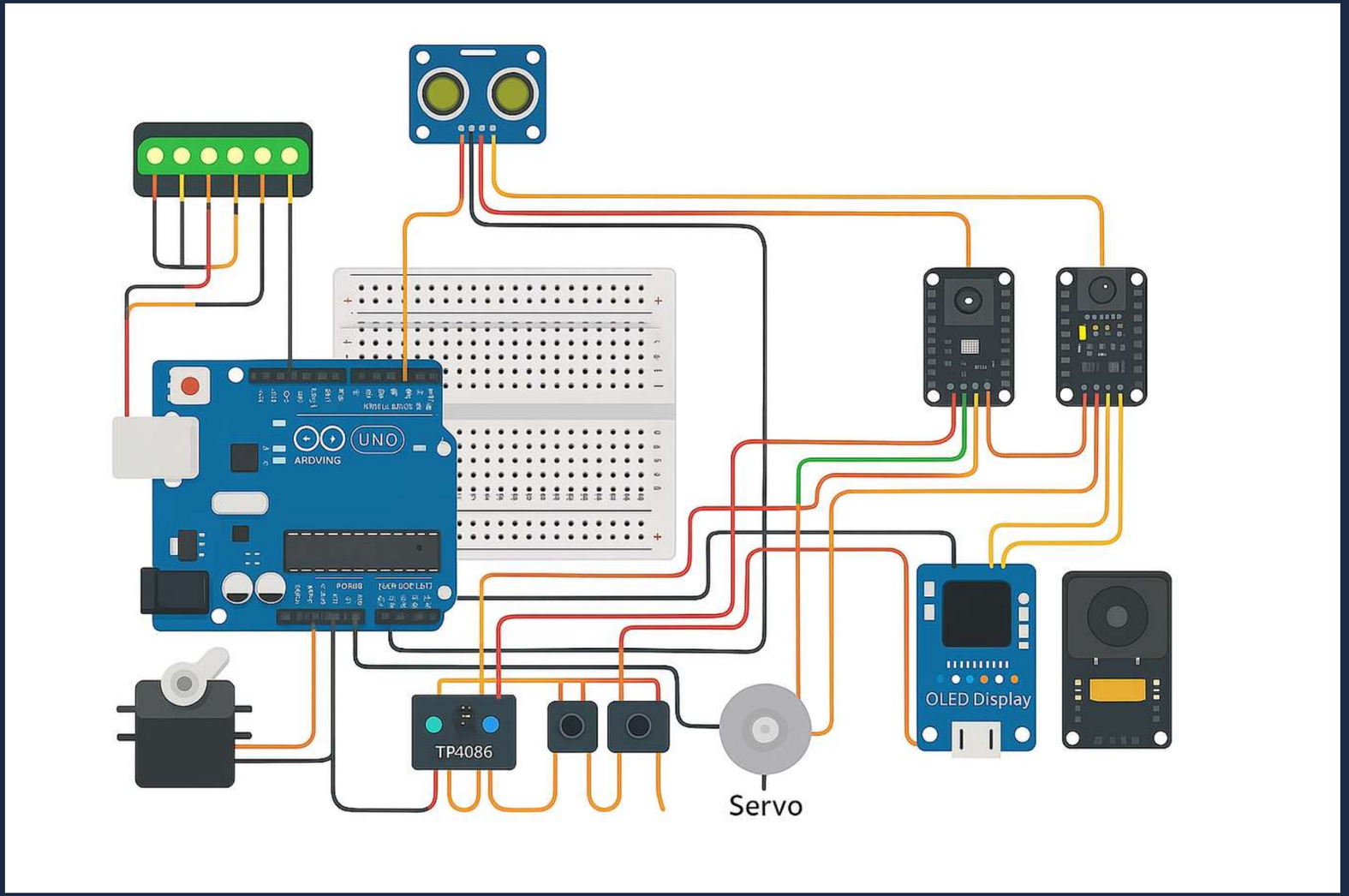
This block diagram shows the working of the Smart Line-Following and Surveillance Robot.

The Arduino Uno controls sensors and motors, while the ESP32-CAM streams live video.

IR sensors guide the line path, and the ultrasonic sensor avoids obstacles with the help of a servo motor.

L293D motor driver runs the gear motors, and the OLED display shows status.

Power is managed by 3.7V batteries and a TP4056 charging module.

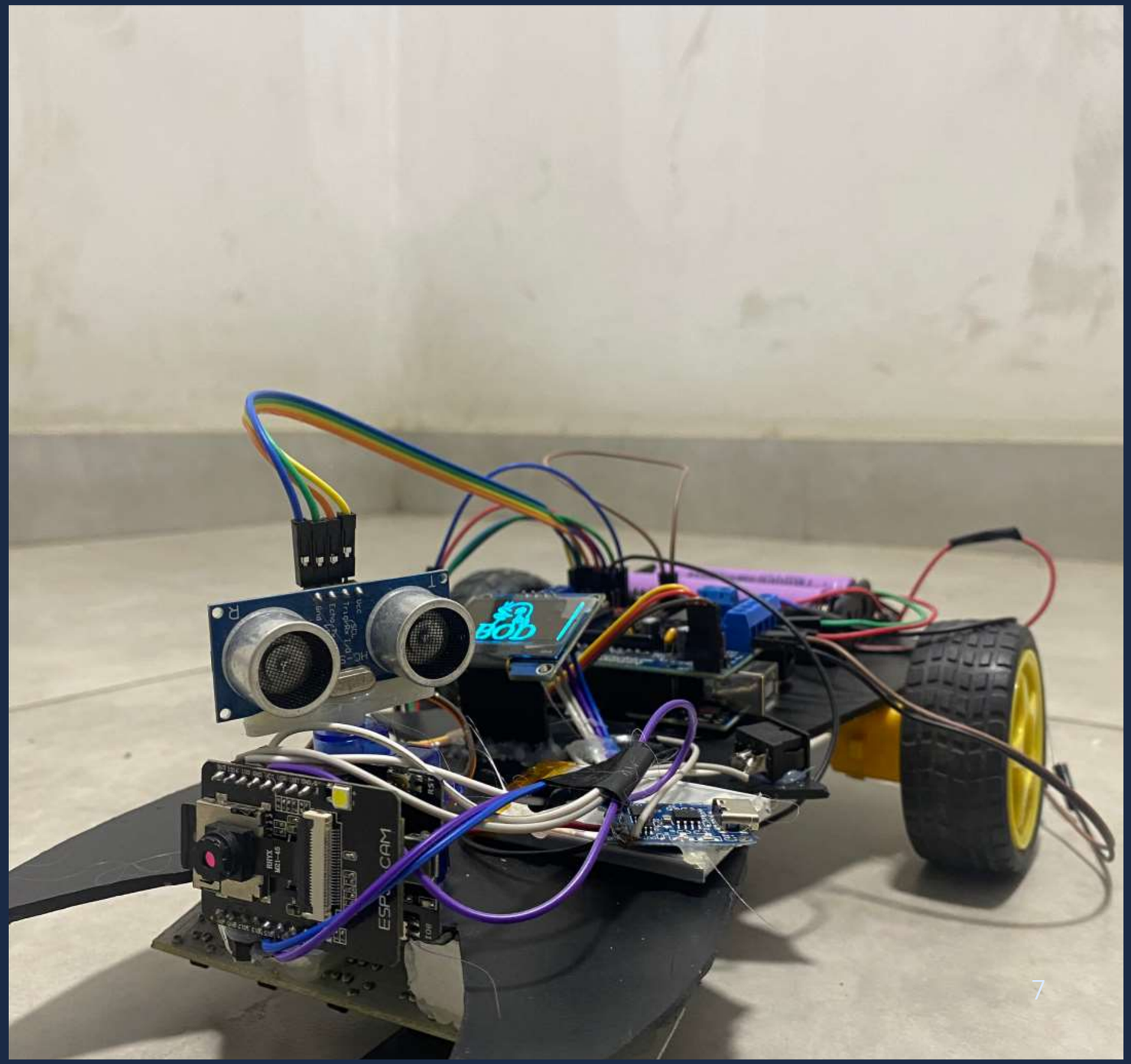


B.O.D system diagram.

PROJECT IMPLEMENTATION IMAGE

Prototype Setup

The prototype of the B.O.D. was built on a two-wheel
acrylic chassis powered by Li-ion batteries. The Arduino Uno
served as the central controller, interfacing with 6 IR sensors
for line tracking, ultrasonic sensors for obstacle detection, and
an ESP32-CAM for real-time video monitoring. The L293D
motor driver controlled the DC motors



Results and Analysis Slide

Result Summary

The prototype met the project objectives—achieving autonomous navigation, real-time detection, and video surveillance within a compact and affordable platform. These results validate the system’s design and demonstrate its potential for low-cost indoor monitoring and educational applications.

Testing Procedure

Testing involved (1) calibrating PID parameters for smooth line following, (2) measuring ultrasonic detection distances and verifying thresholds, (3) validating PIR-triggered alerts, and (4) checking that camera recording starts on detection and stores footage to microSD (ESP32-CAM) or streams to a server.

Team members contributions:

Sadman Sarwer	H.M. Tahsin sheikh	Humayra Jihan Arpita
• Connecting component in the right places. • Activated the power & ultrasonic sensor works. • Enable the ESP32 web cam working module by help from necessary tools. • Update the project regularly and fix the errors.	• Design the architecture of B.O.D. • Combine the ultrasonic sensor to 6-IR line following. • Help in activating the ESP32 network access. • Documenting the report (Latex) & code,annexure Files.	• Listing the project component price in reasonable. • Activate the display connection. • Documenting the video & presentation files. • Survey the project to local people for feedback.

CEP Mapping

Category	Attribute	How Addressed	CO	PO
K4	Specialist Knowledge	Robotics, sensor fusion (IR, PIR, ultrasonic), camera integration	CO1, CO2	PO1
K5	Engineering Design	Line-following PID and alert integration	CO2–CO4	PO3, PO5
P4–P6	Practical Implementation & Testing	Assembly, calibration, validation of modules	CO3–CO5	PO4–PO9
A3, A5	Teamwork & Ethics	Collaboration, safe laser use, eco power source	CO4–CO5	PO6–PO11

Conclusion

The Batwave Object Detective Car successfully integrates line-following navigation, real-time detection, and video surveillance in a compact system. Future improvements include IoT integration for remote monitoring and enhanced image processing.

Thank You

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