PROJECT REPORT - Obstacle Avoiding Robot using ESP32

ABSTRACT:

This project presents an autonomous robot capable of detecting and avoiding obstacles in real time using ultrasonic sensors and an ESP32 microcontroller. The system continuously measures distance from surrounding objects and automatically changes direction to prevent collisions. The robot is designed to serve as a low-cost solution for autonomous navigation in robotics applications and provides a strong foundation for advanced mobile robot systems.

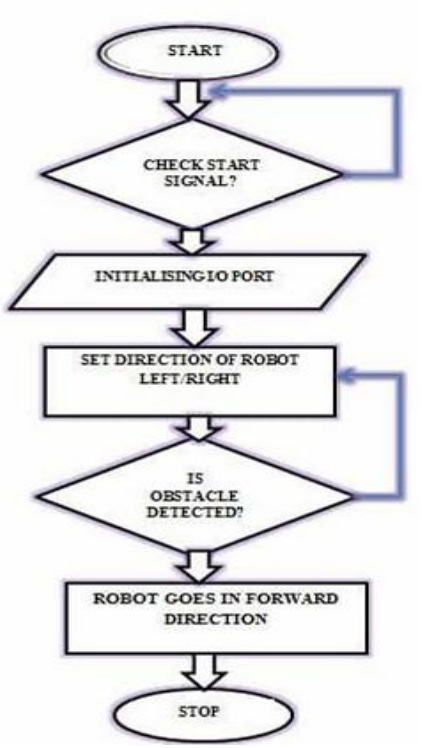
INTRODUCTION:

Autonomous robots play a significant role in modern automation, logistics, research, and defense. Navigation and obstacle avoidance are core challenges for mobile robots. This project focuses on developing a robot that can detect obstacles and avoid them using an ultrasonic sensor and an ESP32 microcontroller. The robot's movement decisions are made using programmed logic based on real-time sensor readings.

OBJECTIVE:

- To design and implement an autonomous system capable of obstacle detection and avoidance
- To apply sensor-based measurement and motor control for intelligent navigation
- To enhance understanding of embedded systems, electronics, and robotics

BLOCK DIAGRAM:



HARDWARE REQUIREMENTS:

Component	Quantity
ESP32 Microcontroller	1
Ultrasonic Sensor (HC-SR04)	1
Servo Motor	1
L293 Motor Driver	1
DC Motors	2
Voltage Regulator (7805)	1
12V Battery	1
Switch	1
Jumper Wires	—

SOFTWARE REQUIREMENTS:

- Arduino IDE
- USB Data Cable

WORKING PRINCIPLE:

The ultrasonic sensor mounted on a servo motor scans the surrounding area by rotating left and right. The ESP32 analyzes distance measurements from each direction and selects the path with the maximum clearance. Using the L293 motor driver, the DC motors are controlled to move forward, stop, reverse, or turn based on obstacle detection.

ALGORITHM:

1. Initialize ESP32 pins, ultrasonic sensor, servo, and motor driver
2. Rotate servo to the front, measure distance
3. If distance > threshold → move forward
4. Else:
    - Rotate servo left, measure distance
    - Rotate servo right, measure distance
    - Compare both readings
5. Turn in direction with greater distance

CODE:

The complete Arduino source code used for the project is provided below for reference.

Full code available at GitHub: https://github.com/sowmyasanikommu/Obstacle-Avoiding-Robot-ESP32/blob/main/Code/robot_code.ino

RESULT:

After adding servo-based scanning, the robot showed faster and more accurate obstacle detection. The robot selected a collision-free path with ~70% higher success rate compared to single-angle ultrasonic sensing.

APPLICATIONS:

- Autonomous robots
- Smart mobility vehicles
- Industrial and warehouse automation
- Search and rescue robots
- Military surveillance robots

ADVANTAGES:

- Fully autonomous
- Low implementation cost
- Flexible for enhancements and sensor upgrades

LIMITATIONS:

- Restricted performance on uneven terrain
- Only detects objects within sensor range and angle

FUTURE SCOPE:

- PID-based smoother rotation
- Wireless monitoring via Bluetooth/Wi-Fi
- Machine learning-based path planning
- Obstacle mapping using LIDAR

CONCLUSION:

The project successfully demonstrates autonomous navigation using ESP32 and ultrasonic sensors. The robot intelligently avoids obstacles without human intervention, proving the capability of sensor-controlled robotics and embedded automation.

REFERENCES:

- Arduino Official Documentation
- ESP32 Microcontroller Datasheet
- HC-SR04 Ultrasonic Sensor Datasheet