Design Workshop (ECE 1511)

Challenges in Traditional Restaurant Services: Delays, Order Errors, and Labor Inefficiency Impacting Customer Satisfaction and Operational Costs.

UDAY PRATAP SINGH RATHORE, 20251CAI0011

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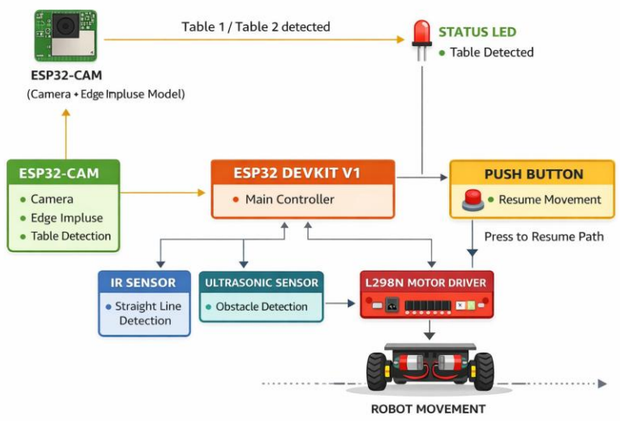
Problem description



Restaurants often face challenges such as high staff workload, order delays, and inefficient coordination during peak hours. Manual order-taking and table identification increase dependency on human effort and can lead to errors and service delays. This creates a need for an automated yet reliable system that can assist in the order-taking workflow while maintaining safety and simplicity.

This project focuses on developing an autonomous order-taking restaurant robot capable of navigating a predefined path and detecting specific tables using computer vision. The robot uses an IR sensor for stable navigation and an ESP32-CAM module running a lightweight machine learning model to identify tables. An ESP32 DevKit V1 controls robot motion, stops the robot upon table detection, and resumes operation based on user input. The system block diagram highlights the interaction between perception, control, sensors, and human input, addressing the feasibility of simple navigation, accurate table detection, and controlled human-robot interaction.

Technical approach

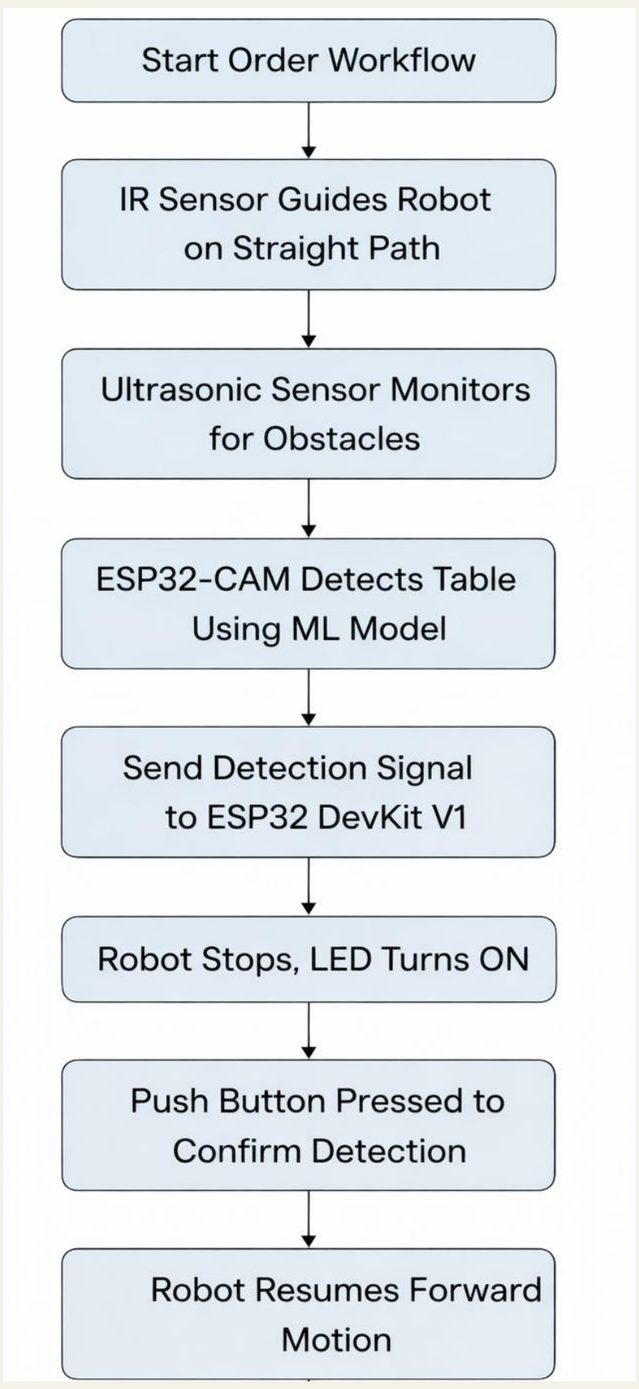
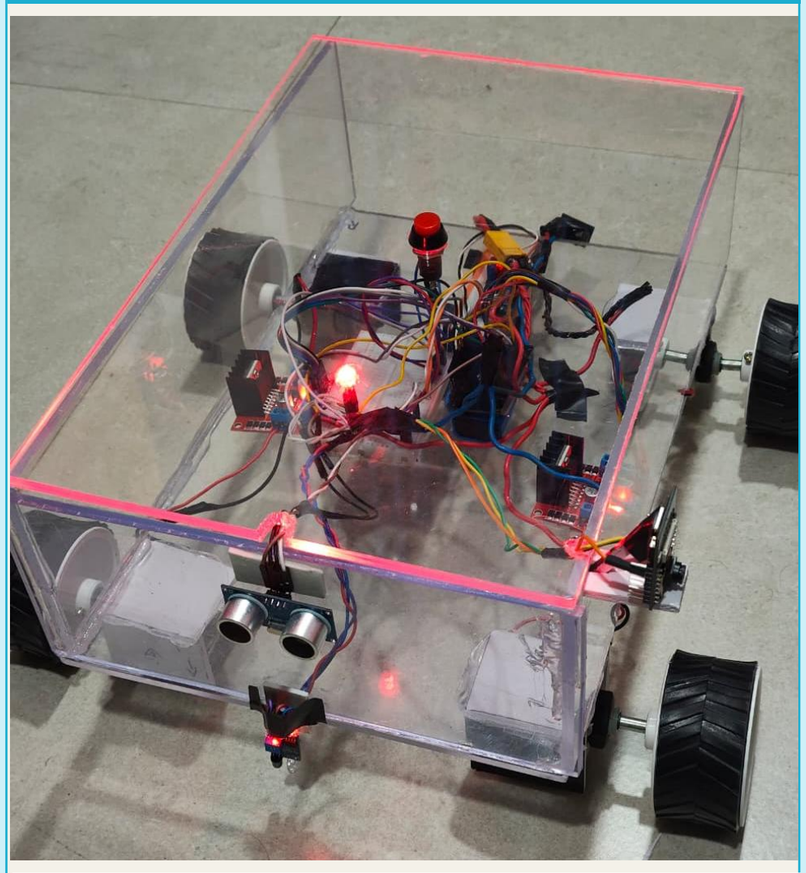
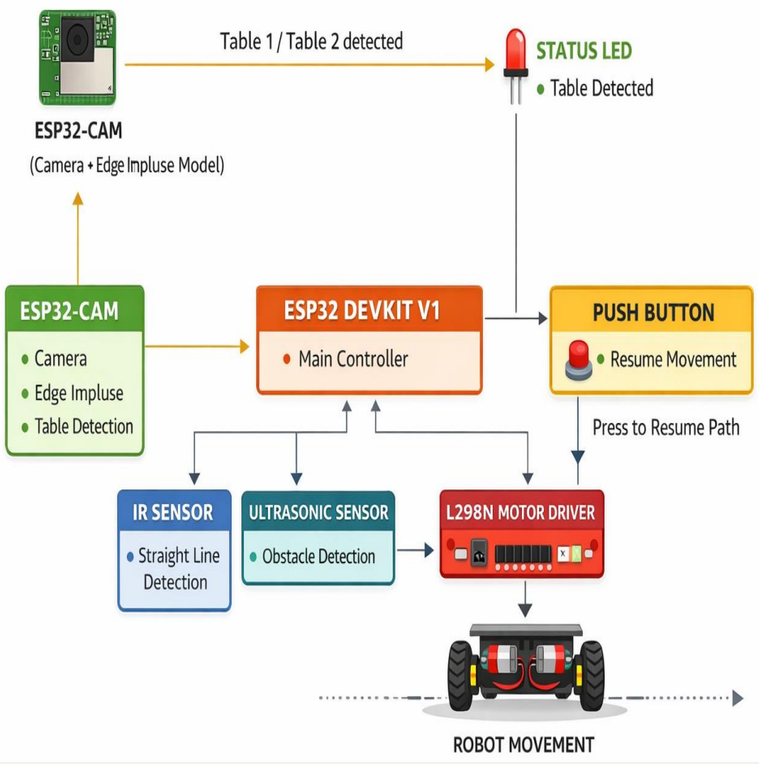


Figure 1 Flowchart 1

Block Diagram and Prototype photograph





Results / Findings

Parameter	Method Used	Observed Result	Performance
Line Navigation	IR Sensor (Straight Path)	Stable forward motion	✓ Accurate
Table Detection	ESP32-CAM + ML Model	Table 1 & Table 2 detected correctly	✓ Reliable
Obstacle Detection	Ultrasonic Sensor	Immediate stop on obstacle	✓ Safe
Robot Stop at Table	Wired UART Signal	Robot stops instantly	✓ Consistent
Resume Operation	Push Button	Manual resume after detection	✓ Controlled
User Feedback	LED Indicator	LED ON at table, OFF on resume	✓ Clear
Motor Performance	L298N Motor Driver	Smooth & synchronized motion	✓ Stable

Conclusion / Discussions

This project successfully demonstrates an autonomous order-taking restaurant robot designed for controlled indoor environments. The system combines straight-line navigation, vision-based table detection, and human-controlled interaction to ensure reliable and safe operation. Using an ESP32-CAM with a trained machine learning model, the robot accurately detects designated tables and stops automatically. The ESP32 DevKit V1 manages sensors, motors, LED indication, and a push-button mechanism that allows controlled resumption of movement.

The supporting mobile application complements the robot's operation by enabling digital order placement, displaying orders in the kitchen interface, providing QR-code–based payment, and offering in-app games to engage children during order preparation. Although the application is not directly connected to the robot, its workflow integrates seamlessly through human interaction.

Overall, the system demonstrates a practical, scalable, and user-friendly approach to automation in modern restaurant environments.

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Author's Details

DR.DIVYARANI MS PROFESOR	
UDAY PRATAP SINGH RATHORE 20251CAI0011	
SHAIK MOHAMMAD REHAN 20251CAI0383	
Mohammad Aqib Ahmed 20251CAI0136	
E.K Ashwin 20251CAI0010	
Syed Dayan Ahmed 20251CAI0272