Automatic car parking system using esp32

Group members:

Malik Ahsan 2501522

Muhammad Shahzaib 2501528

Ali Raza 2501561

BE MECHATRONICS (F-25)

DEPARTMENT OF MECHATRONICS ENGINEERING

FACULTY OF ENGINEERING

AIR UNIVERSITY, ISLAMABAD

Chapter 1 – Preliminaries

1.1 Proposal

The Automatic Car Parking System is designed to automatically open and close a parking **barrier** when a car passes. The system uses an **ultrasonic sensor** to detect the car, a **servo motor** to move the barrier, and an **ESP32 microcontroller** to control the system. The main aim is to **reduce human effort, improve safety, and manage parking efficiently**.

1.2 Initial Feasibility

The project is feasible because:

- Components are **affordable and easily available**.
- Programming the ESP32 using **Arduino IDE** is simple.
- The system can be applied in **small parking lots or university parking areas**.

1.3 Comparison Table of Similar Products

Parameter	Manual Parking Barrier	IR Based Parking System	Our Proposed System
Sensor Type	No sensor	IR Sensor	Ultrasonic Sensor
Automation Level	Manual	Semi-Automatic	Fully Automatic
Actuator Used	Human force	DC Motor	Servo Motor
Controller	None	Microcontroller	ESP32
Accuracy	Low	Medium	High
Human Involvement	High	Medium	Very Low
Cost	Low	Medium	Low
Reliability	Medium	Medium	High

From the comparison table, it is clear that the proposed automatic car parking system is more efficient and reliable than traditional systems. Unlike manual and IR-based systems, our system uses an ultrasonic sensor and ESP32, which provides higher accuracy and full automation. It also reduces human involvement and operational errors while keeping the cost low.

1.4 Technical Standards

- **Ultrasonic Sensor**: 2–400 cm range, ±3 mm accuracy
- **Servo Motor**: 180-degree rotation, 1.8 kg-cm torque

1.5 Team Roles & Details

Team Member	Role
Malik Ahsan	Team Lead
Muhammad shahzaib	Project Manager
Ali Raza	Technical Integrator & Tester

1.6 Work Breakdown Structure

1. Sensor integration
2. Servo motor control
3. ESP32 programming
4. Integration
5. Testing & debugging

1.8 Estimated Budget

Component	Quantity	Cost (PKR)
ESP32	1	1200
Servo Motor	1	350
Ultrasonic Sensor	1	300
Jumper wires & Breadboard	-	200
Miscellaneous	-	200
Total	-	2250

Chapter 2 – Project Conception

2.1 Introduction

Parking in tight areas can be difficult. This project solves the problem by **automating the barrier movement**. The **ultrasonic sensor detects a car**, the **ESP32 processes the signal**, and the **servo motor rotates the barrier**. This allows cars to pass **without manual operation**.

2.2 Literature Review

- 5 research papers on automatic parking systems.
- 3 commercial products: Tesla Autopark, Bosch Parking Assistant, Valeo Park4U.
- 2 WIPO patents on sensor-controlled parking barriers.

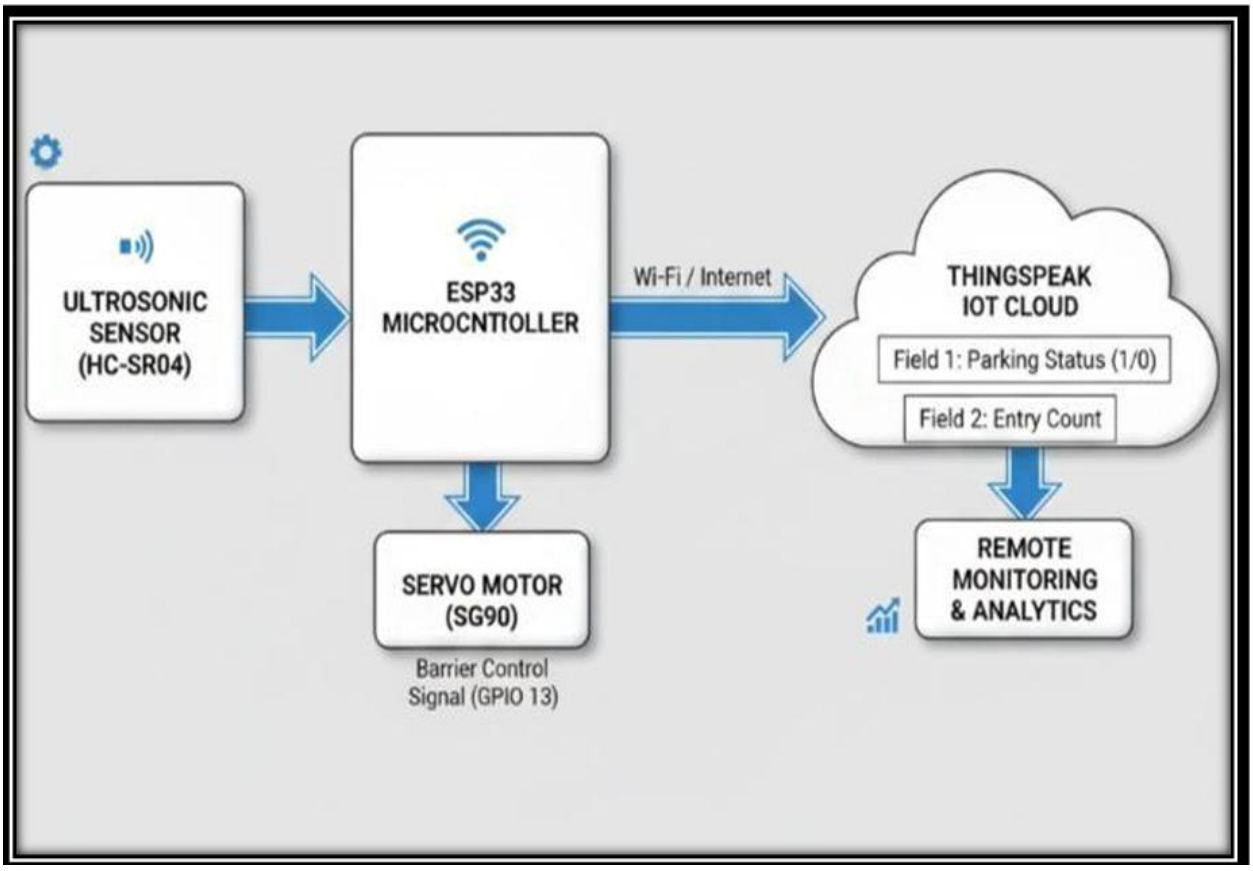
2.3 Features & Operational Specifications

- Automatic barrier opening and closing
- Car detection using ultrasonic sensor
- Servo motor controlled barrier
- LED indicators for occupied or empty parking (optional)
- Potential for IoT integration

2.4 Project Development Process

1. Requirement analysis
2. Component selection (ESP32, sensor, servo)
3. Programming ESP32 using Arduino IDE
4. Integration of sensor and servo
5. Testing and debugging

2.5 Basic Block Diagram



2.6 Deliverables

- Working prototype
- Circuit diagram

- Block diagram
- Arduino code with comments

Chapter 3 – Product Design (ICT Relevant Parts)

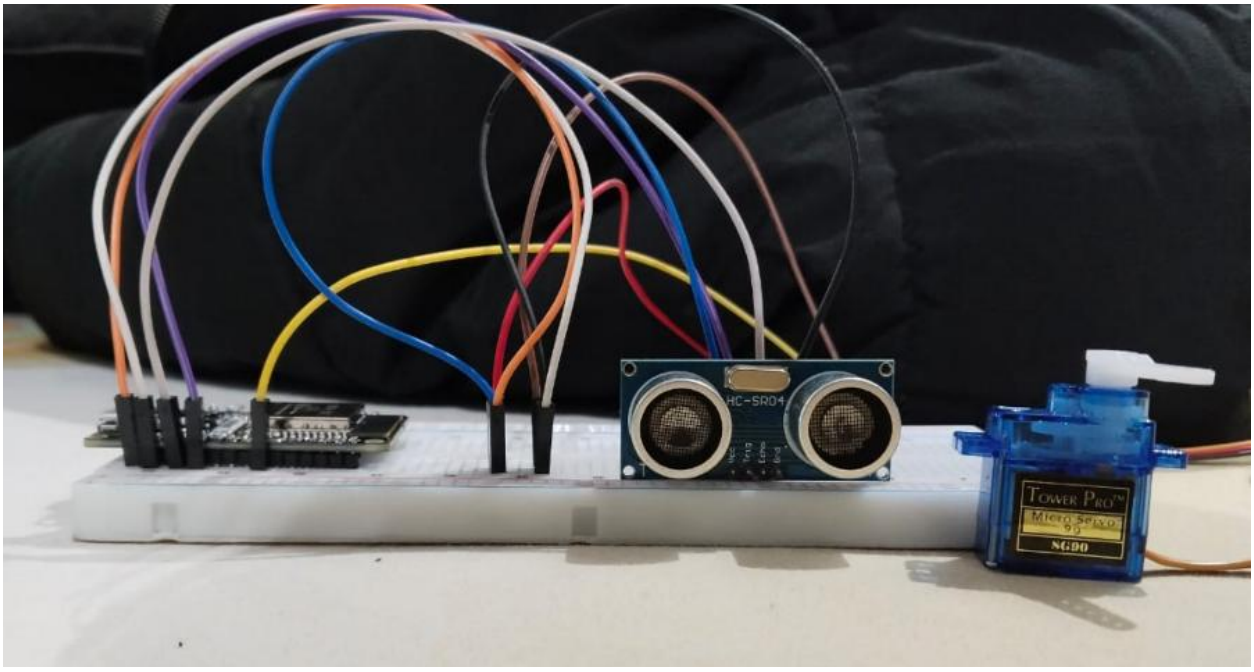
3.1 System Consideration

- Safety: Barrier must move smoothly without damaging vehicles
- Compactness: Must fit in small parking areas
- Ease of use: Fully automatic

3.2 Criteria for Component Selection

- **ESP32**: Fast processing, Wi-Fi capable
- **Ultrasonic Sensor**: Accurate distance detection
- **Servo Motor**: Precise angular control

3.3 Free Body Diagram



Chapter 4 – Mechanical Design

4.1 Mechanism Selection

The barrier is rotated using a **servo motor** to open and close automatically.

4.2 Platform Design
The base is made of **acrylic or wood** to mount the sensor, servo, and ESP32 securely.

4.3 Material Selection

- Acrylic: lightweight, durable, and easy to mount

4.5 Actuator Specifications

- Servo motor: 180-degree rotation, 1.8 kg-cm torque, 5V

Chapter 5 – Electronics Design and Sensor Selection

5.1 Component Selection

- ESP32 microcontroller
- Ultrasonic sensor HC-SR04
- Servo motor
- Jumper wires, breadboard

5.2 Sensor Specifications

- HC-SR04: Distance 2–400 cm, Accuracy ±3 mm, Voltage 5V

5.3 Power Requirements

- ESP32: 5V, 500 mA
- Servo motor: 5V, 1A

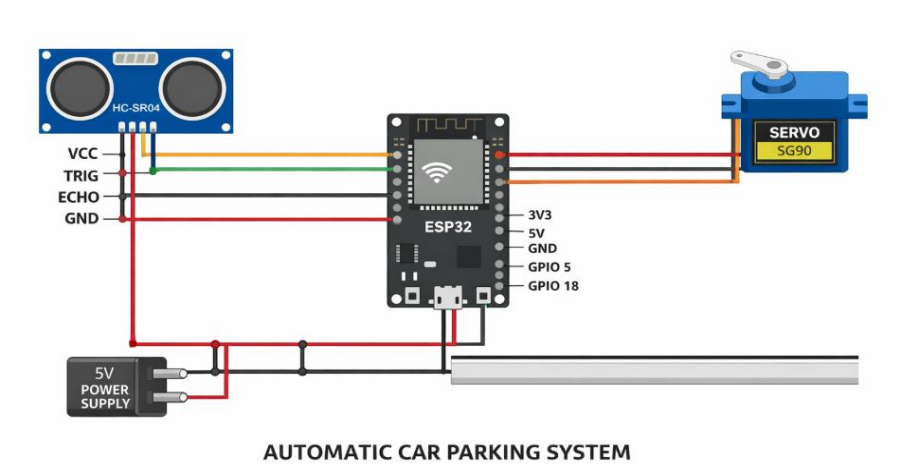
5.4 Motor Selection

- Servo motor chosen for **precise rotation control**

5.5 Feedback Mechanism

- Sensor detects car → ESP32 commands servo → Barrier moves

5.6 Electronics Design Deliverable



Chapter 6 – Software/Firmware Design

6.1 Input/Output Pinouts

- Trig: GPIO5
- Echo: GPIO18
- Servo: GPIO15

6.2 Controller Selection

- ESP32: Fast, programmable, Wi-Fi enabled

6.3 Software Design

- Arduino IDE reads sensor data and controls servo

6.4 State Machine & Flowchart

(Insert flowchart: Car detected → Barrier opens → Car passes → Barrier closes)

6.5 Test Cases

- Car present → Barrier opens
- Car absent → Barrier closes

6.6 Deliverable

- Fully commented Arduino code

Chapter 7 – Simulations & Integration

7.1 Hardware Integration

- Connect ESP32, ultrasonic sensor, and servo motor

7.2 Software Integration

- Arduino code controls servo based on sensor input

7.3 Wiring Plan

- Color-coded wires for sensor, servo, and ESP32 power connections

Chapter 8 – System Test Phase

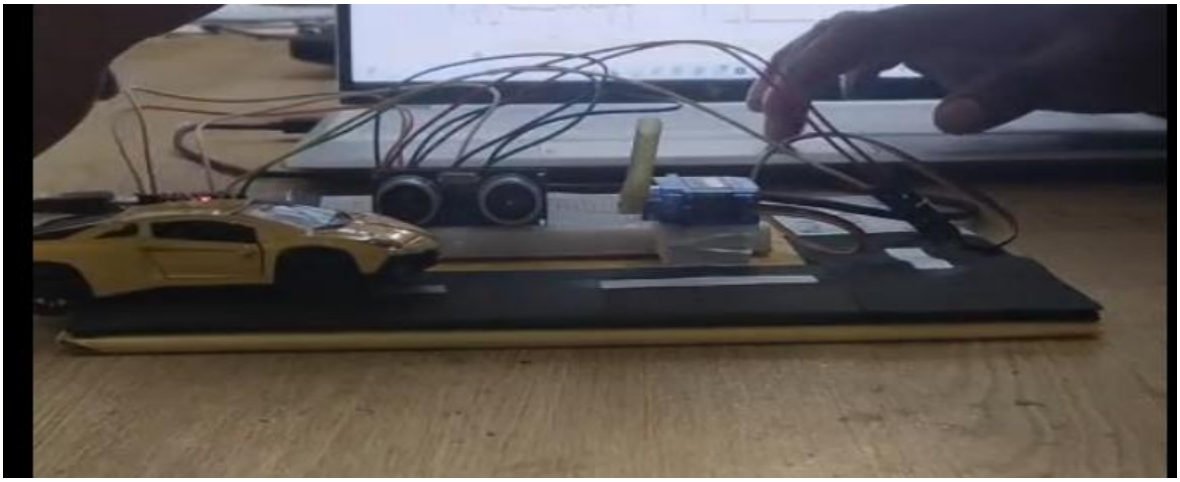
8.1 Final Testing

- Test barrier opening/closing
- Sensor detection accuracy

8.2 Challenges Faced

- Incorrect sensor readings sometimes
- Servo motor not moving initially

8.3 Project Photos



Chapter 9 – Project Management

9.1 Individual Role Execution

Malik Ahsan: Team Lead

As a team lead, I was responsible for managing the overall progress of the project. I coordinated with all team members and ensured that the project objectives were clearly understood. I helped in selecting the main components such as the ESP32, ultrasonic sensor, and servo motor.

I also supervised the implementation phase and assisted in solving technical problems faced during development. Additionally, I contributed to preparing the project report and ensured that the report followed the given format and submission guidelines.

This role helped me improve my leadership, communication, and time management skills.

Ali RAZA : Project Manager

As a project manager, my main responsibility was planning and organizing project activities. I helped create the work breakdown structure and ensured that tasks were completed within the allocated time. I also monitored the project budget and ensured efficient use of resources.

I regularly communicated with team members to track progress and reported updates to the team lead. This role helped me develop planning, coordination, and project management skills.

Muhammad Shahzaib rafaqat: Technical integrator & Tester

As a technical integrator and tester, I worked on the hardware and software integration of the automatic car parking system. I connected the ESP32 with the ultrasonic sensor and servo motor according to the circuit diagram.

I tested the system to ensure the barrier opens when a car is detected and closes after the car passes. I also identified and fixed errors during testing and documented the results. This role improved my skills in system integration, testing, and debugging.

9.2 Success / Failure

- System works as planned
- Minor challenges in wiring and testing

9.3 Team Feedback

- Positive: teamwork, problem solving

- Negative: time management, minor delays

9.4 Budget Allocation

- Total cost ~2200 PKR (see Chapter 1.8)

9.6 Risk Management

- Sensor misalignment
- Power supply failure

Chapter 10 – Feedback for Project and Course

- Learned programming ESP32
- Learned integrating hardware and software
- Recommendation: Use multiple sensors for larger parking areas

Chapter 11 – YouTube Video

Link: *https://youtu.be/4suP9oqYDTg?si=VmwBpDHFc6YAAY6v*