iParkVision

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Smart IoT-Based Parking Management System

1. Introduction

Rapid urbanization has increased vehicle density, causing congestion and inefficient parking. Traditional systems lack real-time monitoring and rely on manual management, leading to wasted time and fuel.

Problem Statement:

Parking today is inefficient, unmonitored, and inconvenient for users.

Solution:

iParkVision is an IoT-based smart parking system that automates gate access using RFID, monitors slot availability with ultrasonic sensors, and provides real-time updates via Blynk IoT.

2. Objectives

- Provide real-time monitoring of parking slot availability
- Automate gate control using RFID authentication
- Enable remote parking status monitoring via mobile application
- Reduce traffic congestion and parking search time
- Improve parking security and efficiency

3. Hardware Components

Component	Purpose
ESP32 Microcontroller	Main controller and Wi-Fi connectivity
RC522 RFID Reader	User authentication
RFID Cards	Vehicle access authorization
HC-SR04 Ultrasonic Sensors	Vehicle detection & slot monitoring
SG90 Servo Motor	Barrier movement
OLED Display (0.96")	Gate messages & system status
I2C LCD (16×2)	Slot occupancy display
Jumper Wires	Connections
Breadboards	Circuit assembly
4×AA Batteries	Power supply

4. Software Tools

Software	Function
Visual Studio Code	Code editor
PlatformIO	Compilation & upload
Blynk IoT	Cloud dashboard & mobile control

5. PlatformIO Configuration

```
monitor_speed = 115200
lib_deps =
miguelbalboa/MFRC522
marcoschwartz/LiquidCrystal_I2C
adafruit/Adafruit GFX Library@^1.12.3
adafruit/Adafruit SSD1306@^2.5.15
blynkkk/Blynk@^1.3.2
```

6. Pin Mapping

Ultrasonic Sensors	
Barrier Trig	GPIO 4
Barrier Echo	GPIO 34
Slot 1 Trig	GPIO 13
Slot 1 Echo	GPIO 35
Slot 2 Trig	GPIO 17
Slot 2 Echo	GPIO 36
Slot 3 Trig	GPIO 16
Slot 3 Echo	GPIO 33
GND of all	GND
VCC of all	5 V
Servo	
VCC	Battery (+)
GND	Battery (-) and ESP32 GND
Signal	GPIO 26
RFID	
SDA	GPIO 5
SCK	GPIO 18
MOSI	GPIO 23
MISO	GPIO 19
GND	GND
RST	GPIO 27
3.3	3.3 V
OLED & I2C LCD	
GND & VCC	GND & 3.3 V
SDA & SCL	GPIO 21 & GPIO 22

7. Blynk Virtual Pin Mapping

Feature	Virtual Pin
Slot 1 Status	V1
Slot 2 Status	V2
Slot 3 Status	V3
Free Slots	V4
Barrier Status	V5
Vehicle Detection	V6
Manual Gate Control	V7
RFID Logs	V8

8. System Architecture

- Ultrasonic sensors monitor slot occupancy and gate presence
- RFID validates authorized users
- Servo motor controls gate movement
- ESP32 processes data and sends real-time updates to Blynk
- Mobile dashboard displays live parking information

9. Working Principle

Vehicle Detection

Ultrasonic sensor at the gate detects approaching vehicles. If detected, the OLED displays "Scan Card".

RFID Authentication

Authorized RFID cards open the gate. Card UID is logged on the Blynk Terminal widget.

Gate Automation

Servo motor opens the barrier for 5 seconds and closes automatically. Gate can also be opened manually via Blynk switch.

Slot Monitoring

Three ultrasonic sensors detect occupied slots and display availability on the LCD and mobile app.

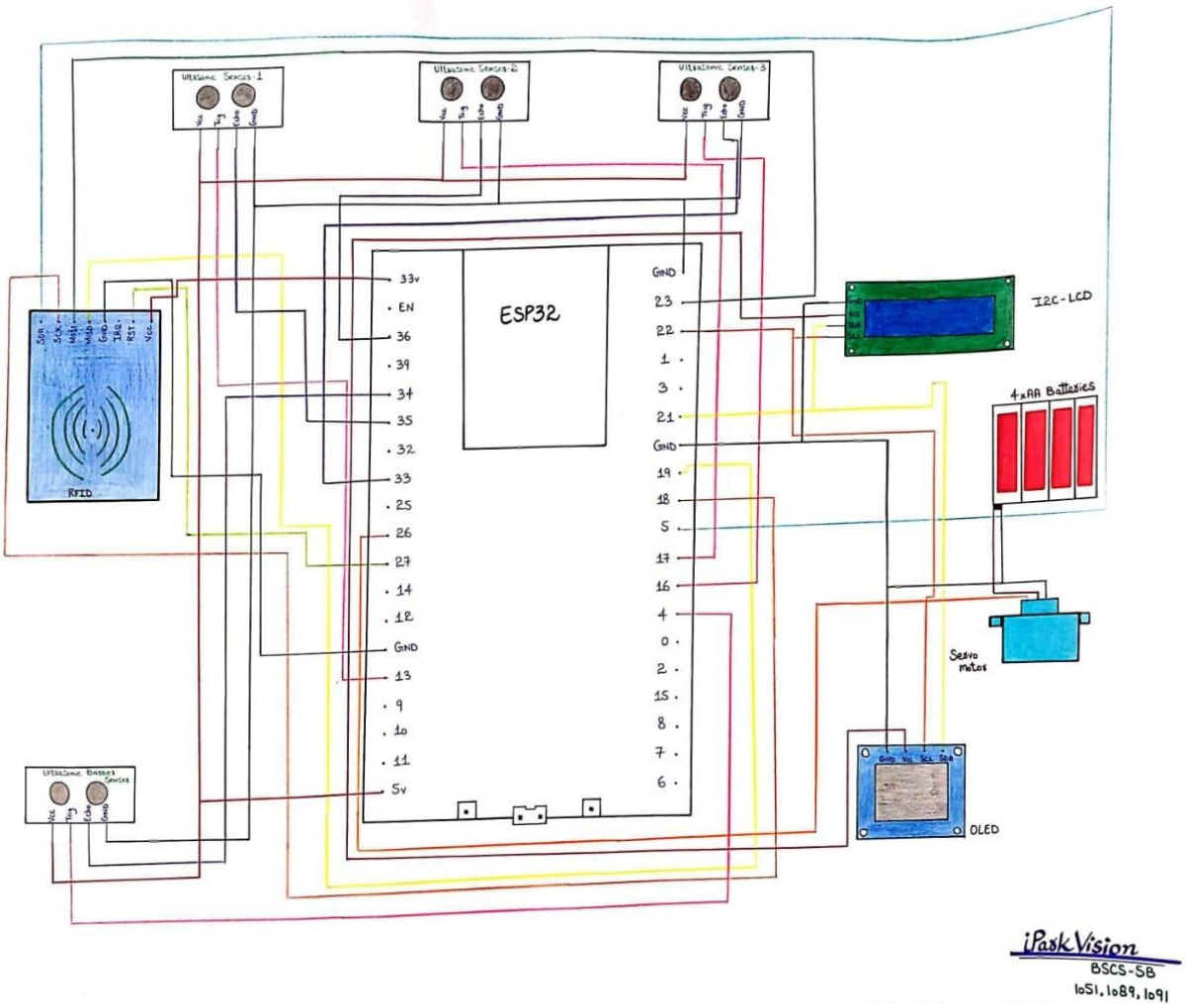
Cloud Monitoring

Blynk app displays:

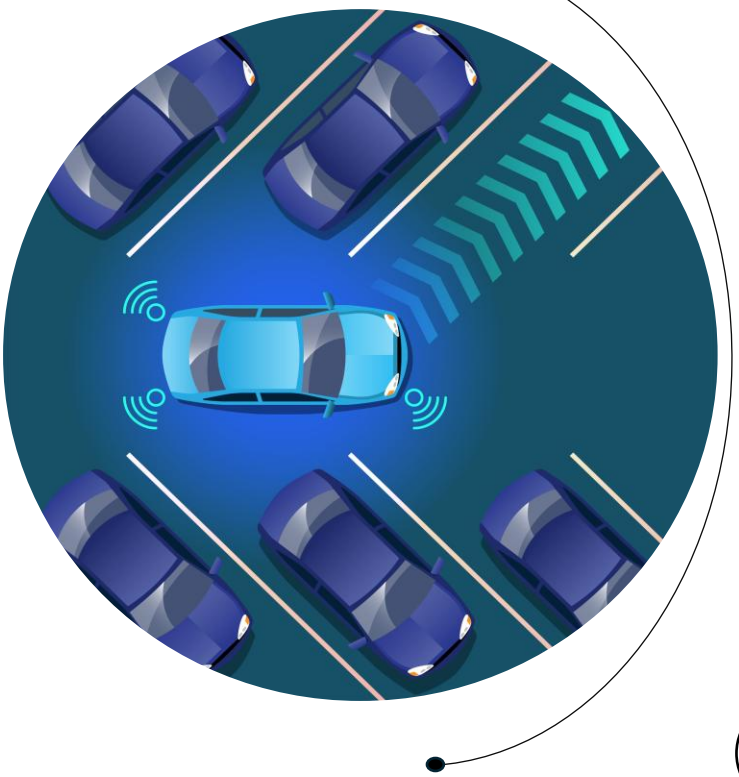
- Slot occupancy LEDs
- Free slots counter
- Barrier status
- Vehicle detection
- RFID logs

10. Circuit Diagram

The figure below illustrates the complete iParkVision hardware setup. It shows the connections between the ESP32 microcontroller, RFID reader, ultrasonic sensors, servo motor, OLED and LCD displays, and the power supply. All components are interfaced carefully to ensure synchronized operation, accurate vehicle detection, secure access control, and real-time data communication to the Blynk IoT platform.



11. System Flow:



01 Vehicle detected

02 OLED prompts scan

03 RFID verified

04 Gate opens

05 Slots monitored

06 Data sent to cloud

12. Results

- Accurate slot occupancy detection
- Reliable RFID access control
- Live monitoring via mobile phone
- Automatic and manual gate control
- Reduced parking congestion and waiting time

13. Conclusion

iParkVision demonstrates an efficient, secure, and scalable smart parking solution using embedded IoT technologies. It integrates sensing, automation, authentication, and cloud connectivity to provide real-time parking management. This system can be deployed in malls, offices, campuses, and smart cities to improve parking efficiency and user experience.

14. Future Enhancements

- Database-based vehicle registration
- Safety and fire protection module for real-time hazard detection
- License plate recognition
- Mobile booking system
- Expansion to multi-floor parking