

D. Camera Module

- Captures the vehicle image or number plate at entry/exit.
- The captured data can be stored or processed for security and record-keeping.

E. GSM / Wi-Fi Module

- Used for communication and alerts.
- Sends SMS notifications or cloud updates (slot availability, entry/exit status, alerts).
- Enables IoT monitoring of the parking system.

F. LCD Display with Keypad

Displays system information such as:

- Available parking slots
- Access status (Authorized / Unauthorized)
- Keypad allows manual input or system configuration.

G. RC (Remote Control / Control Unit)

- Provides manual or wireless control of the parking gate when needed.
- Useful for emergency or override operations.

H. Relay Module

- Acts as an electrical switch.
- Isolates the MCU from high-power devices like motors.
- Controls the servo motor safely.

I. Servo Barrier

- Controls the physical gate/barrier of the parking system.
- Opens or closes based on commands from the MCU after successful verification

- Common ground is shared among all modules for proper operation.

VI. ADVANTAGES

A. Security & Authentication

- Multi-factor verification combines license plate recognition + fingerprint biometrics, preventing unauthorized access.
- No physical tickets or cards to lose, steal, or forge.
- Individual user accountability through biometric identification.

B. Operational Efficiency

- Real-time slot availability detection eliminates wasted circling time.
- Automated barrier control reduces manual intervention and gate congestion.
- <3 second response time from detection to barrier opening.

C. Reduced Human Intervention

- Fully automated entry/exit using sensors and servos.
- No need for manual security staff → reduces operational cost.

D. Efficient Slot Utilization

- IR sensors continuously monitor slot availability.
- Prevents false parking and shows accurate vacant slots.

VII. LIMITATIONS

A. Dependency on GSM Network

- SMS alerts depend on mobile network availability.
- In poor signal areas, SMS delivery may be delayed.

B. Limited Speed of SMS Communication

- GSM SMS is slower compared to internet-based notifications.
- Not suitable for real-time updates like live parking maps.

VIII. HARDWARE COMPONENTS LIST

A. ESP32-S3

- Dual-core Xtensa LX7 (up to 240 MHz)
- Wi-Fi + Bluetooth 5
- Multiple GPIOs, UART, SPI, I2C
- Low power consumption
- Used as main controller

B. ESP32-CAM Module

- OV2640 camera (2MP)
- Supports JPEG, face detection
- MicroSD card support
- Used for number plate / image capture

C. IR Sensors (Slot Detection)

- Operating Voltage: 3.3V – 5V
- Digital output
- Used to detect vehicle presence
- Low cost and fast response

V. CIRCUIT DIAGRAM

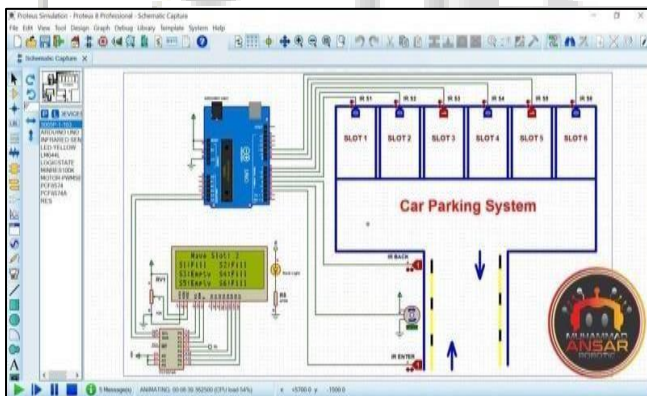


Fig. 2: Reference circuit diagram

- Microcontroller acts as the main control unit of the system.
- IR sensors are connected to detect vehicle presence at entry, exit, and parking slots.
- Sensor outputs are given to the microcontroller through digital input pins.
- LCD display is interfaced to show slot availability and system status.
- Servo motor is connected to control the parking gate barrier.
- Relay module is used to drive high-power devices safely.
- Power supply provides regulated 5V/3.3V to all components.

D. GSM Module – SIM800L

- Quad-band GSM (850/900/1800/1900 MHz)
- Supports SMS, call, GPRS
- Operating Voltage: 3.7V – 4.2V
- Used for SMS alerts to users

E. Servo Motor (Gate Control)

- Operating Voltage: 5V – 6V
- Rotation: 0° – 180°
- High torque for barrier control
- Used for entry/exit gate

F. LCD Display (16×2 or I2C)

- Displays slot availability & system status
- Operating Voltage: 5V
- I2C version reduces wiring

G. Power Supply

- 12V SMPS / Adapter
- Buck Converter (LM2596)
- Converts 12V → 5V / 4V safely
- Stable supply for GSM & ESP modules

IX. FUTURE SCOPE

A. Mobile Application Integration

- Develop an Android/iOS app for:
 - Slot booking
 - Live parking status
 - Payment history

B. Cloud & IoT Platform Integration

- Connect system to platforms like:
 - AWS
 - Azure
 - ThingSpeak
- Enables remote monitoring and data analytics.

C. Online & Cashless Payment System

- Integrate UPI, RFID wallet, or QR-based payment.
- Automatic parking fee calculation based on duration.

D. AI-Based Number Plate Recognition

- Implement advanced AI/ML algorithms for:
 - High-accuracy ANPR
 - Blacklist vehicle detection
- Improved performance in low-light conditions.

X. CONCLUSION

The smart car parking system developed in this project successfully demonstrates an automated, secure, and user-friendly parking solution using ESP32-S3 as the main controller. The system efficiently detects parking slot availability using IR sensors, controls entry and exit gates through servo motors, and ensures secure access through user authentication.

The integration of the ESP32-CAM module enables vehicle monitoring and number plate image capture, enhancing system security. Additionally, the use of the GSM (SIM800L) module provides real-time SMS alerts to users for

entry, exit, and parking confirmation, making the system functional even without internet connectivity.

Overall, the project reduces human intervention, minimizes parking congestion, improves slot utilization, and enhances user convenience. This system proves to be a cost-effective and scalable solution suitable for parking areas such as malls, offices, apartments, and educational institutions.

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