📘 **PROJECT REPORT**

SMART PARKING MONITORING SYSTEM USING ARDUINO

---

1. INTRODUCTION

With the increase in vehicle usage, efficient parking management has become a major challenge in urban areas. Traditional parking systems rely heavily on manual monitoring, which leads to congestion, inefficiency, and poor user experience.

This project presents a **Smart Parking Monitoring System** using an Arduino microcontroller, ultrasonic sensors, and IR sensors to automatically detect parking slot occupancy, count vehicle movement, and display real-time information.

The system is designed to be **simple, reliable, and power-efficient**, making it suitable for small-scale parking applications and as a base model for IoT-based parking solutions.

---

2. OBJECTIVES

The main objectives of this project are:

- To detect **parking slot occupancy** automatically
- To count **vehicles entering and exiting** the parking area
- To display real-time status on an LCD
- To provide visual indication using LEDs
- To activate the system **only when vehicles are present**, reducing power usage

---

3. SYSTEM OVERVIEW

The system consists of:

- An **Arduino UNO** acting as the control unit
- **Ultrasonic sensors** to detect vehicle presence in parking slots
- **IR sensors** to count vehicle entry and exit
- **LED indicators** to show slot availability

- A **16×2 LCD** to display system status

The Arduino continuously processes sensor data and updates outputs based on predefined conditions.

---

4. BLOCK DIAGRAM DESCRIPTION

The block diagram consists of the following main blocks:

- **Arduino UNO**: Central processing unit that reads sensor inputs and controls outputs.
- **Ultrasonic Sensors (SONAR1 & SONAR2)**: Measure distance to detect whether a parking slot is occupied or empty.
- **IR Sensors (Entry & Exit)**: Detect vehicles crossing the entry and exit points.
- **LCD Display**: Displays slot status and vehicle count.
- **LED Indicators**: Provide visual feedback for slot availability.

---

5. HARDWARE COMPONENTS

5.1 Arduino UNO

- ATmega328P microcontroller
- Operates at 5V
- Provides digital and analog I/O pins

5.2 Ultrasonic Sensors

- Measure distance using sound waves
- Used to detect vehicle presence
- Accurate for short-range detection

5.3 IR Obstacle Sensors

- Detect interruption using infrared light
- Used for entry and exit detection

5.4 LCD Display (16×2)

- Displays parking slot status and count
- Operates in 4-bit mode

5.5 LEDs

- Green LED: Slot available
- Red LED: Slot occupied

---

6. SOFTWARE DESIGN

The system software is written in **Embedded C using Arduino IDE**.

6.1 Key Variables

- peopleCount: Stores number of vehicles inside
- distance1, distance2: Store ultrasonic sensor readings
- systemActive: Controls system ON/OFF state

6.2 Sensor Handling

- Ultrasonic sensors calculate distance using echo timing
- IR sensors use **debounce and latch logic** to avoid false counts

6.3 System Control Logic

- System activates when peopleCount > 0
- System deactivates when peopleCount == 0

---

7. ALGORITHM

1. Initialize LCD, sensors, and LEDs
2. Display startup message
3. Continuously monitor IR sensors
4. Increment/decrement count based on entry or exit
5. If count > 0:
    - Read ultrasonic sensors

    - Update LED and LCD status
6. If count == 0:
    - Turn off sensors and display
7. Repeat the process

---

8. RESULTS AND OBSERVATIONS

- Parking slot occupancy was detected accurately
- Vehicle entry and exit counting was stable due to debounce logic
- LEDs provided clear visual indication
- LCD displayed real-time status without flicker
- Power optimization logic reduced unnecessary operation

---

9. APPLICATIONS

- Smart parking management systems
- Automated vehicle monitoring
- Smart city infrastructure
- Embedded system learning platforms

---

10. LIMITATIONS

- Limited to two parking slots
- IR sensors may be affected by ambient light
- No remote monitoring or data logging

---

11. FUTURE ENHANCEMENTS

- Integrate IoT modules (ESP8266 / ESP32)
- Add mobile application interface

- Store parking data in cloud
- Increase number of parking slots
- Implement RFID-based vehicle identification

---

12. CONCLUSION

The Smart Parking Monitoring System successfully demonstrates the use of embedded sensors and microcontrollers to automate parking management. The system is efficient, scalable, and suitable as a foundation for advanced smart parking solutions.

---

13. REFERENCES

1. Arduino Official Documentation
2. Ultrasonic Sensor HC-SR04 Datasheet
3. IR Obstacle Sensor Datasheet
4. Embedded Systems Design – Raj Kamal

---

14. AUTHOR

Sudeep J Elahole
B.Tech Electronics and Communication Engineering
Embedded Systems Enthusiast