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SMART PARKING SYSTEM

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Problem Statement:

Parking in urban areas is often a challenging task due to limited space and inefficient management. Finding available parking spots quickly can be frustrating for drivers, leading to congestion, and wasted time. Traditional parking systems lack real-time monitoring and communication, making it difficult for drivers to locate vacant spaces efficiently.

Objectives:

- Develop a smart parking system that offers real-time monitoring and communication to optimize parking space utilization.
- Implement a solution that detects the presence of cars in each parking space and communicates this information to drivers.
- Create a user-friendly mobile application and web dashboard for real-time monitoring and management of parking spaces.
- Utilize IoT technologies to enable seamless data collection, storage, and analysis for efficient parking management.

Scope:

The project focuses on creating a smart parking system equipped with IoT sensors and a mobile/web application interface. It includes:

- Design and implement a smart parking system prototype with three parking spaces equipped with Infrared (IR) sensors to detect car presence.
- Incorporate a servo motor to control the garage door based on parking space availability.
- Develop a mobile application using Flutter to display real-time parking availability to drivers.
- Create a web dashboard to visualize parking status using MQTT data.
- Utilize Firebase for real-time data storage and analysis.

Proposed Solution:

✓ **Hardware Components:**

- Garage equipped with IR sensors at each parking space to detect car presence.
- Servo motor to control the garage door.
- Two LEDs at the entrance to indicate parking availability.

✓ **Software Components:**

- Nodemcu microcontroller to collect data from IR sensors and control hardware components.
- Firebase for real-time data storage and analysis.

- MQTT protocol for communication between hardware components and software.
- Mobile application developed using Flutter to display parking availability to drivers.
- Web dashboard to visualize parking status and availability.

✓ **Functionality:**

- IR sensors detect car presence at each parking space.
- Servo motor controls the garage door based on parking availability.
- LEDs indicate parking availability at the entrance.
- Data is sent to Firebase for real-time storage and analysis.
- Mobile application and web dashboard retrieve data from Firebase and MQTT broker to display parking availability.

✓ **User Interaction:**

- Drivers can use the mobile application to view real-time parking availability and locate vacant spaces.
- Web dashboard provides similar functionality for users accessing it from a desktop browser.
- LED indicators at the entrance provide immediate feedback to drivers regarding parking availability.

- **Inputs and Outputs:**

Inputs:

Input	Description
IR Sensor (Spot 1)	Detects car presence in parking spot 1.
IR Sensor (Spot 2)	Detects car presence in parking spot 2.
IR Sensor (Spot 3)	Detects car presence in parking spot 3.
IR Sensor (Entrance)	Detects car presence at the garage entrance.
Mobile Application	User input for checking parking status and availability.
Web Dashboard	Administrative input for monitoring and managing parking spaces.

Outputs:

Output Device	Description
Servo Motor	Opens or closes the garage door based on availability.
Green LED	Indicates availability and entry permission.
Red LED	Indicates the garage is full and entry is denied.
Mobile App Display	Shows garage status and availability of parking spaces.
Web Page Display	Shows garage status and availability of parking spaces.

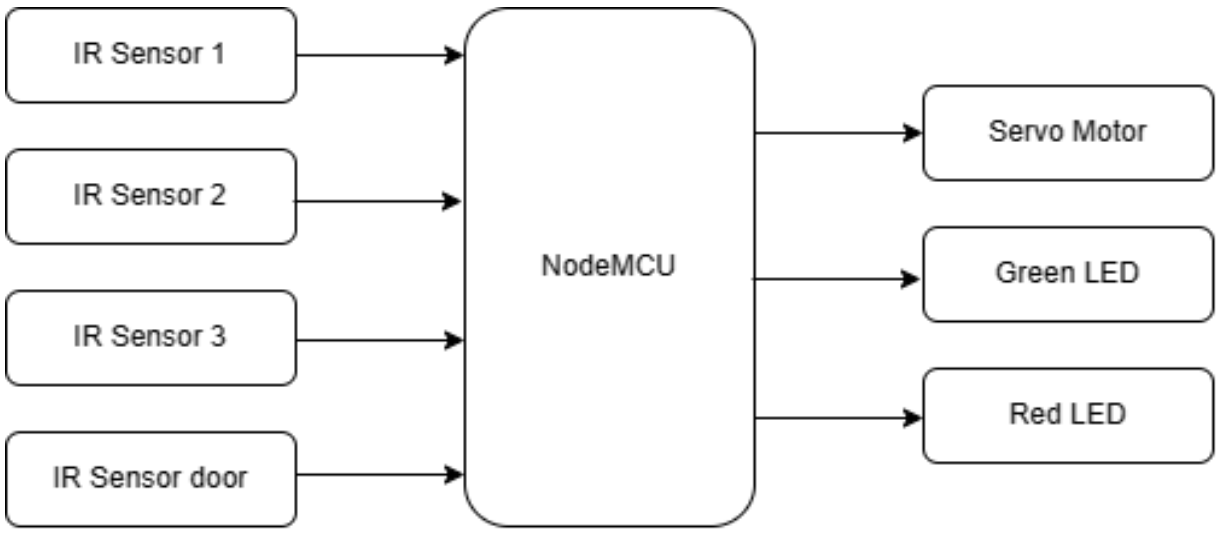
Device Layer:

Sensors	Function
IR Sensor at each parking spot	Detects whether a parking spot is occupied or not.
IR Sensor (Entrance)	Detects the presence of a car at the garage entrance.

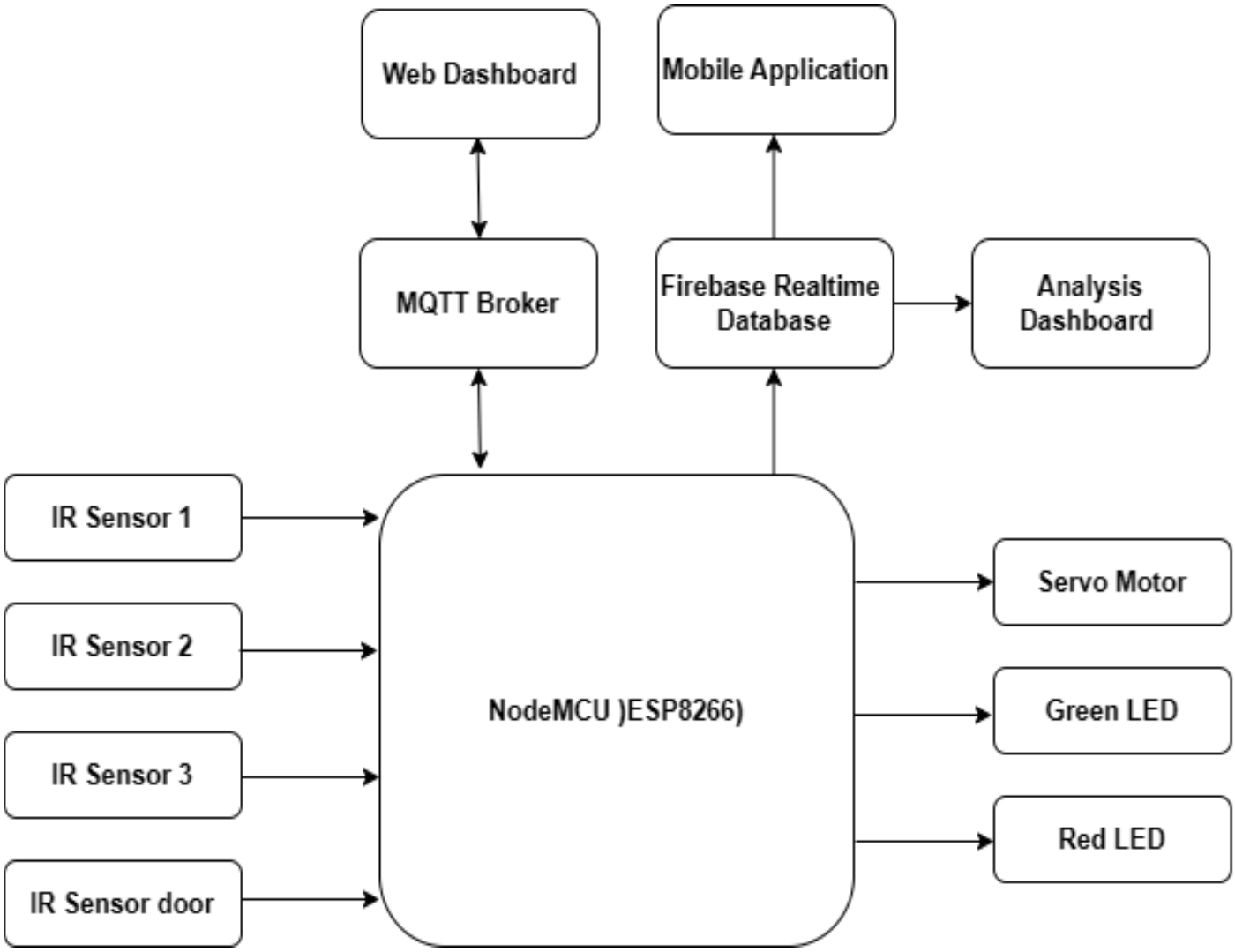
Actuators	Function
Servo Motor	Opens and closes the garage door based on availability.
Green LED	Indicates the door is open and a spot is available.
Red LED	Indicates the door is closed and no spots are available.

Block Diagrams and System Architecture:

Hardware Block Diagram:



- **System Architecture Diagram**



▪ Test Strategy:

Test Execution:

1. **IR Sensor Detection Test:**
    - **Description:** This test verifies the functionality of IR sensors in detecting the presence of cars in parking spaces.
    - **Procedure:** Simulated cars were placed in each parking space, and the output of the IR sensors was monitored.
    - **Result:** All IR sensors successfully detected the presence of cars, and the corresponding data was transmitted to the NodeMCU.
2. **Entry Door Test:**
    - **Description:** This test evaluates the performance of the entry door system in response to approaching vehicles.
    - **Procedure:** A simulated car approached the entry door, and the behavior of the servo motor and LEDs was observed.
    - **Result:** The servo motor opened the door, and the green LED turned on when an available parking spot was detected. Otherwise, the red LED remained off, indicating a full garage.
3. **Firebase Data Storage Test:**
    - **Description:** This test validates the real-time storage of sensor data in Firebase.
    - **Procedure:** Sensor data was transmitted to Firebase, and the database was checked for the presence of the latest data.
    - **Result:** Sensor data was successfully stored in Firebase, and updates were reflected in the database in real-time.
4. **Mobile Application Test:**
    - **Description:** This test ensures the accuracy of parking availability information displayed in the mobile application.

- **Procedure:** The mobile application was accessed, and the displayed parking status was compared with the actual status in the garage.
- **Result:** The mobile application accurately reflected the parking availability status and the total number of cars in parking retrieved from Firebase.

5. **Web Dashboard Test:**

- **Description:** This test confirms the real-time visualization of parking status on the web dashboard.
- **Procedure:** The web dashboard was accessed, and the displayed parking status was compared with the actual status obtained from the MQTT broker.
- **Result:** The web dashboard displayed real-time parking status obtained from the MQTT broker, providing an accurate representation of the garage status and the total number of cars in parking.