RV College of Engineering®
Mysore Road, RV Vidyaniketan Post,
Bengaluru - 560059, Karnataka, India

Department of Electronics Communication Engineering

Project-based Learning (PBL): Microcontroller & Programming (EC243AI)

AY:2024-25

SWABHAV: Speech Emotion Recognition (SER)

Faculty: Dr. Rajith Kumar B K

Vijay Kumar Gupta **(1RV23EC182)**
Shrihari Gitte **(1RV24EC415)**
Pradeep A **(1RV24EC412)**

1.Introduction

The **Car Parking Management System** is an innovative smart solution designed to simplify and modernize the way parking spaces are managed. In today's fast-paced world, finding a vacant parking spot can be frustrating and time-consuming. This project aims to address that problem by providing a real-time monitoring system that automatically detects and displays the availability of parking slots. Using a simple combination of sensors and microcontrollers, the system identifies which parking spots are occupied and which are free.

The information is not only shown on a digital display but is also shared wirelessly through a web-based interface that can be accessed from any smartphone or computer connected to the same network. This means users can conveniently check parking availability before even reaching the spot. The system is efficient, easy to use, and highly reliable, making it ideal for use in places like shopping malls, offices, residential societies, and campuses. By combining hardware automation with a smart online dashboard, this project demonstrates how technology can be used to improve everyday life and reduce unnecessary hassle.

2 Problem Statement

In many urban and semi-urban areas, the increasing number of vehicles has led to a significant rise in parking-related issues. Drivers often waste valuable time and fuel searching for available parking spots, especially in crowded places like shopping malls, offices, hospitals, and residential complexes. The absence of a real-time parking management system leads to congestion, frustration, and inefficient use of parking resources.

To address this challenge, there is a clear need for a smart system that can **continuously monitor parking slots** and **display real-time availability** to users in a simple and accessible manner. The aim is to develop a cost-effective, user-friendly solution that can automatically detect the occupancy status of parking slots and share this information instantly through a local digital display and a web-based dashboard. This will help users make informed decisions and reduce the overall time and effort spent searching for parking.

3 Objectives

- **To design a microcontroller-based automated parking system**
  Develop a system that operates independently using STM32 to monitor and control parking activities.This reduces reliance on manual supervision and ensures efficient operation.
- **To detect the presence of vehicles using IR sensors**
  IR sensors are used to sense whether a vehicle is present in a parking slot.This data helps determine slot availability in real time.
- **To process sensor data using the STM32 microcontroller**
  STM32 collects, analyzes, and responds to sensor inputs efficiently.It acts as the central controller for the entire system.
- **To reduce manual intervention in parking management**
  The system operates automatically, needing little to no human input.This lowers operational errors and reduces labor costs.
- **To save time and fuel by reducing the search time for parking**
  Real-time slot visibility minimizes unnecessary vehicle movement.This improves user convenience and environmental efficiency.

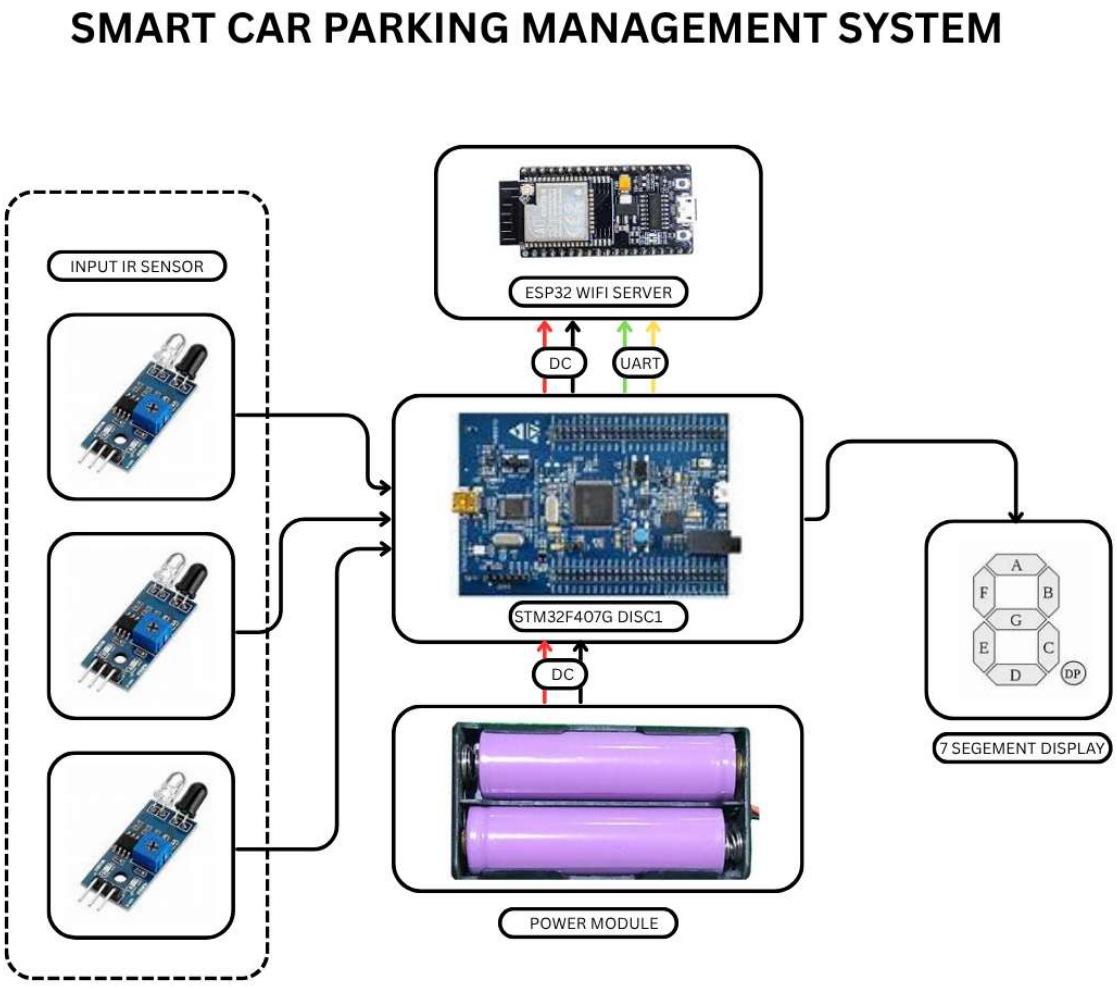
- **To develop a user-friendly and cost-effective solution.**

  The system is simple to use and built with affordable components.It balances functionality with economic viability.

- **To ensure accurate and real-time monitoring of parking slots**

  The sensors continuously update slot status without delay.This ensures up-to-date information is always available.

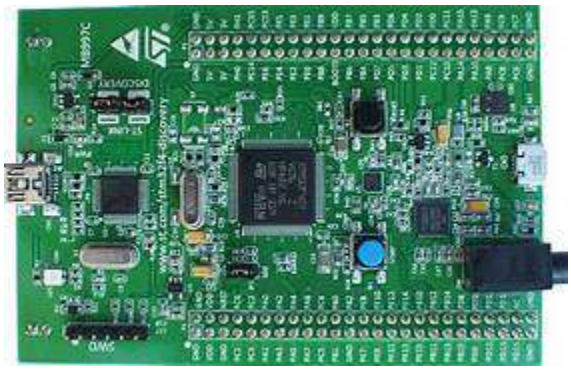
4. Block Diagram



5.Tools Used

Hardware Tools Used

- **STM32 Microcontroller**



The main controller of the system that processes sensor inputs, controls the servo motor, updates the display, and manages overall system logic.

- **ESP32 Microcontroller**

A Wi-Fi and Bluetooth-enabled microcontroller used for adding IoT features like remote slot monitoring through mobile apps or cloud services.

- **IR Sensors**

Infrared sensors detect the presence or absence of vehicles in each parking slot by emitting and receiving IR beams.

- **Power Supply Unit**

Provides regulated voltage and current to safely operate all electronics, including sensors, microcontrollers, and motors.

- **Transistors [2N2222]**

  Used for switching and amplification purposes in circuits. They help control high-power devices like motors with low-power microcontroller signals

Software Tools Used

STM32CubeMX

It is a graphical configuration tool used to initialize STM32 microcontrollers. It allows developers to easily configure peripherals, clocks, and pin assignments through an intuitive interface. CubeMX also auto-generates initialization C code, which can be exported to IDEs like Keil.

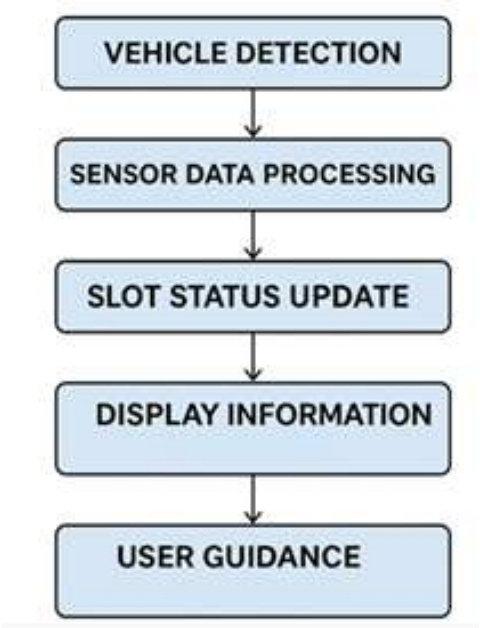
Keil uVision

This IDE is used for programming ARM-based microcontrollers, including STM32. It provides tools for code editing, compiling, debugging, and flashing firmware.

Arduino IDE

Arduino IDE is an open-source platform used to write, compile, and upload code to Arduino boards for electronics projects.

6.Methodology



- **Sensor Installation**

IR sensors are fixed at each parking slot to detect whether a vehicle is present or not.

These sensors send signals to the microcontroller based on the presence or absence of a car.

- **Microcontroller Setup**

The STM32 microcontroller is configured using STM32CubeMX and programmed using Embedded C.

It acts as the brain of the system, managing sensor inputs, display output, and gate control.

- **Sensor Data Processing**

  The STM32 reads signals from the IR sensors to determine which slots are occupied.

  Based on this, it updates the system status and controls other components accordingly.

- **System Integration**

  All the components—sensors, microcontroller, display, and motors—are connected and tested.

  Proper integration ensures that the system functions smoothly and reliably as a whole.

- **IoT Feature**

  A Wi-Fi module (e.g., ESP8266) can be added for remote monitoring of slot availability.This enables users to check parking status through a mobile app or web portal

7.Project Specification

Hardware Specfication

Component	Description
STM32F407G-DISC1	Microcontroller unit used to detect sensor inputs and process slot status
ESP32 Wi-Fi Module	Microcontroller with Wi-Fi capability to host the web dashboard and receive data from STM32
IR Sensors (x3)	Used for detecting vehicle presence in individual parking slots (active low output)
7-Segment Display	Displays the number of available parking slots locally (active high, pins PD8–PD14)
Power Supply	5V regulated power supply for sensors and microcontrollers
Connecting Wires	For GPIO, UART, and power connections between STM32, ESP32, and sensors
USB Cable	For programming STM32 and ESP32

Software Specifications

Software/Tool	Purpose
STM32CubeIDE	For writing and uploading the embedded C code to the STM32F407 board
Arduino IDE	For coding and uploading ESP32 firmware (UART + WebServer functionality)
HTML/CSS/JS	For designing the web-based user interface/dashboard
WebServer Library	Used in ESP32 to serve web pages over the local network
Serial Communication	For data transmission between STM32 and ESP32 using USART2 and UART2

Functional Specifications

- Detects the presence or absence of vehicles in **3 parking slots** using IR sensors.
- Displays the **number of available slots** on a **7-segment display**.
- Sends real-time availability data from STM32 to ESP32 using **serial communication (UART)**.
- Hosts a **responsive web dashboard** via ESP32 that:
    - Shows the number of vacant and occupied slots
    - Displays **connection status** and **IP address**
    - Provides **visual status** (green for available, red for occupied) of each slot
- Refreshes data automatically every few seconds without manual input.
- Alerts users when **no slots are available** using a visual warning on the dashboard.

8.Challenges and Solutions

- **Sensor Inaccuracy**

  IR sensors can mis-detect due to ambient light or dirt on the lens. We ran calibration routines at power-up, added shielding, and filtered raw readings in software to achieve consistent, reliable vehicle detection.

- **Microcontroller Programming**

  Getting peripherals to work together was complex. Using STM32CubeMX for pin/peripheral setup and Keil uVision for code debugging streamlined development, reduced register-level errors, and sped up firmware iterations.

- **Real-time Updates**

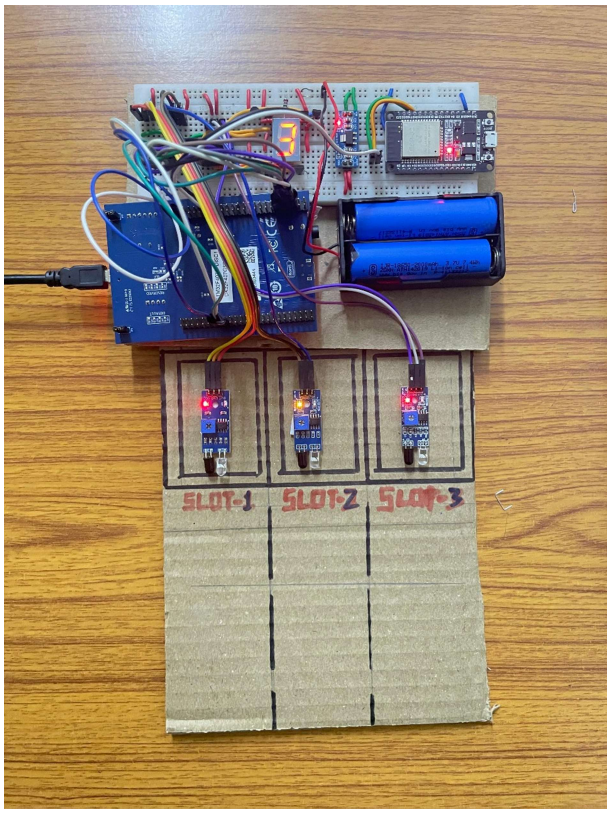
  Polling every sensor slowed the system. We switched to interrupt-driven GPIO and timer callbacks, so slot-status changes trigger immediate MCU attention, keeping the updates virtually instantaneous.

- **Component Integration**

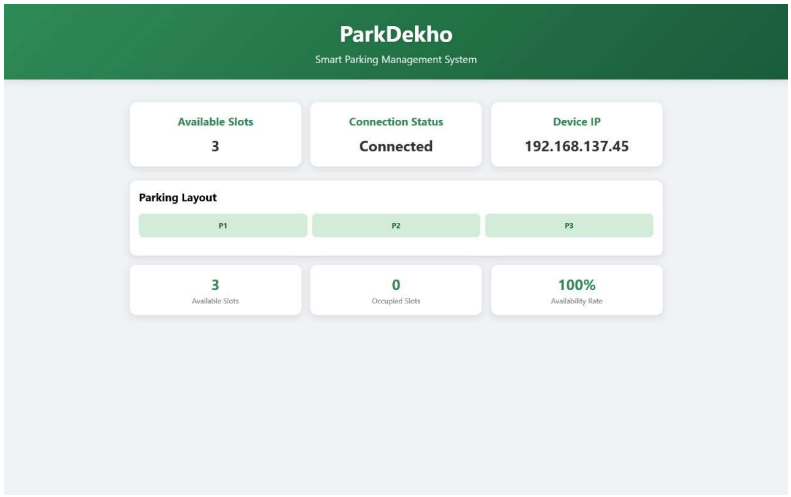
  Mixed-signal noise and mismatched logic levels caused early glitches. We introduced level shifters, common-ground star wiring, and step-by-step interface testing before full assembly, ensuring stable, interference-free operation.

9.Results and Discussions

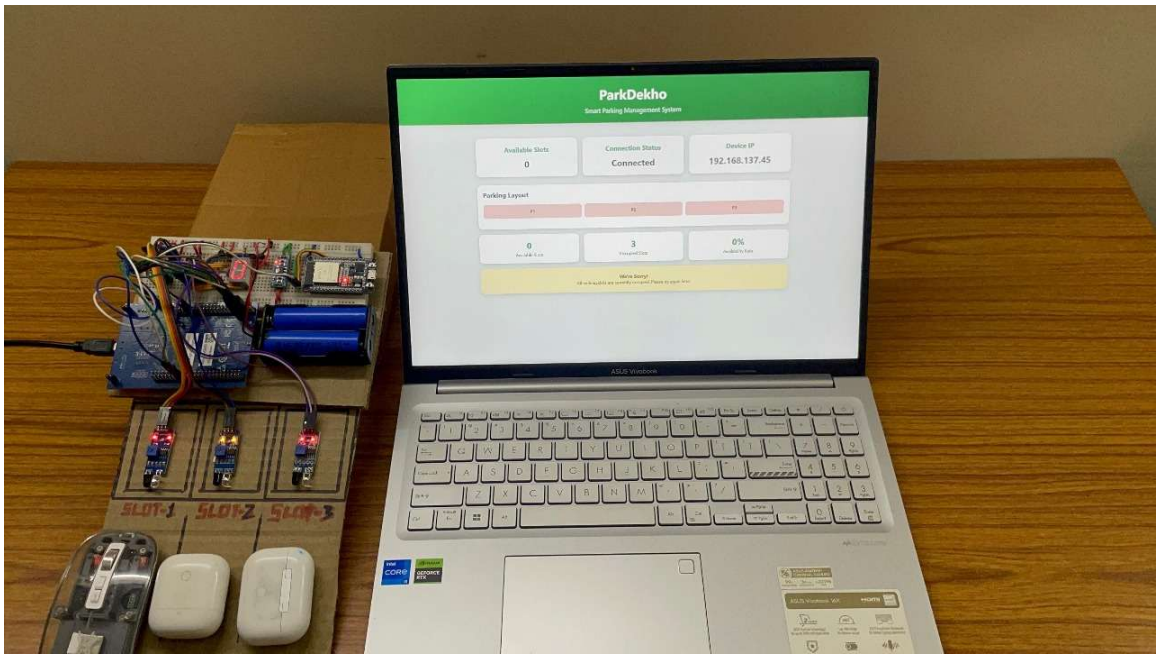
The Final Prototype



The Simple User Friendly Webpage



The Prototype Under Test



10.Outcome of Project

- **Efficient management of parking slots using automation**

  The system automates slot monitoring and gate control, eliminating the need for manual supervision and reducing operational delays.
- **Reduced congestion and time spent searching for parking**

  By guiding vehicles directly to available slots, the system decreases traffic buildup and driver frustration within parking areas.
- **Improved user convenience and reduced human error**

  Automated entry, exit, and display minimize reliance on staff and prevent errors in **Low-cost and scalable solution for urban use**

  Built with affordable components and modular design, the system can be implemented in both small and large-scale parking facilities.
- **Better traffic flow and environmental benefits from reduced idling**

  Reduced search time leads to lower fuel consumption and emissions, contributing to smoother traffic flow and cleaner air.

11.Conclusion and Further Scope

The Smart Parking Management System using the STM32 microcontroller provides a reliable and efficient solution to address modern urban parking issues. By automating the detection of vehicle presence, slot availability display, and gate control, the system reduces human intervention, saves time, and enhances user convenience. It significantly minimizes congestion and fuel wastage, while also ensuring a smoother parking experience. The system's cost-effective and modular design makes it highly suitable for implementation in commercial complexes, public areas, and smart city infrastructure.

Looking ahead, the project can be enhanced by integrating IoT features to enable remote monitoring through mobile apps or web portals. Advanced features such as RFID-based access, automatic license plate recognition, and digital payment integration can further improve functionality. The system is also scalable to support multi-level parking setups. With these upgrades, the project can evolve into a complete smart parking solution adaptable to various urban environments.