IOT Based Smart Parking Management System

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Abstract

This Finding a parking space in busy areas is often difficult and time-consuming. This project presents an IoT-based Smart Parking Management System designed to solve this problem by helping users find available parking slots easily and quickly. The system uses sensors to detect whether a parking spot is occupied or free and sends this information to users in real-time through the internet. A microcontroller like ESP8266 or ESP32 collects the data and communicates with a cloud platform or mobile app. This helps reduce traffic congestion, saves fuel, and improves the overall parking experience. The system is low-cost, efficient, and can be implemented in malls, offices, public places, and smart cities.

Keywords: Adafruit IO, IOT (Internet of Things), RFID, Real-time Slot Detection, ESP8266.

1. Introduction

The project entitled smart parking system is to manage all the parking facilities for a user. With the recent growth in the economy and due to the availability of low-price cars in the market, every average middle-class individual can afford a car, which is a good thing, however, the consequences of heavy traffic jams, pollution, less availability of roads and spot to drive the motor car. One of the important concerns, which is to be taken in accounting, is the problem of parking those vehicles. Though, if there is space for parking the vehicle but so much time is squandered in finding that exact parking slot resulting in more fuel intake and not also environment-friendly. It will be a great deal if in some way we find out that the parking itself can provide the precise vacant position of a parking slot then it'll be helpful not limited to the drivers but also for the environment. Initially, when the user is about to enter the location, the LCD displays the number of empty and filled spots and when the user is with their vehicle near the parking detect sensor, he/she would be thrown a notification on the mobile app of the parking slot number, where they should park their vehicle. The main important benefit of a smart parking system is its advanced technology. It follows the latest technologies and concepts to assure profitable outcomes. The design and implementation of smart parking are very easy to supervise and manage. This system can be easily handled by the staff members because of its well-organized structure

2. Literature review

1. D. J. Bonde "Automated car parking system commanded by android application" in Proc. IEEE Conf.,03-05, Jan 2012 The aim of this project is to automate the car and car parking as well. A miniature model of an automated car parking system that can regulate and manage number of cars that can be parked in given space at any given time based on the availability of parking slot. Automated parking is a method of parking and existing cars using sensing device. The entering and leaving to the lot is commanded by an android application.
2. Microcontrollers such as the ESP8266 and ESP32 are widely adopted in IoT systems due to their built-in Wi-Fi capabilities and compatibility with cloud platforms. Studies such as the one by Sharma et al. (2019) highlight the use of ESP8266 for transmitting parking status data to a centralized server. These microcontrollers are programmable via the Arduino IDE and can efficiently handle sensor input and Wi-Fi communication simultaneously.
3. Cloud connectivity is essential for real-time monitoring and remote control. Early systems used SMS or Bluetooth for communication, but recent literature emphasizes the use of cloud platforms such as Thing Speak, Blynk, and Firebase. However, these platforms often present limitations in dashboard customization or require complex setups. Adafruit IO, by contrast, is cited in multiple hobbyist and academic projects (e.g., Singh et al., 2021) for its simplicity and effectiveness in visualizing real-time data. It supports MQTT and HTTP protocols, making it suitable for lightweight IoT applications. Adafruit IO also allows the creation of interactive dashboards that can display slot status, manage devices, and handle user interaction such as pre-booking.
4. Recent developments in SPS have focused on enhancing user experience. Features such as mobile apps, real-time maps, and pre-booking options are discussed in studies like that of Al-Turjman et al. (2020). The ability to reserve parking spaces remotely has searched for slots and been shown to significantly reduce time spent to optimize parking lot usage during peak hours. By leveraging Adafruit IO's dashboard interface, developers can create reservation buttons, status indicators, and occupancy logs, enabling systems to support interactive functionalities without the need for complex backend development.
5. M. M. Rashid, A. Musa, M. Ataur Rahman, and N. Farahana, A. Farhana "Automatic Parking Management System and Parking Fee Collection Based on Number Plate Recognition" International Journal of Machine Learning and Computing, 93-98, 2012. This paper discussed on automatic parking system and electronic parking fee collection based on vehicle number plate recognition. The aim of this research is to develop and implement an automatic parking system that will increase convenience and security of the public parking lot as well as collecting parking fee without hassles of using magnetic card. The auto parking system will able to have less interaction of humans and use no magnetic card and its devices. In additions to that, it has parking guidance system that can show and guide user towards a parking space. The system used image processing of recognizing number plates for operation of parking and billing system. Overall, the systems run with pre-programmed controller to make minimum human involvement in parking system and ensure access control in restricted places.

3. Existing System

Now a days Traditional or existing parking systems are mostly manual and involve limited use of technology. In these systems, drivers must search for available parking spots on their own, which often leads to unnecessary time loss, traffic congestion, and increased fuel consumption. Payments are usually handled manually through cash or paper tickets, and there is little to no real-time information available about space availability. As a result, the overall user experience is inefficient and inconvenient.

4. Proposed System

1) **Gate Operation:** If a slot is available and the IR sensor detects vehicle.
   NodeMCU activates the servo motor to open the gate.
   Python starts a timer to calculate parking duration for billing
2) **Slot Detection:** IR sensors installed in each parking slot detect if a space is occupied**.**
   NodeMCU updates this data and sends it to the Python server.
3) **Exit & Billing:** Upon exit, the same RFID is scanned again.
   Python calculates the total parking time.
   Billing is done based on predefined rates (e.g., ₹10/hour).
   A receipt is generated (console printout / PDF / database log).
4) **Data Storage**: All entry/exit times, vehicle IDs, and charges are stored using SQLite or CSV files via Python.
   This data can be used for reporting, user history, and future enhancements.

5. Bock Diagram

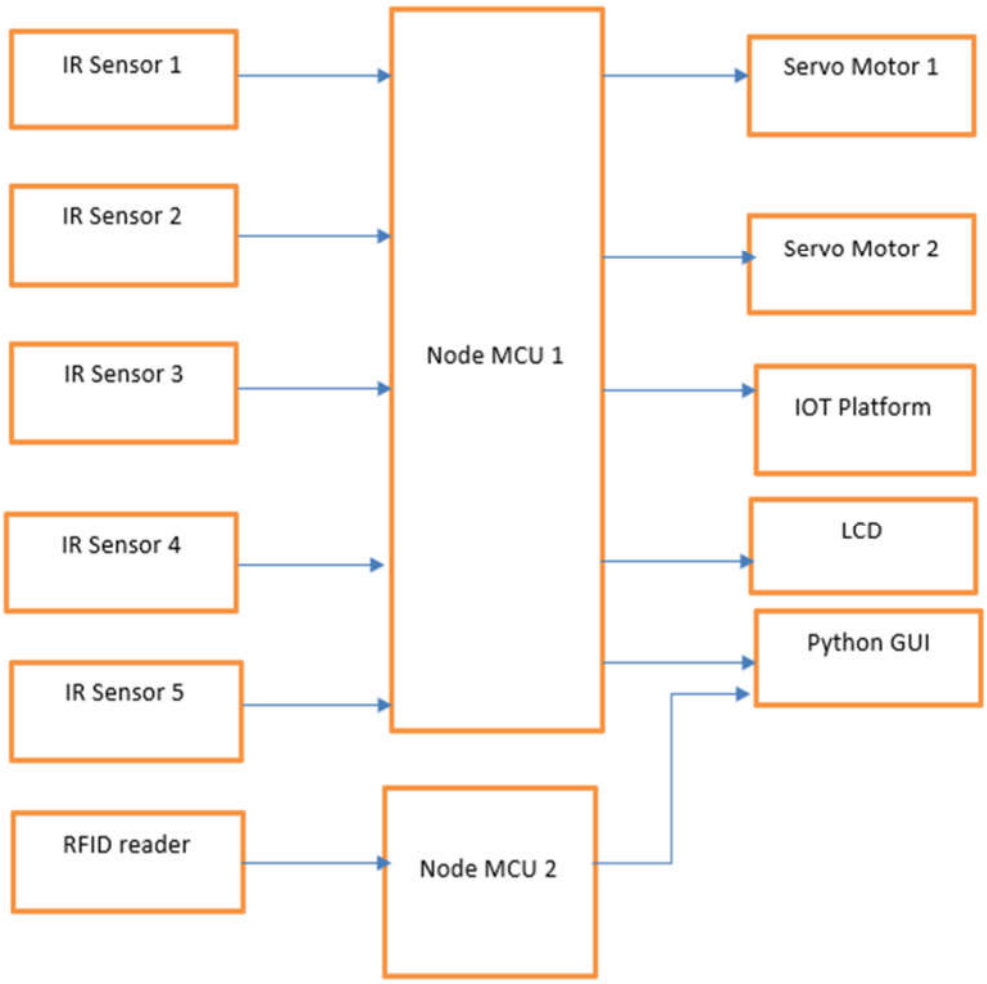
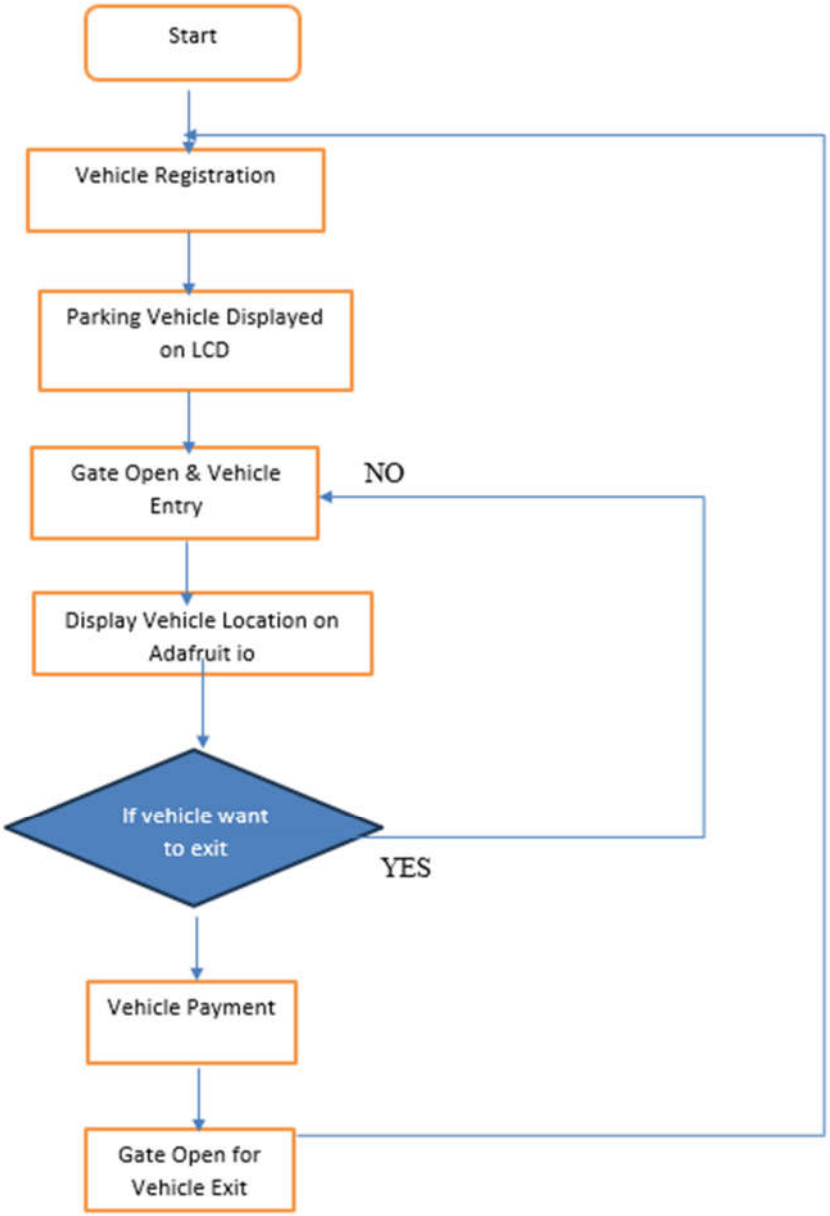


Fig. Block Diagram

6. Flow Chart



7. Working

The working of this project is being any vehicle reach at gate IR sensor will identify the object using IR sensor gate will open. There is using one servo motor for open the gate for vehicle entry. One's vehicle entered in the parking then registration is done of vehicle. Vehicle will park on available Parking Slot which is display vehicle location on Adafruit IO IOT flatform. We can easily monitor parking slot is empty or occupied using GUI. If vehicle want to left parking, then payment will do by using RFID reader. If bill paid the vehicle will exit by exit gate, then gate will open using servo motor and IR Sensor. In this way IOT based smart parking system is available. This is real time monitoring, low time, which saves time, reduces traffic, and improves the overall parking experience.

8. Hardware

NodeMCU: - It is 32-bit microcontroller. It has inbuilt ESP8266 wifi module. It can easily connect to the internet by providing SSID and Password. It can be programmed through Arduino IDE. It an work on 3.3 V. D1 and D2 will act as SCL & SDA pins of NodeMCU and is connected to the SCL & SDA pins of max30100 sensor.

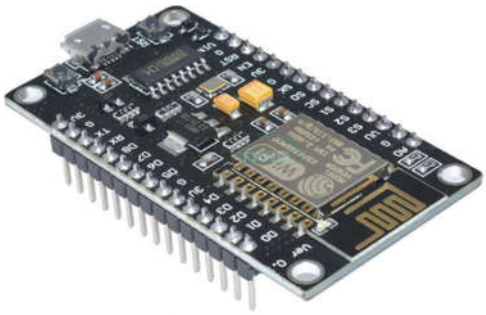


Fig. NodeMCU

IR Sensor: - IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations. There are five basic elements used in a typical infrared detection system: an infrared source, a transmission medium, optical component, infrared detectors or receivers and signal processing. Infrared lasers and Infrared LEDs of specific wavelength used as infrared sources.

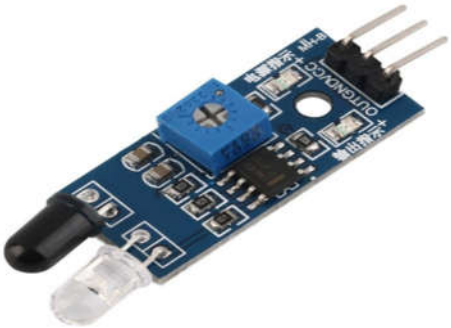


Fig.IR Sensor

RFID Reder: - An RFID (Radio Frequency Identification) system consists of two main components: a reader and a tag. The RFID reader contains a radio frequency module and an antenna that creates a high-frequency electromagnetic field around it. The RFID tag is attached to whatever object we want to identify or track. Most tags are passive, which means they don't have batteries or their own power source. Instead, they wait quietly until they enter the reader's electromagnetic field. When a tag enters this field, the radio waves from the reader create a tiny electrical current in the tag's antenna. This small current gives the tag just enough power to wake up its microchip. The microchip contains important information about the object the tag is attached to. Once powered up, the tag sends this information back to the reader. This process is called backscatter, where the tag doesn't generate its own radio signal but instead modifies the reader's signal.

Fig. RFID Reader

Servo Motor: - A servo motor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration. It works by using a closed-loop feedback system to maintain a desired position, continuously correcting for any deviations. This is achieved by comparing the desired position (input signal) with the actual position (feedback from a sensor) and adjusting the motor's rotation to minimize the error.

Fig. Servo Motor

9. Result

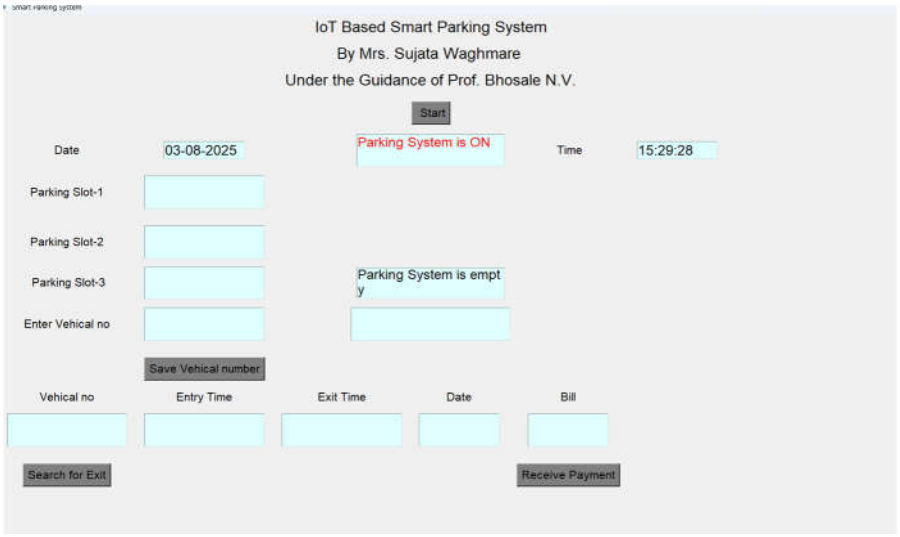


Fig.1 Parking System is ON

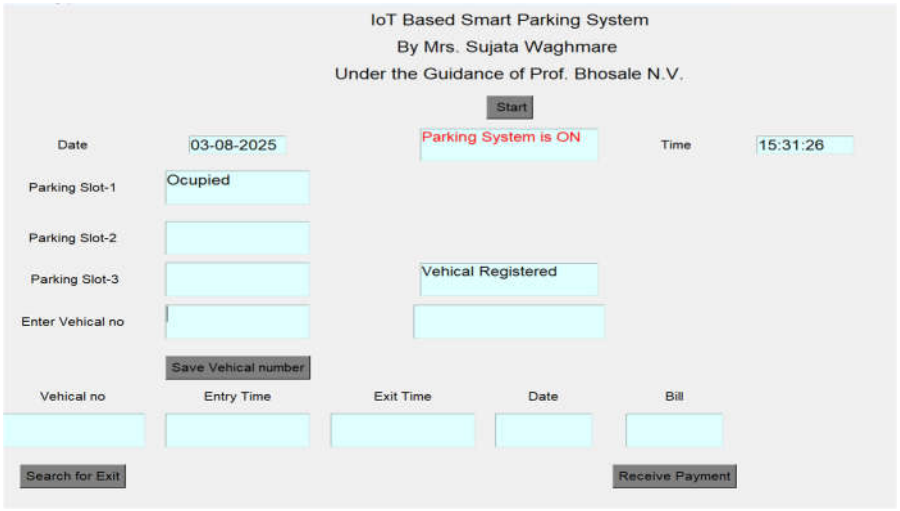


Fig.2 Vehicle Registered

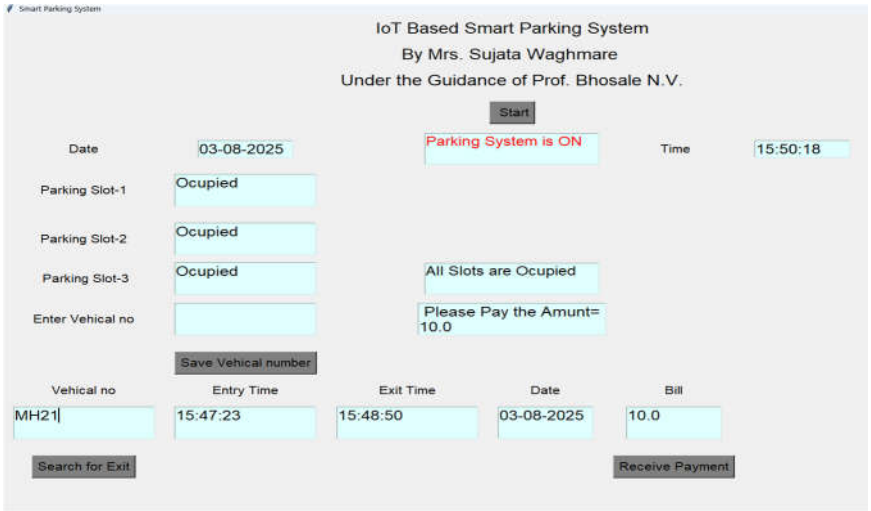


Fig.3 All Slot Occupied

10. Conclusion

The concept of Smart Cities has always been a dream for humanity. Over the past couple of years, large advancements have been made in making smart cities a reality. The growth of the Internet of Things and Cloud technologies have given rise to new possibilities in terms of smart cities. Smart parking facilities and traffic management systems have always been at the core of constructing smart cities. In this Project, we address the issue of parking and present an IoT-based Cloud integrated smart parking system. The system that we propose provides real-time information regarding the availability of parking slots in a parking area. Users from remote locations could book a parking slot for them by the use of our mobile application. The efforts made in this paper are indented to improve the parking facilities of a city and thereby aim to enhance the quality of life of its people..

11. Project Image

12. References:

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