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IOT SOLUTIONS FOR EFFICIENT PARKING MANAGEMENT

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Abstract- *In recent times the concept of smart cities has gained great popularity. Thanks to the evolution of the Internet of Things the idea of a smart city now seems to be achievable. Consistent efforts are being made in the field of IoT to maximize the productivity and reliability of urban infrastructure. Problems such as traffic congestion, limited car parking facilities, and road safety are being addressed by IoT. In this project, we present an IoT-based cloud-integrated smart parking system. The proposed Smart Parking system consists of an on-site deployment of an IoT module that is used to monitor and signalize the state of availability of each single parking space. A mobile application is also provided that allows an end user to check the availability of parking spaces and book a parking slot accordingly. The paper also describes a high-level view of the system architecture. Towards the end, the project discusses the working of the system in the form of a use case that proves the correctness of the proposed model.*

Key Words: *(Node MCU ESP8266 Microcontroller, IR sensor, Servo Motor, Adafruit.IO)*

1. INTRODUCTION

An IOT-based Parking Management system that integrates with the mobile Application. It provides a comprehensive parking solution for both the user and owner of the parking space. Features are provided for identifying the nearest free space depending on the size of the vehicle, navigating to the parking slot, and computing account information on a daily, weekly, and monthly basis. With the recent growth in the economy and due to the availability of low-priced 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 into accounting, is the problem of parking those vehicles. However, if there is space for parking the vehicle so much time is squandered in finding that exact parking slot resulting in more fuel intake and not also environment friendly.

Over the last few years, the Internet of Things (IoT) has utterly altered habitual human behavior by providing them with numerous facilities and comfort options to have ease in everyday life. Equipped with an Internet connection and sensor networks, electronic devices in the digital world are connected through IoT technology. Research conducted on the prospects of IoT has figured out an exponential increment of IoT devices. As per estimation, more than 25 billion IoT-based appliances will be connected to the internet by the end of 2020. IoT enables integration, interaction, and communication with digital electronic devices, sensors, and actuators which provide the required services to attain specific goals more efficiently. IoT's security uses various security measures, making it a matrix for other technological advancements.

With the rapid growth and development of the Internet of Things (IoT) and cloud-based intelligent systems, the idea of smart cities has taken on a whole new meaning. A Smart City aims to: Reduce operational costs Improve city management Enhance efficiency Improve productivity A smart city is a system that systematically monitors and manages infrastructure, buildings, intelligent transportation systems, healthcare, education, energy consumption, public safety, and more. SPS In the smart city concept, SPS is a key component of the transportation system. In highly compact, densely populated sectors in cities, there is a significant shortage of parking space. About 30% of vehicles on the roads in major cities search for vacant parking lots manually, and it takes about 7.8 min for a parking lot to be found.

In recent research in metropolitan cities, the parking management problem can be viewed from various angles such as high vehicle density on roads. This results in annoying issues for the drivers to park their vehicles as it is very difficult to find a parking slot. The drivers usually waste time and effort in finding parking space and end up parking their vehicles and finding a space on the street which further leads to space congestion. It is very difficult and time-consuming to find parking space in most metropolitan areas, and commercial areas, especially during the rush hours. It is often costly in almost every big city all over the world to find proper and secure parking spaces. In the worst case, people fail to find any parking space, especially during peak hours and the festive season. Reducing the amount of time and bother required to find an open parking place is one objective of smart parking systems. In addition to reducing CO2 emissions, noise, and other pollutants, being able to precisely direct a car to an open place has several positive environmental effects. There are regulations regarding parking in every city and

on every street. Cities place a lot of value on parking spots. A city must have adequate parking spots to give its citizens and tourists a place to leave their vehicles. A city needs to cater to the demands of the drivers because vehicles are a major component of transportation.

Cloud computing and IOT have witnessed large evolution. Both the technologies have their advantages, however several mutual advantages can be foreseen from their integration. On one hand, IOT can address its technological constraints such as storage, processing and energy by leveraging the unlimited capabilities and resources of Cloud. On the other hand, Cloud can also extend its reach to deal with real world entities in a more distributed and dynamic fashion by the use of IOT. Basically, the Cloud acts as an intermediate between things and applications, in order to hide all the complexities and functionalities necessary for running the application. Below are some of the factors that led to the amalgamation of Cloud and IOT. It aims to optimize parking availability, enhance user experience, and reduce traffic congestion. It can incorporate security features and surveillance systems to enhance safety and deter theft. The direction of the system includes real-time parking space detection, reservation systems, mobile applications for users, and data analytics for efficient parking management. It's a great solution to improve parking efficiency and convenience. IoT is the buzzing technology of the current era, where all devices are interconnected with one another through the internet. Every device interconnected with the internet possesses a unique identifier. These devices can be computational devices, mechanical devices, and digital devices. They can transfer data without human-to-human or human-to-computer interaction. IOT technology acts as one of the primary key technologies that developers use for SPS. The rapid development of the internet, communication, and information technology has led to the development of smart parking systems that are efficient and cost-effective. As a result, a lot of researchers have implemented different Smart parking management systems based on different technologies and sensors.

This can help reduce traffic congestion and improve the overall traffic flow in the car park. These systems allow motorists to easily find available parking spaces without having to drive around the car park, saving time and reducing frustration. It has to provide the secured parking space for the users in metropolitan cities. And to save time for the vehicle owner to search the parking slots. The aim of implementing Smart parking system is to provide secured parking platform given for the vehicle owners. In light of the above, in the authors reviewed several smart parking solutions created by researchers by briefly describing their cutting-edge solutions.

2 LITERATURE REVIEW:

JongHo Shin, HongBae[1] Jun City transportation management, Parking guidance algorithm. A comprehensive overview of the Proposed algorithm which helps in effective usage of parking spaces in the city. It reduces energy consumption and traffic congestion in the city and also provides the actual time status of parking availability in a city. The proposed algorithm helps to maximize the utilization of space resources of a city and reduce unnecessary energy consumption and CO2 emission of wandering cars since it is designed to control the utilization of parking facilities efficiently and reduce traffic congestion due to parking space search. Finding an available parking spot in city centers can be a cumbersome task for individual drivers and also negatively affects general traffic flow and CO2 emissions.

Sarang Deshpande[2] proposed Hierarchical Wireless Sensor Networks and Vehicle Parking Guidance. This work proposes an innovative approach to guide vehicle drivers to the parking space using Hierarchical Wireless Sensor Networks. In a hierarchical wireless sensor network (HWSN) there is a hierarchy among the nodes based on their capabilities: base stations, cluster heads, and sensor nodes. Proposed an algorithm using hierarchical wireless sensor networks for vehicle parking guidance system Due to heterogeneity in the characteristics of Wireless Sensor Networks (WSN), it has become a most prominent technology to bind things with the Internet and with the end users. Wireless Sensor Networks are self-healing and active in nature, that is, they can sense, instruct, request, and respond and can easily be adapted to Wireless Sensor and Actuator Networks (WSAN).

Tang et al.[3]Parking slot, fog computing architecture, Smart VANETs, real-time. The paper details a Fog computing-based smart parking system that combines the benefits of both vehicle ad hoc networks (VANETs) and fog computing to reduce gasoline waste, average parking cost, and vehicle exhaust emission and improve parking facilities. The experience of finding a vacant parking slot can be very stressful in densely populated areas, especially during peak hours. Smart parking, aiming to assist drivers in finding desirable parking slots more efficiently through information and communication technologies such as vehicle ad hoc networks, has received extensive attention recently.

Tekouab ou *et al.[4]* Smart cities, IoT Regression, Parking availability, Ensemble models. Smart cities are part of the ongoing advances in technology to provide a better life quality to its inhabitants. Urban mobility is one of the most important components of smart cities. In addition, finding places to park even in car parks is not easy for drivers who run in circles. Studies have shown that drivers looking for parking spaces contribute up to 30% to traffic congestion. The tests that we carried out on the

Birmingham parking data set allowed to reach a Mean Absolute Error (MAE) of 0.06% on average with the algorithm of Bagging Regression (BR). This results have thus improved the best existing performance by over 6.6% while dramatically reducing system complexity.

H. Canli and S. Toklu [8] proposed a deep learning-based application. For the experimentation purpose they used ISTPARK dataset. The objective of their study was to build a deep learning and cloud-based application so that the searching time for vacant parking slot get reduced and they also used deep learning with LSTM in the proposed application to predict the parking space. The accuracy rate is 99.57% which is dependent on capacity, time, density, day, and holiday. To predict the parking space occupancy rate, a deep learning-based LSTM model, which models multivariate and large data sets almost seamlessly, was used. To demonstrate the effectiveness of the model, models were created in different parameters andscenarios and compared with SVM, Random Forest, and ARIMA models.

3 METHODOLOGY:

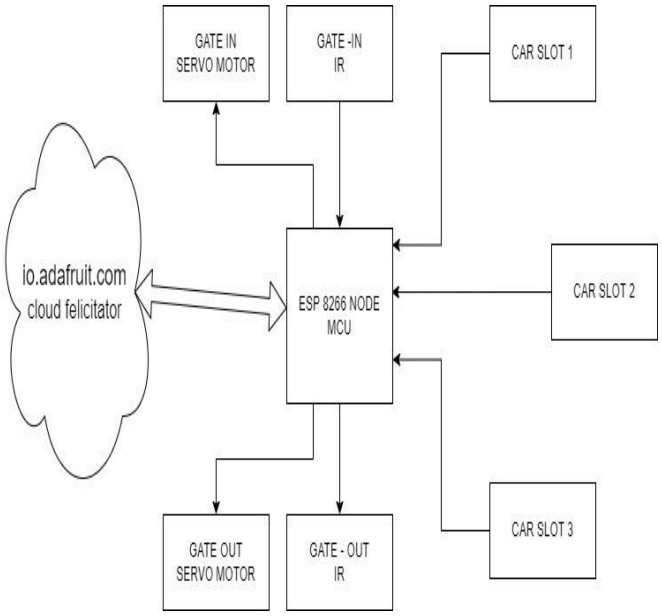

Fig -1: Block Diagram of proposed method

ADAFRUIT IO

In the realm of Internet Of Things development, managing and visualizing collected data from various sensors and devices is paramount. Adafruit IO has emerged as a powerful platform to simplify IOT data Management, enabling developers to seemingly gather, store, and collect data from their connected devices. In this comprehensive guide, we delve into the intricacies of Adafruit IO, exploring its features, applications, and potential impact on IOT development. It allows you to connect and control different devices and sensors remotely. The webpage you're seeing is supposed to show a list of data or information from those devices.

Adafruit IO is a platform designed to display, respond, and interact with your project's data. It also keeps your data private (data feeds are private by default) and secure. It is a cloud server that can be used to connect to IoT devices through wifi and to control these devices through a dashboard. It can be used as a free service and it has got a simple easy-to-use interface to design dashboards.

MQTT PROTOCOL

A computer or program that controls access to a centralized resource or service within a network. MQTT is a standard-based messaging protocol, or set of rules, used for machine-to-machine communication. Smart sensors, wearables, and other Internet of Things (IoT) devices typically have to transmit and receive data over a resource-constrained network with limited bandwidth. To automate the parking procedure by monitoring metrics such as distance and available parking spaces, Node MCU and IBM Cloud are used. The distance is measured, and the information is sent to Node-RED over the MQTT protocol. The Node-RED dashboard allows the user to view availability from any location. The distance is measured, and the information is sent to Node-RED over the MQTT protocol.

The Node-RED dashboard allows the user to view availability from any location. If the distance is too great, the space is unoccupied. If the parking area is fully occupied, the owner or person in control of the parking lot is also notified. Here an Application Programming Interface is used. It is a software intermediary that allows two applications to talk to each other. An API, or application programming interface, is a set of rules or protocols that let software applications communicate with each other to exchange data, features, and functionality. An API is very much the same thing as a UI, except that it is geared for consumption by software instead of humans.

HARDWARE IMPLEMENTATION

Node MCU

The Node MCU contains Wi-Fi as well as a Node microcontroller. Node Microcontroller has 3Mb of ROM which can be used to upload a program. The ESP8266 module consists of a microcontroller and a Wi-Fi chip. It can be programmed to perform various tasks and communicate with other devices over a Wi-Fi network.

IR SENSOR

Infrared Obstacle Sensor Module has two part IR transmitter and IR receiver that sends out IR energy and

looks for reflected IR energy to detect presence of any obstacle in front of the sensor module.

SERVO MOTOR

A servo motor is used when you want to rotate an object at a specific angle or distance. It is simply a motor that is controlled by a servo mechanism.

4 DESIGN AND IMPLEMENTATION

DESIGN:

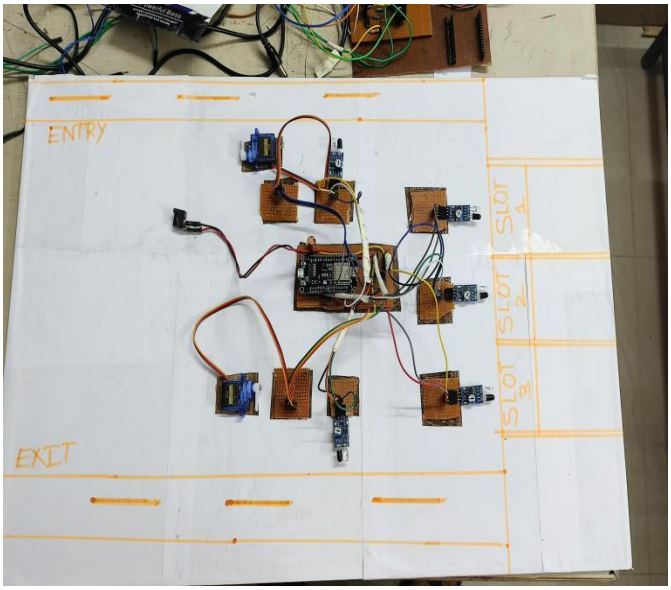

Fig 2: Circuit Diaram

In this Smart Parking System using IOT, we are using five IR Sensors and two servo motors. IR sensors and Servo motors are connected to the Node MCU. Node MCU controls the complete process and sends the parking availability and parking time information to Adafruit IO so that it can be monitored from anywhere in the world using this platform. Two IR sensors are used at the entry and exit gate so that they can detect the cars at the entry and exit gate and automatically open and close the gate. The gate in a servo motor works based on the principle of pulse width modulation (PWM). The control signal sent to the servo motor is a series of pulses with varying widths. The width of the pulses determines the desired position of the gate.

Two servo motors are used as entry and exit gates, so whenever the IR sensor detects a car, the servo motor automatically rotates from 45° to 140°, and after a delay, it will return to its initial position. Another three IR sensors are used to detect if the parking slot is available or occupied and send the data to Node MCU. Adafruit IO dashboard also has two buttons to manually operate the entry and exit gate.

IMPLEMENTATION

Go to the Adafruit IO website and create an account. It's free to get started. A feed is like a data channel where you can send and receive information. Create a new feed by giving it a name and selecting the data type. To send data to Adafruit IO, it needs a compatible device or sensor. Follow the documentation or tutorials provided by Adafruit to connect your device to the platform.

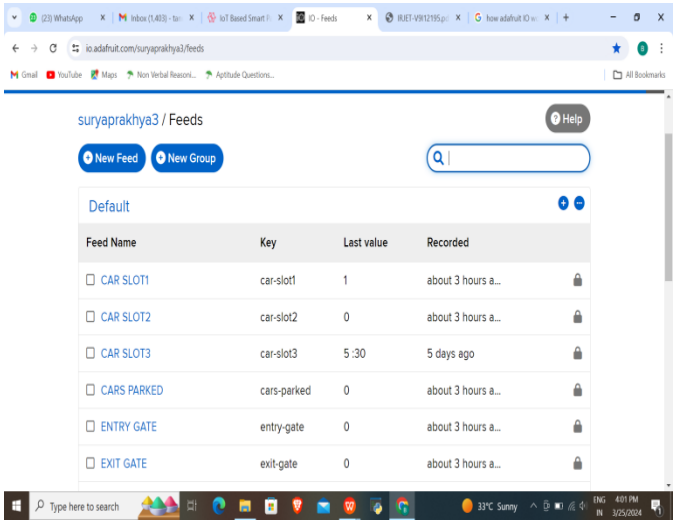

Fig-3 Feeds on the dashboard for parking management

Once your device is connected, you can start sending data to Adafruit IO. Use the provided libraries or APIs to send data to your specific feed. You can send sensor readings, control commands, or any other relevant information. Adafruit IO provides various tools to visualize and control your data. You can create dashboards, charts, and widgets to monitor and interact with your connected devices.

In Adafruit IO, feeds are used to store and retrieve data. It need to create feeds for various aspects of your parking system, such as sensor data (e.g., occupancy status of parking spots), user input. IoT device to read sensor data and send it to Adafruit IO. This will need to use Adafruit's libraries and APIs to establish a connection and publish data to the appropriate feeds.

5 RESULT AND DISCUSSION

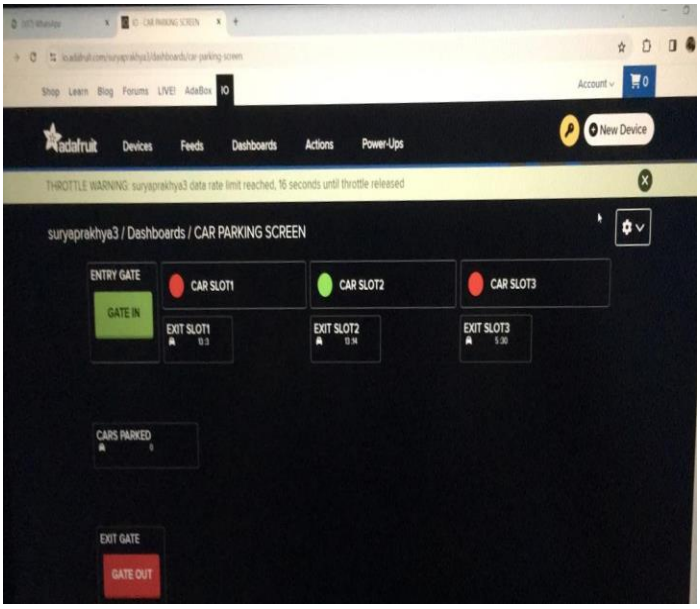

Fig -4: Experimental result

The demand of smart parking system is increasing significantly. This allows user to involve real time access of the availability of the parking space. This web page may show the current availability of parking spaces, indicating which spots are vacant and which are occupied. The web page could provide an allowing users for their parking directly through the interface. It helps us to offer guidance and directions to available parking spaces, helping users navigate to the nearest open spot. In this web page can also show stored parking history.

6 CONCLUSION

This project provides an efficient way of parking system that can be used in multiple versions like apartments, Multiplex, Hospital, etc. The problems that would arise while working with a smart parking system as well as the solutions have been described which gives a good platform for all the users. The implementation of a smart parking system, assures the ease of life for individuals who struggle in daily routines of their day-to-day life. The system that we propose provides real-time information regarding the availability of parking slots in a parking area. So the users can save their time from searching for parking slots.

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