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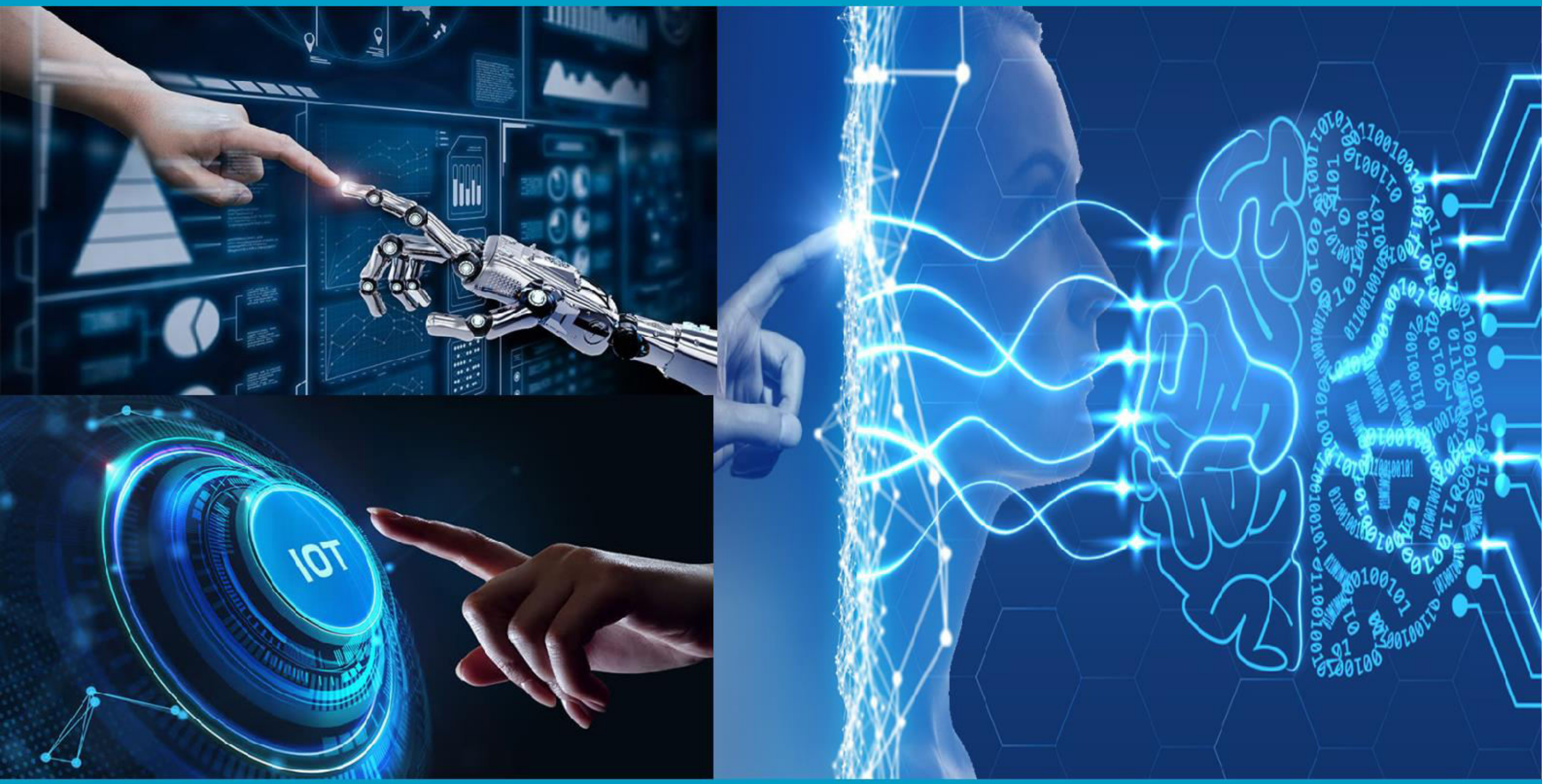

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Smart Parking System Using IOT

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ABSTRACT: Recently, smart city concepts have achieved great success. Thanks to the development of the Internet of Things, the idea of smart cities seems to have become a reality. The field of IoT is a constant effort to maximize the productivity and reliability of urban infrastructure and human needs. Issues such as traffic congestion, limited parking, and road safety plague people. So we can address this with IoT. This article introduces an IoT-based cloud-integrated smart parking system. The proposed smart parking system consists of an on-site deployment of IoT modules used to monitor and notify the availability of individual parking spaces. A mobile application is also provided that allows end-users to check parking space availability and book parking spaces accordingly. It also provides an overview of system architecture and city infrastructure. Finally, we describe how the system works in the form of use cases that prove the correctness of the proposed model.

I.INTRODUCTION

The concept of IoT started with things like identity communication devices. A device can be tracked, controlled, or monitored by a remote computer connected over the Internet. IoT is Internet that enables communication and networking of devices and physical objects or "things". Two prominent words.IoT consists of "Internet" and "things". The Internet means a vast global network of servers, computers, tablets and mobile phones connected using internationally used protocols and connection systems. The Internet makes it possible to send, receive, or communicate information.

A small, embedded device that interacts with remote objects or people through connectivity. The scalable and resilient nature of cloud computing empowers developers. This means that things (wearables, watches, alarm clocks, home appliances, ambient objects) become intelligent, sensing, computing and communicating via small, embedded devices that interact with distant objects and people via connectivity. By doing so, we provide a vision that comes to life and works. The scalable and resilient nature of cloud computing allows developers to build and host their applications on cloud computing. The cloud is the perfect partner for the IoT as it acts as a platform to store all sensor data and access it remotely [11]. These factors have brought both technologies together to form a new technology called the Cloud of Things (CoT). In Cot, things (nodes) could be accessed, monitored, and controlled remotely through the cloud. Due to the high scalability of the cloud, any number of nodes can be added or removed from an IoT system in real time. Simply put, IoT can be described in the form of an equation:

Physical Objects + Controllers, Sensors, Actuators + Internet = Internet of Things

II.LITERATURE REVIEW

The ideal of building smart cities is becoming possible with the advent of the Internet of Things. One of the key issues in smart cities is parking and traffic control systems. In today's cities, it is always difficult for motorists to find free parking spaces, and it tends to become more difficult as the number of private car users increases. This situation can be seen as an opportunity for smart cities to take measures to improve the efficiency of parking resources, resulting in less search times, traffic congestion and traffic accidents.

Parking and congestion can be solved by informing drivers in advance of the availability of parking spaces in and around their destination. Recent advances in the development of low-cost, low-power embedded systems are helping developers create new applications for the Internet of Things. Following the development of sensor technology, many modern cities

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have decided to deploy various IoT-based systems inside and outside the city for surveillance purposes.

A recent survey conducted by the International Parking Association shows a growing number of innovative ideas related to parking systems. There are now certain parking systems [8] that claim to provide citizens with real-time information about available parking spaces. Such systems must use powerful sensors in parking lots to monitor occupancy and high-speed data processing units to gain actionable insights from data collected from a variety of sources.

Our proposed smart parking system is implemented using a cloud-connected mobile application. This system helps users to know the availability of parking spaces in real time.

Cloud computing and IoT are making great strides. Both technologies have their advantages, but their integration can foresee some mutual advantages. On the one hand, IoT can address technical limitations such as storage, processing, and power by leveraging the unlimited capabilities and resources of the cloud [4]. On the other hand, with IoT, the cloud can also extend its reach to handle real-world entities in a more distributed and dynamic way. Essentially, the cloud acts as an intermediary between things and applications, hiding all the complexity and functionality that applications need to run. Here are some of the factors that have led to the convergence of cloud and IoT:

Storage Capacity:

IoT involves a multitude of information sources (things) that generate vast amounts of unstructured or semi-structured data. As a result, IoT requires the collection, access, processing, visualization and sharing of massive amounts of data [14]. The cloud offers unlimited and inexpensive on-demand storage capacity, making it the best and most cost-effective solution for processing IoT-generated data. Data stored in the cloud can be accessed and visualized from anywhere using standard APIs.

Compute Power:

Devices used in IoT have limited processing power. Data collected from various sensors are typically sent to more powerful nodes where they can be aggregated and processed [18]. IoT computing needs can be met by leveraging the cloud's unlimited processing power and on-demand model. With the help of cloud computing, IoT systems can process data in real time and enable highly responsive applications.

Communication Resources:

A fundamental function of IoT is to allow IP-enabled devices to communicate with each other through dedicated hardware. Cloud computing offers an affordable and effective way to connect, track, and manage devices from anywhere on the Internet [16]. By using integrated applications, IoT systems can be monitored and controlled across remote locations in real time.

Scalability:

The cloud offers a scalable approach to IoT. Resources can be increased or decreased dynamically. Given cloud integration, you can add or remove any number of "things" from the system [22]. The cloud allocates resources according to the needs of things and applications.

Availability:

Cloud integration makes resources easily available anywhere. Many cloud providers guarantee 59% availability. In the cloud, applications are always up and running, providing continuous service to end users.

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Interoperability:

IoT involves the use of devices that are heterogeneous in nature. These devices may have different hardware or software configurations, which can lead to compatibility issues. Ensuring interoperability between these devices becomes very difficult in an IoT environment [19]. The cloud helps solve this problem by providing a common platform for different devices to connect and interact. Devices can share and exchange data in any acceptable format.

II. PROPOSED SYSTEM ARCHITECTURE

This section provides an architectural overview and mathematical model for intelligent parking systems. Our proposed parking system consists of various actors working in sync with each other. Below is a mathematical model that defines our smart parking system

Table 1: Nomenclature Table

SYMBOL	MEANING
T	Parking time
C	Driver's car number
P	Amount paid
U	User ID
S	Parking slot
M_i	Driver
O	Occupancy rate
X()	Input function
Y()	Output function
F()	Computation function
I()	Identity function

- M_i< X(T,C,P,U,S) // Driver provides input to the input function
- X()<F(S,T) // Input function notifies the computation function
- X()<I(P,C,U) // Input function notifies the identity function
- O_i= F(S,T)<Y()// Computation function notifies the output function and the resultant is stored in form of the occupancy rate.
- O_i= 0|1// Occupancy rate can either be 0 or 1. Where 0
- specifies occupied and 1 means vacant.

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The following figure gives an outlined view of the complete system.

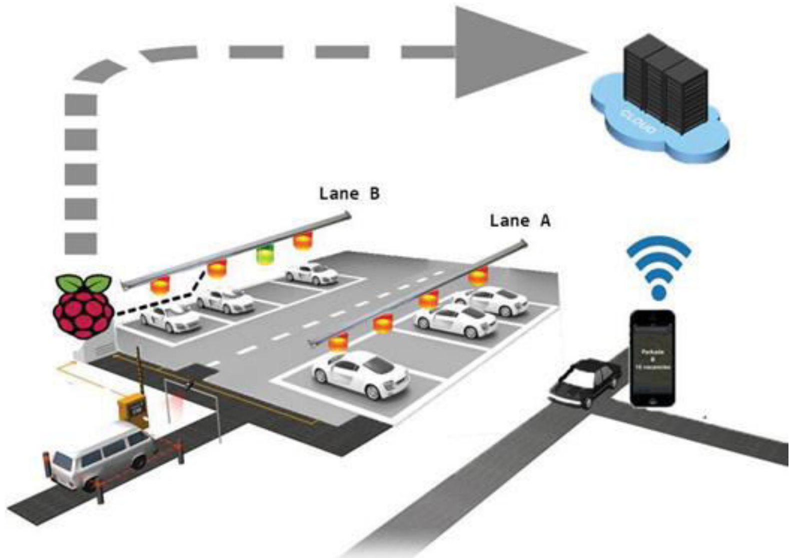

Figure 1: Smart Parking System

The diagram above shows the parking lot where the parking system is implemented and how the communication between the various actors takes place. The main players that make up the parking system are:

Parking Sensor:

Our parking systems use sensors such as infrared, passive infrared (PIR) and ultrasonic sensors. The work of these sensors is the same. H. Record the parking area and determine if the parking space is available. In this case, an ultrasonic sensor is used to detect the presence of a car. The ultrasonic sensor connects wirelessly to the Raspberry Pi via the ESP8266 chip. The ESP8266 Wi-Fi chip consists of a self-contained SOC with an integrated TCP/IP protocol stack that allows any microcontroller to access Wi-Fi networks. The sensor connects to his 5V power supply from the Raspberry Pi or an external source. External sources preferred.

Processing Unit:

It consists of a Raspberry Pi, an on-chip processor. A computing unit acts like an intermediary between sensors and the cloud. All sensors are wirelessly connected to the processing unit. A single Raspberry Pi unit consists of 26 GPIO pins, so you can connect 26 different sensors. However, this number can be increased by connecting a multiplexer (MUX). To send data through the GPIO pins, we need to connect the ground of the Raspberry Pi and the sensor. A Python script runs on the chip to check the status of various GPIO pins and update that information in the cloud. Data collected from various sensors is sent to the Raspberry Pi via an esp8266 chip. The Raspberry Pi then sends this data to the IBM MQTT server over a channel using the MQTT protocol. The MQTT[15] protocol (Message Queue Telemetry Transport) is a publish/subscribe based "lightweight" messaging protocol used on top of the TCP/IP protocol. It is designed to connect between remote locations when limited amounts of data need to be transferred or when bandwidth availability is low.

Mobile App:

A mobile application serves as an interface for end users to interact with the system. The application is developed with Apache Cordova and Angular Js framework using JavaScript as programming language. The purpose of using Apache Cordova is to create applications that can run on both Android and iOS platforms using the same source code. Your application connects to your IBM MQTT server through a secure channel and two-factor authentication. The purpose of this mobile application is to provide information about the availability of parking spaces and enable end-users to reserve corresponding parking spaces. Data is transferred between the IBM MQTT server and the mobile application in JSON format. To ensure proper communication, both the Raspberry Pi and the mobile application need to be subscribed to

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specific channels on the IBM MQTT server.

Cloud:

The IBM MQTT server is hosted in the cloud. The cloud acts as a database that stores all records related to parking lots and end users who have access to the system. It tracks each user connected to the system and manages information such as parking time, parking time, amount paid by the user and payment method. This is due to the flexible nature of the cloud, the system allows him to add any number of users at any time of the day. Data stored in the cloud is continuously backed up and can be easily and quickly restored in the event of a system failure. If you look closely at the figure, you can see that lane A has a red light and lane B has a green light, indicating that the parking space is vacant. This is because for Lane A, there are currently no cars parked there, but the slot is already reserved by a user, so it is still a red light. On the other hand, Lane B's parking lot shows a green light because it is neither reserved nor parked.

III. IMPLEMENTATION AND WORK

The previous section described the architecture and technology stacks involved in smart parking systems. This section describes the implementation and functionality of the system in real-life scenarios. The following flowchart describes the complete process of reserving a parking space, parking the car in that parking space, and exiting the parking area.

Experiments were conducted to show how the system works at each step from checking the availability of parking spaces to parking the car in an actual available parking space. This is achieved by implementing intelligent parking systems in mall parking lots. Below are the steps drivers need to take to park their car with our parking system.

Step 1:

Install the smart parking application on your mobile device.

Step 2:

Find your destination and nearby parking using our mobile app.

Step 3:

Select a specific parking space.

Step 4:

See the different parking spaces available in this parking lot.

Step 5:

Select a specific parking space.

Step 6:

Select how long (in hours) you want to park your car.

Step 7:

Pay for parking with an e-wallet or credit card.

Step 8:

After successfully parking the car in the selected parking space, check the occupancy in the mobile application.

The above procedure of reserving a slot and parking the car in that exact slot is explained. Drivers must confirm their occupancy once they have parked their vehicle in their chosen space. Figure 1 shows just this scenario, where the driver must declare its presence. This feature is added so that only real drivers can park their car in a specific parking space. If the driver parks the car and he does not confirm occupancy within 30 seconds, an alarm will sound, informing authorities that the car has been parked in the wrong place. Even if the actual driver accidentally neglects to do this, you can always stop the alarm by confirming occupancy. Notifications using this scenario are sent to both the driver and the parking attendant when the driver exceeds the parking time limit. Drivers have the option to extend their parking time and pay for the additional time. If the driver does not do this, the parking attendant will make a note of this and demand money for

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the extra time in the form of a penalty. This fine is imposed on the driver when the car leaves the parking lot.

IV.CONCLUSION

The concept of smart city has always been a dream of mankind. In recent years, the realization of smart cities has made great strides. The growth of the Internet of Things and cloud technologies has created new opportunities in terms of smart cities. Smart parking facilities and traffic management systems have always been at the heart of building smart cities. This article delves into the topic of parking and introduces an IoT-based cloud-integrated intelligent parking system. Our proposed system provides real-time availability of parking spaces. Remote users can reserve parking spaces using a mobile application. The efforts made in this paper aim to improve the city's parking facilities and thereby improve the quality of life of its inhabitants.

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