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# Smart Parking: A New IoT-Based Ideas for Vehicle Parking

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Smart parking is an innovative solution leveraging Internet of Things (IoT) technology to optimize vehicle parking management. This concept addresses common urban challenges such as finding available parking spaces, reducing congestion, and enhancing overall efficiency. The system employs a network of sensors, including ultrasonic, magnetic, and camera-based technologies, to monitor parking space occupancy. These sensors communicate through wireless networks to a central cloud-based platform that processes real-time data and provides actionable insights. Drivers can access this information via mobile applications, allowing them to locate and reserve parking spots, make seamless payments, and receive navigation assistance. Smart parking systems offer significant benefits, including reduced search time for drivers, optimized use of parking spaces, lower emissions, and increased revenue through dynamic pricing. Despite challenges such as infrastructure costs and data security concerns, smart parking represents a crucial component of smart city initiatives, promoting sustainable urban development and improving the quality of life. Future advancements may include integration with autonomous vehicles, enhanced predictive analytics, and interconnected urban management systems, further revolutionizing the parking experience. The user can obtain parking information faster and spend less time looking for a spot. In order to prevent auto theft, RFID technology is employed.
**Keywords:** Smart Parking System; Parking Slots; IoT; Automation; Smart City; RFID technology.

## 1. Introduction

Urbanization and the rapid growth of vehicle ownership have intensified parking challenges in cities worldwide. Congestion, inefficient use of parking spaces, and the time-consuming process of finding a parking spot contribute to traffic problems and environmental pollution. To address these issues, smart parking systems leveraging Internet of Things (IoT) technology have emerged as a revolutionary solution.

India is the nation with the second-highest population in the world. Indian cities are growing and developing without an appropriate architectural plan for parking areas. The result would be that as time went on, the number of cars would increase in an inverse proportion to the number of parking spaces available. The lack of sufficient roadside parking spots and the inappropriateness of walking on pavements are the main reasons why vehicle parking is still a problem in India. Many people travel to other locations for business, so it's likely that they are unfamiliar with the neighbourhood. Consequently, individuals may find themselves parking their vehicles in restricted areas, leading to penalties and other consequences at their place of employment. Additionally, in order to prevent squandering their valuable time—even in cases where they know where the parking lot is—they need to confirm that a spot will be open before pulling up. Nowadays, the largest problem is always getting a parking space during rush hour in a large metropolis.(1)

In order to find the parking spot efficiently and avoid wasting parking space or time searching, the authors proposed an intelligent framework. The research suggests an architecture that tracks available parking spots in real-time and shows users the closest accessible parking spaces and slots. Many people just park their automobiles since they don't know the area well or don't have enough time to go find a spot. Furthermore, a spot might not be available when they get to the parking lot. They end up paying fines for parking their autos in forbidden areas. Therefore, a system that displays parking space locations and available slots to visitors will be very beneficial to the public. It also lets users schedule a time slot and shows them the route to the parking area. In our busy life, when everyone is always thinking about the next thing, this method would not only save a tonne of time but also save the user from having to pay large fines. Parking lot owners will benefit as well because their spaces won't be kept unoccupied in n vain, in addition to the user. As a result, we put forth and created a prototype for a smart parking system that attempts to address the aforementioned issues. The application, cloud, and interface make up the three key parts of this system's design. The interior parts and a few other elements. The mobile app initially assists us in locate the closest parking spot; the spots are coloured red and green. Green denotes at least one open parking space, while red means that all available spaces are taken. The real-time cloud database from which this real-time data is retrieved provides accurate information to the user. The parking space marker enables us to learn information about the parking space, including the name, address, and number of free cars and bike slots.

Smart parking systems utilize a network of IoT devices, including sensors and cameras, to monitor and manage parking space availability in real-time. These systems provide drivers with up-to-date information on available parking spots via mobile applications, enabling them to find and reserve spaces efficiently. The integration of cloud computing allows for the processing and analysis of large volumes of data, optimizing space utilization and enhancing overall operational efficiency.

This innovative approach to parking management offers numerous benefits, such as reducing the time drivers spend searching for parking, lowering vehicle emissions, and alleviating urban congestion. Additionally, smart parking systems can generate significant revenue through dynamic pricing models and provide valuable data insights for city planners.

Data can be transferred over a network by the Internet of Things (IoT) without requiring

human contact. IoT benefits user-uploaded data into the cloud and makes use of low-cost wireless technology. The user can preserve transparency with the aid of IoT. The idea of the Internet of Things originated with the identification of objects for interconnecting various devices. These gadgets can be controlled or monitored using internet-connected PCs. The phrases "Internet" and "Things" are significant components of the phrase "Internet of Things," where "Internet" refers to a wide network that links servers and devices (2). The usage of smart parking may be a way to reduce user inefficiency, time spent searching for parking, and the overall cost of fuel used. In this, the output is obtained through analysis and processing of the data that was gathered from the sensor.

The data is communicated by devices that extract the relevant information and send it to an Arduino device. The required devices concurrently receive the data along with command instructions. Together with the cellular network module, which alerts and guides the user, the Arduino sends a signal to the servo motor. Ensuring the security of the user identity, the reader module scans the RFID card assigned to the registered user as soon as they reach the parking area. This gives the customer the ability to receive SMS notifications about available parking spaces on their registered cell phone number. It is separated into three sections: the parking lot, which houses Arduino gadgets and IR sensors, is the first. User engagement with the parking lot is made possible by these devices. The essay's second section discusses cloud web services, which act as a go-between for users and parking lots. The availability of parking spaces determines how the cloud is updated. Not only can the admin, who oversees the cloud service, examine it to determine its availability. The paper's third section discusses the user side. The user receives an SMS notifying them to the availability using the cellular network module. Both the cloud and the parking lot can be interacted with by the user. In order to save time, the user gets notified when there are no more parking spaces available.

## 2. Literature Review:

Traditional parking systems have long been plagued by inefficiencies, including the difficulty of finding available spaces and managing high demand in urban areas. Studies have shown that a significant portion of urban traffic congestion is caused by vehicles searching for parking spaces, which contributes to increased fuel consumption and environmental pollution.

In many large cities, finding parking for residents during the busiest times of the day is a major difficulty. As a result, people lose a lot of time searching for the perfect parking spot or waiting in queue for one. For that reason, this leads to traffic congestion. Numerous scholars have suggested different SPS techniques and technologies to overcome these problems in light of the challenges.

This study examines an ingenious parking system that utilises Android. User safety is guaranteed via licence plate detection. This tactic attempts to decrease the time spent looking for parking spots that are available and to offer payment methods that don't require holding hands. This smart parking system can be used in malls, parks, and medical facilities. Users of this programme can make reservations for parking spots ahead of time. There is also navigation available for further help. The Internet of Things, or IoT, is a vital part of our

everyday existence. Parking help is supplied via the application so that the user may find their parked car. LED indicators on every parking lot make it possible to distinguish between occupied and empty spaces. Payments can be made by users using RFID technology and online transactions. The parking lot's occupancy is ascertained using the infrared proximity sensor. (3)

The application of cloud-based and RFID technology to urban parking services is covered in this study. It offers a method that makes use of the RFID idea and links an IoT device to a cloud-based system. The closest parking spot that is available is indicated to the user by these features. A website that provides information about parking space availability is being developed with the goal of creating an environment that is easy to use. Finding a parking spot in a congested area can waste time and gas, necessitating the deployment of assistive technology that could notify registered users when spaces become available. The object is inspected by the reader module using RFID, and the implementation process then proceeds. The number of reserved and available parking spaces is graphically displayed on the webpage, and communication is facilitated by the WIFI module. This includes host parking database administration, which gathers and keeps track of information regarding the driver's identity and parking spot. The web service that the administrator has created will notify the user when the parking reservation time is about to expire. The main drawback is that someone else might take over a reserved parking spot; QR scanners are used to verify the user's identity in order to avoid this (7). It allows us to provide a way in which a user can utilise mobile applications to reserve a parking place by indicating the type of car and the destination. The cloud will retain the reservation data and utilise GPS to find the quickest path from the user to the parking spot. Furthermore, the distance from the reader module to the webpage. Over the last two years, a great deal of progress has been achieved in the creation of smart cities. The suggested solution gives users access to real-time data on parking lot space availability. Remote customers can book a parking spot for themselves using our mobile app. The purpose of this paper is to improve a city's parking infrastructure and, in turn, its citizens' quality of life. (4).

The critical need to make cities smarter is fading as more and more people move into industrially and technologically advanced metropolitan areas. Cities are becoming sentient through data exchange, millions of RFID tags and sensors, analytics, machine learning, and artificial intelligence. One of the main issues of smart cities nowadays is controlling the number of vehicles on the road and providing an adequate number of well-managed parking spots to prevent urban traffic congestion. Automated technology that guides the driver to parking spots close by. This article describes a real-time prototype of an intelligent parking system based on the Internet of Things (IoT). (5).

Internet of Things (IoT) technology facilitates the design and deployment of a truly smart parking system that provides information on available spots and assists users in locating the closest availability. This article uses computer vision to recognise licence plates on cars in order to boost security. Before getting inside their car, the user can utilise a mobile device to pay for their parking space. so obtaining the parking reservation. The user is informed of the parking lot's location, the number of spaces that are available, and any other pertinent information. The work extracts text from licence plates using efficient techniques and algorithms. An algorithm estimates the user's least cost based on the vehicle's arrival into the

parking place, which is detected by an ultrasonic sensor. (6).

It is possible to reserve a parking spot using the smart parking system based on reservation (SPSR). Data concerning the driver's identity and parking position are gathered and stored as part of the host parking database maintenance process. When the parking reservation time is about to expire, the administrator will send a notification to the user via the web service. The main drawback is that QR scanners are used to identify the user in order to stop someone else from using a reserved parking space. (7).

It enables us to propose a method for a user to reserve a parking space by specifying their destination and vehicle type using mobile applications. The cloud will store the booking information, which will determine the shortest route from the user to the parking space using GPS. Additionally, the location of the user will be routinely updated in the cloud. When the user arrives at the parking space, their RFID is verified and they are granted access. Cloud servers are responsible for invoicing. The smart parking system requires the registration of the parking space before it can be used, which is the primary drawback (8).

The implementation of wireless sensor networks (WSN) in a car parking system is discussed in this paper using a server that utilizes Xbee and Zigbee. The parking system is capable of identifying the vehicle stopped in the designated space, with the aim of making it economical and user-friendly. The accuracy of the data maintained by the car parking system is ninety percent (9).

Both the parking area administrator and the user can benefit from a comprehensive parking solution provided by a smart parking system. It shows reserved user identities and allotted parking spots. The user can find their way to the nearby parking lot, depending on the size of the car. Hourly, daily, weekly, or monthly parking space reservations are available to users. Based on its dimensions, an algorithm has been designed to find the closest parking space. On-demand services are booked and paid for via the user's mobile application. (10).

## 3. System Architecture:

A. Proposed System

It is separated into three sections: the parking area, which has an IR sensor and Arduino devices, is the first. The user interacts with the parking IoT through these devices, and the second portion consists of cloud-based web services that operate as a go-between for the user and the parking area. The cloud is updated based on whether the parking spot is available. The user can view the cloud services to check their availability, which are managed by the administrator. The last section is the user interface. The cellular network module sends an SMS to the user based on availability.

Parking Details: We will divide the details of parking in two types of categories

i. Infrastructure Details- In this category we will store the details related to the infrastructure of parking like block division, floors in a block, size, number of parking slots etc.

- Number of blocks are tracked in a parking lot.

- Associated codes are stored with each block. which is usually given uniquely identifying codes, such as “X”, “Y”, “Z”, “A1”, “A2”, “A3”, and so on.
- Digits indicate floors number in the block. The number “1” indicates that this is a ground-level block with no floors.
- Floors are mentioned because in multi-level parking lots, a blocks may have more than one floor.
- Number of slots that exist on a floor.
- Identifies the floor to which a slot belongs.

ii. Reservation details- Under this category we will store the reservation details of the parking slots.

- Stores the pass purchased date.
- Identification of customer who is making this reservation.
- Storing the expected date and time of the customer’s arrival.
- Storing the duration for which the reservation was made.
- Storing the date on which the reservation was made.
- Internal column that assigns a parking slot to a customer once their request is captured and the payment has been made.

Customer: There is two type of customers.

i. Random Customer- These are the customer not having regular pass.

- Stores the plate number of a customer’s vehicle.
- Stores the date and time when the vehicle was registered with the parking lot.

ii. Regular Customer- These are the customer who have regular pass with them.

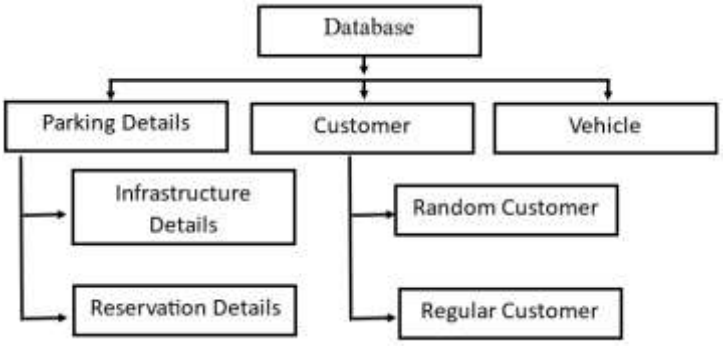
- Indicates whether a customer has regular pass. If the column stores a value of true, then there must exist a valid entry in the regular table. Once a pass expires and the customer has not yet renewed it, the value in this column is updated to false.
- Stores the date on which the pass was purchased.
- Stores the date on which the pass will be considered valid, which may not necessarily be the date of purchase, as some customers purchase passes in advance.
- Stores the number of days for which a pass is valid. A monthly pass usually remains valid for 30 days.
- Stores the cost, in local currency, that a customer must pay to purchase a pass.

Vehicle- This will be divided on the basis of size (length & Width) of the vehicle.

Table 1 Type of Vehicle in India

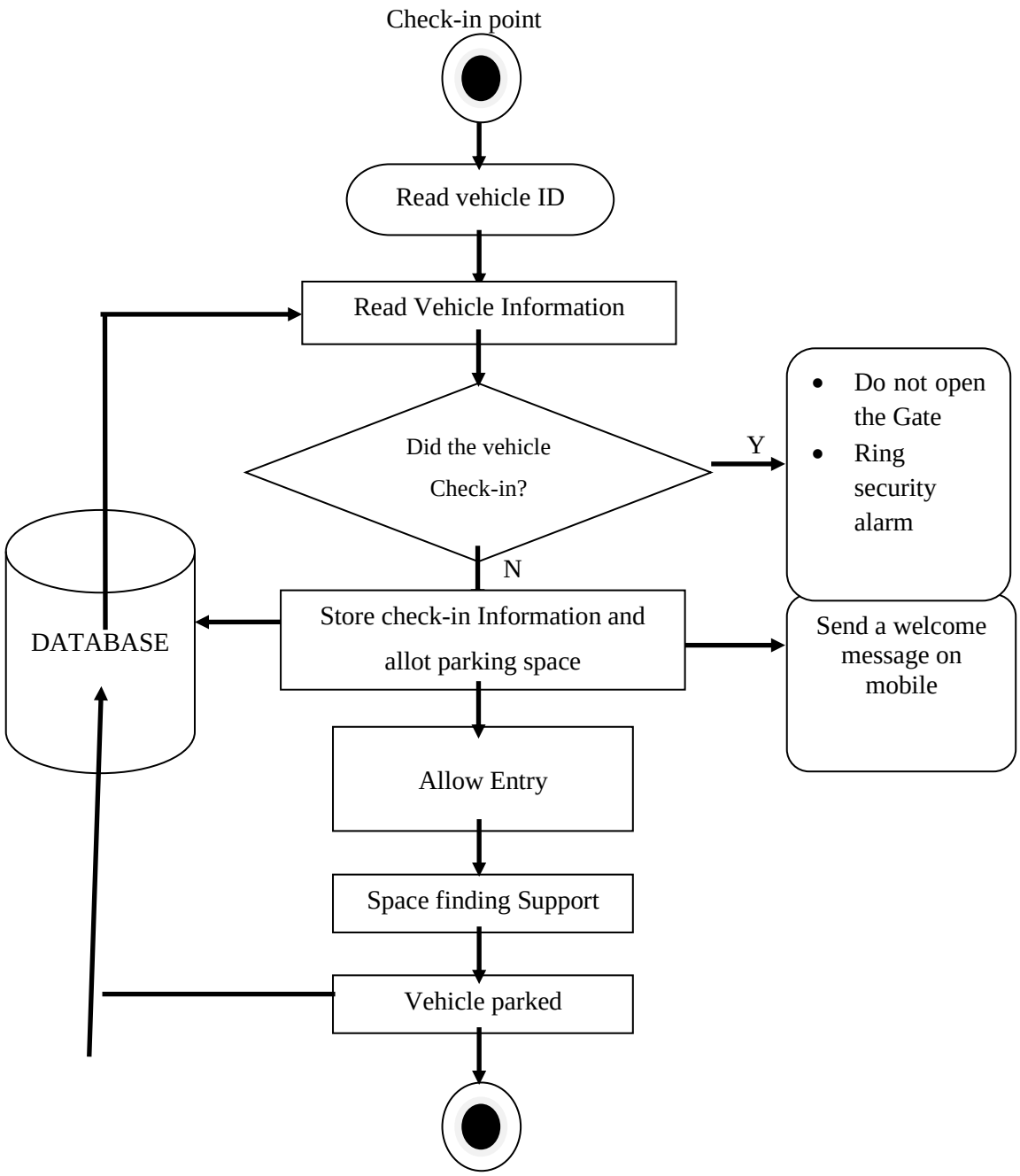
| Car segment | Length of the car | Classification | Car model belonging to the segment |
|---|---|---|---|
| A1 | Up to 3,400 mm | Ultracompact cars | Suzuki Alto, Tata Nano, Mahindra e2o |
| A2 | 3,401 to 4,000 mm | Sub-four meter | Maruti Suzuki Wagon R, Hyundai i10, Suzuki Swift, Suzuki Baleno (subcompact), Hyundai Xcent, Honda Amaze, Maruti Suzuki Dzire, Ford Aspire, Mahindra Verito, Hyundai i20, Tata Zest |
| A3 | 4,001 to 4,500 mm | Entry-level mid-size sedans | Hyundai Verna, Honda City, Suzuki Ciaz |
| A4 | 4,501 to 4,700 mm | Small family cars | Toyota Corolla, Škoda Octavia, Chevrolet Cruze |
| A5 | 4,701 to 5,000 mm | Mid-size Executive cars | D-segment: Toyota Camry, Škoda Superb<br>E-segment: Mercedes-Benz E-Class, BMW 5 series |
| A6 | More than 5,000 mm | Grand saloons | Mercedes-Benz S-Class, Audi A8, BMW 7 series, Jaguar XJ |
| B1 | <4,001 mm | Small vans | Maruti Omni, Tata Venture |
| B2 | >4,000 mm | Mid-size MPVs/minivans | Toyota Innova, Suzuki Ertiga, Mahindra Marazzo, Kia Carnival |
| SUV | Any | SUVs | Renault Duster, Honda CR-V, Ford Endeavour, Hyundai Creta, Audi Q7, Toyota Land Cruiser |

Basic details to create database for parking system




The proposed model will work in two parts

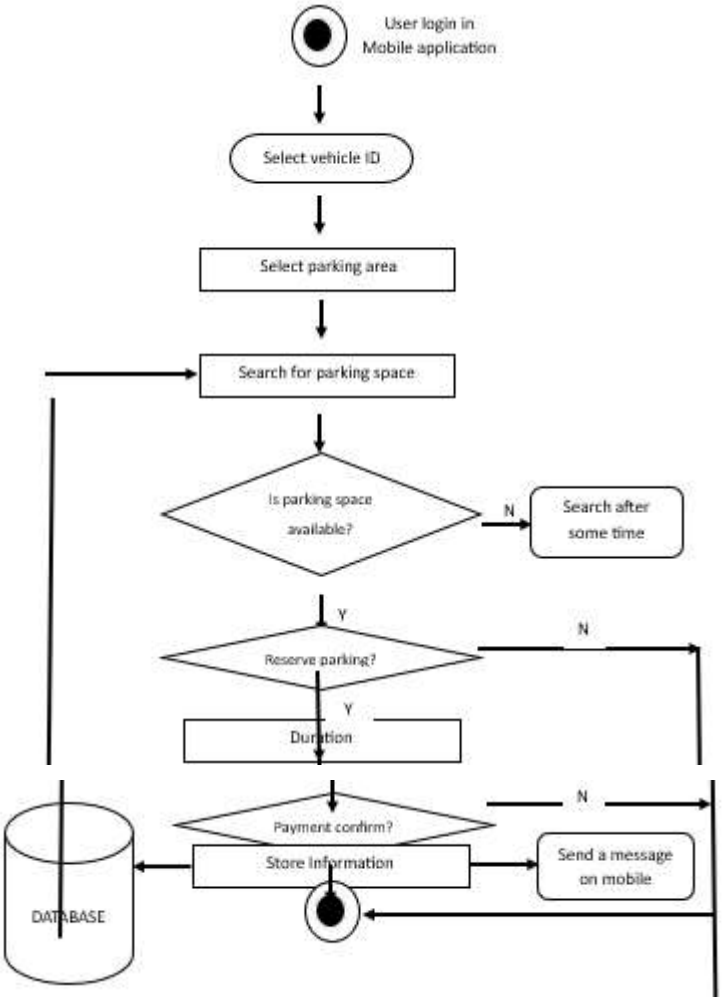
1. Identification and check-in process




2. End user support

i. User registration

ii. Automated parking system details




Hardware Required

The three main parts of hardware are the IR sensors, RFID card, and GMS module. To access a parking spot, a user needs to have an RFID. The registered user's data is stored on the RFID card. When the vehicle enters the parking spot, a reader module scans the registered user's RFID badge. As the data is sent to the Arduino to verify the parking area's availability, the user is simultaneously notified by SMS of the parking area's status. The message is sent by the cellular network module based on its availability. An infrared sensor generates signals in response to the presence of a vehicle.

RFID Reader: - Reader is used to read the vehicle's information at the time of check-in or check-out.

Vehicle RFID Tag: - This contains vehicle's information. Specifics of the module: 1. cellular network Module the cellular network module is a circuit that establishes communication between.

Software Required

The cloud server acts as a go-between for the modules. The cloud server is linked to the Wi-Fi module. When a car using an RFID card enters and exits the parking lot, the user receives text messages via the SMS module. The message transmissions from the SMS module are managed by the cloud. The cloud's state changes from 0 to 1 as soon as the IR sensor detects the car, and the automobile's status changes from 1 to 0 when it leaves the parking lot.Platform: - Windows 32 bit

Language: - JAVA jdk1.7

Database: - My SQL

Details of the module:

A. Cellular Network Module

A circuit called the cellular network module facilitates communication between microcontrollers and cell phones. Through a mobile network, voice, MMS, and SMS communications are transmitted. The GPRS cellular network expansion allows for fast data transfer speeds. Time division multiple access is the transmission technique used in cellular networks.

Figure 2. cellular network Module

B. IR Sensor

infrared sensors are electronic devices that identify objects in their environment. Infrared radiation is released by this apparatus. There isn't anything nearby if this equipment doesn't pick up any reflected infrared light. If the sensor detects light, it indicates the existence of an object.


Figure 3. IR Sensor

C. RFID Card

RFID devices consist of a substrate, an antenna, and an integrated circuit (IC). It might be a credit card that transmits information about a query to a per-user module or the identification of distinctive proof. RFID labels use radio waves to communicate data in the form of nearly a question. The following uses for RFID labels are also possible when they are affixed to objects

Figure 4. RFID Card

D. READER Module

This module is a tool that scans and collects data from the RFID card. It is possible to track objects with this card. As soon as the vehicle enters the parking lot, the user scans the RFID card, sending the administrator all of the card's data through this module.


Figure 5. Reader Module

E. Servo Motor

It's a rotator mechanism that allows control over both linear and angular motion. To open and close the gate, a servo motor is used. The servo drive works by sending electrical signals to the servo motor, which causes movement.


Figure 6. Servo Motor

F. Arduino Nano

There are numerous uses for this small module. Input/output pin count is 22, with 14 of those being digital pins. Its flash memory is roughly 32 kilobytes. These pins are capable of controlling analogue and digital pins alike. This module is a board that works with breadboards and can be utilised in any location.

Figure 7. Arduino

G. WIFI Module

TCP/IP and the HTTP POST method are used to communicate data from an embedded system to the Internet. It is a product of espressif system. A 32-bit microcontroller containing 80kb of user data. It has sixteen gpio ports.

Figure 8. WiFi Module

IMPLEMENTATION:

The implementation of the proposed system is described in this section. Every user who uses the parking spot is carrying an RFID card with their personal data on it. When the module scans the RFID tag, it sends the user's information to it. At this point, the parking space's availability is determined by the IR sensor. The parking barrier gate won't open if there isn't a space available. A registered message is sent via a cellular network module and delivered to the user when a parking place is available or unavailable. By putting all of the data in the cloud, the WIFI module helps the system. It connects the gadgets to the cloud server.

WELCOME GUEST <NAME>:-)

THANKS <Name> FOR USING PARKING:-)

SORRY <Name> NO FREE SPACE: - (

Figure 9. Message will be Received by User

In this case, the user scans the given RFID card. The barrier gate opens, letting the user place their car, and they receive the message "Welcome, username" if there is room. The message "thanks for using smart parking username" is only displayed once the user scans the RFID one more before leaving the parking spot. The database containing the user's parking space actions will be stored on the cloud.

The cloud status will notify the user if a particular storage space is available. The cloud status is changed from 0 to 1 when the car is parked and from 1 to 0 when it is driven away. This is done by the IR sensor, which also detects an object. The user may park his car if the cloud status is 0. Every two minutes, the cloud's state is updated.

## 4. RESULT & DISCUSSION

There is an increasing demand for advanced parking management systems. This allows users to view the parking spaces' current availability. It is not possible to check the availability of parking slots and make reservations with the current system in the modern day. The prior technology was a vision-based monitoring system that required a lot of time and labour to

estimate parking spaces by counting the number of cars arriving and departing a certain region. The second approach that is currently in use is sensor-based and uses ultrasonic sound waves to detect the presence of automobiles. It is followed by two-tier parking, which makes use of the concept of parking cars on top of each other. This article's outcome is a parking lot that saves time, is affordable for the user, and is connected to the outside world. Auto theft falls as a result of this article. A car's fuel consumption is reduced as it searches for this article.

## 5. CONCLUSION & FUTURE WORK

Significant progress has been achieved in the last several years to realise the vision of the smart city. Cloud computing and the internet of things have opened up new possibilities for smart city development. Smart city development has always relied heavily on intelligent parking facilities. The system provides real-time processing and parking spot information. This paper saves users' time while increasing the efficiency of finding a suitable parking spot. That helps to address the growing problem of traffic congestion. Users will be able to remotely book parking spots in the future. It is possible to include GPS, reservation features, and licence plate readers in the future.

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