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Review Paper on Smart Parking Systems

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Abstract: *The increase in population has resulted in an increase in the number of automobiles. This has made the task of finding a parking spot difficult. According to recent studies, about 40% of the traffic volume is made up of vehicles cruising to find a parking spot. The aimless drive-in search for a parking spot can result in traffic congestion, an increase in air pollution and wastage of time and fuel. The solution for this problem is a smart parking system. This system would provide the user the capability to view the parking slots availability in a place or book a slot in advance. Smart parking facilities have always been the core of constructing smart cities. They are an ideal solution for decreasing urban traffic and pollution. Smart parking systems can be implemented in shopping areas, institutions, and airports to facilitate hassle free parking.*

Keywords: Smart Parking System, IoT

I. INTRODUCTION

The exponential increase in population has led to increase in the number of automobiles. With the improvement in economy and availability of cheap second-hand vehicles almost everyone owns at least one automobile. This has its own advantages and disadvantages. One of its advantages is that it allows people to easily travel from one place to another comfortably. The disadvantages include that it has become a reason for traffic congestions, increase in air pollution etc. The increase in the number of vehicles has also made it difficult to find a parking space. The aimless search for a parking space by the people can lead to traffic congestions, increase in pollution and wastage of time and fuel. Smart parking systems are used to solve these issues.

There are several types of smart parking systems available, each has its own unique features and benefits. Some of the common types of smart parking systems are: -

- **Sensor-based systems:** Sensor-based systems use the sensors that are installed in parking slots to detect the presence of a vehicle. This information is then transmitted to a central system which will display the availability of parking spaces in real-time.
- **Camera-based systems:** Camera-based systems make use of the cameras that are installed in the parking areas to capture images of the vehicles and their plates. These images are then processed to check if they are parked legally or not.
- **Mobile app-based systems:** Mobile app-based systems provide the drivers the capability to book and pay for parking spots using mobile phones. These apps also have the capability to provide real-time information on parking slot availability, location and pricing.
- **IoT-based systems:** IoT-based systems makes use of a network of interconnected devices to manage the parking slots. This network of devices includes sensors, cameras, mobile devices and other smart devices.

II. LITERARTURE SURVEY

A smart parking system offers a modern and intelligent approach to parking management, enhancing urban mobility, reducing traffic congestion and improving the overall quality of life in cities. This type of system can be developed in different ways and can be equipped with different functionalities.

In paper [1], an app is created using which the user can view the nearby parking spaces along with their occupancy rates. The user must give as input the date on which the user would like to travel and the destination address and upon clicking the search button the Parking Finder API returns a list of the parking areas nearest to the destination address

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along with their occupancy rate and the time required to walk from the parking area to the destination address. This list is displayed on the screen. A parking space is considered to be nearby if it is within 2km from the destination address. The listed parking areas will have at least one free parking space. If the date entered by the user is a past date an error message is shown. If the date is the current date, then a request is made directly to the CB-SPS (Cloud based - Smart Parking Server) Server and the occupancy data of each parking area in the list is retrieved from it. If the date entered is a future date, then the request is sent to the LSTM Based Service which then predicts the occupancy rates of each of the parking areas in the list and then returns the result.

In paper [2], both an app and a website version of the smart parking system has been developed. The app was developed in Android Studio using java and the website was developed using HTML and CSS. The hardware used to implement the system are: Raspberry Pi 3, Arduino Uno, MFRC522 RFID Reader/Writer and Servo Motors. The user will have to register himself at the entry gate and once he is registered, and RFID card is issued to the user. The details collected during the registration process are stored in a 16GB SD card. The user can then view the available slots through the app or website. In this system the booking is done by the admin. The available slots are shown in green colour and the unavailable slots are shown in red colour. The user can choose an available slot and a parking token (RFID tag) corresponding to that slot is issued to the user. The user can travel to the chosen slot using Google maps. Upon reaching the slot the parking token is scanned. If the tag is the correct tag for that slot, the servo motors are triggered and the barricade will open allowing the user to park the vehicle. This is done to ensure that the users do not park in the wrong slots. The barricade remains open for one minute and closes automatically after. The parking token should be returned at the exit gate.

In paper [3], the hardware used to implement the system are: Ultrasonic Sensor, Ultrasonic Ranging Module HC-SR04, Arduino and Raspberry Pi. The parking lot information is stored in the Raspberry Pi and it is interfaced with GPS (Global Position system) to give the location of the parking lot. The smart parking system is in the form of an app and has the capability to guide the car to the nearest parking area. To make use of the services provided by the app the user will have to be registered. Here every parking slot in a parking area have an Ultrasonic sensor installed and the Ultrasonic Ranging module is used to calculate the time interval between the Trigger and Echo pulses. This information is then used to calculate the distance between the vehicle and the sensor using code. If this value is less than the set threshold the status of that slot is updated to denote that slot is unavailable. This system allows the user to book a slot. Users have to access the cloud server to book a slot in an available parking area. The system will then check for an available parking place and if there is an empty slot this information is communicated with the user. The user upon receiving this information can book that empty slot online. If there is no parking available it will try to find another parking station within close proximity of user and if there is no other parking station close to the user it will display the message “No Parking Space”. If the user books a slot successfully a QR code is generated with the booking date and time. This QR code should then be shown at the entry gate. Upon detecting the vehicle at the slot, the Arduino starts a timer. It then notes the time when the vehicle leaves and this information is given to the Raspberry Pi to generate the bill. This amount can be deducted from the user’s credit card or be paid in cash at the exit gate.

In paper [4], to implement the system the hardware used are: GSM Module, IR Sensor, RFID Card, Reader Module, Servo Motor, Arduino Nano and WiFi Module. Every user must be registered. Registered users have an RFID card that contains the user’s information. When the user enters the parking area the RFID card is scanned by the reader module and the details of the user are transferred into the module. The IR sensor will check whether the parking space is free. If, there is no space available the parking barricade will not open and a message will be sent to the user with the help of a GSM module. If space is available, the user receives a message “Welcome username” and the barricade opens and the user can park the car. When the user exits the parking space the user again has to scan the RFID and a message will be received by the user “thanks for using smart parking username”. The database about the user’s activity in the parking space will be stored in cloud database. The user will know that a particular space is available with the help of the cloud status. When the car is parked the IR sensor detects the presence of an object and updates the cloud status from 0 to 1 and when the car leaves, the cloud status is updated from 1 to 0. So, the user can park his car where the cloud status is 0. The cloud status is updated every 2 minutes. The WIFI module helps to store all the data in the cloud. It connects the devices with the cloud server.

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In paper [5], to implement the system the hardware used are: IR Sensor, WiFi Module, RFID Reader, RFID tag. The smart parking system is in the form of an app and a website. Every user must be registered. Once the user is registered, they can see the slot availability, book a slot and make payment. If the user books a slot after successful payment the slot status is updated to 'RESERVED' and shown in red. The available slots are shown in green with the text 'EMPTY'. As soon as the vehicle enters the parking slot, the timer is started and as soon as the vehicle moves out of the parking slot, the timer is turned off and the total cost will be displayed.

In paper [6], to implement the system the hardware used are: Ultrasonic Sensor, Pi Camera, Raspberry Pi. The smart parking system is in the form of an app. The database used is Firebase Real-Time Database. The information collected from the Ultrasonic sensors and Pi camera are used as the input. The ultrasonic sensors are used to detect the vehicles. The circuit has been designed to give the response of the sensors for objects within the range of 30cm. The output from ultrasonic sensor will be sent to firebase Real-Time database to check if the parking is legal. The LED in the prototype is used to indicate the presence or absence of a vehicle. Red LED turns on when ultrasonic sensor detects the vehicle while green LED turns on when the sensor does not detect the vehicle. Pi camera detects the vehicles within the drawing line and will send the data to Firebase Real-Time database. Drawing line will be in green colour if there is no vehicle detected and will be counted as a free spot while it will be shown in red colour if a vehicle is detected within drawing line and that spot will be counted as occupied. PayPal has been used as medium for the user to make a payment in the mobile application. The user can make a payment by entering e-mail and password or by entering details card bank number and the payment fee will be send to the admin.

III. COMPARISON OF PAPERS

Sl. No.	Paper	Method	Advantage	Disadvantage
1.	Deep Learning-based Mobile Application Design for Smart Parking	Parking Finder API to find the nearby parking areas. Cloud based - Smart Parking Server to obtain real-time occupancy data. LSTM for prediction.	Predicts the occupancy rate for a particular date. High accuracy.	Does not allow users to book a spot. Does not generate bills.
2.	Smart Parking System (S-Park)– A Novel Application to Provide Real-Time Parking Solution	Raspberry Pi to store data. RFID Card for authentication. Google maps for navigation.	Creates both application and website. Uses google maps to help the user reach the spot easily.	Booking is done by the admin. Requires someone to issue the RFID card. RFID is not always reliable.
3.	A Cloud Based Smart Parking System	Cloud to store data. QR code for authentication. GSM module for communication. GPS for navigation.	Generates bill. Booking is done by the user. Provides options of other parking spaces nearby when spots in current parking space is unavailable. Has more storage capacity.	Uses GPS for navigation. Comparatively costly.
4.	A Smart Parking System using IoT	Cloud to store data. IR sensors for detection. RFID Card for authentication.	Has more storage capacity. Sends notification about availability of slots.	Does not generate bills. Does not provide navigation support. Does not allow booking

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		GSM module for communication.		of slots.
5.	Smart Parking Management System	IR sensor for detection. Raspberry Pi to store data. RFID Card for authentication.	Creates both website and application. Allows booking of slots.	Does not provide navigation support. Requires someone to issue the RFID card. RFID is not always reliable.
6.	IoT Based Smart Parking System	Ultrasonic sensor for detection. Firebase to store information.	Linked to PayPal. Allows booking of slots.	Does not provide navigation support. Does not allow booking of slots.

Although, the IR sensors are cost effective, compact, has minimal maintenance and provides fast response they are highly susceptible to environmental factors and has limited detection range. Ultrasonic sensors on the other hand are less affected by environmental factors and have long detection range but they are more costly, larger in size and consumes more power compared to IR sensors. Using QR codes is more cost effective, easier to implement and convenient for the user compared to RFID technology.Firebase is easier to integrate and developer friendly than cloud. GPS has outdated mapping data. It is not capable of providing real-time traffic information and is less user friendly compared to Google Maps.

An ideal smart parking system would incorporate various technologies and features to efficiently manage parking spaces and enhance the overall parking experience. Here are some key components and functionalities that would make up an ideal smart parking system:

- **Real-time parking availability**: The system should provide real-time information about the availability of parking spaces in different areas, helping drivers locate vacant spots quickly. This can be achieved through sensors installed in parking lots or by integrating with existing infrastructure like parking meters.
- **Mobile app and navigation integration**: A dedicated mobile application can allow users to access real-time parking information, reserve spots in advance, and navigate to the nearest available parking spaces. Integration with popular navigation apps can further optimize the routing process.
- **Automated payment and ticketing**: The smart parking system should enable automated payment methods, such as mobile payments or integrated payment systems, eliminating the need for physical tickets or cash transactions. This ensures a seamless and hassle-free payment process for users.
- **Parking guidance and wayfinding**: The system should provide clear guidance to drivers, directing them to available parking spots through digital signage, mobile app maps, or in-car navigation systems. This reduces congestion and helps drivers save time searching for parking spaces.
- **Smart parking enforcement**: The system can incorporate license plate recognition technology to monitor parking violations and enforce parking regulations effectively. Automated alerts and digital tickets can be issued to drivers who violate parking rules, improving overall compliance.
- **Data analytics and reporting**: The system should collect and analyse parking data, including occupancy rates, peak hours, and user behaviour. These insights can help parking operators make informed decisions, optimize parking operations, and plan future infrastructure improvements.
- **Security and safety measures**: The smart parking system should prioritize the safety and security of users and their vehicles.
- By incorporating these features, an ideal smart parking system can significantly improve parking efficiency, reduce traffic congestion, enhance the user experience, and contribute to sustainable urban development.

IV. CONCLUSION

This review paper has provided an analysis of smart parking systems, exploring the technologies and the challenges, associated with these innovative solutions. Smart parking systems have emerged as a promising approach to address the

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growing parking management issues in urban areas. By leveraging advanced sensor technologies, data analytics, and communication protocols, these systems optimize parking space utilization, enhance user experience, and contribute to sustainable urban development.User-friendly interfaces, mobile applications, and convenient payment systems play a significant role in enhancing user convenience and satisfaction. Emerging technologies like the Internet of Things (IoT), artificial intelligence (AI), etc. hold immense potential for further enhancing smart parking systems. These technologies can enable advanced functionalities, such as real-time parking navigation, personalized parking recommendations, and autonomous vehicle integration with parking infrastructure.

REFERENCES

[1]. Canli, H. and Toklu, S., 2021. Deep learning-based mobile application design for smart parking. IEEE Access, 9, pp.61171-61183.
[2]. Anand, A., Kumar, A., Rao, A.M., Ankesh, A. and Raj, A., 2020, December. Smart Parking System (S-Park)–A Novel Application to Provide Real-Time Parking Solution. In 2020 Third International Conference on Multimedia Processing, Communication & Information Technology (MPCIT) (pp. 93-96). IEEE.
[3]. Rizvi, S.F.H., Shams, R., Fattani, M.T. and Siddique, A.A., 2022, February. A Cloud Based Smart Parking System. In 2022 Global Conference on Wireless and Optical Technologies (GCWOT) (pp. 1-5). IEEE.
[4]. Elakya R, Juhi Seth, Pola Ashritha, R Namith, Smart Parking System using IoT.
[5]. Pomaji, A., Boinwad, S., Wankhede, S., Singh, P. and Dhakulkar, B., 2019. Smart parking management system.
[6]. Ismail, M.M.S., Jusoh, M., Sabapathy, T., Osman, M.N., Rahim, H.A., Yasin, M.N.M. and Fazilah, A.F.M., 2019, December. IoT Based Smart Parking System. In Journal of Physics: Conference Series (Vol. 1424, No. 1, p. 012021). IOP Publishing