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An IoT-Based Parking System with Vehicle-Aware Slot Allocation and Integrated Stolen Vehicle Detection

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Abstract - Growing number of vehicles on roads due to urbanization has made finding a parking spot very difficult. Drivers spend approximately 3.5 minutes to 14 minutes looking for a parking spot in urban areas. Additionally, up to 30% of urban traffic consists of vehicles cruising for parking [1]. This paper proposes an enhanced Internet of Things (IoT) based smart parking system with a vehicle-aware slot recommendation mechanism which makes use of user-registered vehicle specifications to recommend appropriately sized parking spaces. Parking reservation is made through a mobile application and a QR code-based access and payment framework allows users seamless entry and exit via dynamically generated QR codes. In order to identify stolen vehicles entering the parking facility, an added security layer is provided by connecting with external law enforcement databases and generate real-time alerts for authorities.

Keywords: Smart parking system, SPS, slot recommendation, stolen vehicle detection, QR Code authentication

1. INTRODUCTION

Rapid growth in vehicles in cities and urban areas has made finding a parking spot really difficult for drivers in various public spaces such as shopping malls, hospitals, offices, and railway stations. Drivers entering parking areas without knowing the slot availability status move around the parking area to find vacant slots. In addition, the slow movement of vehicles parking areas lead to increased fuel consumption and traffic congestion [2].

Vehicle security is another significant issue with parking lots. Vehicles in regular parking spaces are not verified to determine whether or not they are stolen. By using modern technologies, smart parking system can be developed to solve the above issues. Various technologies like sensors, databases etc., can be integrated with the smart parking system to improve the parking space monitoring system. Furthermore, an automatic slot recommendation system can be integrated with the smart parking system to improve the parking experience of the users.

2. LITERATURE SURVEY

A smart parking system (SPS) consists of several components such as a user application, data management system, communication system and occupancy sensors that guide drivers to vacant spaces, and optimize parking efficiency, thereby reducing congestion and fuel consumption [3,4].

Numerous studies have been conducted that have explored the development of SPS using IoT, RFID, and sensor-based technologies notably on the improvement of its efficiency and security. A Radio Frequency Identification (RFID) enabled SPS had combined RFID technology for vehicle identification and Infrared (IR) sensors for detection of slot occupancy. While an Arduino board acted as the central processing unit, IoT/GSM connectivity was used for real-time data transfer and automated billing. The Wi-Fi/GSM module transmitted parking data to a cloud server and also alerted users via an SMS. Despite its efficient slot allocation and automated billing, it lacked in vehicle categorization and detecting stolen vehicles, limiting its application [5]. In a different study, vehicles were equipped with unique RFID tags were monitored continuously. Any unauthorized movement of the vehicles triggered an alert to the cloud server. Although the system efficiently monitored vehicle movement and helped in theft detection, it too failed to address automatic vehicle [6].

Another RFID based smart parking system presented a hybrid approach of combining RFID for vehicle identification, ultrasonic sensors for slot detection, and IoT/GSM communication for efficient parking management. A Raspberry Pi microcontroller was used to communicate with the cloud server via IoT or GSM to update slot status and send SMS alerts about available spaces. The system relied heavily on Internet connectivity making it less effective in areas where signal was low [7].

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Recent advances have examined the use of deep learning and machine learning for parking prediction. A work on Hybrid Spatial–Temporal Graph Convolutional Networks (HST-GCN) for on-street parking availability prediction had proposed integrating Graph Convolutional Networks (GCNs) to capture spatial dependencies among parking zones with temporal models (GLU + 1D conv) to capture time dynamics. Experiments conducted using real-world datasets were highly accurate in predicting on-street parking occupancy [8].

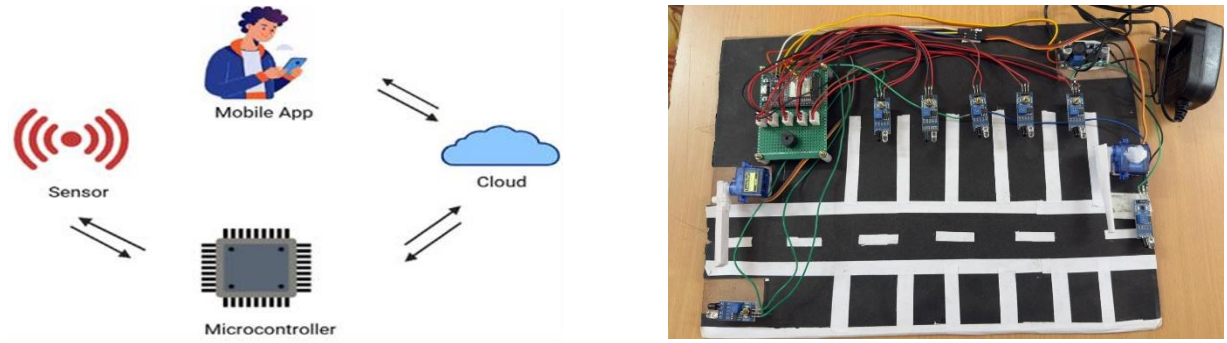
A review of smart parking system based on IoT had also highlighted the lack of vehicle differentiation based on their size and real time theft prevention mechanisms [9]. A survey conducted on smart parking management systems reviewed parking solutions highlighting technologies used for slot allocation and management such as IoT, ZigBee, edge computing and meta-heuristic optimization (firefly algorithm). A significant limitation stated by the paper is the lack of theft detection and stolen vehicle detection [10].

3. METHODOLOGY

A. System Architecture

The proposed system has four layers: frontend, logic, middleware and database. An ESP32 microcontroller is employed as the central processing unit, IR sensors are used for parking slot occupancy detection while servo motors are utilized for gate control. Two mobile phone cameras (not pictured in the prototype) are used as QR code scanners. The application interface or frontend is built using HTML, CSS and JavaScript. The user interface allows the users to view available slots, make bookings, receive a QR code and use it for entry and exit. The admin dashboard enables the administrators to monitor the slots in real-time, manage the bookings made, track vehicle entry/exit activity and receive notifications about stolen or blacklisted vehicles.

A PHP logic layer handles operations such as generating QR codes and verifying them during entry and exit, validating bookings, updating slot and booking statuses, receive A MySQL database store and maintains the user records, booking details, slot statuses, entry/exit logs categorization details of cars, and a list of stolen or blacklisted vehicles. The Node.js (Express) middleware bridges the gap between the application and the hardware and functions as the real-time communication hub of the system by routing signals between them, and everything is synchronized without any delay.



(a) (b)

Figure 1 (a) System architecture (reprinted from [11] licensed under CC BY 4.0) and (b) prototype of the proposed smart parking system

B. Process flow

Users are required to sign up on the mobile application using their vehicle details and mobile number to be able to use the smart parking system. Once registered, a reservation for a parking spot can be made on the desired date and time. The system includes a database that contains details such as different makes of cars and their types. Further, all the cars are categorized into hatchbacks, sedans and SUVs based on their size. When users book slots, the system automatically recommends slots based on the size of their cars. The users have the option of choosing from the slots that are recommended or if wanted can choose another slot of their choice.

Once the payment is made, users get a QR code which can be scanned at the gate to enter the parking lot. These QR codes contain booking information such as vehicle details, booking ID, and the allocated parking slot. If the users wish to extend the duration of their booking, they can do so by logging into the application. When leaving the parking facility, users must scan their QR codes at the exit gate to be able to leave the facility. After exiting, the users are requested to fill a feedback form regarding their parking experience which would help in improving the system in the future.

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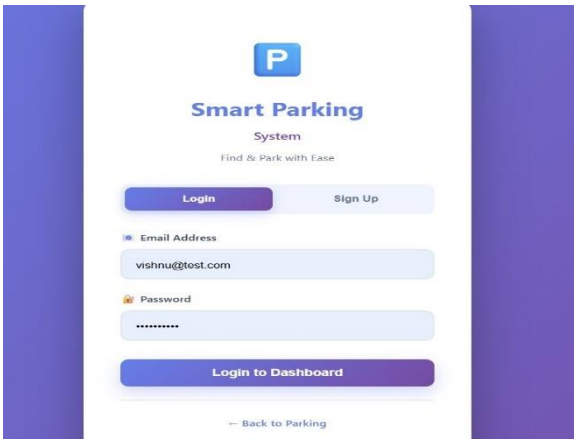
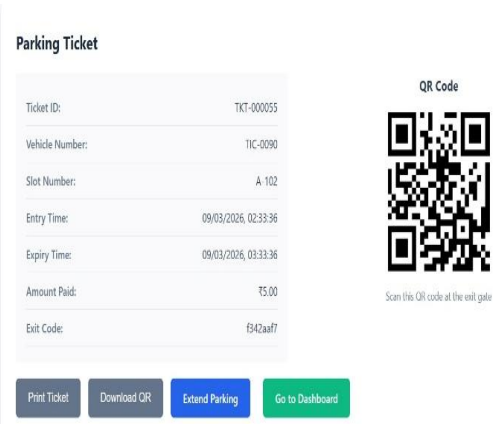
Another unique feature of the system is its stolen vehicle detection ability. Through collaboration with the local law enforcement, the system maintains a database of stolen or blacklisted vehicles. When a vehicle that has been stolen or blacklisted is registered on the application, the administrator is automatically notified. However, the system does not block the parking process, and the user is still allowed to continue with the parking procedure.

4. Results and Discussions

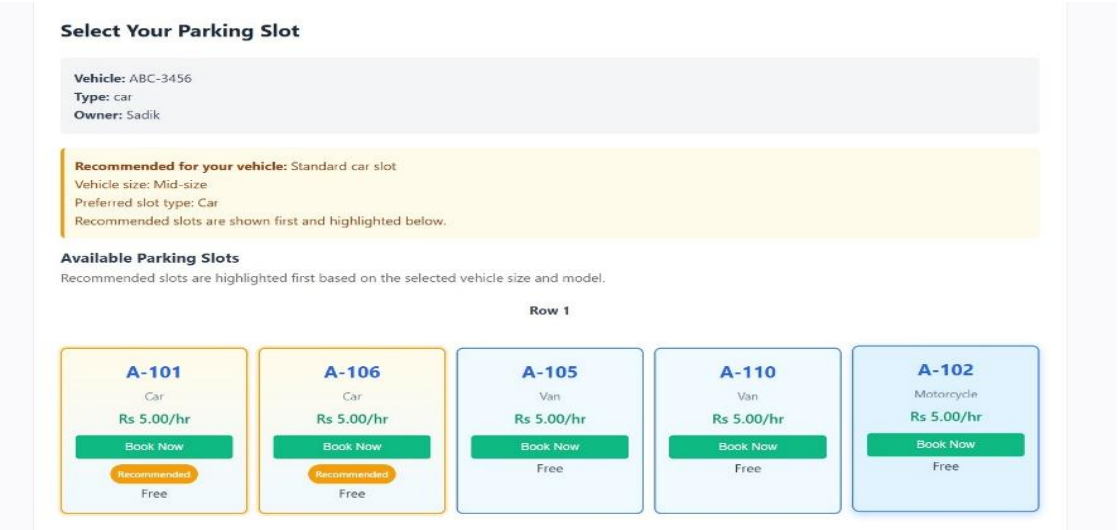
The user login/sign up page of the application can be seen in Fig. 2(a). When users try to book a parking slot, the system recommends slots based on the size of their cars which are highlighted in orange colour and all the other available slots appear in green colour as shown in Fig.2(c). Slots that are occupied or unavailable appear red in colour (not shown here). Once the slots are finalized and the payment is made, a parking ticket with all the details of the booking and a unique QR code as shown in Fig. 2(b).



(a)



(b)



(c)

Figure 2 (a) User registration or signup page of the system (b) Parking ticket generated after reservation with a QR code (c) automatic slots recommended by the system based on the vehicle.

On the other hand, the admin dashboard allows the administrator to have an overview of the entire system given in Fig 3 (a). Using the slots option, the admin will be able to monitor in real-time all the occupied and vacant slots. Details such as the list of vehicles that have registered or signed for the parking facility and user feedbacks can also be accessed by the administrator. When a vehicle that has been stolen or blacklisted is registered the system gives an alert to the admin who in turn will inform the law enforcement. Fig. 3 (b) shows the list of stolen vehicle alerts that the admin had received. All the entries highlighted in red denote vehicles that have an active stolen/blacklisted complaint whereas the non- highlighted entries are cases that have been resolved.

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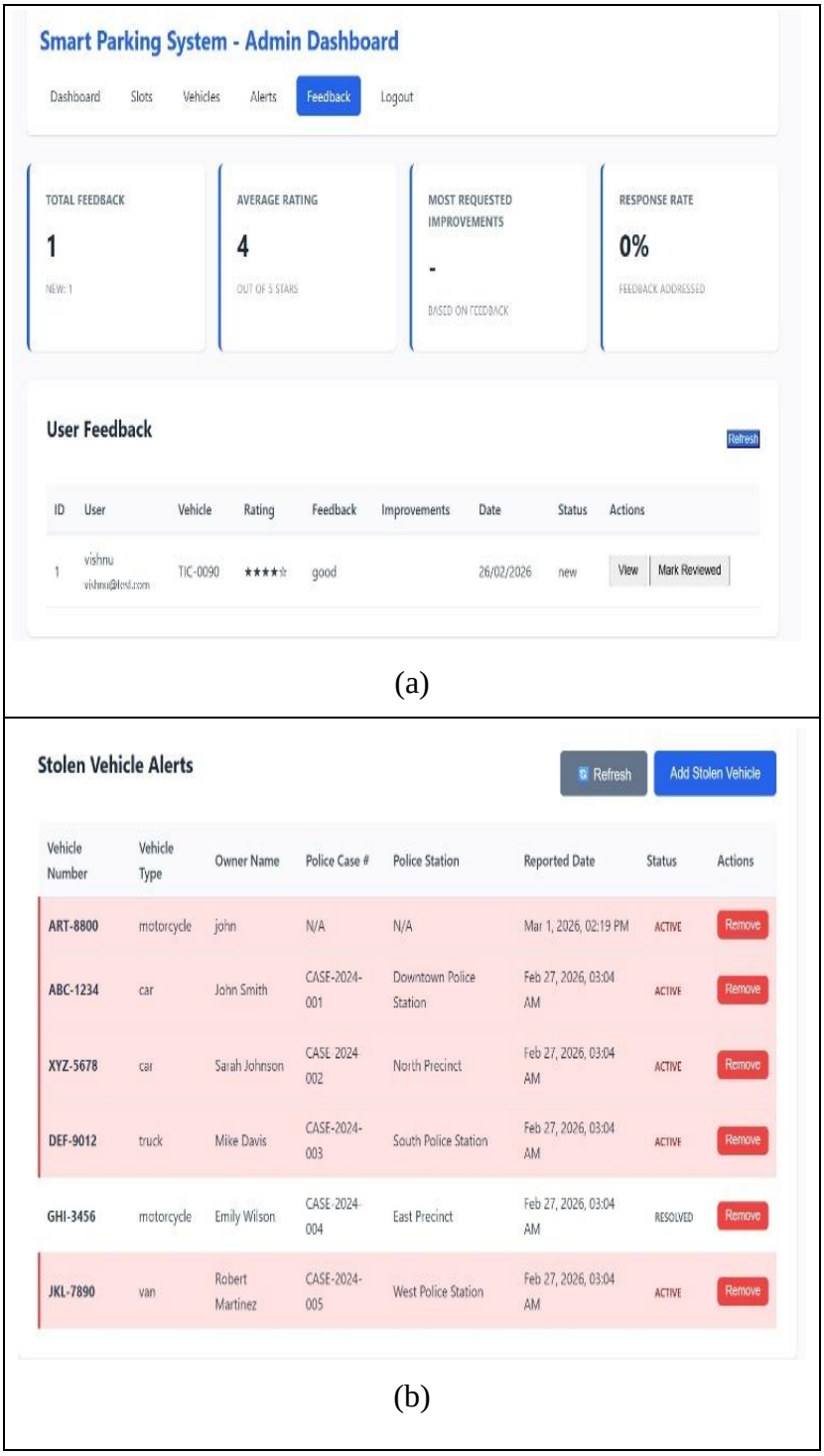

Figure 3 (a) Dashboard of the admin portal (b) alert for stolen vehicles

5. CONCLUSION AND FUTURE SCOPE

In conclusion, the proposed system successfully addresses the challenges of growing urban parking by incorporating a vehicle-aware slot recommendation mechanism which aids in space optimization. The QR code enabled access and payment guarantees a seamless user experience. Moreover, the stolen/blacklisted vehicle detection adds an additional layer of security. Further improvements can be made to the proposed system by employing advanced data analytics and digital twins for urban planning and optimization of traffic.

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REFERENCES

[1] D. C. Shoup, "Cruising for parking," Transport Policy, vol. 13, no. 6, pp. 479–486, 2006, doi: 10.1016/j.tranpol.2006.05.005.
[2] X. Sui, X. Ye, T. Wang, X. Yan, J. Chen, and B. Ran, "Microscopic simulating the impact of cruising for parking on traffic efficiency and emission with parking-and-visit test data," Int. J. Environ. Res. Public Health, vol. 19, no. 15, p. 9127, 2022, doi: 10.3390/ijerph19159127.
[3] A. Fahim, M. Hasan, and M. A. Chowdhury, "Smart parking systems: Comprehensive review based on various aspects," Heliyon, vol. 7, no. 5, p. e07050, 2021, doi: 10.1016/j.heliyon. 2021.e07050.
[4] G. Revathi, V.R.S. Dhulipala, Smart parking systems and sensors: A survey. 2012 Int. Conf. Comput. Commun. Appl., 1–5 (2012).
[5] S. Patel, M. Verma, and K. Gupta, "IoT-based parking system to prevent unauthorized vehicles," Int. J. Res. Appl. Sci. Eng. Technol. (IJRASET), vol. 11, no. 3, pp. 49350–49353, 2023.
[6] M. Rahman, A. Hossain, and S. Islam, "Radio frequency identification based smart parking system using Internet of Things (IoT)," IAES Int. J. Robot. Autom., vol. 10, no. 1, pp. 12–19, 2021.
[7] S. Singh and R. Mehta, "A review of smart parking system based on Internet of Things," Int. J. Intell. Syst. Appl. Eng., vol. 6, no. 4, pp. 248–250, 2018.
[8] Y. Geng and C. G. Cassandras, “A New Smart Parking System Based on Wireless Sensor Networks,” *IEEE Transactions on Intelligent Transportation Systems*, vol. 14, no. 3, pp. 1129–1139, 2013.
[9] X. Zhang, Y. Liu, and H. Chen, “Hybrid Spatial–Temporal Graph Convolutional Networks for On-Street Parking Availability Prediction,” *Remote Sensing*, vol. 13, p. 3338, 2021, doi: 10.3390/rs13163338.
[10] M. A. Al-Kharusi and H. Al-Badi, “Intelligent Smart Parking System Using IoT and Cloud Computing,” *International Journal of Computer Applications*, vol. 178, no. 32, pp. 15–20, 2019.
[11] L. P. Sampath and K. S. S. Boggavarapu, “IoT-based Smart Parking System for Industry 4.0 with QR Code Access and Real-Time Navigation,” *EPJ Web of Conferences*, vol. 336, p. 03003, 2025, doi: 10.1051/epjconf/202533603003.