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PARKING SPACE RECOMMENDATION SYSTEM

Geetha L S
Assistant Professor
Department of Computer Science
BNM Institute of Technology
Bengaluru, India
lsgeetha@bnmit.in

A Indhu Chowdary
Department of Computer Science
BNM Institute of Technology
Bengaluru, India
indhu.alikapati@gmail.com

Akshay M S
Department of Computer Science
BNM Institute of Technology
Bengaluru, India
akshayakki2001@gmail.com

Lalana Nagaraj
Department of Computer Science
BNM Institute of Technology
Bengaluru, India
lnrajwork2022@gmail.com

Manish Athreya
Department of Computer Science
BNM Institute of Technology
Bengaluru, India
ayerhtahsinam@gmail.com

Abstract- ***As we know, the problem of the rapidly increasing number of vehicles around the world exacerbates the issue of the unavailability number of parking spots. The problem of unprecedented growth in the private vehicle segment has created a major problem with parking spaces. Not only is it frustrating, but it's also time-consuming. the average time a driver will park is approximately 8-10 minutes. In addition, it also puts pressure on the driver's pocket as today's parking facilities are getting more expensive every day. According to industry statistics, 30% of traffic jams exist due to drivers trying to find free parking spaces. The proposed intelligent parking system offers additional convenience and automation to both companies and clients. This paper also evaluates the benefits and shortcomings of the suggested approaches. This paper finally proposes a software-based solution for managing the parking spaces and recommending the slots based on users' location.***

Keywords: Metaheuristic optimization algorithm, Parking Recommendation system (PGS), Real-time occupancy information, Smart parking system, UPI, Parking availability status, Google Maps API, Shared parking, Integrated Parking Management System(IPMS), Parking navigation system

I. Introduction

In urban areas, a parking management system is necessary to provide parking places to guests. The majority of the current parking lots have minimal or no amenities for controlling vehicle movement, as well as restricted parking places. Every day, there is more demand for parking in Indian metros. It is quite challenging to conveniently plan parking spots following demand due to the restricted land resources. An effective and efficient technology-based solution must be employed to maximize the usage of available spaces rather than adding more parking spaces. By giving parking attendants and drivers a real-time map of available spaces, smart parking solutions can reduce the amount of time they spend looking for a spot. Not only do modern parking systems identify free spaces, but, it also reduces manual intervention and thus reduce the time for providing the service to the automobile driver. Parking guidance systems provide drivers with convenient command over parking systems with remarkable features and characteristics. New and creative techniques are developed to meet the needs, helping the driver locate open spaces and utilize the parking facilities. However, creating and testing a reliable technique to merge parking occupancy data collected by cameras and payment data collected from a payment management system is very challenging without a shared identity in the two datasets (For instance, license plate numbers in the first case or a precise parking spot in the second). Consequently, this study's goal is dual. In order to combine information using occupancy information from a conventional parking payment management system obtained via utilizing a camera-based detection method, a metaheuristic optimization algorithm is first built, put into practice, and tested. Similar to other systems, simple occupancy data includes a bay's number, and the hours of arrival and departure, whereas payment information, also includes number plates and the start and end times of parking sessions (determined by the amount paid). The combined occupancy-payment information acquired as of the outset technique is then used to develop and test an estimating model for parking occupancy. This model can then be used to infer parking occupancy based on payment data given the lack of permanent parking occupancy monitoring devices.[1].

The majority of the current parking system uses a variety of sensors, including GPS and ultrasonic (Global positioning system). These sorts of sensors require expensive installation costs as well as ongoing maintenance costs. These sensors can't be used in an open parking area. The majority of sensors are readily damaged by rain or sunlight. There are two ways for a user to reserve parking spots. Parking spaces may be reserved in person at a parking lot or online. When making an online reservation, the user must pay a deposit through one of several online payment processors. After a successful transaction, the user is given access to a parking place for a specific period. When a user makes an onsite reservation, he must scan his code in the scanner app as soon as he

enters the parking lot [2]. The primary contribution of this study is the extraction of data from publicly available sources, which is then utilized to develop a model for service evaluation and a ranking algorithm dubbed Parking rank. Additionally, when there is a lack of occupancy data, the driving cost-sensitive algorithm will collaborate with the rank value to recommend parking lots. Each parking lot's initial rank value is based on its service capacity, which may be inferred from the information made available to the general public on the billboard, as opposed to Page rank, which gives every page the same initial value. (a) Service scope: This characteristic identifies the variety of customers that parking lots serve. (a) The complete quantity of parking spots - More vehicles can be parked in a parking lot for a given amount of time if there are more parking spots available. (c) Cost - More cars are willing to park when the cost is cheap [3].

As far as the authors' knowledge goes, there are no works that specifically address how to increase parking space usage from the perspective of the government and the likelihood that a search request will be successful from the perspective of the driver. They offer three suggestions depending on how parking spaces are currently being used and compare these suggestions to the straightforward distance-based method [4]. In general, people go to the parking lots to check if a spot is available before parking, or else they look for another place to park. Instead of having to guess whether there will be a spot available in the parking lot they are headed to, users may now utilize the app to find another location. This suggestion aims to create a system of applications that would allow users to reserve their preferred parking space[5]. Identifying problems with existing smart city parking applications that do not meet the diverse human-centric end-user needs, creating a collection of personas to serve as a representation of the numerous parking application end users, a set of user stories being developed for the field of smart parking applications to better serve these various end-user needs, prototyping a parking application using React Native and performing its cognitive walkthrough evaluation and discussing the lessons learned for implementation [6].

It is essential to encourage individuals to use shared parking. The author created a sophisticated parking management system (donated as IPMS) to handle this problem. IPMS can simulate parking actions when both the general public and the proprietors of resources for shared parking have ambiguous arrival and departure schedules. The report highlights three major contribution areas:1) In the context of shared parking in time and space dimensions, a novel framework for managing parking resources is provided to control access to parking spaces and guarantee that all parking needs of the owners are addressed. 2) a sophisticated parking management system automatically evaluates the parking data that has been gathered and chooses the best management strategy The number of ideals required to restore parking spots and the number of P-users required for effective management and exploitation of parking resources was found to be correlated in an intriguing inverted S pattern. through iterative training, pieces have been based on the technology of agent simulation. Using historical parking behavior data, this system enables the representation of the stochastic and dynamic aspects of the arrival and departure of P-users and O-users.3) The most effective management techniques were determined via a case study. We observed an intriguing inverted S-shaped link between the number of ideals needed for restored parking spaces and the number of P-users for efficient management and utilization of parking resources[7].

Additionally, even though parking-related issues such as shared parking, parking reservations, and Analyzing parking behavior and traffic emissions when cruising have received a lot of attention recently. According to what we know, there hasn't been an integrated research methodology for assessing the decrease in traffic emissions brought on by the best arrangement for shared parking spaces. This study's goal is to address the aforementioned knowledge gap and enhance our understanding of the connections between potential traffic emission reduction and the best-shared parking space management. This study's major goal is to determine how much traffic emissions could be reduced by fewer cars cruising for parking spots after shared parking is put in place. To accommodate the greatest number of cruising cars possible, a model of the initial proposal was for pure integer linear programming [8]. Smart parking apps enable mobile payments in addition to letting drivers book spaces depending on their convenience. A positive development for mobility and parking concerns in India's metropolitan regions is the progressive adoption of technology as part of a set of interventions by many smart cities in India.

II. Literature Survey

Behrang Assemi proposed a metaheuristic optimization approach to combine transactions from a traditional parking payment management system with snapshots of bay-level parking occupancy taken with basic cameras. This is a complete hardware-based real-time bay-level surveying model. The validation of parked vehicles' license plates, parking bay occupancy data, and parking payment transactions based on various payment methods are all merits. The high cost of hardware as well as future environmental and situational situations that cannot be avoided are drawbacks[1].

Mayur Sevak proposed a parking guidance system (PGS) might significantly cut down on the time needed to find parking spots. A suggestion is to compile real-time occupancy data for parking lots across the city and utilize it to inform parking suggestions. Contrary to pricey real-time data, it is simple and inexpensive to collect public information regarding parking lots. Merits include QR code generating for monitoring the lots, Cost-effective, and QR assigned to each parking slot. Demerits are Duplication of QR codes, low security, and Errors during the generation of QR codes [2].

Shi Dong proposed that the majority of proposing schemes advocate recommending the closest or most affordable parking place from the perspective of the driver. However, making such a vain choice could result in low utilization. Merits include Reasonable and efficient parking lot recommender, Parking lot ranking, and Reduced investment in sensory device processing. Demerits are No prior slot availability specification, Rank recommended based on availability not on the prize, and Simultaneous recommendation to multiple users [3].

Hui-Ling Chang suggested that you reserve a parking space. The system offers a variety of parking spaces nearby depending on the location. On the app, users may reserve a spot as well as examine the prices for various spots for their two- and four-wheeler vehicles. Merits include the parking lot usage, predicted driving distance, success rate, and anticipated walking distance. Demerits are overall distance to the destination is increased, not suitable for areas with fewer parking lots [4].

Sagar Piyush Parikh proposes the application of a QR (Quick Response) code and a special program that can fix the issues with the current parking system. A trouble-free system will make it easier for both the vendor and the user to solve most issues. Both sides benefit from the simpler payment process and time savings. The primary duties would be to collect information on various parking lots, Authentication of logins for websites and apps, Status of the parking availability in real-time, central database/server for all user data, retention of user data for security reasons, and enhancement of user experience Data analysis and application. Merits include Parking lot reservations, Rental of parking space. Demerits are delayed in updating lots, glitching in maps UI [5].

Chenin Li proposes personas representing a broad representation of parking app user groups were constructed after collecting information on various human-centric issues from user reviews and literature. These personas were used to develop user stories, classify them, and prioritize the parking jobs. Merits include navigation, integration with the live car park database, notification support, feedback reporting, and many more. Demerits include hard accessibility to retrofit, and drivers with mobility issues, elderly drivers, and drivers who have many vehicles because of their jobs or families may find it challenging to accommodate, and they need to be supported differently than other users [6].

Pengfei Zhao proposes a framework for managing shared parking resources in terms of time and space. This study demonstrates how the suggested shared parking solutions might increase the effectiveness of parking resources. Merits include an integrated parking management system (IPMS) that saves status data of parking spaces, reproduction of previous parking behavior, the decision of whether or not to allocate parking spaces to a user, and user guidance. Demerits include the use of just a single parking space scale to represent the stochastic nature of owners' and users' arrival or departure times, as well as the distribution of incorrect parking space mathematical models [7].

Pengfei Zhao, Parking navigation systems may be able to decrease the number of cruising cars and help cut down on traffic emissions. The precise impacts of such a step are, however, still largely unknown. Theoretical justification for reducing parking demand and environmental issues is provided by this research. Benefits include the branch-and-cut algorithm's ability to find the best solution to the supply and demand problem for parking, which reduces traffic emissions, and the use of shared parking spaces. Demerits are overlapping parking timings and allocation of parking space to multiple users [8]

III. Methodology

A. System Architecture

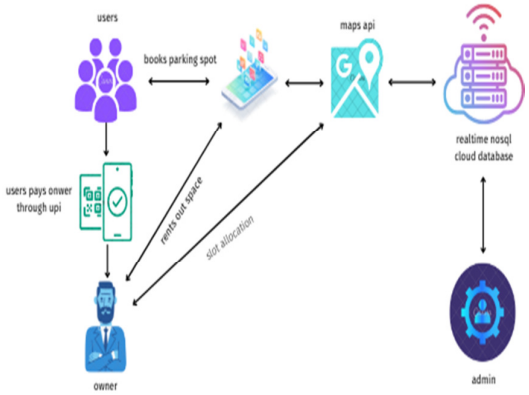

Figure 1. System Architecture

Small sellers with limited money can readily deploy a straightforward yet cutting-edge system based on UPI payments. The Parkode application is made with Android Studio, and its UI is designed with the aid of XML. The backend is made up of Java, and the data is kept in a real-time NoSQL cloud database called Firebase. The app can be used by owners and users alike. By entering their names, contact details, email addresses, passwords, and whether they want to be users or owners, respectively, users and owners can join up in the app. Two-factor authentication is used to later confirm them. By describing the slot details, the rental rate, and the location, all of which are kept and pinned on a board, owners can rent out their spots. The user can reserve a parking place at his convenience by entering information about his vehicle, including the start and end times, by logging in. The user must pay the owner through one of the several online upi payment options available, such as Paytm, Google Pay, Phonepe, etc., in order to complete the reservation. Following a successful transaction, a parking space is booked for the user for a certain period of time, and an invoice is generated. The database that the administrator oversees displays a list of the slots that have been reserved along with the corresponding earnings. The full procedure described above is shown in Figure 1.

B. Parking Space Distribution and Allotment

Based on the user's current position, the application uses the Google Maps API to suggest to him the nearest parking spots (shown by pins on the map or accessible in neighbouring areas).GPS navigation directs the user to the designated parking place. The parking lot is divided into several slots. Parking places are allotted in accordance with the order of arrival. The nearest and farthest parking lots fill up first and second, respectively. As the automobiles follow a clearly defined course, this will help the user save time and solve the parking lot traffic problem. A 15-minute minimum reservation period is ideal. This is considered so that the client may reach the parking space and and leave his automobile parked within that grace period; at this point, invoicing for reservations that are more than 15 minutes apart from one another starts. If a user keeps their car in the same spot after the exit time, the space is taken up until that user departs, preventing another user from making a reservation for it. When the owner gets the alert to check out the over-parked user, he has the choice to prolong the time for that user until 30 minutes before the exit time, at which point he can either personally check out the user or take the necessary action against him.

C. System Modules

Figure 2 depicts the three elements that make up the Parkode app. The user, who essentially uses the app to reserve a spot, is the initial module. Automatic licence plate recognition happens, and the user profile is there. Owner, who may essentially rent out his area, reserve a time slot for users, and also put their profile, is the second module. Data is stored and updated in the third module, admin, which is controlled by the app's administrators. The information obtained on parking practises will be processed and saved using this module.

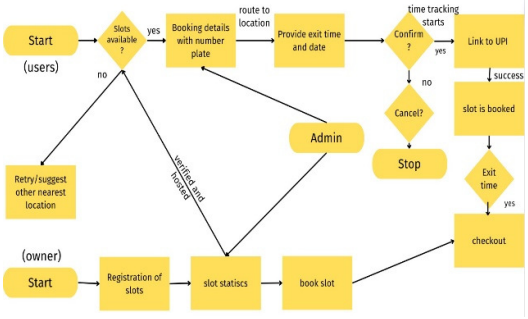

Figure 2. Flowchart of the System modules

i. User Module

- Registering in as a new user and verifying using two-factor authentication.
- The user dashboard includes GPS maps, nearby locations, and booking history.
- GPS maps identify the user's present location and display parking spot pins.
- The pinned parking spaces are provided nearby, together with information on their availability, rental costs, and a booking option.
- Booking an area entail providing booking information, choosing an exit time and date, and outlining an amount. Once these details have been supplied, an upi payment page is redirected via an UPI platform, and an invoice pdf is generated for the payment.
- The user is sent to the reserved space after the reservation is confirmed. The user then receives notifications that it's time to check out and time has elapsed before the exit time and after it has passed.
- Booking History displays all of the user's past reservations.
- When a user scans a plate, the number plate is automatically recognised using the platerecognizer api, and there is also the option to manually add the vehicle type and plate number.
- User profiles include personal information, upi information, a password change option, and an option to log out from the app.

ii. Owner Module

- Registering in as a new owner and verifying using two-factor authentication.
- Dashboard for the owner that shows the status of his parking space and slot.
- Status displays the availability and occupied details, the rental charge, and the type of vehicle.

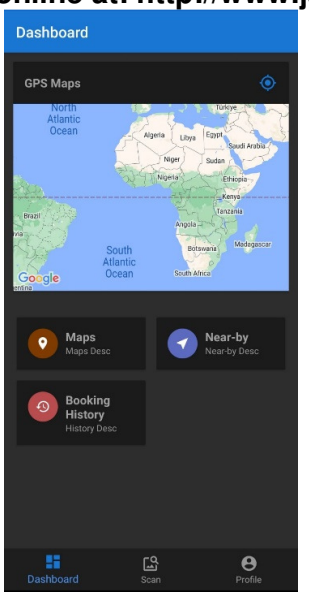

Figure 3. User Home Page

- When the status is clicked, the history of reservations is displayed in an encrypted format with start and exit times and an option to check out the current user.
- The slot name and the vehicle's license plate number that is now parked in that space are both listed in the slot status.
- Owner Add: By providing an email address and a vehicle plate number, the owner can reserve a spot for a user or for himself. The user is notified of this reservation and can reserve a parking space by simply confirming.
- Owner profile includes personal information, upi information, a password change option, and an option to log out from the app.

iii. Admin Module

- The Firebase admin will maintain track of parking spot allocation.
- The admin has the ability to change the number of parking spaces allotted, as well as to increase, decrease, or cancel the allotment and delete data from the database.
- Additionally, it has access to any customer's payment history and can impose penalties as necessary.
- The user/owner module links straight to the admin module for any question or feedback.
- Support the release of major application updates and fixes.

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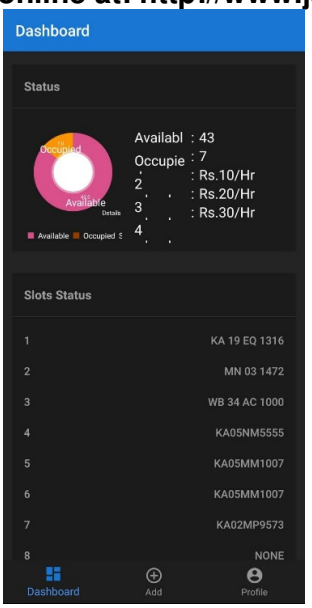

Figure 4. Owner Home Page

IV. Evaluation and Results

A small seller is using the app for a short period of time as a trial. Since then, the vendor has seen an increase in income. Additionally, the issue with traffic congestion and finding a free parking space is resolved. In Figure 5, a comparison between two customers—Customer 1 and Customer 2—has been made. In the time vs. money graph (INR), customer 1 makes an online reservation and stays within the permitted time restriction, however customer 2 goes over the time limit and has additional fees added to his account. The seller is fully permitted to alter the total amount due and the hourly rate.

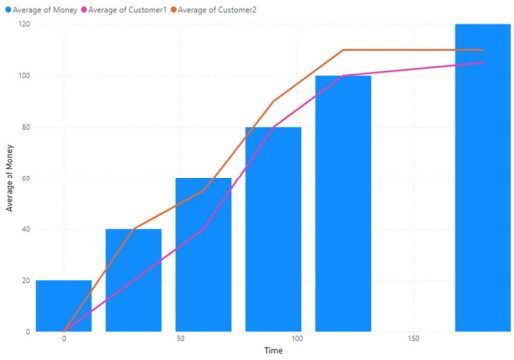

Figure 5. Price comparison among two customers

We discovered that the over-parked user hadn't moved his car from the parking spot after the owner checked out the user on the app without physically verifying it. In order to prevent another user from booking the same area, it is recommended that the owner physically confirm in that circumstance.

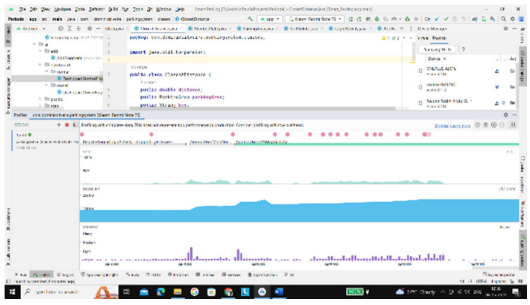

Figure 6. Performance Testing of the app

The user interface design of the programme offers simple navigation, timely and pertinent content, a user-friendly booking and payment method, speedy performance, and accessibility features as shown in Figure 6. A variety of Java's features can support the security of the backend system. Java offers a number of authentication and authorisation advances, including OAuth, LDAP, JAAS, and Spring Security, to secure access to backend systems. Java provides HTTPS, SSL/TLS protocol support, allowing for secure communication. Firebase provides a variety of security mechanisms to safeguard the confidentiality, integrity, and availability of the data stored in its database. All data in transit is encrypted by Firebase using SSL/TLS, preventing data modification and eavesdropping.The database data that is available to whom can be decided by developers using Firebase's rule-based permission framework.Firebase's real-time database monitoring enables users to identify any suspicious activity or data anomalies.

V. Conclusion and Future Works

Thanks to smart parking technologies, cities can manage and reduce the number of individuals who use the streets to hunt for parking. The main effects of this technology on traffic are those that make parking quicker, easier, and less of a hassle, even though it also ensures parking safety. Implementing the new software-based system can easily address the majority of problems with the current parking systems, including proper space management, time management, and traffic difficulties (caused by vehicles moving irregularly in search of parking places). Our parking solution is undoubtedly more cost-effective than the existing parking system. This approach is easily implementable by a variety of small and large parking providers without significantly modifying the current parking infrastructure. This publication also suggests a hybrid parking space recommender system and a smart parking system are used to address the parking issue at hand. In subsequent efforts, the application might make use of a more potent algorithm for contextually proposing slots that can incorporate several models and take into consideration variables like the weather, holidays, etc.

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