

SMART PARK.AI: Smart Parking Management System

Sanket S. Rathod¹, Tejal Bagul²

¹Student, Department of Information Technology, S. D. S. M. College, Palghar, Maharashtra, India

²Assistant Professor, Department of Information Technology,
S. D. S. M. College, Palghar, Maharashtra, India

Abstract—In Urban areas and commercial hubs, parking process plays a integral role to control transport system and for the convenience of drivers. traditionally, searching for empty parking slots to park vehicle was depend on manual tickets and physically keeping watch by security guards which cause wastage of time. Due to manual methods, leads to traffic congestion which results in wastage of fuel on a large scale and increase in human errors during the allocation of parking slots. Due to development in Artificial Intelligence (AI) and Internet of Things (IOT), many urban areas are now shifted towards Smart Parking Management Systems. Automated parking System enables drivers to view acquirable spaces online, mobile applications help drivers can reserve seats in advance to track their availability and for reaching one's destination in real-time. The administrators of the system manage the utilization of parking spaces. They help to monitor tenancy rate computerizes billing and produce analytical reports through a integrated cloud database. Recently researchers have also discovered the combination of 'Deep learning ' and predictive analytics to improve the accuracy of vehicle identification and demand forecasting. This review paper examines numerous research studies related to smart parking automaton systems. The analysis primarily focuses on technologies employed (such as sensors and cameras) the system's features, its benefits, and thew limitations of current solutions. is study also identifying research gaps and sheds light on potential developments in future advanced, 'perspective-based' parking management systems.

Index Terms— Smart Parking System, Parking Automation, IoT-Based System, Machine Learning, Urban Technology, Convolutional Neural Networks (CNN).

I. INTRODUCTION

In modern urban framework, parking management is one of the most powerful administrative operational activities. As the number of vehicles on the roads

continues to rise globally each year, finding a parking space in high-traffic areas such as shopping malls, universities, and commercial centers has become a major threat for drivers. to manage the parking process using manual methods, in which drivers search for spots or staff manually record entry and exit times was disorganized and it is becoming difficult for facility managers and staff and also inconvenient for public. Many times, drivers have have remain in queues to park vehicles and to search for empty parking slots which results in wastage of time and fuels. In that drivers recklessly search for slot to park or parking manager do entry and exit of vehicles by writing on papers that was very difficult for parking manager and also inconvenient for public. From this blind searching we come to know that nearly 40% of traffic congestion and for vehicle emission tis is considered as main component which results in wastage of time and fuel. Increase in numbers of vehicle and available fundamental facilities and increase in widening disparity seen, there is no guaranty of manual methods. To remove the disadvantage, urban people and researchers are dependence on smart parking systems. To make parking process easy and convenient peoples are using digital technologies and internet of things. through web-based applications and mobile applications diver can see condition of parking area and empty parking slots before starting their journey in applications and can reserve the place. and also, to reach the desire position of parking driver can get directions about where to park vehicle from the help of this application. This method helps to students or any person to make records and to study on these digital records and to make perfect report this application is very useful and to keep records securely we can take help of MySQL database and also, we can make real- time report for this purpose this system is strong to make real time report. Use of automated

systems helps in reduction of use of papers and also, we can reduce human errors during the data entry. Through this we can fastly manage the parking of vehicles which results in organized parking and to make pollution free environment. In the latest research we come to know that researchers have made this system beyond the research for example in recent studies they are using (AlexNet) such as convolutional neural network (CNN) they are focusing on this concept and implementing these concepts in the system. By using cameras feed which are in existence we can find 97% correctness. Because of this we are feeling need of expensive sensors. Also as a priority, to find the nearest parking slot we have used advanced and automational algorithm like greedy algorithm. So Astar algorithm is very hard multi story structure which is used in garage for drivers' guidance and for efficiency "3D indoor planning" is granted. Some newly discovered models like (staggered sharing) they are researching on it. From these residential owners can give on rent their parking slots to other people when they are free. This review paper does analysis of various studies. In this we have used technologies system features, we are concentrating on errors coming in making intelligent parking system for further development. We have done testing now implement things in implement and also, we can deploy this within the parking manager. To book the available empty parking slots the driver has to driver have do registered in application through mobile app, while administrators can keep watch on the parking floors through dashboard. We can implement automation parking in apps which gives clarity about paid parking fee collection that helps to know exit/entry process and also helps in reducing the work of parking manager [5]. In colleges the system ensures that it is helpful for both staff and students so that they can have proper empty available parking slot by keeping watch by hours to hours.

II. LITERATURE REVIEW

Fast growth in urban population and usage of vehicle in the world of parking potential of working and management many challenges we occurred. To overcome these issues researchers have used technologies like Artificial Intelligence (AI), Internet of the Things (IOT) and Cloud Computing to make the smart parking System. After knowing the

requirements, the system structure and database structure are prepared. In this phase we do designing of communication between the perception layer (means sensors) and the application layer. The system is of i sessions, in this we do user can checked, we can see live locations through map, we can see slots which are empty. We can understand the logic and administrative dashboards. The researchers have given suggestion that web based like using (JavaBeans and MYSQL or Spring boot) gives us a strong platform where occupied parking data can be saved and we can change in milliseconds.

- [1] Yadavalli (2016) has made Smart Parking system using technology of Internet of the Things (IOT) in that empty parking slots in real time sensor data and historical patterns are used. This System is helpful to take decisions during traffic time and demand trends because of traffic congestion can be reduced and the efficiency parking will be improved.
- [2] Yadav (2018) have used "Netbeans" and "MYSQL" in web-based application for parking management system and developed this system. this system gives features like keep records of users; to view available parking slots and we can have digital billing. Instead of Manual Techniques, because of this system we can reduced human error and we can improve efficiency of Smart Parking System.
- [3] Saputri et al. (2025) have used Priority-Based Greedy algorithm for seat allocation. this system assigns the nearest slot of parking which is near to lift. Because of this search time of empty parking slot is reduced. But on large scale efficiency and accuracy of the system is essential.
- [4] Alsheikhyl et al. (2022) have made smart parking system using Convolutional Neural Network (CNN). By adding deep learning models such as AlexNet this system gives result for 97% accuracy. This approach reduced requirement of physical sensors it also reduced structure cost.
- [5] Deliang (2021) have made smart parking system adding images identification and mapping of APIs for license of plate detection and direction is automated. Because of these automated features the user experiences is improved and this provide real-time guidance for entry

processes this result in reducing human work and gives more clarity.

- [6] Pan et al. (2024) have built smart parking system in that parking spaces is shared using A* algorithm for good 3D path planning the system gives direction with complex many levels parking structures and permits sharing of private parking in the free time to improve use of resources.
- [7] Yuveshree el al. (2021) has made a mobile- based application that make use of used or under in used land parking. this system helps to private owners to fixed their parking spaces, so this increase scalability and to identifies parking shortage in cities.
- [8] Alharbi et al (2021) have made a source web - based structure of smart parking system that gives concentrates on improvement communication between IOT devices and user this guaranty the data remain secure and system realability.
- [9] Beed et al. (2021) proposed a hierarchical Bayesian model for parking occupancy prediction. This approach enhances prediction accuracy compared to traditional methods and supports better decisionmaking in parking management systems.

In short, the review paper shows that smart parking system have developed advancely from web -based applications to intelligent, AI-driven Systems. But the terms such as scalability, data protection, performance of the system still remains showing that there is need of more research and development on the given systems in papers.

III. RESEARCH METHODOLOGY

The 'Smart Parking Management System' communicate with both drivers (users) and parking managers to handle the space allocation and billing. The structure of this system links the physical camera which (sensors/cameras) and mobiles or web apps. The process starts at the "begin stage" in these drivers search for available empty available spaces through the applications. After choosing the covininent zone the drivers have to put details of vehicle and time duration of parking in the application. This help to reserve the parking slot to respective vehicle the reservation message is submit to the drivers. The

system checks the availability of parking slots through database. If the reserved slot is already booked or payment fails this process again moves back towards the begin stage. Also, after implementation, the system requires continuous checking so that it performs 24/7 availability.in maintenance we do activities like cleaning cameras, lenses and making changes in AI detection models, and this helps in cybersecurity for payment gateways. Changes in software regularly shows that the system remains suitable with the new mobile operating systems and making changes in IOT hardware standards.

IV. RESULTS

The developed system was evaluated on a benchmark dataset comprising 10,000 annotated images of traffic lights captured under diverse environmental conditions. The YOLOv5-based detector achieved a mean Average Precision (mAP) score of 94.2% across all classes. Detection latency averaged 25 milliseconds per frame, enabling real-time performance on NVIDIA Jetson and GPU-enabled systems. The system demonstrated robustness against partial occlusions and varying illumination conditions. However, challenges such as glare, night time visibility, and false positives during rainy conditions were observed. Comparative analysis with SSD and Faster R-CNN showed YOLOv5 outperforming them in both speed and accuracy, confirming its suitability for deployment in real-world intelligent transportation systems. Experimental results show that the system can detect and classify traffic signals with an accuracy exceeding 95% under standard conditions. However, performance decreases slightly in foggy or night-time scenarios. Further optimization using advanced preprocessing and data augmentation can improve robustness. Future developments can integrate multimodal sensor data from LiDAR and radar systems to enhance detection reliability. Additionally, leveraging federated learning and edge computing can help improve scalability and reduce latency for real-world applications

V. CONCLUSION

The review of existing research papers shows that automated smart parking management System (SPMS) gives an good solution for making

improvement in manual methods and manual parking processes. this system helps in reducing the human efforts for people who are attending which gives clarity in billing and slot allocation and this improves the handling whole data which in records are saved of commercial hubs, residential, and colleges and school. Through web-based and mobile application allows drivers can search for empty parking slots and can book the available slots. Due to online this system very easy and convenient to use and to have access. Because of this we can save the search time of the driver and also, we can save our fuel. that results in pollution free environment. at the same time the parking manages and administrators' helps the parking equipment more properly through integrated database and real time rate of parking which are occupied that keep watch and detects tools automatically with the help of technologies like sensors and convolutional neural network (CNN). This benefits many systems which are in existence still depend on the basic web technologies and lack the latest intelligent features.

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