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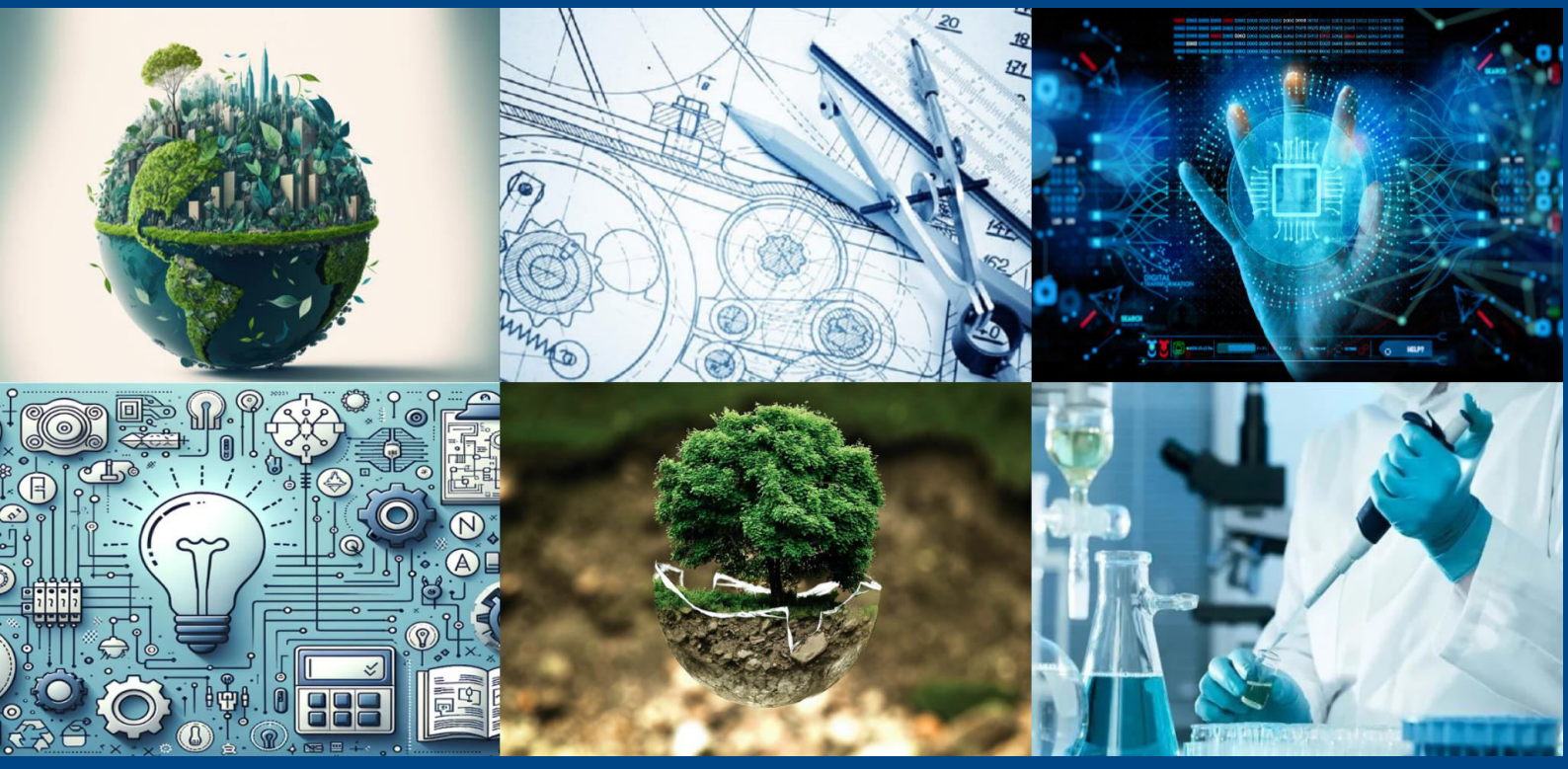

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Smart and Effective Real Time Management of Street Parking

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ABSTRACT: ParkXpert is a smart and efficient real-time parking management system that is developed as a web based solution to the issues of traffic congestion, use of parking space inefficiently and commuter inconvenience in urban areas. Using a modern technology stack of React.js, Node.js, Express.js for the backend and MongoDB or JSON based storage for the database, this system allows ease of use between users and parking infrastructure through a user friendly and responsive interface. ParkXpert's core functionalities are live parking spot tracking, real time parking spot reservations, and a minimalistic admin dashboard to manage parking zone effectively. By viewing available spots, booking them in real-time and receiving instant feedback on their booking status, users can save a lot of time on parking search and reduce vehicle emissions

I. INTRODUCTION

In the context of the fast urbanization and motorization, contemporary cities are confronted with a task of efficient urban street parking management. With the ever increasing number of vehicles, roads become congested, fuel is wasted, pollution is increased and there is driver frustration, a significant portion of which is caused by inefficient parking systems.

It was found that about 30 percent of urban traffic is due to cars circling to gain a parking spot. Not only does this contribute to traffic congestion and higher greenhouse gas emissions, but it also costs the commuters substantial amounts of money and psychic distress.

While smart city initiatives have brought new innovations to transport, traffic control and public safety, the least optimized urban system — parking — has yet to receive the same attention**.**

Traditional parking systems heavily rely on manual processes, static information boards and inefficient enforcement strategies. The smart cities demand the modern systems that the outdated ones are ill-equipped to fulfill Smart parking has become an essential part of the intelligent mobility infrastructure as smart cities seek sustainable and data driven solutions. Nevertheless, most of the existing smart parking solutions rely on IoT devices, expensive hardware, and complex sensor systems, which are hard to scale and maintain in cost sensitive environment.

To get smart parking benefits without the barriers of high infrastructure investment, cities need a software-centric system that is scalable and adaptable.

ParkXpert is a real time, web based smart parking management system which is a user friendly and a cost effective alternative to the traditional and IoT dependent systems. ParkXpert was designed for flexibility and simplicity, enabling users to use a clean web interface to view, reserve and navigate to available parking spots without any external hardware.

A modern, full stack web technology stack is used to develop the system with a clean communication between frontend, backend and database layers.

ParkXpert is a modern, efficient parking management. It does not require the cost and complexity of sensor based systems while providing core smart parking functionalities by focusing on software driven design. ParkXpert is a very

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practical and deployable solution for cities that want to modernize their parking infrastructure with a low capital expenditure and scalable architecture, intuitive UI, and extensible backend.

And not only is this project an answer to one of the essential urban challenges, it also demonstrates the potential of full stack web development to tackle real world problems

II. LITERATURE REVIEW

In this era of complex and dense urban landscapes, one common challenge with regard to city mobility persists: inefficient street parking management. With the limited supply of parking spaces and growing number of vehicles in the cities, cities experience the consequences of congestion, longer travel time, air pollution and frustrated drivers. Urban traffic studies indicate that 30 percent of city traffic is made up of vehicles looking for empty parking spots.

Currently, the urban parking systems rely on static signage, manual supervision, and physical enforcement, which are not agile or intelligent enough to cope with the modern urban parking demands. In reaction, researchers and developers have come up with and put into practice different smart parking solutions largely based on hardware technologies such as IoT sensors or advanced software models like AI/ML. But these systems almost always run into barriers of cost, maintenance complexity and scalability.

In this chapter, the current state of the art of existing smart parking systems is reviewed and the technological and functional gaps that ParkXpert aims to fill through a web first, software first architecture are outlined.

Emerging technologies are being used by smart parking systems to provide real time information on space availability, streamline payment process, and make best use of public infrastructure.

The literature survey shows that though smart parking systems have made great use of IoT and AI technologies, these are still unavailable to many communities because of high cost, complexity and infrastructure requirements. Also, there are points of failure in environmental sensors and predictive models and operational concerns.

Analysis of Existing Smart Parking Solutions
Several commercial and municipal systems have been deployed to address the global parking problem. Some representative case studies are given below.

SFpark – San Francisco, USA
These are used along with in ground sensors and dynamic pricing algorithms. Although the project was successful at reducing congestion, it resulted in high infrastructure costs and devices needed constant maintenance of sensors and meters.

ParkMobile – North America
A mobile app enabling parking space payments across various cities. It provides little real time status updates and does not come with a native reservation system unless integrated with city infrastructure.

Smart Parking Ltd – United Kingdom
It uses AI powered computer vision (CCTV) for the monitoring and enforcement. It raises some questions about user privacy, system surveillance and high implementation complexity.

ParkXpert's Differentiation

- Being aware of the complexity of hardware intensive systems, ParkXpert was designed to be a lightweight web based solution. The design philosophy is based on the practicality, cost effectiveness and easy deployment.
- Unlike sensor-dependent solutions, ParkXpert uses:
- React.js is used for the frontend which provides the responsive and interactive UI.
- Backend in Node.js + Express.js to manage reservations and status updates
- A real time management of parking data in MongoDB or JSON based database.

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- Monitor and manual control over availability with a simple admin dashboard
- By letting ParkXpert run on top of IoT hardware, this architecture also frees it from needing to develop specific hardware that would enable core smart features, including:
- Live availability display
- Instant booking and reservation confirmation
- Admin overrides and zone control
- Clean and mobile-friendly design

For a strategic alternative, ParkXpert provides a way to keep the user facing benefits of modern smart parking, while providing them through simplified, scalable and software only architecture. It is particularly well-suited for: Pilot deployments, Budget-conscious municipalities, Educational institutions, Commercial complexes and shopping districts. ParkXpert forgoes the complexities of hardware and prediction engines and delivers a clean, efficient, real world ready solution to the parking management problem.

III. METHODOLOGY OF PROPOSED SURVEY

The implemented system named ParkXpert serves as a web-based real-time parking management platform to handle issues regarding ineffective space usage together with congestion problems and substandard driver interactions. ParkXpert functions differently from IoT sensor or AI prediction model reliant smart parking systems because it provides modern web technology enabled real-time services for space viewing and reservations without depending on any physical installations.

The architectural structure of the system and its operational capabilities between members and server databases are fully explained in this section. The implementation method requires low resource utilization while providing flexible capacity growth and can be easily deployed.

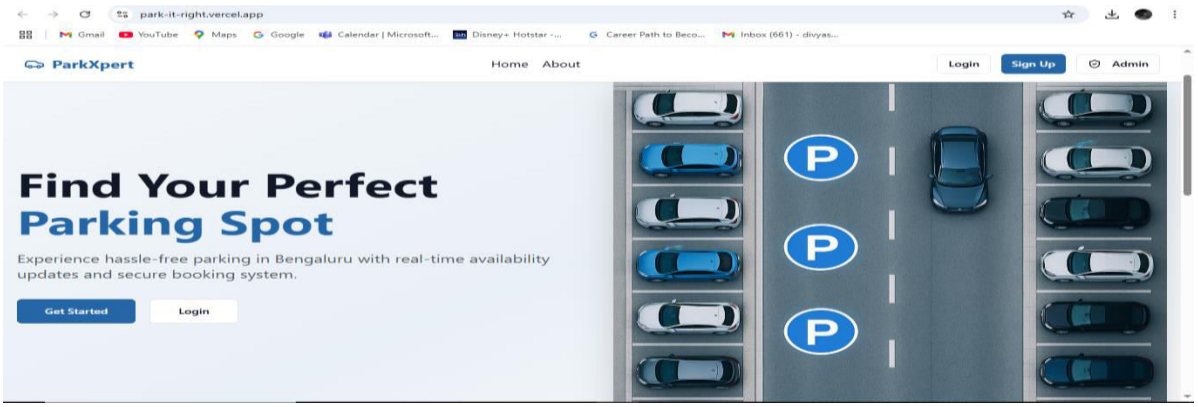

Figure no. 1

System Architecture Overview

ParkXpert organizes its operations through an architecture design that divides functions into frontend elements and backend elements joined by a database layer. The system exchanges information via RESTful.APIs while maintaining real-time functionality yet relies on lightweight polling to provide simulated live updates regarding parking space status.

System Components

Frontend (Client Side)

The development of the frontend utilizes React.js as a JavaScript library for creating dynamic user interfaces. TailwindCSS through its ability to style provides a tidy modern design that adapts uniformly to different screen sizes.

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Key Functionalities:
Displays a visual layout of parking areas with clickable spots. The interface shows current bookings and availability status for every car parking spot in real time. Through user interface interaction users can book parking spots according to the system. The software provides an administrative login system which uses pre-defined logins for backend session authentication.

Frontend Technologies Used: React.js: Component-based frontend library, Tailwind CSS: Utility-first CSS framework for rapid UI design, HTML5/CSS3: Basic web structure and styling.

Backend (Server Side): The backend development consists of Node.js and Express.js combination that processes API requests and performs session control while accessing and managing data in the layer. The backend system both follows booking protocols and protects available booking spots for users.

Core Responsibilities:
The system delivers RESTful API endpoints to enable user interface communication.
The system needs to process spot bookings as well as liberation rules.
The application uses backend components to authenticate administrators for routing sections that require protection.
The system processes data demands by updating the storage repository.
Backend Technologies Used:
Node.js operates as an implementation of JavaScript that enables server-side programming.
One of the deployed backend components utilizes Express.js as a lightweight solution for both routing functions and middleware implementations.

Database Layer:
The data layer uses two different operational modes according to the deployment environment scheme. For production cloud storage requirements MongoDB provides a solution within the system. The flat file storage format uses JSON for implementing lightweight databases and prototyping purposes during local development. Each parking zone remains an object having an array of spots alongside unique spot IDs and status fields.

Methodology Workflow: The application has a simple workflow layout for users which maximizes both efficiency and readability.

Parking Spot Modeling: Each parking facility contains a set of individualized spots that users can identify. The status of each parking spot can either be available or booked or the system displays an invalid status which allows administrator intervention. The system uses structured JSON format or MongoDB collection to store its data.

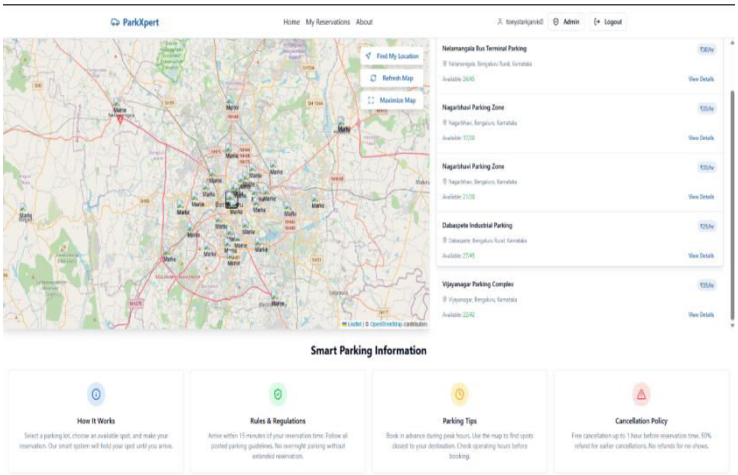

Figure no. 2

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Reservation Process

1. A user interfaces displays the available spots for viewing purposes.
2. The user makes a POST request toward the server once selecting their desired parking location.
3. The backend checks: The server checks if that particular spot remains vacant at present. The system changes the status to booked if the spot is available.
4. The user interface updates itself with the new status right after the server finishes processing.

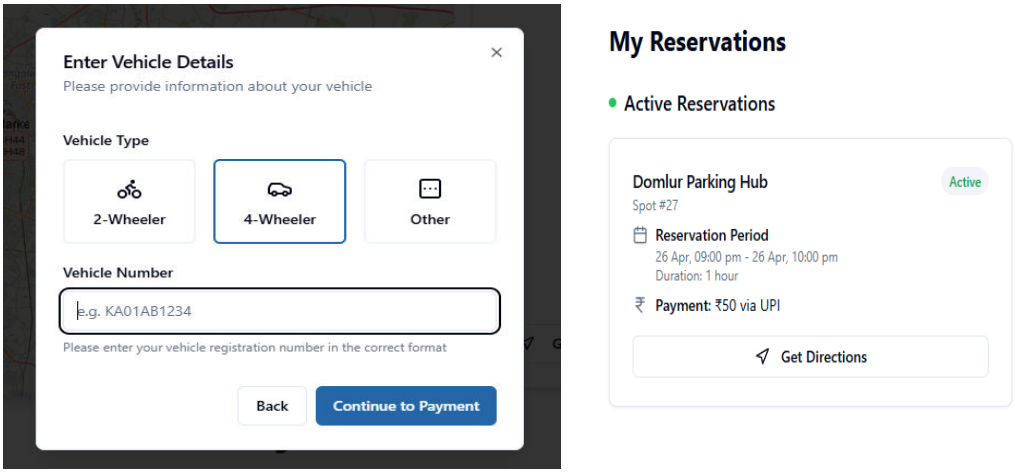


Figure no. 3

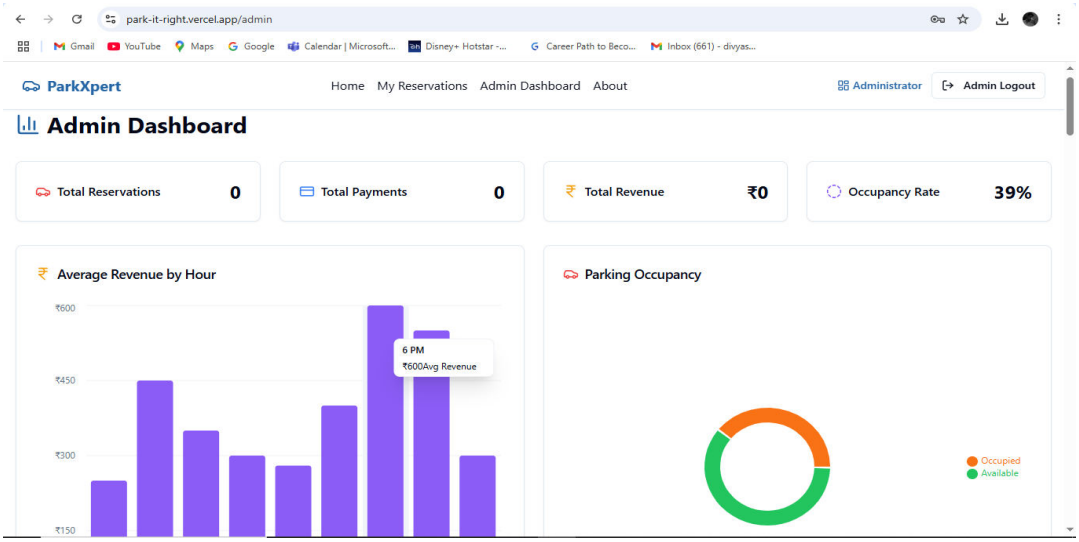
Real-Time Updates

The server updates are fetched through polling queries that execute every few seconds. A Web Socket-based communication system will replace polling as the real-time bi-directional update method in future software updates.

Admin Dashboard and Controls

The platform lets administrators access their account through established log in credentials.

•Admin dashboard allows: Resetting all spots to available. System usage monitoring along with optional enhancement of activity logging can be integrated into the platform (optional system enhancement).



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Deployment Strategy

ParkXpert operates through Vercel as its cloud deployment platform which specializes in displaying frontend and backend full-stack stacks in production. Through Vercel developers can trigger CI/CD pipelines directly from GitHub along with serverless functionality and static content serving.

Summary

Through ParkXpert academia verified that basic smart parking solutions can be achieved with a basic web interface that avoids costly infrastructure along with complicated artificial intelligence methods. The system develops realistic parking solutions via clean architecture which maintains separate responsibilities alongside modular design for deployments that remain adaptable and easy to support.

Thankfully ParkXpert operates effectively across different types of parking facilities ranging from university campuses through to office buildings and commercial areas and public parking facilities.

IV. CONCLUSION AND FUTURE WORK

Conclusion

The ParkXpert: A Smart and Effective Real-Time Parking Management System project created a contemporary parking management resolution that applied software-only components instead of building complex IoT structures or AI models. The clean full-stack framework composed of React.js along with Node.js Express.js and MongoDB/JSON successfully handled fundamental urban mobility parking difficulties caused by space usage inefficiencies.

Throughout its development and deployment:

Real-time visibility about parking spot availability was achieved by the system. Users obtained immediate access to reserve particular parking spaces while maintaining reliability throughout the process.The system provided administrators with complete manual oversight capability to manage spot statuses at all times.Both performance and latency remained high and the data maintained thorough consistency throughout diverse devices within multiple environments.The deployment on Vercel platform confirmed the system is suitable for wide-scale use in production environments.TheParkXpert solution demonstrated that democratizing smart parking requires lightweight software-based concepts which establish efficient and cost-effective operations for institutions and campuses and other venues.The prototype from the first deployment phase of ParkXpert maintains its potential for development to increase its impact across additional features.

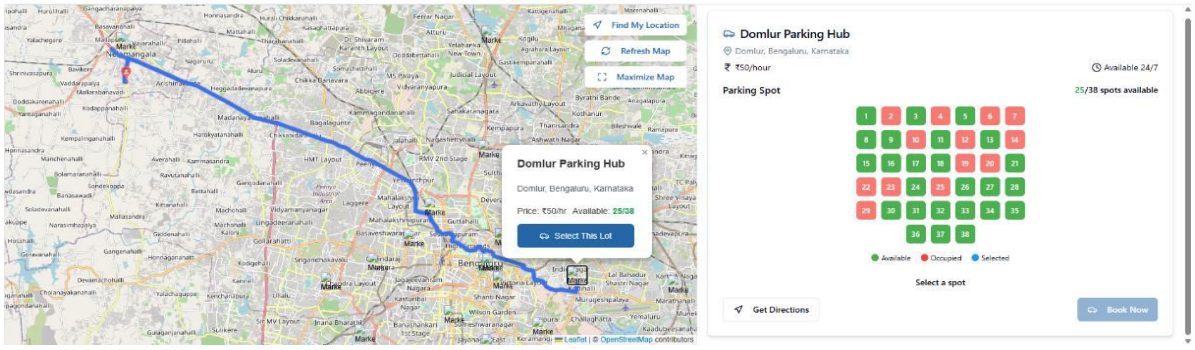

Figure no. 5

Future Work

ParkXpert provides a solid base that enables intelligent development directions for upcoming versions. These include:

- The system should implement WebSocket or Server-Sent Events (SSE) technology to achieve real-time push updates instead of requiring polling.
- Integration with Google Maps API for guided navigation to the reserved spot.
- User authentication and session tracking systems will let users access their personalized booking records and storage of their preferences.

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- The platform should include payment gateway functionality for charging money from user accounts through restricted time periods. Early future versions will use machine learning models in modular structures for demand prediction alongside slot recommendation logic.

REFERENCES

1. Neupane, D., Bhattarai, A., Aryal, S., Bouadjenek, M. R., & Farzaneh, S. (2023). SHINE: Deep learning-based accessible parking management system. *Expert Systems with Applications, 238*, 122205. https://doi.org/10.1016/j.eswa.2023.122205
2. Yan, S., O'Connor, N. E., & Liu, M. (2023). U-Park: A user-centric smart parking recommendation system for electric shared micromobility services. *arXiv preprint arXiv:2303.03152*. https://arxiv.org/abs/2303.03152
3. da Luz, G. P. C. P., Sato, G. M., Gonzalez, L. F. G., & Borin, J. F. (2024). Smart parking with pixel-wise ROI selection for vehicle detection using YOLOv8, YOLOv9, YOLOv10, and YOLOv11. *arXiv preprint arXiv:2412.01983*. https://arxiv.org/abs/2412.01983
4. Nguyen, T. T., &Sartipi, M. (2024). Smart camera parking system with auto parking spot detection. *arXiv preprint arXiv:2407.05469*. https://arxiv.org/abs/2407.05469
5. Al Mamun, A., Hasib, A., Mussa, A. S. M., Hossen, R., & Rahman, A. (2024). IoT-enabled smart car parking system through integrated sensors and mobile applications. *arXiv preprint arXiv:2412.10774*. https://arxiv.org/abs/2412.10774
6. Puspitasari, D., Noprianto, N., Hendrawan, M. A., & Asmara, R. A. (2021). Development of smart parking system using Internet of Things concept. *Indonesian Journal of Electrical Engineering and Computer Science, 24*(1), 611–620. https://doi.org/10.11591/ijeecs.v24.i1.pp611-620
7. Rekha, G. S., Deepak, K., Prasad, A., Hegde, A., & Chandrashekhar, V. (2024). Smart parking system with research on Thread communication protocol. *International Journal on Recent and Innovation Trends in Computing and Communication, 12*(2), 809–816. https://ijritcc.org/index.php/ijritcc/article/view/11093
8. Laaouafy, M., Lakrami, F., &Labouidya, O. (2024). A smart parking system combining IoT and AI to address improper parking. *International Journal on Information Technologies and Security, 16*(2), 39–50. https://doi.org/10.59035/ZMRY7124
9. Naidu, R., Perla, V., Vinay, V., &Nedunchdran, A. V. (2024). Smart parking infrastructure: RFID, IoT, mobile app, and Google Maps integration for seamless navigation. *Journal of Electrical Systems, 20*(3). https://journal.esrgroups.org/jes/article/view/7809
10. Sayeed, M. A., Islam, M. R., Kabir, M. A., & others. (2023). IoT Raspberry Pi based smart parking system with weighted K-nearest neighbours approach. *Civil Engineering Journal, 9*(8), 1677–1689. https://doi.org/10.28991/CEJ-2023-09-08-012
11. Vijayalakshmi, S., Bose, S., Logeswari, G., & Maheswaran, N. (2025). Smart parking: Intelligent intrusion detection system in VANET enabled car parking system. *Automatika, 66*(2), 281–299. https://doi.org/10.1080/00051144.2025.2476802
12. Hasan, M. S., & Bhuiyan, M. M. R. (2022). IoT based smart parking system. *EAI Endorsed Transactions on Internet of Things, 8*(31), e1–e8. https://eudl.eu/doi/10.4108/eai.24-3-2022.2319006
13. Sultana, M., Ali, M. N., Hossain, M. M., & Rahman, M. M. (2021). Smart parking system using Internet of Things. *Elementary Education Online, 20*(5), 6602–6609. https://ilkogretim-online.org/index.php/pub/article/view/6602
14. Dewi, A. R. C., &Maulidevi, N. U. (2021). Development of a smart parking system based on Internet of Things using object-oriented analysis and design method. *Journal of Physics: Conference Series, 1524*(1), 012111. https://doi.org/10.1088/1742-6596/1524/1/012111

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