International Journal of Interdisciplinary Innovative Research & Development (IJIIRD)
ISSN: 2456-236X
Vol. **11** Special Issue **02** | **2026**

Smart Parking System

Mrs. Roshana N.Girase[1] , Pro.Y.P.Sushir[2], Pro.T.Y.Kharache[3], Dr.Sudhir paraskar[4], Pro.R.V.Pimpale[5]

[1] *Student , Electronics and Power, pad. dr. V. B. Kolte college of engineering, Malkapur, Maharashtra, India*
[2,3,4,5] *Professor , Electronics and Power, pad. dr. V. B. Kolte college of engineering, Malkapur, Maharashtra, India*

DOI: 10.5281/zenodo.19289188

ABSTRACT

Rapid urbanization and the increasing number of vehicles have led to severe parking management challenges in modern cities, resulting in traffic congestion, fuel wastage, and time loss. A Smart Parking System is proposed to address these issues by leveraging Internet of Things (IoT) technologies and real-time data processing. The system utilizes sensors installed in parking slots to detect vehicle presence and continuously monitor parking availability. The collected data is transmitted to a centralized server or cloud platform, where it is processed and made accessible to users through a mobile or web application. Users can view real-time parking availability, reserve slots in advance, and navigate efficiently to vacant parking spaces. The system also supports automated billing and monitoring, reducing human intervention and operational costs. By optimizing parking space utilization and minimizing unnecessary vehicle movement, the Smart Parking System enhances user convenience, reduces traffic congestion, and contributes to sustainable urban mobility. This solution is suitable for implementation in smart cities, commercial complexes, hospitals, and public parking areas [2].

Keywords:- Smart Parking System, Internet of Things (IoT), Parking Slot Detection, Real-Time Monitoring, Wireless Sensor Networks, Cloud Computing, Smart Cities, Mobile Application, Automated Billing.

1. INTRODUCTION

Rapid urbanization and the continuous growth in the number of vehicles have made parking management a major challenge in modern cities. Drivers often spend a significant amount of time searching for vacant parking spaces in crowded areas such as shopping malls, hospitals, office complexes, and public parking zones. This not only leads to traffic congestion and increased fuel consumption but also contributes to pollution and driver frustration. Traditional parking systems, which rely on manual monitoring and static signage, are inefficient and unable to adapt to real-time changes in parking availability [2]. A Smart Parking System is an intelligent solution that uses modern technologies such as Internet of Things (IoT), sensors, RFID, and mobile applications to efficiently manage and monitor parking spaces [1]. The system detects the availability of parking slots in real time and provides this information to users through digital displays or mobile apps, guiding them directly to empty spaces. This automated approach optimizes the utilization of parking resources, reduces waiting time, and enhances user convenience. A Smart Parking System is an advanced parking management solution designed to efficiently monitor, control, and optimize the use of parking spaces in urban and semi-urban areas. With the rapid increase in the number of vehicles, traditional parking methods have become inefficient, leading to traffic congestion, long waiting times, fuel wastage, and increased pollution. A smart parking system addresses these challenges by using modern technologies to provide real-time information about parking availability and automate the parking process [3].

The system typically integrates technologies such as the Internet of Things (IoT), sensors, wireless communication, mobile applications, and cloud computing. Sensors installed in parking slots detect the presence of vehicles and send real-time data to a central server. This information is then made available to users through mobile apps or digital displays, guiding them to the nearest available parking space. Some systems also support features such as online reservation, automated entry and exit, digital payments, and security monitoring [5].

The architecture of the Smart Parking System is based on an Internet of Things (IoT) framework that enables real-time monitoring, data processing, and user interaction. The system consists of sensor nodes installed in individual parking slots using ultrasonic, infrared, or magnetic sensors to detect vehicle presence. These sensors are interfaced with microcontrollers such as Arduino or ESP32, which collect and transmit occupancy data through wireless communication technologies like Wi-Fi, GSM, LoRa, or MQTT protocols. The transmitted data is received by a centralized cloud or server platform where it is processed, stored in a database, and analyzed to determine parking availability and usage patterns. The processed information is then made accessible through a mobile application or web-based dashboard, allowing users to view real-time parking

status, reserve slots, receive navigation guidance, and perform digital payments. An administrative interface enables monitoring, system control, and billing management. This layered architecture ensures scalability, efficient resource utilization, reduced traffic congestion, and seamless integration with smart city infrastructure [7].

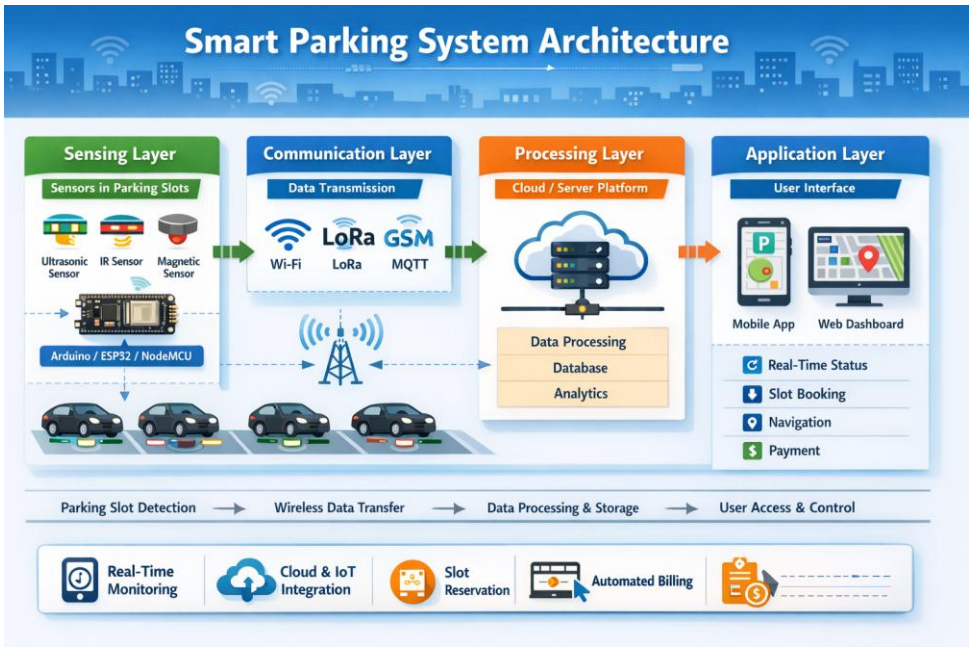

Fig 1: Architecture Design

1.1 Problem Statement

Rapid urbanization and the continuous increase in the number of vehicles have intensified parking management challenges in urban areas, commercial complexes, and public spaces. Traditional parking systems rely on manual monitoring and fixed signage, which fail to provide real-time information about parking availability, leading to traffic congestion, increased fuel consumption, time wastage, and driver frustration [9]. The lack of efficient space utilization, poor monitoring, and absence of automated billing further contribute to operational inefficiencies and higher management costs. Additionally, drivers often spend significant time searching for vacant parking spaces, increasing environmental pollution and road congestion. Hence, there is a critical need for an intelligent, automated, and real-time parking management solution that efficiently monitors parking occupancy, optimizes space utilization, and provides accurate information to users while minimizing human intervention [10].

1.2. Research Objectives

- To develop an automated system for efficient management of parking spaces.
- To detect and display real-time availability of parking slots.
- To reduce time spent by drivers searching for parking spaces.
- To minimize traffic congestion caused by unnecessary vehicle movement.
- To optimize the utilization of available parking resources.
- To provide a user-friendly interface through mobile apps or digital displays.

1.3 Motivation

The motivation for developing a Smart Parking System arises from the growing challenges associated with urban traffic congestion, inefficient parking space utilization, and increasing environmental pollution. As the number of vehicles continues to rise, traditional parking management approaches are no longer adequate to handle real-time parking demands. Drivers frequently waste time and fuel searching for available parking spaces, leading to frustration, increased carbon emissions, and unnecessary traffic congestion [11]. The lack of automated monitoring and real-time information also results in poor parking management and higher operational costs. Advances in Internet of Things (IoT), wireless communication, and cloud computing technologies provide an opportunity to design an intelligent parking solution that offers real-time availability updates, efficient space management, and improved user convenience. This motivation drives the development of a smart, automated parking system that supports sustainable urban mobility and smart city initiatives [12].

1.4 Research Gap

Although several parking management solutions have been proposed using sensor-based and IoT-enabled technologies, significant research gaps still exist in terms of scalability, real-time reliability, and system integration. Many existing systems focus only on basic parking slot detection without addressing issues such as network latency, data accuracy, and fault tolerance in large-scale deployments [6]. Limited attention has been given to adaptive communication mechanisms that ensure uninterrupted data transmission in dense urban environments. Additionally, most systems lack intelligent data analytics for predicting parking demand, peak-hour congestion, and dynamic pricing strategies. User-centric features such as seamless reservation, secure digital payment, and integration with navigation services are often insufficiently explored. Furthermore, challenges related to energy efficiency of sensor nodes, interoperability with smart city infrastructure, and data security remain inadequately addressed. These gaps highlight the need for a comprehensive, scalable, and intelligent smart parking framework that integrates real-time monitoring, predictive analytics, and secure cloud-based services [8].

2.LITERATURE REVIEW

In recent years, various studies have explored different smart parking architectures and techniques, including sensor-based slot detection, RFID-based vehicle identification, camera-based monitoring, and intelligent routing algorithms for space allocation. These systems aim to improve parking efficiency by guiding drivers to available slots, enabling advance reservation, and integrating digital payment mechanisms. The literature also highlights the role of cloud platforms and data analytics in improving scalability, reliability, and system performance. This literature review examines existing smart parking solutions proposed by different researchers, focusing on their methodologies, technologies, performance, and limitations. By analyzing previous work, the review identifies gaps and challenges such as system cost, scalability, security, and real-time accuracy, providing a foundation for proposing a more efficient and reliable smart parking system for modern urban environments [2].

1. S. Mathur et al. “ParkNet: Drive-by Sensing of Road-Side Parking Statistics” The paper *“ParkNet: Drive-by Sensing of Road-Side Parking Statistics”* proposes an innovative mobile sensing approach for estimating on-street parking availability using vehicles equipped with ultrasonic sensors and GPS units. Instead of deploying costly fixed sensors in every parking slot, the ParkNet system leverages drive-by vehicles, such as taxis, to collect parking occupancy data while they move through city streets. The sensed data is geo-tagged and transmitted to a central server, where machine learning algorithms are used to classify parking spots as occupied or vacant. The study demonstrates that drive-by sensing can achieve high accuracy in detecting parking availability while significantly reducing deployment and maintenance costs. Experimental evaluations conducted in urban environments show that ParkNet provides reliable real-time parking statistics and can scale efficiently across large cities. This work highlights a cost-effective and scalable alternative to traditional sensor-based smart parking systems and serves as a foundation for crowdsourced urban sensing applications [1].
2. S. Nawaz, C. Efstratiou, C. Mascolo “ParkSense: A Smartphone Based Sensing System for On-Street Parking” The paper *“ParkSense: A Smartphone Based Sensing System for On-Street Parking”* presents a novel approach for detecting on-street parking availability by utilizing sensors embedded in smartphones. The proposed system leverages data from accelerometers, gyroscopes, and GPS sensors available in smartphones carried by drivers to identify parking events and infer vacant or occupied parking spaces. ParkSense employs signal processing and machine learning techniques to distinguish parking maneuvers from normal driving behavior, enabling accurate detection without the need for dedicated parking infrastructure. The collected data is aggregated on a centralized server to generate real-time parking availability maps. Experimental results demonstrate that the system achieves reasonable accuracy while significantly reducing deployment and maintenance costs compared to fixed sensor-based solutions. This work emphasizes the feasibility of infrastructure-free, crowdsourced parking sensing and highlights challenges related to data sparsity, energy consumption, and user participation [2].
3. Fabusuyi, Hampshire, Hill “Evaluation of a Smart Parking System” The paper *“Evaluation of a Smart Parking System”* focuses on the assessment of a real-world smart parking deployment to understand its effectiveness, usability, and operational impact. The study evaluates a sensor-based parking management system that provides real-time information on parking availability to drivers through digital displays and mobile platforms. Key performance indicators such as parking search time, occupancy rates, system reliability, and user behavior are analyzed using empirical data collected during the system’s operation. The results indicate that the smart parking system significantly reduces the time spent searching for parking spaces, improves parking space utilization, and enhances overall traffic flow in urban areas. The paper also discusses user acceptance, economic feasibility, and challenges related to sensor accuracy, maintenance, and scalability. This evaluation provides valuable insights into the practical benefits and limitations of smart parking systems and highlights the importance of data-driven assessment for large-scale urban deployments [3].

4. (SFMTA) San Francisco Municipal Transportation Agency "SFpark Pilot Project Evaluation" The *SFpark Pilot Project Evaluation* presents a comprehensive assessment of a large-scale smart parking initiative implemented by the San Francisco Municipal Transportation Agency (SFMTA). The project aimed to optimize parking availability and reduce traffic congestion through the deployment of in-ground parking sensors, real-time data collection, and dynamic pricing strategies. The evaluation analyzes multiple performance metrics, including parking occupancy, parking turnover, search time for parking, traffic conditions, and user compliance. Findings from the pilot indicate that real-time information and demand-responsive pricing significantly improved parking space utilization, reduced parking search time, and enhanced overall traffic efficiency. The study also examines public response, system costs, and operational challenges such as sensor maintenance and data accuracy. This evaluation serves as a benchmark for smart city parking solutions, demonstrating the effectiveness of data-driven parking management while highlighting practical challenges associated with large-scale urban implementation [4].
5. K.-H. Liu "On-street smart parking networks at a fraction of their cost: Practical design and deployment considerations" The paper *"On-street Smart Parking Networks at a Fraction of Their Cost: Practical Design and Deployment Considerations"* investigates cost-effective alternatives to traditional on-street parking sensor deployments. The study focuses on designing low-cost wireless sensor networks that can reliably monitor parking occupancy while significantly reducing installation and maintenance expenses. It explores practical considerations such as sensor placement, communication protocols, power consumption, network scalability, and data reliability in real-world urban environments. Through experimental deployments and performance evaluations, the authors demonstrate that optimized hardware selection and efficient network design can achieve comparable accuracy to expensive commercial systems at a fraction of the cost. The paper also highlights challenges related to environmental interference, sensor calibration, and long-term maintenance. This work provides valuable insights into affordable and scalable smart parking network designs, making smart parking solutions more feasible for large-scale urban adoption [5].
6. Y.-Y. Chu "IoT in Vehicle Presence Detection of Smart Parking System" The paper *"IoT in Vehicle Presence Detection of Smart Parking System"* presents an Internet of Things (IoT)–based approach for accurately detecting vehicle presence in parking spaces using low-cost sensors and wireless communication technologies. The proposed system integrates parking slot sensors, such as ultrasonic or infrared sensors, with microcontroller units to monitor occupancy in real time. The sensed data is transmitted through IoT communication protocols to a centralized cloud platform, where it is processed and displayed to users via a web or mobile application. The study emphasizes real-time monitoring, system scalability, and ease of deployment in both indoor and outdoor parking environments. Experimental results demonstrate reliable vehicle detection with minimal latency and reduced human intervention. The paper highlights the effectiveness of IoT technologies in enhancing parking space utilization while also discussing challenges related to sensor accuracy, environmental conditions, and network reliability [6].
7. Jung "An IoT-based smart parking management system" The paper *"An IoT-Based Smart Parking Management System"* proposes an intelligent parking solution that leverages Internet of Things (IoT) technologies to automate the monitoring and management of parking spaces. The system employs sensors installed in parking slots to detect vehicle occupancy and microcontroller units to collect and transmit real-time data using wireless communication protocols. The gathered data is processed on a centralized cloud or server platform, where parking availability is updated dynamically and made accessible to users through a web or mobile application. The study focuses on improving parking space utilization, reducing search time, and minimizing human intervention. Experimental validation demonstrates improved accuracy and responsiveness compared to traditional parking systems. The paper also discusses implementation challenges such as scalability, sensor deployment cost, and data security, highlighting the potential of IoT-based systems in smart city parking management [7].
8. G. Ali et al. "IoT Based Smart Parking System Using Deep Long Short Memory Network" The paper *"IoT Based Smart Parking System Using Deep Long Short Memory Network"* presents an advanced smart parking framework that integrates Internet of Things (IoT) infrastructure with deep learning techniques to enhance parking management and prediction accuracy. The system collects real-time parking occupancy data using IoT-enabled sensors deployed in parking slots and transmits the data to a centralized cloud platform. A Deep Long Short-Term Memory (LSTM) network is employed to analyze historical and real-time parking data to predict future parking availability and occupancy patterns. The proposed approach improves decision-making by enabling proactive parking guidance and demand forecasting. Experimental results demonstrate that the LSTM-based model achieves higher prediction accuracy compared to traditional statistical and machine learning methods. The study highlights the effectiveness of combining IoT and deep learning for intelligent parking systems, while also discussing challenges related to computational complexity, data quality, and real-time deployment [8].

9. S. Bock, S. Di Martino, A. Origlia "Smart Parking: Using a Crowd of Taxis to Sense On-Street Parking Space Availability" The paper *"Smart Parking: Using a Crowd of Taxis to Sense On-Street Parking Space Availability"* proposes a crowd sensing-based approach for monitoring on-street parking availability by utilizing taxis as mobile sensing platforms. The system equips taxis with sensing devices and GPS modules to collect real-time data on parking space occupancy while they traverse urban roads. The collected data is aggregated and processed on a centralized server to generate accurate parking availability information for different city regions. The study demonstrates that leveraging a large fleet of taxis enables wide-area coverage, high data freshness, and scalability without the need for deploying fixed sensors at every parking location. Experimental evaluations show that the proposed method achieves reliable occupancy estimation and reduces infrastructure costs. The paper also discusses challenges such as data sparsity in low-traffic areas, sensing accuracy, and dependence on taxi density, highlighting both the potential and limitations of crowd sourced smart parking systems [9].
10. A. Fahim et al. "Smart parking systems: comprehensive review based on various aspects" The paper *"Smart Parking Systems: Comprehensive Review Based on Various Aspects"* provides an extensive survey of existing smart parking solutions, analyzing them from multiple perspectives such as sensing technologies, communication protocols, system architectures, deployment environments, and user services. The review categorizes smart parking systems based on sensor types (ultrasonic, infrared, magnetic, and camera-based), networking technologies (Wi-Fi, Zigbee, LoRa, NB-IoT), and data processing approaches (cloud, edge, and fog computing). It also examines application features including real-time monitoring, reservation mechanisms, navigation support, and pricing strategies. The paper highlights key challenges such as scalability, deployment cost, energy efficiency, data security, and system interoperability. By comparing different approaches and identifying their advantages and limitations, the study offers valuable insights into current research trends and future directions for smart parking systems within smart city ecosystems [10].

3. PROPOSDED METHODOLOGY

The proposed Smart Parking System employs an Internet of Things (IoT)–based methodology to enable real-time monitoring and efficient management of parking spaces. Vehicle presence in each parking slot is detected using ultrasonic or infrared sensors interfaced with a microcontroller such as Arduino or ESP32. The sensor data is transmitted wirelessly through communication technologies like Wi-Fi, GSM, or MQTT to a centralized cloud or server platform [7]. The server processes and stores the data in a database, continuously updating parking slot availability and maintaining historical records for analysis. This processed information is presented to users through a mobile or web-based application, allowing them to view real-time parking availability, reserve slots, receive navigation assistance, and perform digital payments. An administrative interface supports system monitoring, billing, and maintenance. The methodology ensures reduced parking search time, optimized space utilization, and seamless integration with smart city infrastructure. The sensed occupancy data is transmitted to a cloud-based server through wireless communication protocols, including Wi-Fi or MQTT. The server processes and stores the data in a centralized database and dynamically updates parking availability information. A user interface in the form of a mobile or web application provides real-time parking status, slot reservation, and navigation support to users, while an administrative module manages system monitoring and billing. This methodology enhances parking efficiency, reduces search time, and supports scalable deployment in smart city environments. Vehicle presence is detected using sensors installed in each parking slot and processed by a microcontroller [8]. The collected data is transmitted wirelessly to a cloud server, where parking availability is updated continuously. Users can access this information through a mobile or web application to locate and reserve vacant parking spaces efficiently. The research methodology for the Smart Parking System follows a systematic and structured approach to design, develop, and evaluate an intelligent parking management solution. The methodology begins with an extensive literature review to analyze existing parking systems, technologies, and their limitations. This helps in identifying research gaps and defining the functional requirements of the proposed system. In the next phase, system architecture is designed by selecting suitable hardware and software components, including IoT sensors, microcontrollers (such as Arduino or Node MCU), communication modules (Wi-Fi/GSM), and cloud platforms. Parking slots are equipped with sensors to detect vehicle presence, and the data collected is transmitted to a central server for processing. A mobile or web-based interface is developed to display real-time parking status, guide users to available slots, and allow booking functionality. The implementation phase involves integrating hardware with software, configuring data transmission protocols, and implementing algorithms for slot detection and allocation. The system is then tested under various real-world conditions to measure performance metrics such as accuracy of detection, response time, reliability, and system efficiency. User feedback and analytical results are used to refine and optimize the system. Finally, the system's effectiveness is evaluated by comparing its performance with traditional parking methods, validating its contribution towards reduced congestion and improved parking management [11].

4. LIMITATIONS

- **High Initial Deployment Cost** Installation of sensors, communication modules, and cloud infrastructure requires a significant initial investment, especially for large-scale parking areas.
- **Sensor Accuracy and Reliability Issues** Environmental factors such as rain, dust, temperature variations, and physical obstructions can affect sensor performance, leading to false occupancy detection.
- **Network Dependency** The system relies heavily on continuous internet or wireless connectivity. Network failures or latency can disrupt real-time data updates.
- **Maintenance and Operational Challenges** Sensors and electronic components require periodic maintenance and replacement, increasing long-term operational costs.
- **Scalability Constraints** scaling the system to cover large urban areas may introduce challenges related to data handling, network congestion, and system synchronization.
- **Energy Consumption** Battery-powered sensor nodes may face power constraints, requiring frequent battery replacement or energy-efficient designs.
- **Data Security and Privacy Concerns** Transmission and storage of real-time parking data may be vulnerable to cyber threats if proper security mechanisms are not implemented.
- **User Adoption and System Integration** Effective usage depends on user awareness and acceptance, as well as integration with existing urban infrastructure and traffic management systems.

5. CONCLUSION

The Smart Parking System successfully demonstrates an efficient and automated approach to managing parking spaces using IoT and embedded technologies. By integrating components such as RFID authentication, IR sensors, Arduino controller, Wi-Fi connectivity, and servo-based gate control, the system ensures secure vehicle entry, real-time monitoring of slot availability, and effective utilization of parking resources[12]. This intelligent solution significantly reduces the time spent searching for parking, minimizes traffic congestion, and enhances user convenience while improving overall security and operational efficiency. The system also supports cloud-based monitoring and remote access, making it suitable for modern smart city applications. With its reliability, scalability, and low maintenance requirements, the Smart Parking System provides a practical foundation for future advancements in intelligent transportation and automated urban infrastructure [14]. The Smart Parking System presents an efficient and intelligent solution to the growing challenges of parking management in urban environments. By leveraging Internet of Things (IoT) technologies, real-time sensing, and cloud-based data processing, the system effectively monitors parking space availability and provides timely information to users. This approach significantly reduces parking search time, traffic congestion, fuel consumption, and environmental pollution while improving parking space utilization. Although challenges such as deployment cost, sensor reliability, and network dependency exist, the proposed system demonstrates strong potential for scalable and sustainable implementation in smart cities. Overall, the Smart Parking System enhances user convenience, operational efficiency, and supports the development of intelligent urban transportation infrastructure [22].

6. ACKNOWLEDGEMENT

I would like to express sincere gratitude to all those who contributed to the successful completion of this research on the Smart Parking System. Special thanks are extended to the institution for providing the necessary facilities and a supportive research environment. I am deeply thankful to the faculty members and mentors for their valuable guidance, constructive suggestions, and continuous encouragement throughout the research work. Appreciation is also extended to colleagues and peers for their cooperation and insightful discussions. The support and contributions of everyone who directly or indirectly assisted in this study are gratefully acknowledged.

7. REFERENCES

[1] S. Mathur et al. “ParkNet: Drive-by Sensing of Road-Side Parking Statistics” ACM MobiSys (Mobile Systems, Applications, and Services), 2010
[2] S. Nawaz, C. Efstratiou, C. Mascolo “ParkSense: A Smartphone Based Sensing System for On-Street Parking” ACM MobiCom, 2013
[3] Fabusuyi, Hampshire, Hill “Evaluation of a Smart Parking System” The paper *“Evaluation of a Smart Parking System”* TRB (Transportation Research Board) Paper / TRR, 2013
[4] (SFMTA) San Francisco Municipal Transportation Agency “SFpark Pilot Project Evaluation” SFMTA Report, 2013

[5] K.-H. Liu "On-street smart parking networks at a fraction of their cost: Practical design and deployment considerations" Wiley – ETT (Transactions on Emerging Telecommunications Technologies), 2014
[6] Y.-Y. Chu "IoT in Vehicle Presence Detection of Smart Parking System" The paper *"IoT in Vehicle Presence Detection of Smart Parking System"* IEEE ECICE (Eurasia Conf. on IoT, Communication and Engineering), 2020
[7] Jung "An IoT-based smart parking management system" The paper *"An IoT-Based Smart Parking Management System"* IJCVR, 2020
[8] G. Ali et al. "IoT Based Smart Parking System Using Deep Long Short Memory Network" The paper *"IoT Based Smart Parking System Using Deep Long Short Memory Network"* MDPI Electronics, 2020
[9] S. Bock, S. Di Martino, A. Origlia "Smart Parking: Using a Crowd of Taxis to Sense On-Street Parking Space Availability" IEEE Transactions on Intelligent Transportation Systems, 2020
[10] A. Fahim et al. "Smart parking systems: comprehensive review based on various aspects" The paper *"Smart Parking Systems: Comprehensive Review Based on Various Aspects"* Heliyon (ScienceDirect), 2021
[11] GokulKrishna et al. "An IoT based Smart Outdoor Parking System" IEEE ICACCS, 2021
[12] Agarwal et al. "IoT based Smart Parking System" IEEE ICICCS, 2021
[13] C. P. Lee et al. "Edge computing-enabled secure and energy-efficient smart parking system" Microprocessors and Microsystems (ScienceDirect / Elsevier), 2022
[14] E. Kadusic et al. "A Smart Parking Solution by Integrating NB-IoT Radio Communication and Cloud Computing" MDPI Future Internet, 2022
[15] S. C. Koumetio Tekouabou et al. "Improving parking availability prediction in smart cities with IoT and ensemble-based model" Journal of King Saud University – Computer and Information Sciences (ScienceDirect), 2022
[16] J. L. Atiqoh et al. "Blockchain-based Smart Parking System using Ring Signature" IEEE / Computer Society Proceedings, 2022
[17] M. Baza et al. "Privacy-preserving Blockchain-assisted private-parking" Computers & Electrical Engineering (Elsevier), 2022
[18] Y.-C. Yu et al. "Smart Parking System Based on Edge-Cloud-Dew Computing Architecture" MDPI Electronics, 2023
[19] A. O. Elfaki et al. "A Smart Real-Time Parking Control and Monitoring System" MDPI Sensors, 2023
[20] H. Khan et al. "IoT-based cost-effective smart parking system" AIP Conference Proceedings, 2023
[21] M. Lyu et al. "Short-term prediction of on-street parking occupancy using deep learning" Journal of Traffic and Transportation Engineering (Elsevier/KeAi), 2024
[22] W. A. Jabbar et al. "Internet of things enabled parking management system" AIP Conference Proceedings, 2024
[23] K. K. Gaurav et al. "A blockchain-enabled private parking space allocation" Computers & Industrial Engineering (Elsevier), 2024
[24] M. A. Ala'anzy et al. "Real time smart parking system based on IoT and fog computing" Scientific Reports (Nature), 2025
[25] Y. Azi "Smart Parking System Mobile Application using Ultrasonic Detector" (Published paper via ResearchGate record), 2022