OPEN ACCESS
J. OF ICT, VOL. 5, NO. 1, PP.046-056, JUNI 2023

ISSN : 2686-1089 (ONLINE)
DOI: 10.52661

Journal of Informatics and Communications Technology (JICT)

A Literature Review for Understanding the Development of Smart Parking Systems

Nanang Cahyadi [#1], Pietra Dorand [#2], Nurwan Reza Fachrur Rozi[#3], Laksamana Aidzul Haq [#4], Refsi Indra Maulana [#5]

Telecommunication Engineering Department, Telkom University
Jl. Raya Daan Mogot No.KM. 11, Kota Jakarta Barat, DKI Jakarta, Indonesia

[1] nanangcahyadi@telkomuniversity.ac.id
[2] pietra@telkomuniversity.ac.id
[3] nurwan@telkomuniversity.ac.id
[4] laksamanaaidzulhaq@student.telkomuniversity.ac.id
[5] refsiiindra@student.telkomuniversity.ac.id

Abstract

Smart parking systems that use AI, data analytics, and IoT are a result of urbanization and rising automobile utilization. These systems are designed to enhance user experience, shorten search times, and make the most of available space. AI analyzes real-time data, proposes open places, and projects demand in the future. Infrastructure costs, stakeholder cooperation, and system compatibility continue to be issues, nevertheless. To maintain user confidence, privacy, and ethical usage in the study of smart parking systems, in-depth literature reviews are essential. The systematic literature review (SLR) method was used to examine AI-based smart parking solutions, such as wireless sensor networks, ultrasonicsensor nodes, reservation-based systems, intelligent parking guidance, IoT-based on-street infraction monitoring, central parking management systems, and energy-efficient automated solutions. Budgetary restrictions, stakeholder participation, interoperability concerns, data privacy, security, and moral ambiguities are all problems. To test scenarios, understand rules, processes, and algorithms in limited contexts, researchers need to develop reliable outdoor sensor and data technologies for outside application.

Keywords: Smart parking systems, AI-based smart parking solutions, Data analytics, IoT, User experience

I. INTRODUCTION

RAPID urbanization and the rise in the number of motor vehicles in cities have created significant obstacles for effective and structured parking. Smart parking systems, which attempt to offer creative solutions for parking management, have been a key focus of technical research to address this problem. Intelligently detecting and managing parking availability is made possible by smart parking systems, which make use of cutting-edge technology like artificial intelligence (AI), data analytics, and the Internet of Things (IoT).

Smart parking system research has advanced significantly in recent years. Modern researches have concentrated on the creation of increasingly complex and effective systems with the intention of accelerating parking search times, maximizing parking space use, and improving user experience. A cloud-based smart parking approach using IoT, UHFRFID, and IEEE 802.15.4 Wireless Sensor Networks, has been proposed. A

mobile application helps users find vacant parking locations, and fuzzy logic estimates vacant size based on energy efficiency. Intelligent parking assistants, reservation systems, Bluetooth communication, and parking navigation systems have been developed to improve parking experience. A new cloud-based approach has been developed to reduce waiting time, and machine learning methods like artificial neural networks, support vector machines, and regression have been analyzed.[1]. Additionally, the application of AI in smart parking systems has emerged as a significant trend. AI is being utilized to evaluate real-time data, recommend available parking spots to users, and forecast future parking demand.

The paradigm of the "smart city" seeks to enhance municipal services and advance sustainable growth. Staff and students at the University of Mauritius frequently choose the nearest parking spots, which causes parking challenges. The suggested ontology, which is based on the Smart Parking ontology from Wise-IoT, covers the fields of public administration, transportation, and traffic congestion. It focuses on the realms of traffic congestion, public administration, and transportation while developing ontologies in an agile and modular manner. The Protégé tool will be used to create future works, which will be tested in actual circumstances[2].

Smart parking system adoption has the potential to help metropolitan areas in a variety of ways. These technologies can improve overall transportation efficiency, lessen traffic congestion, and minimize carbon emissions by effectively managing parking spots. Additionally, by decreasing the time and effort required to find parking spaces, they can enhance user experience and relieve drivers' stress. There are still issues and factors to consider despite the possible advantages and technical developments. These include the price of putting in place smart parking infrastructure, the necessity of cooperation between many stakeholders,and the system interoperability across various parking facilities and cities. To establish trust and guarantee user approval, concern pertaining to data privacy, security, and ethical use of obtained information must also be carefully considered.

Smart parking systems that make use of AI, data analytics, and IoT provide innovative solutions to the problems caused by urbanization and an increase in the number of vehicles. The development of sophisticated technologies to decrease the time it takes to find parking, maximize space use, and improve userexperience has been the main emphasis of this field of study. Adoption of these technologies may result in more efficient transportation, less traffic, and lower emissions. However, concerns including interoperability, stakeholder collaboration, and infrastructure expenses must be addressed. To ensure that improvements are in line with user trust, privacy, and ethical issues, thorough literature studies are essential for understanding new trends and filling knowledge gaps in the study on smart parking systems.

II. METHODOLOGY

Using a systematic literature review (SLR) technique to undertake an extensive study of the present state of research in smart parking systems enabled us to obtain a thorough understanding of the developments, trends, and knowledge gaps regarding the use of AI in smart parking systems, implementation strategies for open and limited parking spaces, as well as the challenges and constraints faced in their development. This part goes through the specific approach to performing the SLR and the precautions to make sure the review was thorough and objective.

Choosing suitable papers required specifying the inclusion and exclusion criteria during the literature search phase. Information was gathered from a variety of sources, including databases, journals, and conference papers. To capture the core of the study issue and enhance the retrieval of pertinent material, it was essentialto choose the right keywords. Below is the search design employed to identify relevant papers pertinent to the research.

Examining abstracts and titles for relevance was part of the selection process. The next step was to gather full-text publications, which were then carefully reviewed for inclusion. To guarantee the accuracy and value of the articles, the selection criteria were meticulously followed.

Table 1 Search Design for Findings Relevant Papers

Parameters	Results
Research Question	RQ1 - How far along is the technology for smart parking systems now? RQ2 - With the addition of AI, how has research on intelligent parking systems developed? RQ3 - Which open and constrained parking spots use smart parking system technology? RQ4 - What difficulties and limitations did the creation of smart parking systems encounter?
Keyword Search	Smart Parking System
Sources	IEEE Explorer and Semantic Scholar
Publication's Year	2018 – 2023
Conditions	Paper should be research paper not a survey/literature review paper.

The chosen papers were examined and synthesized using a methodical process. To gather and arrange pertinent data, a hierarchical framework was created. Key findings and common themes and patterns across the literature were presented using analytical approaches, such as the use of tables or matrices.

Table 2 Obtained Papers and Accepted Papers for Further Analysis

Source	Searched Paper	Accepted Papers
IEEE Explorer	2060	19
Semantic Scholar	100	15

To guarantee the validity and trustworthiness of the systematic literature review, these methodological stages were strictly adhered to. Such scientific methods present a thorough and impartial overview of the fieldof smart parking systems research by paving the way for intelligent comments and suggestions in the parts that follow in this article.

III. FINDINGS AND ANALYSIS

The main conclusions and insights thorough assessment of the literature on smart parking systems are presented in this section. In this study, smart parking systems (SPSs) are examined in several contexts, including wireless sensor networks, ultrasonic sensor nodes, reservation-based systems, intelligent parking guidance and information systems, IoT-based on-street violation management, central parking management systems, and energy-efficient automated systems. The parking lot statuses are detected and monitored by these systems, which also offer services like auto-tolling, security management, unoccupied parking, incorrectparking, and payment options[3].

The literature also emphasizes implementation tactics for both open and constrained parking spots. To maximize parking space usage and improve the entire parking experience, innovative solutions including dynamic pricing mechanisms, reservation systems, and intelligent parking guiding systems are being

developed. However, difficulties and limitations were found, including budgetary restrictions, stakeholder participation, interoperability problems, data privacy, security, and ethical dilemmas. For the creation and use of smart parking systems to be effective, several issues must be resolved.

The systematic literature review presents these findings and analysis to offer valuable insights into the state of research in smart parking systems. It also offers recommendations for researchers, practitioners, and policymakers on how to tackle problems and make the most of the potential of AI-driven smart parking systems in urban settings. There are common research group in smart parking systems, namely; (1) Artificial Intelligence (AI) and Machine Learning, (2) Sensors and Data Technologies, (3) Mobile Applications and User Experience, (4) Infrastructure and System Design, (5) Policy and Management, (6) Sustainability and Environmental Impact.

Artificial Intelligence and Machine Learning: Utilizing artificial intelligence (AI) and machine learning approaches addressed to forecast parking space availability, control parking line wait times, and maximize parking space use. Using a deep LSTM network and deep learning model and incorporating data from the internet of things were considered as suggested framework forecasts parking availability. The training dataset was the Birmingham Parking dataset. Effective assessment of parking spot availability is ensured by validation utilizing performance evaluation methodologies[4].

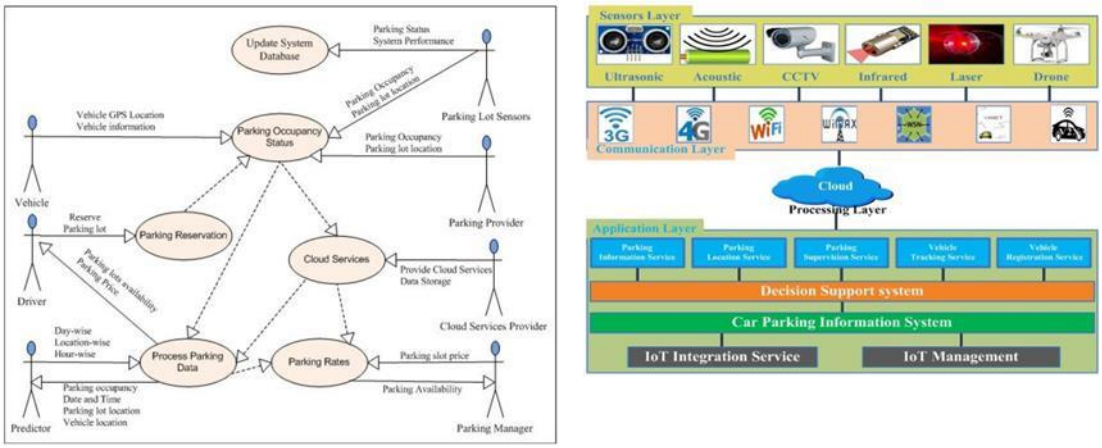

Figure 1 IoT and AI based smart parking system[4].

Sensor and Data Technologies: The Development and use of sensor technology for locating available parking spaces provide information on how such spaces are used and tracking their utilization. The goal of this project was to create an IoT-based outdoor parking framework that would make it simple to find and pay for parking spaces. The sensor-based technology lowers labor expenses, offers security, and discovers vacancies. Future improvements will boost localization and offer real-time parking area viewing. The simple- to-use program will help drivers quickly obtain real-time parking spot openings and location data[5]. The report suggested that IoT-based smart outdoor parking solutions for better communication and transparency. These systems make use of wireless sensor networks, low-energy Bluetooth beacons, and sophisticated real- time monitoring. They are scalable without using up more processing resources and offering security. To identify vehicle occupancy, the system makes use of physical sensors including PIR, Ultrasonic, and Infrared[5].

Another study introduces the technology that gives precise parking information with a 97.03% accuracy rate and is based on a 3D scene at Macao International Airport. It is a cost-effective option for smart parking lots and shines in open areas[6]. Additionally, this study introduces a user-dedicated smart parking scheme based on user-intent-based smart services, user/vehicle status detection, and high-resolution proximity

estimate. Such study employs sensors and wireless signals for in-depth user and vehicle status detection and BLE-beacon-based outside localizations. Thus, the technology enhances the efficiency of parking service operations[7].

Another report informed the photovoltaics-based smart car parking prototype, including data on panel power, dimensions, and ultrasonic sensor circuits for obstacle warning. [8]. Furthermore, in the literature study, a multi-layer smart parking system incorporating multi-parametric sensor nodes, low-power wireless communication, and edge-cloud computation were proposed. Such system aims at optimizing income and ensuring ideal slot availability through dynamic parking management, real-time car surveillance, and adynamic pricing system.[9].

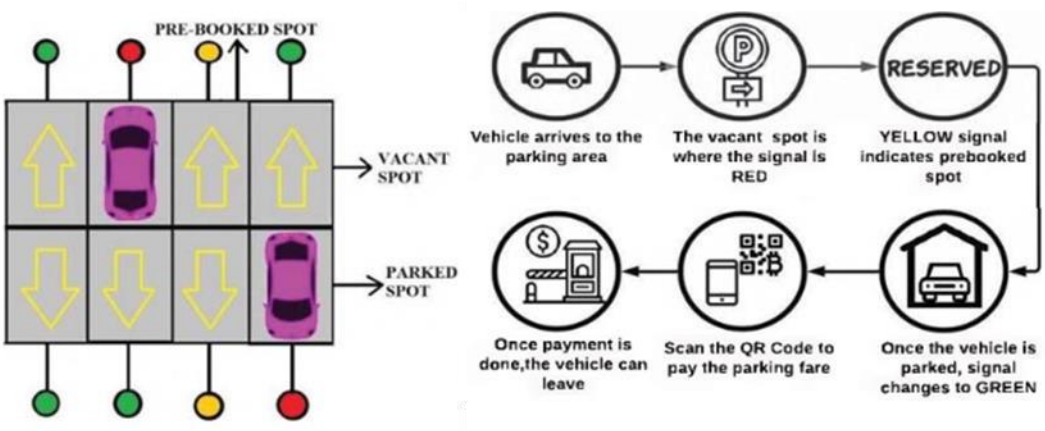

Figure 2 Overview of Outdoor Smart Parking System[5]

Additionally, the literature review identifies the UParking system, a smart parking management system that uses IoT technology, as a further discovery. An ANPR camera, a TCRT5000 sensor, a mobile app, and a website are all integrated into this system along with other networked devices. Such technology could be combined with other systems and tested in various environments by enhancing parking management methods.[10].

Mobile Applications and User Experience: Focusing on improving user experience through intuitive interface design, real-time information, and seamless interaction with payment systems, development of user-friendly mobile applications for simple parking search, reservation, and payment.

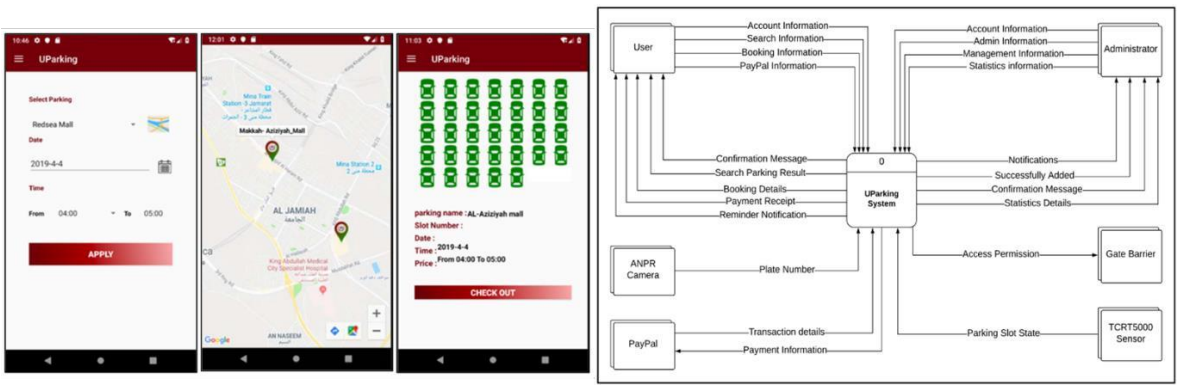

Figure 3 Mobile Application and Context Diagram[10]

Next, the E-parking system prototype provides a cutting-edge parking management solution for civic facilities. Drivers may use it to check parking availability, reserve spaces, spot illegal parking, gauge how long a space will be used, and automatically collect parking fines using convenient payment methods[3]. A user-friendly app is made available for all user actions, from finding a parking spot to make a confirmed reservation. The circuitry utilized throughout the whole process is simple to build and affordable for companies to apply[11].

A new architecture for a smart parking system utilizing BLE beacon devices is presented in this research. The objective was to create a smartphone application that would allow users to locate and pay for parking, as well as give parking facility owners management tools conveniently and securely[9]. To provide automated cashless invoicing, hacking notification, and post-trip booking, this paper suggests a smart parking system for drivers utilizing the internet of things. Additionally, the system alerts traffic police on parking locations and enhance the quality of life in a smart city[12].

The user experience and positioning effectiveness are improved by a smart parking solution utilizing AR and video navigation. Without sensors or expensive infrastructure, the system is aesthetically pleasing,functional, and economical. The design tested on the campus of An-Najah National University might be used in smart city settings[13].

Infrastructure and System Design: Designing the infrastructure and systems for smart parking, including sensor networks, planning parking layouts, managing communication networks are an integration to other transportation infrastructure. For university campuses, researchers were creating a smart parking ontology while taking IoT concepts and interoperability into account. Using an agile, modular approach, the ontology makes use of pre-existing ontologies such as Wise-IoT, SSN, and FOAF[2]. Mesh networks, Android OS tools, and IoT Area concepts were used in the solution to provide deployable and reasonably priced solutions. It makes use of the Up Board with DK-EVAL-04A communication module, the small PC platform, IQRF technology, and the DPA protocol. Analysis of current techniques and solutions is done[14].

To increase the comfort and convenience of car parking, the smart parking system made use of cloud computing, fog computing nodes, sensors, and parking management software. Subscription, advanced reservation, and non-reservation cars are the three parking classifications that are considered. The system processes and collects data using wireless connection capabilities. The article provides a full description of the system's design, functioning, availability prediction, parking-spot selection, and pricing algorithms[15]. The paper examines mesh network position, data collator positions, and hybrid radio duty cycling effects. It proposes a concise data format for occupancy data, reducing packet exchange between data collators and consumers[16].

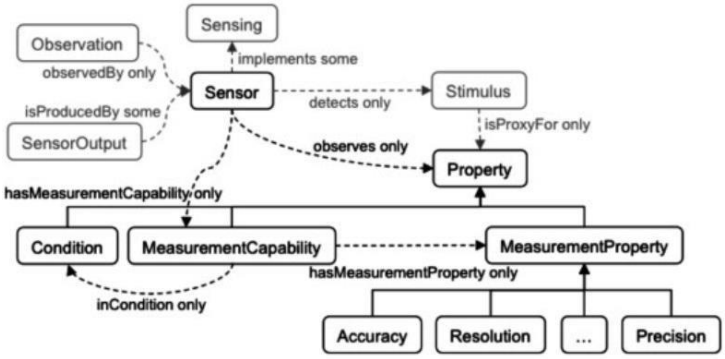

Figure 4 SSN Ontology[2]

By solving scalability issues in IoT-cloud systems for autonomous vehicles (AVs), this work contributes to smart parking. The study improves the current IoT-cloud platform for AVs utilizing fog-blockchain technologies, putting a special emphasis on QoS, low latency, system efficiency, and security. The deployment of the inclusive, long-term, successful, and high-performing SAVP system makes an SP solution possible[17]. For IoTRec, a system that enables drivers to assess predicted availability of parking spaces and routes. This study describes the semantic data modeling of parking and traffic sensors data. REST APIs are used to connect the planned IoTRec into Santander's Rich Parking application, making it simple to interface with other IoT applications and providing effective services. The article also emphasizes the creation of a GDPR-compliant implementation, a prototype for demonstration and review by smart city residents, and the providing of predicted availability statistics in real-time based on past IoT data[18]. Such argument aims at creating a prototype of an Internet of Things-based smart parking system for reservations of parking spaces onuniversity campuses[19].

Meanwhile, the project intends to give customers with a flexible, seamless parking system, eschewing conventional and application-based ways to increase the effectiveness of managing parking spaces in India and other nations[20]. The system reduces fuel expenses and optimizes vacancies by using VP_ID for user identification and the IOTPS algorithm to search for openings and optimize vehicle parking[21].

Policy and Management: Researching pricing rules, operational management, policy regulations, and economic modeling in the context of smart parking systems are then discussed. In this study, a green PAYG smart parking system that makes use of vacant garage spaces around-the-clock is presented. Such study implemented an IDFP algorithm for the best fees and used an ASP.NET Web API for communication[22]. The project met its goals by evaluating data and reducing the amount of area needed for a prototype rotary automated parking system by 24.7% and the amount of time needed for each man-hour by 6 minutes. This demonstrates how well the system can handle the nation's time and space problems[23].

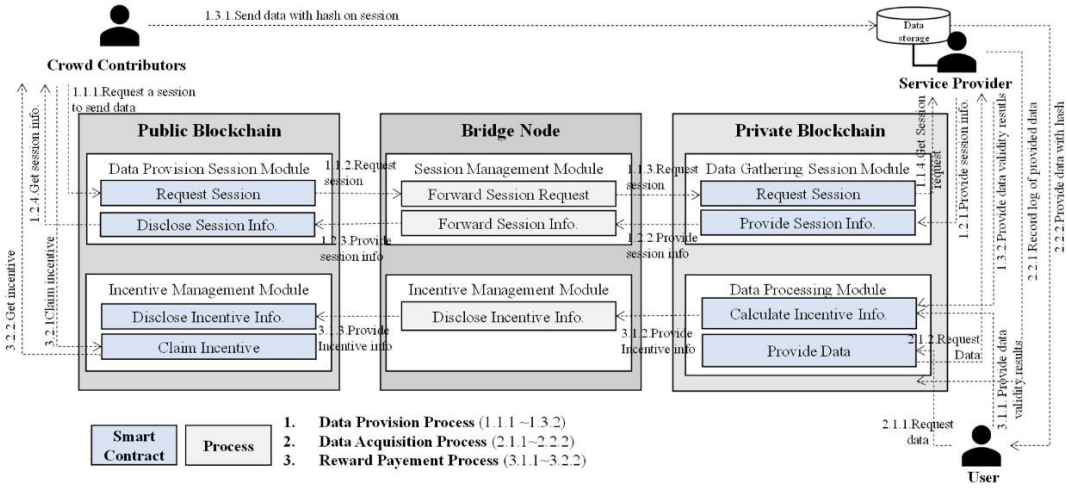

Figure 5 Functional Module and Data Flow in Multi-Blockchain System[24]

To automate the incentive model and distribute sensitive information on a private blockchain, a bridge node is created for 1:1 information exchange between two blockchains. The real-time exchange of gathered data among service providers and parking information are made possible by this technology. The suggested framework involves the distribution of secure sensing data, clear incentive payments, and enough information. Through the blockchain, the donor obtains secure session data and sends it straight to the service provider. This technique can improve data transfer efficiency and fend off passive assaults from trustworthy service providers[24].

Such paper's goal is to analyze and research the current parking system while implementing the novel notion of queuing theory to address the parking issue in metropolitan areas[25]. This study suggests a consortium blockchain-based decentralized smart parking system that protects user privacy and uses a blockchain network built by parking lot owners to track parking offers[26]. By offering a sensor platform and mobile app for in-the-moment interaction with parking lot infrastructure, the Smart Parking Management System (SPMS) intends to assist drivers in resolving parking difficulties. This cuts down on search time and makes it easier to locate parked autos. To demonstrate the system's efficacy and examine the possibility of its integration in actual parking lots, a small-scale testbed was created[27].

Sustainability and Environmental Impact: Analyzing innovations, methods that more efficient energy use, less congested roads through smart parking management are also discussed. The paper explains the techniques that decrease energy use, traffic congestion, and time spent looking that enable drivers to plan their trips depending on the availability of parking on days and hours[4]. By directing cars to the parking location, the drivers chose a reservation-based smart parking system hoping to lessen traffic congestion. In addition to displaying available and reserved spots, a visual interface uses GPS technology to locate adjacent sites. Users can pay for booked spots using cashless payment modules, which improves the system's dependability and convenience[28].

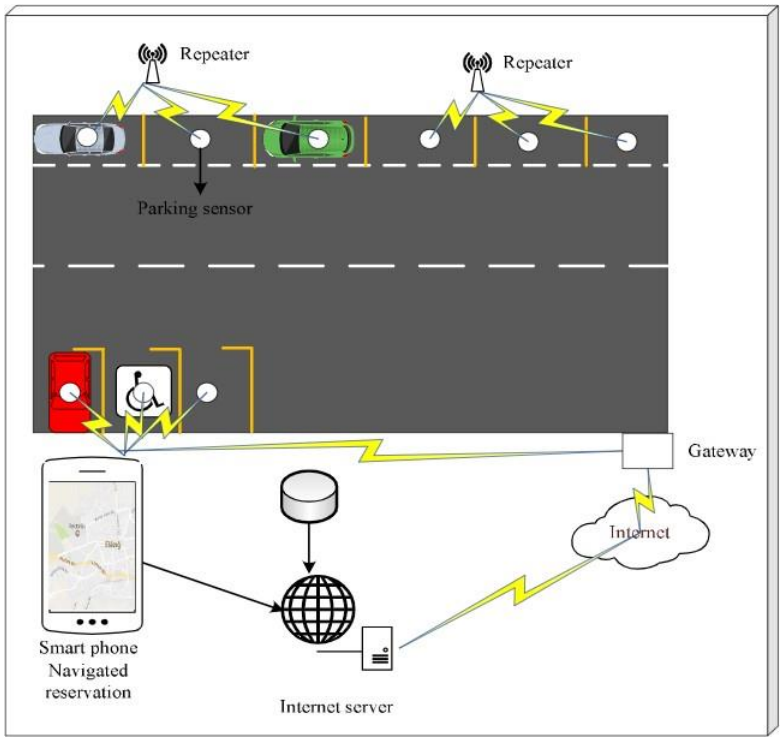

Figure 6 Work Diagram of Navigation Based Smart Parking System[1]

For locating open parking spaces in smart cities, a newly improved reservation-based strategy is suggested. The approach leverages GPS information from cars to apply a genetic algorithm to locate the closest open space. The method's benefits have been demonstrated in a variety of situations with positive performance outcomes[1]. Urban areas may benefit from IoT and cloud developments, and smart parking garages are a key component of creating smart communities. At last, the appearance of parking spaces is enhanced, waiting times are decreased, and traffic congestion concerns are addressed[29].

IV. DISCUSSION

A thorough literature study about smart parking systems is discovered in this discussion session for the sake of finding and evaluating the most recent results of research on intelligent parking systems. The usage of IoT, parking management, sensor technologies, and user experience are just a few of the topics discussed. However, examining the research that has been done highlighted interesting findings related to the creation of smart parking systems.

There is a lot of promise for the creation of smart parking systems as AI technology develops. The research in this area has not, however, completely realized the promise that AI has to offer. Findings from a report that show that just one instance of the construction of a smart parking system incorporating AI has been seen thus far confirm this. The development of smart parking systems is a huge potential to further investigate and optimize the application of AI.

Smart parking system research has undergone several breakthroughs to support sensor and data technologies, but the bulk of these improvements have not yet addressed the difficult outdoor circumstances. Therefore, there is a clear need for research to concentrate on creating reliable sensor and data technologies that are especially suited for outdoor environments. Diverse advancements in sensor and data technologies have been made in the field of research on smart parking systems.

It is important to keep in mind, nevertheless, that these developments have mostly ignored the complexity of outside environments. This provides a significant research opportunity to focus on developing reliable sensor and data technologies that can successfully function in outside situations. Researchers can close the existing gap and provide solutions that are more suited for the difficulties experienced in outdoor smart parking systems by concentrating on outside-specific factors, such as changeable weather, shifting lighting conditions, and unforeseen impediments. To fully realize the promise of smart parking systems, it is therefore essential to explore and create sensor and data technologies that are durable and dependable in outdoor settings.

Studies on parking system management and regulation have frequently centered on test-bed settings. To assess the efficacy of policies and procedures, more diverse scenario testing is necessary. There hasn't been much study on confined parking systems, and algorithms specifically designed for restricted spaces are urgently needed. To fully evaluate the efficacy of policies and systems under various conditions, a widerrange of scenario testing is required. On managing parking systems in limited areas, little study has been done. To evaluate the effectiveness of current algorithms and create new ones for parking space control, further testing is required. More comprehensive scenario testing and research on parking systems in confined areas will lead to better answers and new understandings of rules, procedures, and algorithms.

V. Conclusion

The literature review on smart parking systems concludes with an emphasis on user experience, IoT, parking management, and sensor technologies. Smart parking systems might be completely transformed by AI technology, but this promise has not yet been fully realized by study. Smart parking system development offers a big potential to research and improve AI applications. The majority of sensor and data technology developments, nevertheless, have not addressed the difficulties of outside situations. Researchers must concentrate on creating dependable sensor and data technologies that can operate in outdoor settings if they are to fully realize the promise of smart parking systems. To evaluate the effectiveness of policies and processes, particularly in cramped locations, more varied scenario testing is required. A greater knowledge of the regulations, practices, and algorithms will result from further study of parking systems in constrained spaces.

REFERENCES

[1] I. Aydin, M. Karakose, and E. Karakose, "A Navigation and Reservation Based Smart Parking Platform Using Genetic Optimization for Smart Cities."

[2] S. Devi Nagowah, H. Ben Sta, and B. Ashwin Gobin-Rahimbux, "An Ontology for an IoT-enabled Smart Parking in a University Campus," 2019.

[3] IEEE Communications Society and Institute of Electrical and Electronics Engineers, *An IoT-based E-Parking System for Smart Cities*.

[4] G. Ali *et al.*, "IoT based smart parking system using deep long short memory network," *Electronics (Switzerland)*, vol. 9, no. 10, pp. 1–18, Oct. 2020, doi: 10.3390/electronics9101696.

[5] S. Gokulkrishna, J. Harsheetha, S. Akshaya, and D. Jeyabharathi, "An IoT based Smart Outdoor Parking System," in *2021 7th International Conference on Advanced Computing and Communication Systems, ICACCS 2021*, Institute of Electrical and Electronics Engineers Inc., Mar. 2021, pp. 1502–1506. doi: 10.1109/ICACCS51430.2021.9441766.

[6] B. Liu, H. Lai, S. Kan, and C. Chan, "Camera-Based Smart Parking System Using Perspective Transformation," *Smart Cities*, vol. 6, no. 2, pp. 1167–1184, Apr. 2023, doi: 10.3390/smartcities6020056.

[7] S. Park, "D-park: User-centric smart parking system over ble-beacon based internet of things," *Electronics (Switzerland)*, vol. 10, no. 5, pp. 1–15, Mar. 2021, doi: 10.3390/electronics10050541.

[8] M. Z. M. Nasir, S. Salimin, B. Chan, and S. A. Jumaat, "Prototype development of smart parking system powered by solar photovoltaic," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 18, no. 3, pp. 1229–1235, 2020, doi: 10.11591/ijeecs.v18.i3.pp1229-1235.

[9] K. Plataniotis, A. Mackey, and K. N. Plataniotis, "Smart Parking System Based on Bluetooth Low Energy Beacons with Particle Filtering." [Online]. Available: https://www.researchgate.net/publication/338737767

[10] Kullīyāt al-Taqnīyah al-ʻUlyā (United Arab Emirates) and Institute of Electrical and Electronics Engineers, *UParking: Developing a Smart Parking Management System Using the Internet of Things*.

[11] A. Somani, S. Periwal, K. Patel, and P. Gaikwad, "Cross Platform Smart Reservation Based Parking System."

[12] Vaigai College of Engineering, Institute of Electrical and Electronics Engineers. Madras Section, and Institute of Electrical and Electronics Engineers, *Smart parking system with pre & post reservation,billing and traffic app*.

[13] M. Al-Jabi and H. Sammaneh, "Toward Mobile AR-based Interactive Smart Parking System," in *Proceedings - 20th International Conference on High Performance Computing and Communications, 16th International Conference on Smart City and 4th International Conference on Data Science and Systems, HPCC/SmartCity/DSS 2018*, Institute of Electrical and Electronics Engineers Inc., Jan. 2019, pp. 1243–1247. doi: 10.1109/HPCC/SmartCity/DSS.2018.00209.

[14] V. Sobeslav and J. Horalek, "A smart parking system based on mini PC platform and mobile application for parking space detection," *Mobile Information Systems*, vol. 2020, 2020, doi: 10.1155/2020/8875301.

[15] M. Balfaqih, W. Jabbar, M. Khayyat, and R. Hassan, "Design and development of smart parking system based on fog computing and internet of things," *Electronics (Switzerland)*, vol. 10, no. 24, Dec. 2021, doi: 10.3390/electronics10243184.

[16] T. Anusha and M. Pushpalatha, "Efficient Communication Model for a Smart Parking System with Multiple Data Consumers," *Smart Cities*, vol. 5, no. 4, pp. 1536–1553, Dec. 2022, doi: 10.3390/smartcities5040078.

[17] A. Shahzad, A. Gherbi, and K. Zhang, "Enabling Fog–Blockchain Computing for Autonomous-Vehicle-Parking System: A Solution to Reinforce IoT–Cloud Platform for Future Smart Parking," *Sensors*, vol. 22, no. 13, Jul. 2022, doi: 10.3390/s22134849.

[18] Y. Saleem *et al.*, "IoTRec: The IoT Recommender for Smart Parking System."

[19] C. Ajchariyavanich *et al.*, "Park King: An IoT-based Smart Parking System," 2019.

[20] S. Kazi, A. professor, U. Ansari, and S. Khan Student, "Smart Parking based System for smarter cities."

[21] M. Kannan, C. Priya, M. L. W. Mary, and R. Manikandan, “Towards Smart City through Virtualized and Computerized Car parking System using Arduino in the Internet of Things,” 2020.
[22] A. Sant, L. Garg, P. Xuereb, and C. Chakraborty, “A Novel Green IoT-Based Pay-As-You-Go Smart Parking System,” *Computers, Materials and Continua*, vol. 67, no. 3, pp. 3523–3544, Mar. 2021, doi: 10.32604/cmc.2021.015265.
[23] IEEE Control Systems Society. Chapter Malaysia and Institute of Electrical and Electronics Engineers, *Design and Implementation of a Rotary Parking System for a Truly Smart City*.
[24] M. Kim and Y. Kim, “Multi-blockchain structure for a crowdsensing-based smart parking system,” *Future Internet*, vol. 12, no. 5, May 2020, doi: 10.3390/FI12050090.
[25] S. K. Niranjan, Institute of Electrical and Electronics Engineers, Institute of Electrical and Electronics Engineers. Bangalore Section, and IEEE Computational Intelligence Society. Bangalore Chapter, *Navigation based -Intelligent Parking Management System using Queuing theory and IOT*.
[26] W. Al Amiri, M. Baza, K. Banawan, M. Mahmoud, W. Alasmary, and K. Akkaya, “Privacy-Preserving Smart Parking System Using Blockchain and Private Information Retrieval.”
[27] Jāmiʿat al-Ḥasan al-Thānī, Institute of Electrical and Electronics Engineers, and IEEE Smart Cities Technical Community, *Towards a Smart Parking Management System forSmart Cities.*
[28] “SMART PARKING SYSTEM TO REDUCE TRAFFIC CONGESTION.”
[29] R. Atiqur, “Radio frequency identification based smart parking system using Internet of Things,” *IAES International Journal of Robotics and Automation (IJRA)*, vol. 10, no. 1, p. 41, Mar. 2021, doi: 10.11591/ijra.v10i1.pp41-50.