International Journal of Industrial Engineering
2023;7(1):13-20.
ISSN: 2456-8449

Development of a Smart Parking Management System Using Round Robin Scheduling

P. Anandan[1*], G. Suresh[2], N Anbuselvan[3], N. Kumaratharan[4]

[1]*Department of Electronics and Communication Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India.*
[2]*Department of Electronics and Communication Engineering, Sri Indu College of Engineering and Technology, Hyderabad, Telangana, India.*
[3]*Department of Electrical and Electronics Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India.*
[4]*Department of Electronics and Communication Engineering, Sri Venkateswara College of Engineering, Chennai, Tamil Nadu, India.*

[*]*Corresponding author: anandanvp2000@gmail.com*

Abstract. The use of Radio Frequency Identifications (RFID) technology in automations has resulted in significant reductions in transactions costs and decreases in stock scarcity. Most RFID networks include several forms of automation. There are a variety of RFID devices, including readers, writers, scanners, sensors, and controllers. Selecting an RFID-enabled smart parking system with the Round Robin algorithm provides a complete answer for precise car identification, equitable space distribution, better traffic flow, and improved user experience. By combining the advantages of both technologies, a parking management system that is both effective and well-organized is produced. Using RFID technology in conjunction with a fair allocation technique, a Smart Parking System using the Round Robin algorithm aims to provide an effective, well-organized, and user-friendly parking management system. The challenges faced by parking-lot management systems have been addressed in this research with the use of RFID technology. Key elements of RFID technology include RFID readers, RFID labels, computers, obstacles, and software. Management, control, transaction reporting, and operations of parking lots in different sections of the city have all been taken care of by the program. RFID reader's label and barrier would be used to manage the parking lots' check-in and check-out processes. Using this technology would drastically cut down on the expense of human resources. With RFID technology, unattended, secure, atomized parking lots will soon be a reality. Results show that the 98% of accuracy and 1% of loss in validation data set.

Keywords: Radio Frequency Identification, Automation, Parking-Lot, Round Robin Algorithm and Smart Parking system

INTRODUCTION

Because of technological progress, parking has become an issue in the present decade. Because of the high concentration of people in metropolitan areas, parking, and traffic congestion are constant issues. Vehicle parking has emerged as a global problem. It has been calculated that daily oil consumption by autos stands at about one million. This study presents a real-time, fully automated method for parking vehicles. To put this system into action turned to Internet of Things (IoT). When two physical devices are connected through IoT, information or data may be sent between them. The suggested system makes use of the Arduino Uno microcontroller [1]. The primary function of Arduino in the proposed system is to serve as a medium for the exchange of data between various sensing and controlling digital devices and interactive objects. To facilitate car parking, the suggested system makes use of an Arduino Uno board, and a Node links the parking lot to the internet. The suggested system used infrared sensors installed in each parking spot to detect when a spot was vacant. The user may reserve a parking spot in advance, with all the details already stored on the server. Everyone has their own unique ID and password. The system would send a message to the admin if there was any kind of abuse [2].

Parking lots are a need for public buildings like shopping centers and movie theaters. Since the productivity of a vehicle in Indonesia is increasing at such a high rate, it is becoming more difficult to locate an empty parking space. It will be difficult for drivers to locate a parking spot, causing them to spin in circles as they hunt for available spots. This will only serve to further confuse them and increase the likelihood that they will ultimately

Received: 06.01.2023 Revised: 11.02.2023 Accepted: 24.02.2023

fail to park their vehicle. Due to poorly managed security systems and data, parking lot auto thefts have been on the rise, even in recent times. Traditional parking tickets are often used, and when one is misplaced or accidentally dropped, auto thieves may use it to drive off with a stolen vehicle [3]. A smart parking system would be the answer to this predicament. A smart parking system is a computerized system designed to make the parking process easier for cars. For this study, the Ethernet shield will be used to transmit information from the system to the Internet and vice versa. His study's overarching goal is to develop an intelligent parking system based on online parking spot transactions and monitoring. The system is composed of a microcontroller, an Ethernet shield, a database, a website where users may see information about available parking spots, and an ultrasonic sensor to locate such spots.

This article looks at some of the issues plaguing conventional parking lots. It also details the negative effects and inconvenient nature of conventional parking facilities. To help drivers locate an available parking spot, the authors of this study propose and outline the architecture of an IoT-based Smart Parking Systems. It also helps you avoid the hassle of driving through crowded parking areas. This article introduces a brand-new parking system that uses IoT via Wi-Fi and RFIDs. The authors propose an IoT based solution to the problem that centers on mobile apps, sensors, RFIDs, and Arduino [4]. The system makes it simple for customers to locate parking lots in the area, along with seeing real-time availability at each lot. They may reserve a parking spot using the app, then drive to the lot and verify their identity with an RFID tag. Using sensor data, the amount owed is calculated when you leave the service, and payments are handled via the associated in-app wallets. This innovation helps save time and energy formerly spent on mundane tasks like finding a parking spot and cleaning up pollution.

IoT has contributed much to the improvement of modern living conditions. In the context of Optimized Smart Systems for Transportations employing IoT and RFID technology, this article focuses on the designs, analysis, and assessments of RFID-based frameworks. The project's goal is to integrate cutting-edge IoT and RFID technologies across a wide range of important automotive use cases. IoT enables several cutting-edge digital solutions for urban areas, including smart parking systems, which are an essential component of smart cities. It helps the environment by reducing drive-around emission while providing hassle-free parking conveniences to city inhabitants, metering facilities, and a cash stream for companies. Overall, this article strives towards full automation and digitalization in areas like intelligent and automated parking systems and clear, efficient, and digitalized challan systems [5]. This RFID technology, which is based on paper but also incorporates other technologies like Arduino, is very practical and cost-effective. This study will not only improve the user experience by reducing manual labor and increasing automation, but it will also liberate individuals from the usual hassles of dealing with parking lots, challans, and car paperwork. Because of this, people would have less stress and be more productive. The government's ability to be open and honest with Challans would be bolstered as well. IoT enables several cutting-edge digital solutions for urban areas, including smart parking systems, which are an essential component of smart cities. It helps the environment by reducing drive-around emissions while providing hassle-free parking conveniences to city inhabitants, metering facilities, and a cash stream for companies. Due to their low price, these systems might be widely implemented [6].

The problem statement is discussed below. The obstacles and flaws in the current parking management systems are the focus of the problem statement for a smart parking system that combines RFID technology and the Round Robin algorithm. Conventional parking systems may identify vehicles using antiquated technology or manual processes, which causes delays and inefficiencies. Certain parking systems may assign spots based on the principle of first come, first served. The manual management of traffic flow inside the parking complex may result in delays and bottlenecks during peak hours. Owing to traffic jams in some places and underuse in others. Frustrate among users, unequal parking spot occupancy, and inefficient use of existing resources. Increased wait times decreased operating efficiency, and possible safety risks. Because many parking systems don't have real-time monitoring capabilities, it may be difficult to keep track of occupancy levels and react quickly to demand changes. a lack of data-driven decision-making, poor space usage, and difficulty managing peak times. The acceptance and successful deployment of an RFID-based smart parking system using the Round Robin algorithm depends on resolving these issues. The system's goal is to provide a parking management solution that improves customer happiness, security, fairness, and efficiency.

The following are work contributions.

- The design, construction, and operation of a smart parking system that uses RFID and the Round Robin algorithm are all covered by the contributions made to the system.

- These contributions concentrate on resolving issues with conventional parking systems and enhancing their general effectiveness, equity, and user experience.
- Use RFID technology to identify vehicles automatically and accurately. Minimize mistakes, cuts down on entrance and departure times, and do away with human identification procedures to increase the parking system's efficiency.
- Using of the Round Robin algorithm to ensure sequential and equitable distribution of parking spots. Distributes parking spaces fairly, avoids traffic in certain places, and maximizes the use of available space.
- Utilization trends and real-time monitoring of data analytics are used to measure parking spot occupancy. Makes data-driven decision-making easier, makes proactive peak period management possible, and helps with effective space allocation.
- Create of an easy-to-use interface and parking experience in general. Increases customer pleasure, offers precise information about available parking spots, and fosters a favorable impression of the parking facility.
- Applications of a Round Robin algorithm that is adaptable in real time according to data. Guarantees flexibility in managing parking operations, adapts to shifting demand patterns, and optimizes space allocation tactics.

Together, these efforts result in the creation and deployment of a smart parking system that combines the Round Robin algorithm with RFID technology to overcome major issues with conventional parking management and provide a more effective, equitable, and user-friendly alternative. The following section would be a literature survey discussed in section 2 after that proposed system is discussed using Round Robin algorithm for Smart Parking System in section 3. Then Result and discussion is discussed for the given dataset to improve the accuracy and loss in section 4. Finally, the conclusion provides the overall performance of the smart parking system and future work.

LITERATURE SURVEY

It's difficult for drivers to find a parking spot by eye in a garage full of cars. Traditional approaches to identifying empty or occupied rooms are seen as ineffective and unreliable. Using inexpensive inkjet-printed passive ultrahigh-frequency (UHF) RFIDs tags, this study creates and evaluates an IoT-enabled parking spot vacancy detection system. For the presence/absence detection of vehicles in parking spaces, the suggested system operates by analyzing the intensity of the backscattered signals from the tags at the receiver side. To begin, suggest a cheap passive tag designed for UHF RFID-band operation and pasted onto a plastic material display for parking spots [7]. To make decisions and provide open parking spots to drivers, the RFID reader sends the data it collects from the tags using the message queuing telemetry transports (MQTT) protocols and the Scotland 5G networks implemented in the Python module Pymongo. Using the embedded JavaScript's templates (EJS) for each slot, a Pythons-based web app retrieves information from the databases and displays it on a web app display. When automobiles are present, experimental observations show a significant decline in the received-signals-strength-indexes (RSSI) values at the receiver's end, suggesting that these signal drops may be used for vehicle presences identification in parking spaces. The proposed method is meant to ease the process of finding affordable and efficient parking spots. Recorded and given are test results proving the suggested system's superior performance and accuracy in the circumstances used.[8]. With the rise of the urban population and the subsequent increase in the number of automobiles, parking has become more difficult in cities. To help vehicles rapidly locate available parking spaces, an intelligent parking management system is the best option. An intelligent parking system that prioritizes motorist convenience and sustainability is needed to address these concerns. This work employs RFID technology and a survey of user preferences to suggest a system for managing multi-level parking lots.

To solve the average booking times and central parking management's servers' response time issue, strategy uses a multi-objectives decision-making mechanism. The simulation results demonstrate that compared lowers the responses time of the central parking management's servers by more than 20.1 and 29.78%, respectively. This study suggests novel automated parking systems that make use of the Internets of Things to provide a new payment option and decrease the need for human labor. A control unit in charge of the system's overall model keeps tabs

on everything [9]. Different criteria are used in the proposed system to allocate automated parking systems to any public or private place. This method also presents a paradigm in which users may locate a place with the aid of a website or app and a Google map. A user may pre-book a parking spot at a specified location and pay for it later, depending on whether that spot is still vacant. After a successful payment, an IoT-enabled barrier will automatically open, saving time and eliminating the need for human intervention. The benefit of this arrangement is that payments go straight to the proper authority and administration. The parking system will be improved by this technology, which will make it simpler to track parking spaces' occupancy and reroute drivers accordingly.

The purpose of this study is to design, implement, and test smart parking systems that use RFID sensors for online authentication in a variety of locations. This work is prototyping that uses a working model to test new ideas. Qualitative descriptive analysis methods were used for the data. A smart parking system was developed because of this research, and tests showed that the average time for card verification at parking portals varied by location but was always less than three seconds. The test findings indicate that the developed smart parking system, which makes use of RFID sensors for online verification at various locations, functions as intended [10]. Now that most people live in already advanced, industrialized, technologically advanced metropolitan areas, there is less of a pressing need to make cities smart. Data exchange, Artificial Intelligence (AI), Machine Learning (ML), analytics, and hundreds of RFIDs are all being used to make cities smart. Avoiding traffic congestion is a major goal of today's smart cities, which has led to a rise in the importance of traffic management and the necessity for well-organized parking facilities. In this piece, look at IoT-based, real-time prototypes of intelligent parking systems. The proposed intelligent parking system utilizes electronic devices that detect the parking spaces' availability statuses and assists drivers in locating and selecting parking spaces from among the available spaces, thereby significantly lowering the incidence of traffic congestion and municipal mismanagement [11].

Customers may reserve a parking spot via the website of the planned systems, which is based on the Internet's of Things and Cloud Computing. The systems consist of a reception module, a parking module, and a customer-facing module that operates through the Internet. Customers may quickly enter their parking space by scanning their RFID badges at the door. After they've checked in, they may drive to the parking spot they reserved (online). This system is intended to be smart enough to notify the proper authorities and customers when a vehicle is parked in an improper space. The system's seamless combination of hardware and software allows for easy, transparent, and customizable reservation of parking spaces [12]. The demand for a real-time intelligent parking system has arisen as the number of cars in cities continues to rise. Small cities often have a limited supply of parking spaces, and it may be difficult, if not impossible, to accurately ascertain this quantity using cutting-edge methods owing to limitations in both accessible resources and financial means. Image processing and other modern technologies rely on high-speed internet connections, which might be hard to come by in less populous places due to inadequate or outdated internet infrastructure [13].

This article details how we were able to cut down on internet use by using an Arduino Uno as the only means of communication. The RFID method has been used to verify the identity of those seeking a parking place and their affiliation with a certain group. In addition, GPS technology has been added, which is helpful in areas that span a huge geographical area or where pinpointing precise parking sites is a challenge. The Global Positioning System (GPS) sensors streamline parking even further by supplying the driver with precise coordinates (latitude and longitude) of the parking areas. Proteus software is used for the whole simulation of the system [14]. The number of parking spaces in cities is insufficient despite the ever-increasing number of cars. This suggested solution employs IoT to automate the parking system in the hopes of resolving the problem. The project includes an automated parking service, a tracking system, a management system, an in-the-moment billing and payment system, and a payment processing system. The method is inexpensive to deploy and may help the parking space owner make money by easing the burden of finding parking for the public. The system was built using a wide range of technologies, including IoT, image processing, objects identification, Firebases and many more. A web app and an Android app are both part of the system, which works together to improve the service provided to customers. The system is functional both online and offline [15].

PROPOSED SYSTEM

Using a centralized database system, this research successfully managed the check-in and check-out processes at three separate parking lots. The parking garages are situated all throughout the city. Hardware has been employed for central administration of the parking lots, and software has been used to operate the hardware. In terms of hardware, RFID readers, labels, toy vehicles, obstacles and laptop computers have all been used. The

software requirement for vehicle tracking includes a database management system for storing and organizing the data.The parking lots are managed, and data is accessed using visual programming languages. Phidget's EM Manrin Protocol (EM4 102) and RFID reader board are used. EM Manrin is a read-only protocol that operates at a low frequency of 125 kHz. The RFID reader successfully read RFID labels from distances of 7.62 cm. The information read included 40 bits of unique identifiers. The reader did not have rewritable capabilities. RFID scanners are often quite compact and circular in form.

That would make it simple to mount them on the cars. This program required a network connection between the many PCs involved. Information collected from municipal parking lots was saved in a database called RFIDDATA. Tables titled "Vehicle-information" and "Vehicle Circulation info" were added to the database with respective roles. The primary table stores a vehicle's basic characteristics, while the secondary table records its use statistics. Fields like vehicle lD, plate number, vehicle type, and vehicle model may be found in the primary table. The "Vehicle-Circulation-info" table was used to track a vehicle's check-in and check-out attempt, date, time, parking lot information, and total parking price in inner city parking lots. Database management system coded these two tables and controls their administration. The connection linked the RFID reader to the computer, allowing the program to exchange data with the reader. The barrier also has a connection that was set up. Each parking lot only used a single barrier and reader for RFID. Figure 1 shows the system architecture of the proposed system.

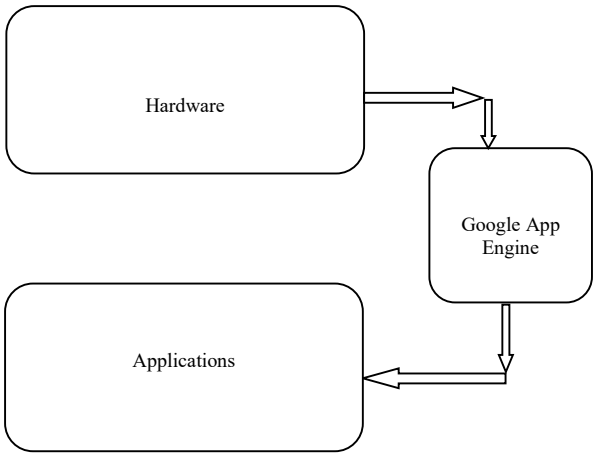

FIGURE 1. System architecture of the proposed system

All the vehicle details provided during the RFID label buying procedure are saved in the RFIDDATA database under the "Vehicle Information" table. When a car is equipped with an RFID label, all its associated data may be easily accessed online. The technology verifies the vehicle's registration every time it is checked in at a parking lot. If the car is registered but doesn't have any check-ins or check-out records, the barrier will rise, and the driver will be allowed to go. The initial step in the process of checking out a car is a database search using the vehicle's identifying number. The system will only enable the check-out of a registered car that has not been tampered with. The system will look up the guest's check-in time and date and replace it with the guest's check-out time and date.

RESULTS AND DISCUSSIONS

To begin, this program checks to see whether the central database already has entries for the car in question, and if not, it stores the basic information entered at registration time. If a vehicle already has a record in the system, no further data will be entered for that car. It is standard procedure for a parking lot to prevent a car from leaving if it has checked in without RFID notice. That way, no one can get in without permission. They wouldn’t be allowed to check cars into any of the city's lots again until you check it out. The central database administrator is the only one who can help with this. Vehicles within range of an RFID reader will have their registration information continuously retrieved. If a vehicle's details are entered into the database at this stage, there will be inconsistencies due to the possibility of duplicate entries. To get around this issue, the scanning process is completed when the car moves out of the RFID reader range.

A parking lot's RFID scanner won't be able to process the identifying data of two automobiles that pull up next to each other. Parking lot entrances should only be wide enough for a single car to pass through at a time to prevent such bottlenecks. At the entrances of parking lots, having spotlights that are wired directly to the RFID reader may alert cars to the presence or absence of parking spots. That way, you won't have to drive aimlessly trying to find a parking spot. If you lose Internet access while these procedures are running, you will also lose access to the master database. A local database system is activated when this occurs. When connectivity is restored, the systems will once again use remote databases. This research demonstrates that all a city's parking lots may be managed efficiently and cheaply via the use of RFID scanners and RFID labels connected to centralized database systems. This prototype will enable centralized management of a city's parking garages via the use of generic hardware. Each member driver's monthly total will be determined at the end of the month. Then, invoices may be generated automatically after each transaction, and the appropriate fees deducted from their bank account and sent into the parking lots' accounts.

With a centralized database system, you can access and manage the system from anywhere in the world. Administrators can check the license plate numbers and departments of parked cars from their computers anywhere in the world, thanks to RFID technology and the internet. Personnel expenses may be reduced with this setup. In the same way that automated teller machines are now a reality, unattended, fully atomized parking lots will soon follow suit. Vehicles may be checked in and out without having to stop. In this manner, congestion issues may be avoided. Drivers won't have to deal with parking penalties at check-in or check-out as they do in more conventional parking lot systems. Figure 2 shows the performance of accuracy, and Figure 3 shows the performance of information loss. Time performance comparisons for existing system and proposed system are shown in table 1.

$$Accuracy = \frac{Correct\ prediction}{Total\ epochs} * 100\%$$

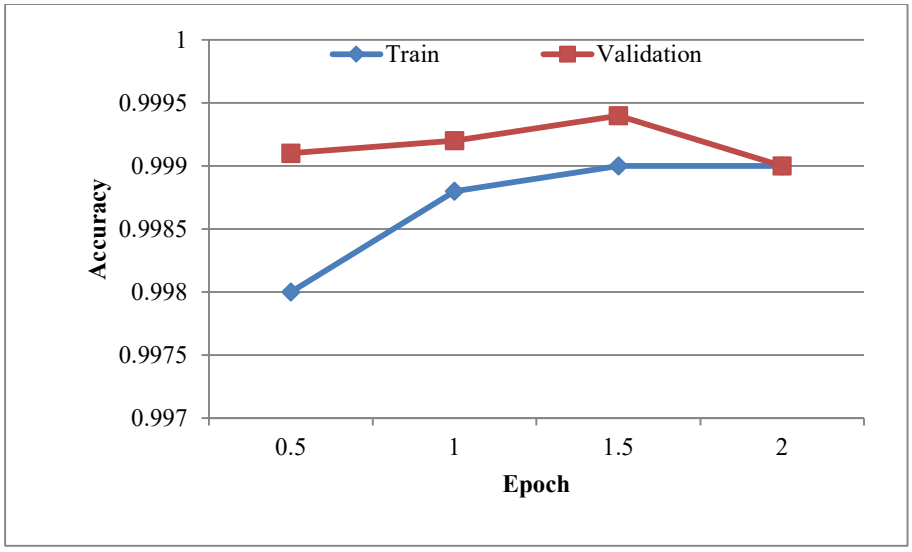

FIGURE 2. System performance of accuracy

$$Loss = input - output$$

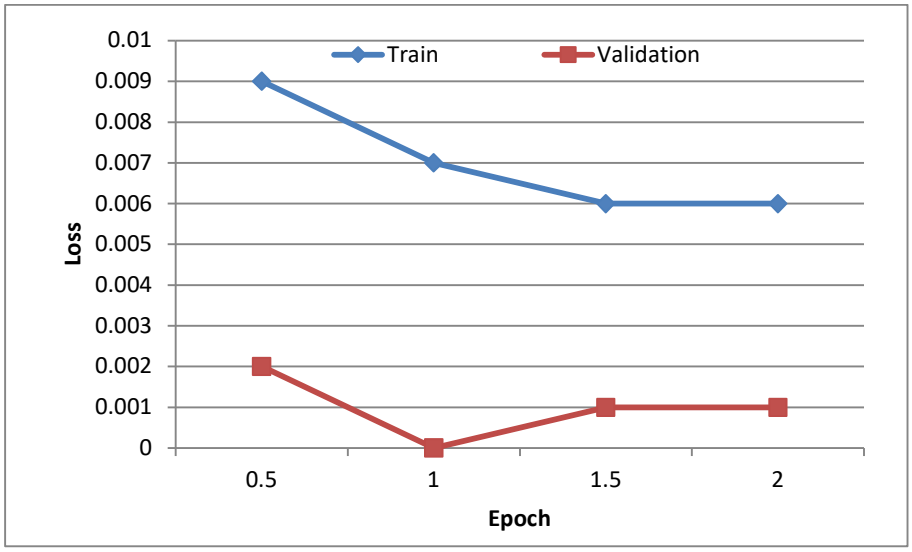

FIGURE 3. System performance of loss

TABLE 2. Time Comparisons

Technique	Time in seconds
Existing system without RFID	1200
Proposed system with RFID	800

There also won't be any issues with people trying to go in with several tickets. Owners of vehicles will no longer be required to make payments at each rental return. This will allow for streamlined circulation inside the parking lot, reducing the potential for the buildup of gaseous emissions. This technology will allow for consolidated vehicle monitoring and decentralized revenue reporting. Both municipal traffic and automobile security may benefit from a set pricing range. In that manner, urban areas will seem more current. Drivers would be able to leave their automobiles in these parking lots with peace of mind rather than on the streets, where they may be damaged or stolen.

CONCLUSIONS

A smart parking system that combines the Round Robin algorithm with RFID may improve several elements of parking management in many ways. Wait times are decreased and traffic flow is streamlined by automated entrance and exit procedures powered by RFID technology. Parking spots are distributed fairly and in a sequential manner according to the Round Robin algorithm. Decreased traffic in some locations, fair vehicle distribution, and efficient use of available space. Vehicles entering the parking facility are reliably identified and authenticated using RFID technology. Remove manual identification procedures, reduce mistakes, and improve vehicle tracking precision. Parking spot occupancy and use trends may be understood via real-time monitoring and data analytics. Data-driven insights to support well-informed decision-making, proactive peak-period management, and optimal parking spot distribution. Together, these findings support the Smart Parking System's effectiveness and provide a parking management system that is more effective, equitable, and user-friendly. The results might have a good effect on the facility's operators as well as the customers, making parking easier and more pleasurable. Future development for an RFID-based smart parking system using the Round Robin algorithm will focus on finding new ways to increase and enhance the system's functionality. Examine if it is possible to automate the physical movement of cars inside the parking facility by incorporating robotic parking technologies. Robotic systems are capable of creative parking experiences and space optimization.

REFERENCES

[1]. M.P. Thakre, P.S. Borse, N.P. Matale, and P. Sharma, 2021, "IoT-based smart vehicle parking system using RFID," *International Conference on Computer Communication and Informatics*, pp. 1-5.

[2]. N. Anggraini, S.M. Dwiyanti, T.A. Putri, Y.P. Sari, A.C. Lusambudi, and A.P. Wahyu, 2022, "Implementation of IoT-Based Smart Parking Using RFID," *Central Asia and the Caucasus*, **23(1)**, pp. 1-6.

[3]. Y. Agarwal, P. Ratnani, U. Shah, and P. Jain, 2021, "IoT based smart parking system," *5th International Conference on Intelligent Computing and Control systems*, pp. 464-470.

[4]. A. Srivastava, A. Gupta, and R. Anand, 2021, "Optimized smart system for transportation using RFID technology," *Mathematics in Engineering, Science and Aerospace*, **12(4)**, pp. 1-7.

[5]. A. Zahid, N. Mufti, S. Ullah, M. W. Nawaz, A. Sharif, M.A. Imran, and Q.H. Abbasi, 2023, "IoT-Enabled Vacant Parking Slot Detection System Using Inkjet-Printed RFID Tags," *IEEE Sensors Journal*, **23(7)**, pp. 7828-7835.

[6]. A. Shimi, M.R. Ebrahimi Dishabi, and M. Abdollahi Azgomi, 2022, "An intelligent parking management system using RFID technology based on user preferences," *Soft Computing*, **26(24)**, pp. 13869-13884.

[7]. R. Priya, A. Abhishek, and A. Utsav, 2021, "A unique automatic parking system by using RFID card and IoT," *In 6th International Conference on Communication and Electronics Systems*, pp. 519-523.

[8]. A. Dhetryansah, and P. Kedua, 2023, "Development of Smart Parking Systems using RFID Sensors for Online Verification in Different Areas," *Internet of Things and Artificial Intelligence Journal*, **3(2)**, pp. 139-147.

[9]. J. Charles, A. Dhage, G. Bodele, T. Bargat, and J. Gawai, "RFID based smart parking system using firebase," *International Journal of Research in Engineering, Science, and Management*, **5(2)**, pp. 31-33, 2022

[10]. M. Khanapurkar, R. Kaushik, R. Mathur, P. Choudhari, R. Gupta, and N. Dheer, 2021, "Design and implementation of cloud-based smart parking management system," *6th International Conference for convergence in technology*, pp. 1-4.

[11]. U. Mittal, T. Shekher, K. Agarwal, S.K. Singh, and H. Chaudhary, 2021, "Real-time smart parking system," *In IEEE 8th Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering*, pp. 1-5.

[12]. A.T. Kabir, P.K. Saha, M.S. Hasan, M. Pramanik, A.J. Ta-Sin, F.T. Johura, and A.M. Hossain, 2021, "An IoT-based intelligent parking system for the unutilized parking area with real-time monitoring using mobile and web application," *International Conference on Intelligent Technologies*, pp. 1-7.

[13]. A. Kalašová, K. Čulík, M. Poliak, and Z. Otahálová, 2021, "Smart parking applications and their efficiency," *Sustainability*, **13(11)**, pp. 1-8.

[14]. T. Anusha, and M. Pushpalatha, 2022, "Efficient Communication Model for a Smart Parking System with Multiple Data Consumers," *Smart Cities*, **5(4)**, pp. 1536-1553.

[15]. M. Balfaqih, W. Jabbar, M. Khayyat, and R. Hassan, 2021, "Design and development of smart parking system based on fog computing and internet of things," *Electronics*, **10(24)**, pp. 1-9.