

# Enhancing Urban Mobility: A Smart Parking System Using IoT and Machine Learning

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**Abstract-** Traffic jams & drivers searching for parking can be a real, especially with more people living in cities and the rise in cars. This paper a smart parking guidance system that helps manage parking spots using the Internet of Things (IoT) & some clever machine learning tricks. It's an IoT solution for the tough parking issues we see in big cities. As the number of cars keeps growing, especially during busy times, it becomes harder for drivers to find available spots. So, we present a cool smart parking system which uses Arduino parts and a mobile app. This system sets up on-site slot modules that keep track of the status of individual parking spaces, showing whether they are free or not. Plus, there's a mobile app so users can check spot availability & even reserve spaces ahead of time. This smart parking system could really help cities save money & protect the environment by cutting down on fuel use & pollution.

**Keywords** - Smart parking system, Ultrasonic sensors, Infrared sensors, Parking lot, IoT, Machine Learning, Reservation

## I. INTRODUCTION

The hunt for the parking lots squanders a good amount of time and energy. Very often, it comes with a high cost involved. It is tough on those individuals who are always in a rush to arrive well on time. Savvy towns and cities employ new technologies to manage their resources better. The parking lots are some of the major assets of a city that have to be decently taken care of.

In our changing world, the Internet of Things (IoT) really assist in innovate new ideas. IoT links apps, sensors & other tech to make our lives easier. It has greatly improved efficiency too! With IoT, making decisions is simpler and

faster – plus it can boost profits and productivity! Our proposed smart parking solution is all about real-time help for drivers. With more people & tech every day; finding parking becomes crucial in public areas. This new tech can make driving easier and safer by cutting down traffic & accidents [2]. Unlike other public spots where parking is more spacious, supermarkets don't have much room for cars! Also, prices for parking at theatres or airports can be sky-high! Drivers often face woes like forgetting where they parked or if they paid the fee. IoT is a modern way that can really push cities toward being smarter!

Simply put, it creates a worldwide network of connected devices that talk to each other. These devices turn into smart tools thanks to shared data—helping users make good decisions easy! Using IoT can fix common problems in cities like finding open parking spots. Sensors gather info about whether spaces are free or not and notify users instantly! This saves time and reduces gas usage while also cutting down on carbon emissions and road congestion [2].

## II. LITERATURE REVIEW

Parking plays a vital role in how we experience transportation. It can really shape our first thoughts about a place. When there isn't enough parking, it can disappoint people & even push them to go somewhere else. This creates issues for drivers and city residents alike. Unfortunately, many projects miss the mark when it comes to parking needs—often because they lack the right info or analysis. But there's hope! A smart system designed for public transport parking could dig into data and suggest how many parking spaces we really need. This can help make cities work better for everyone.

The Internet of Things (IoT) is being looked at closely for lots of uses, including smart parking systems. You know, old-school parking methods in busy cities just don't cut it anymore. They lead to jams and accidents. By using smart outdoor parking with IoT, we can organize parking better and make it more convenient & safer.

Smart cities are all about using the latest tech to manage resources effectively, especially when it comes to urban parking spaces. A new smart parking management system is coming up that tackles these issues! It features options like finding open spots, making reservations, handling payments, sending notifications, tracking stats, and keeping an eye on things. This tech uses IoT ideas and sensors to see if spots are free, which can really enhance life in cities.[24]

Smart parking management helps make the best use of available spots & helps cut down traffic jams. One cool plan called the Smart Parking Management System (SPMS) has a sensing platform plus a mobile app to guide drivers straight to available spaces and even help them find their cars after they've parked!

Cities embracing smart technology are popping up everywhere since more people want IoT tech to manage resources well while keeping data secure & networks running smoothly. One neat solution for smart cities is using IoT to tackle car parking issues. This will help monitor things better & save time—all while cutting back on fuel waste and CO emissions! The idea here is to create a smart parking system that enable drivers to check out & secure open slots— leading to less hassle and a better environment.

Researchers are hard at work solving issues in smart cities, including those pesky parking troubles on college campuses. They're using something called ontologies (that's just a fancy way of organizing info) so different systems can talk to each other easier—especially when creating an ontology for smart campus parking with IoT tech.

The rise of internet-connected gadgets has sparked new ideas for smart city designs—especially focusing on smart parking to fix congestion and wastefulness with fuel. This study suggests setting up a smart parking system that uses queuing theory along with IoT tools like wireless sensors and infrared tech that gives real-time updates about where you can park—all aimed at making user experiences way better!

As cars keep piling up in cities (especially during busy times), finding parking is getting tougher. So, there's progress on an IoT-driven car park management system that tracks available spaces with sensor nodes at each spot sending data back to a central server[21]. This means drivers can check availability from anywhere using the Io Gecko Platform! In Indian cities, millions of vehicles meet very few places to park; it's quite the headache! Finding a space is hard and often leads to cars blocking walkways—which annoys pedestrians! An idea here includes an android app that helps users locate nearby slots based on where they are—they'll even be able to pay digitally from this app!

To boost the effectiveness of smart parking systems while reducing traffic jams, collaborative path-finding is becoming essential. Planning routes for several drivers at once can speed things up & maximize revenue by decreasing vacant time at spaces.

With our Smart Car Parking System (SCPS), people get easy access to non-internet devices everywhere they go—thanks to IoT! This helps drivers find nearby spots quickly plus shows how many spaces are open right at that moment! So now there's less time spent searching for a place—it's not only easier but also kinder on the environment!

In Saudi Arabia's schools, car parking's a big problem as student numbers rise but space doesn't keep up! Common woes include hunting down owners of mis parked vehicles or figuring out who damaged cars—that's just annoying! So, Campus Sense aims to fix this with ANPR cameras plus an app that keeps tabs on and protects those valuable parking slots.[23]

In crowded urban areas, car parking is no small feat—it creates traffic chaos along with wasting precious fuel & time. A proposed fix involves using roadside cameras watching over spots while employing Convolutional Neural Networks (CNNs) to analyse images—searching for free slots! They're even working on an app that tells drivers what spots are open while guiding them right where they need to go!

Predictive Analysis can be the chief component of smart parking systems, capable of optimizing parking management in urban spaces. A smart parking system has been designed based on linear regression to predict the availability of parking slots. Using historical data from time of day and the occupancy rate, it makes real-time predictions regarding the number of vacant spaces available [25]. Linear regression would be an easily accessible choice for more computer-friendly environments such as business districts or residential areas that follow the predictable daily and weekly trends, as it is simple and efficient in computation. In this study, for binary classification, whether a parking spot is available or not, the SVM algorithm has been applied. SVM model is also applied in this because it can handle high-dimensional feature spaces and non-linear relationships so well, which are important features in real-time environments where many factors affect parking availability [22].

Plus, there's talk about creating systems warning us about available spaces so we no longer have to do things manually—this will also trim down how many people are needed while introducing nifty route optimization methods that steer clear of all the traffic!

As big cities grow rapidly, vehicle density keeps soaring making car parking tougher than ever! A neat centralized car parking system idea here directs drivers toward open lots without chaotic traffic around them—saving everyone time while easing congestion!

### III. METHODOLOGY

#### A. EXISTING METHODOLOGY

The current methodology intends to utilize Radio Frequency Identification-technology in the automation of car parking systems within a mall or building. This smart parking system are already executed in Europe, Japan and USA. This project is simple and also cost effective. This smart parking system provides features like user will able to check the availability of parking space in nearest parking, it's also reduced time to find availability of parking area nearby as it can be frustrating to look for parking in crowded areas, leading to wasted time and fuel consumption. As a result, this system is expected to decrease fuel consumption, thereby reducing carbon emissions in the atmosphere.

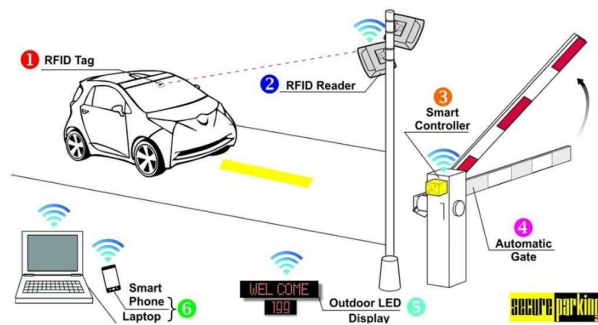


Fig. 1.1 Parking System Using RFID Technology [20]

Following are some more facts concerning the Intelligent Parking Technology that should be emphasized along with to the issues already covered in the paper:

- i. **Instantaneous Monitoring:** Using a mobile app, customers can access the most recent information about free parking thanks to the Intelligent Parking System's continual monitoring of data in real time. Thanks to this function, drivers may make well-informed selections regarding parking locations based on availability right now.[8]
- ii. **Registration Function:** By enabling customers to book parking spots via a mobile application ahead of time, the system lessens the uncertainty and anxiety related to locating a spot in a crowded area. This booking tool guarantees a smooth parking experience while improving the comfort of customers.
- iii. **Transaction Integrity:** Users can pay their parking costs digitally thanks to the Parking Management System's integration of a safe and practical payment gateway into the smartphone app. The parking procedure is made simpler

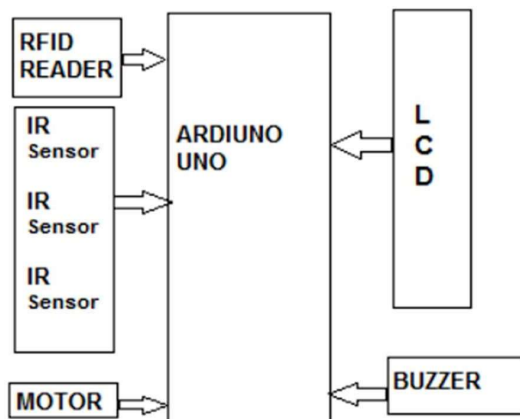
with this cashless payment option, which also does away with the necessity for tangible methods of payment.[7] **Alert System:** Via the mobile app, users can receive messages about the availability of parking spaces, booking assurances, payment receipts, along with other important details. Users can remain updated and involved in the parking network with the assistance of these messages.

- iv. **Versatility and Adaptability:** The Intelligent Parking System's modular structure makes it simple to expand in order to handle a boost in the quantity of customers and parking spots. Future additions of features and technologies can be seamlessly integrated into the system because to its versatile framework.
- v. **Customer feedback method:** Consumers may submit problems they have, offer suggestions for enhancements, and share their thoughts about their parking experiences through the software's feedback method. The communication loop aids in the system's ongoing improvement depending on customer demands and opinions.

#### B. DRAWBACKS OF EXISTING METHODOLOGY

- i. **Booking slots do not have a priority feature,** and therefore, the system does not support the simultaneous booking of slots for multiple users.[8]
- ii. **It is not possible to pre-booked slots which helps to minimize the traffic problems.**[7]
- iii. **Although this application is designed to be user-friendly, it does have a significant limitation when it comes to the payment gateway.**
- iv. **Restricted Parking Lots Inclusion:** The system's capacity for tracking and handling a specific amount of parking spots may be limited, making it difficult to provide details on availability for all parking lots in an entire town or at a certain location.[18]
- v. **One drawback to the SVM model, however, is some potential limitations associated with its applicability within a real-time parking system. For example, scalability may be an issue. As data grows, or as real time data from parking sensors across a whole city come in, computation costs in SVM increase and diminish potential for real-time performance.**

- vi. Networking Problems: Reliance on mobile apps and IoT technology might result in issues



with connectivity, including signal interruptions or network outages, that could affect the system's continuous tracking and reservation features.[5]

- vii. Consumer Acquisition Problems: Some users may find it hard to utilize the platform efficiently, especially if they are not already comfortable using technology or apps for smartphones. This could result in usability concerns and prevent the system from being widely adopted.
- viii. Linear regression is both efficient and interpretable, but requires an assumption of linear relationship among variables, which comes at a cost of reduced flexibility: advanced models of machine learning might often be necessary in order to simulate complex dynamic urban environments, where complex patterns like traffic, weather, and special events may appear in the parking demand.

### C. PROPOSED METHODOLOGY

In this new system two technologies IOT [2] and RFID is used. We are using IOT in this smart parking system which provides availability of vacant parking area nearby thus reducing time for finding the parking area and also to avoid traffic at that area. To park a car, the user must present their RFID card [3] at the entry gate, where a card reader is installed. The RFID card, in addition to its identification function, also holds information about the parking fees. The card reader records the entry time when the driver approaches the gate and transmits this information to the microcontroller. When the user left the parking area, the reader records the exit time. This entry and exit times are then used to calculate the parking fees. To predict parking space availability using the Random Forest algorithm, gather historical information about

occupancy, weather conditions, events and amount of traffic along with real-time data that can be collected from cameras or sensors and integrating this with cloud and edge computing.[21] Then, create features like hour of day, lagging values and aggregation on occupancy rates. Prepare the data-cleanup and preprocessing, missing values treatment and train-test split. Develop and train the Random Forest model to learn the data relationships, along with serving it as a real-time prediction application in an end-user friendly fashion. Iteratively refine the model with updated data and user signals to build toward a scalable solution that is capable of being integrated into navigation applications for convenient use.[19]

Fig 1.2: Illustration of Proposed System

### IV. RESULTS

The demand of smart parking system is increasing day by day therefore smart parking system allows user to find parking area at real time, this will reduce time and will be cost effective for users. This will also help in reducing car theft.

- i. The marketplace for Innovative Parking Solutions: The study emphasizes how the advantages of smart parking mechanisms, like real-time parking spot availability, cost-effectiveness, and a decrease in auto theft incidences, are driving up demand for these systems.
- ii. Convenience and Cost-Effectiveness: By utilizing the automated Smart Parking framework users may locate parking spaces instantly, cutting down on the amount of time they need to spend looking for an available space. Customers save money as a result of this productivity, which also makes parking easier.
- iii. Minimization of Carbon Footprints: The Intelligent Parking System assists in reducing down on fuel use and toxins by shortening the amount of time cars must wait for parking spaces. This makes our surroundings more environmentally friendly.
- iv. Consumer Experience: The combination of the RFID and IoT technologies in the infrastructure provides a seamless interface for users to pay for and gain access to parking lots and reduces the need to involve the person in handling parking.

- v. Prospects for the Future: To effectively manage parking systems, the report proposes additional work incorporating the establishment of an intelligent city infrastructure with a single point of contact. The objective of this upcoming project is to improve urban accessibility and security by using information-based choices and continual evaluation.

## V. CONCLUSION

The Smart Parking System is constructed on the concept of IOT and RFID, it provides solution for current parking system[17]. It is simple and cost effective which also reduces carbon footprints which are emitted during vehicle waiting for parking slots. It will also help in reducing man power in parking area and also help in reducing car thefts.

Important elements to stress at the smart parking systems projects ultimately could be:

- i. Performance Indicators: Emphasize how the technology has improved user experience, decreased traffic congestion, and maximized parking space use.
- ii. Customer Experiences and Remarks: Provide customer reviews and positive remarks from consumers who enjoyed the advantages from the system's features.[2]
- iii. Future Objective: Describe how you see the Intelligent Parking System fitting into the larger objectives of sustainable urban transportation and smart city development.[5]
- iv. Call to Action: To solve the escalating problems associated with industrialization and journeys, promote additional study, cooperation, and the application of automated parking alternatives.[16]

## VI. FUTURE SCOPE

The concept of smart cities has always been in the head of everybody. Our next project is on implementing an intelligent vehicles parking system to function as an operational backbone within a smart city. In this, we will include a central authority that can view the information maintained by the car parking system center. A number of the management and control entities would be granted access, including the highway center, emergency center, traffic control center, and the police. Sensors within the system would report on vehicle availability at any instant in time to parking meters, which in turn would send refreshed information to the central information hub.

A number of extensions and improvements could be made to the intelligent parking system throughout the future to increase its application and effectiveness:

- i. Incorporation of Artificial Intelligence and Machine Learning (ML): By using AI algorithms, the system's capacity to forecast accessibility to parking can be improved by taking into account user behavior, previous information, and current variables like environment or activities.[1]
- ii. Additional Safety Specifications: You can increase general safety and prohibit illegal access to parking spots by using advanced safety technologies like biometric identification or vehicle registration recognition.[12]
- iii. Environmental Initiatives: Eco-friendly measures like encouraging the installation of charging stations for e-cars or providing incentives for carpooling might help the system meet objectives related to equitable urban growth.[11]
- iv. Extension to Smart City Coordination: Working together with various another smart city programs to integrate public transit or development initiatives for example, in order to create a smooth urban experience.[4]

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