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Intelligent Car Parking System- Analysis and Design

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Abstract

The proliferation of personal vehicles has led to increased traffic congestion, pollution, and parking challenges. Key factors contributing to this trend include enhanced affordability due to technological advancements and lifestyle changes, a shift in travel preferences post-COVID-19 towards private transportation for safety, and the comfort and convenience cars offer. However, this growth exacerbates issues like parking scarcity, particularly in urban areas, and safety concerns such as theft and damage from roadside parking. Existing solutions include designated paid/free parking zones, but these are often inadequate. This paper presents an integrated parking management system addressing inefficiencies in traditional manual parking operations. The solution combines an embedded system and Android app to streamline parking for users and owners. The embedded system tracks vehicle entry/exit, automatically generating bills based on parking duration. The app enables users to locate available slots, book in advance, and specify preferred parking spots, reducing search time and hassle. Digital payments eliminate cash handling issues. This system optimizes parking resource utilization, enhances user experience, and boosts operational efficiency, offering a comprehensive solution for modern parking challenges

Keywords- Parking system, RFID, FASTag, IoT, Image Processing, ICPS etc

I. Introduction

Today we are living in the age of Internet and smart gadgets. Internet of Things (IoT) has brought a huge revolution in Technical innovation, digitalization and connectivity. Internet of Things (IoT) based gadget is a network of electronic devices like sensors, controllers etc. that communicate with each another to perform a specific task. Smart phones, gadgets and software applications adds more value to the technology and control various operations from remote location and keeping track of all events. In our study, we have come up with a parking management system using RFID technology. RFID is the most fundamental technology enabling wireless data transfer transmission over network. This technology uses electromagnetic fields for communication and collection of data from the objects with RFID tags attached to them. Government of India has used this RFID technology for Toll collection called FASTag. Using the same principle, we have developed a smart car parking system with auto payment facility. As you all know due to the change in Wagh environmental changes and up gradation of people's life style, car has become very common and affordable. Car is now becoming one of the Some points to be considered, first one by considering background, Rapid urbanization and increasing vehicle ownership. Due to these challenges in parking management like congestion, pollution, wasted time limitations of traditional manual parking system Considering the whole system and challenges research are focusing on analysis and design of an Intelligent Car Parking System (ICPS) with

integration of technologies: embedded systems, mobile apps, data management to optimize parking resource utilization, To enhance user convenience and experience, To reduce traffic congestion and pollution. Fast processing time for toll plaza or parking by using by automatrion

II. Literatire Survey

IoT Smart Parking Using RFIDAllbadi and Shehab (2022) [1] proposed an IoT-based smart parking system using RFID technology for automated vehicle identification, real-time parking insights, and contactless access. IoT Based Smart Vehicle Parking SystemKoya et al. (2022) [2] develop an IoT-based smart vehicle parking system using RFID, IoT sensors, and a mobile app for real-time parking updates and automated billing.

Collaborative Sensing-Based Parking Tracking SystemZhang et al. (2022) [3] propose a collaborative sensing-based parking tracking system for smart cities, using wireless magnetic sensor networks for real-time parking updates and automated guidance.4. Intelligent Parking Management SystemJabbar and Wei (2022) [4] design an intelligent parking management system based on WSN/IoT, using ultrasonic sensors and a mobile app for real-time parking updates and automated billing. Automated Parking System Using IoTSudhakar et al. (2022) [5] develop an automated parking system using IoT, RFID, and a mobile app for real-time parking updates and automated billing. Smart Parking System Using Image ProcessingRuili et al. (2022) [6] propose a smart parking system using image processing, cameras, and machine learning algorithms for real-time parking updates and automated billing.

IoT-Based E-Parking SystemSadhukhan (2022) [7] designs an IoT-based e-parking system using RFID, IoT sensors, and a mobile app for real-time parking updates and automated billing. Smart Parking System with Dynamic PricingZhang et al. (2022) [8] propose a smart parking system with dynamic pricing, using IoT sensors, edge computing, and LoRa communication for real-time parking updates and automated billing. IoT Based Smart Parking SystemKumar et al. (2021) [9] develop an IoT-based smart parking system using RFID, IoT sensors, and a mobile app for real-time parking updates and automated billing.

Smart Parking System Using RFID and IoTPatel et al. (2021) [10] propose a smart parking system using RFID and IoT, for real-time parking updates and automated billing. IoT Based Smart Parking System Using RFIDSingh et al. (2020) [11] design an IoT-based smart parking system using RFID, for real-time parking updates and automated billing. Smart Parking System Using IoT and Machine LearningKumar et al. (2020) [12] propose a smart parking system using IoT and machine learning, for real-time parking updates and automated billing.These studies demonstrate the effectiveness of ICPS in optimizing parking resource utilization, enhancing user convenience, and reducing traffic congestion and pollution. Identified some potential gaps in above studies as Limited focus on user experience like most studies focus on the technical aspects of ICPS, but few explore user preferences, usability, and accessibility. Insufficient consideration of security and privacy, while some studies mention security, more research is needed to address potential vulnerabilities and ensure user data protection. Limited scalability and interoperability, many studies focus on small-scale implementations, but more research is needed to ensure ICPS can be scaled up and integrated with existing infrastructure. Lack of standardization: The use of different technologies and protocols (e.g., RFID, IoT, image processing) highlights the need for standardization to ensure seamless communication between systems. Limited exploration of emerging technologies: Few studies explore the potential of emerging technologies like AI, blockchain, or 5G to enhance ICPS. Insufficient consideration of environmental factors, for example more research is needed to understand the environmental impact of ICPS and optimize systems for sustainability. Limited evaluation of economic viability found like few studies assess the economic feasibility of ICPS, including costs, benefits, and

return on investment. Lack of real-world testing and validation, Many studies rely on simulations or small-scale experiments; more real-world testing and validation are needed to ensure ICPS effectiveness.

Problem Statement

As we know due to the change in environmental changes and up gradation of people's life style, car has become very common and affordable. Car is now becoming one of the important part of life. Along with it a new problem of 'parking a car' is becoming an issue. Road side parking of vehicles has threat of thieves. Fear of parking in unknown property or damage by unknown person etc. There are paid/unpaid parking zone around the city which facilitates the user to rent a parking zone for short duration

III. Design Methodology

Government of India has made FASTag mandatory important parts of life. Along with it a new problem of 'parking a car' is becoming an issue. for all cars to facilitate the online toll collection and encourage digitalization payment to improve There are paid/unpaid parking zone around the city which facilitates the user to rent a parking zone for short duration. But these parking zones transparency. Same principle can be utilized to develop a Smart parking system. System consist of anembedded system for the owner to maintain the are managed manually and there are some issues with the current system like parking space not efficiently utilized, In-Out time is not correctly measured etc To overcome this issue, we have developed a system using RFID (FASTag) and IoT based technology to maintain the parking area. FASTag contain the vehicle details, which are recorded when vehicle entered the parking zone. Based on the IN-OUT time difference, bill is generated Payment can be made digitally through the FASTag like toll plaza. We have also developed an Android application through which the user can parking slots more efficiently and an android mobile application facilitates the user to locate the parking zone and book a parking slot in advance. The system consist of two parts: embedded system installed at parking zone and the android application available with the user. Embedded system and Android application is connected to each other via internet.Timely data sync is done between the system and application.FASTag is a RFID card fitted on car windshield. It contains the vehicle information like registration plate number. It is a prepaid account and user has to recharge it like a prepaid mobile sim card. RFID reader is fitted at entrance and exit of the parking zone. When vehicle enters the parking zone. Vehicle details are read from the FASTag RFID fitted on vehicle windshield. System will record the entry time of the vehicle. When the same vehicle leaves the parking zone at exit gate, advance booking. This was the system will benefit the user as well as owner again the vehicle details are read. Difference between IN time and OUT time is calculated and accordingly the bill is generated. The billed amount will be deducted from FASTag account. In case, FASTag account has less balance, other payment options can be made available. Also the system will display the available parking slots at entrance. The android application will help user to know the available parking slots and do advance booking. And the embedded system will help the owner to utilize the area more efficiently.[13]

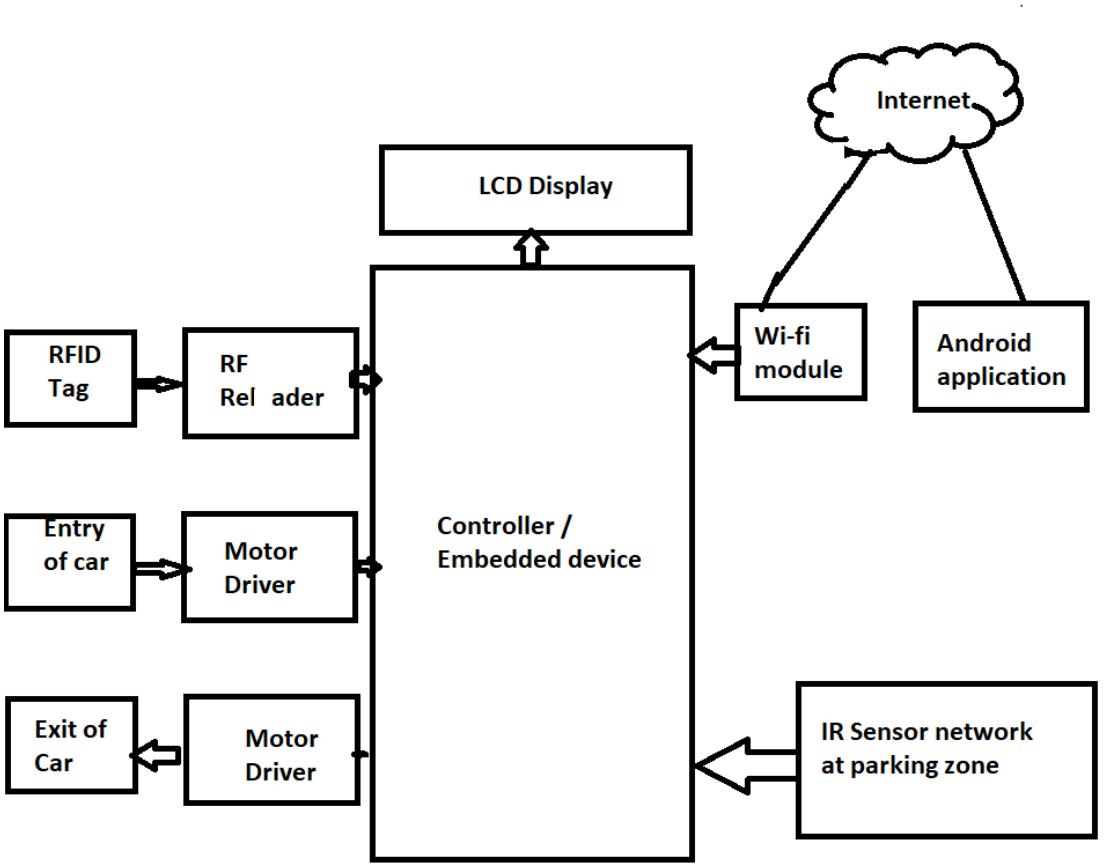

Fig 1: General block diagram of methods to follow

As shown in fig 1 The Android application installed in the user mobile will have user and its vehicle details feed while creating an account or Sign-up activity. When user wants to park his car in nearby parking zone, he will open the application and look for the available parking zone and its availability. If required, he will book a parking slot in advance. The application will send the booking information to the parking system, which is also connected through internet. System will send the confirmation notification to the application. User billing will start only after the vehicle enters parking area.

Parking system consists of embedded system installed at the entry and exit gate of the parking zone. The system consist of the components as follows: Induction motor and its driver to open/close the gate, RFID reader at entry and exit of the gate to read the vehicle details from the FASTag, Display at Entry gate to notify the available parking slots, IR sensors at each parking slots to identify vacant parking slot, Wi-fi device to connect the system to internet and mobile application. The working procedure of the system is as follows:

At entry level steps followed by system

1. When vehicle comes at entry gate, vehicle details are read from FASTag
2. System checks if the vehicle is having an advance booking.
3. If booking is available, parking slot is communicated to the user
4. Gate is opened and entry time is recorded
5. If the vehicle is not having advance booking, system will check the parking status to find the vacant parking slot
6. If a free parking slot is available, Owner defines the parking slot to the user.
7. Gate is opened and entry time is recorded
8. When the car is parked in the given parking slot the latest status is updated to the entry gate display.

Fig 2. Entry level process

At entry level steps followed by system

1. When Vehicle comes at Exit gate, vehicle details will be read again from FASTag
2. Parking duration is calculated based on the difference between the Exit time and the Entry time.
3. Accordingly bill is generate.
4. Billing amount is automatically deducted from the FASTag account.
5. If FASTag account is Nill, user can have another payment mode option can be made available.
6. After successful bill payment, gate will be opened.
7. When the car leaves the parking slot the latest status is updated to the entry gate display.
8. Also the same is published via Internet and status gets updated in mobile application.

Fig 3. Exit level process

IV. Conclusion:

This system has dual benefit: one for the user and the other for the owner. Owner can manage his parking

zone more efficiently. Brings transparency in the billing system. Can give better and effective service to the customer/user. User is also having advantage of having the facility to view the available parking slots and book in advance. This will reduce the waiting time. As the available parking slot is identified at entry gate. The user need not have to find the parking slot of its own. Digital payment system has eliminated the issue of maintaining the change.

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