Journal of Scientific and Technical Research
13 (2) 2023, 09-14
http://www.publishingindia.com/jstr

Novelty in Smart Parking Slot Classifications using RFID and ANPR Approaches

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Abstract: The rising demand for parking and security in public spaces prompted us to come up with this system. The major cause for this is a scarcity of parking space. Traditional parking methods cannot be employed nowadays since they are inefficient at using space; so, different parking systems are required. The offered technique assists the user in finding a free parking space while also keeping the car secure. Tracking parking spots is also important, which may be accomplished with an Internet of Things system equipped with sensors. The objective of the work is to create a system to lower the manpower needed in a parking area, and making it more safe, automated, and easier for the drivers to park their car. In this work, we use of Internet of Things-based car parking system, RFID regulating the movement of the toll gates, allowing vehicles to enter and depart parking spots. A camera in front recording the picture of a car going through the toll gate and automatically collects the number plate of the vehicle, using Automatic Number Plate Detection System (ANPR) as well as other important information such as time and parking slot, which is saved in the database for security purposes, and also directs the Drivers to the empty slots for the parking using parking Displays. In the result of the work shows how the system works and will be beneficial to us in terms of Efficiency, Less complexity, and Automation of whole process. We will also discuss about using Mobile Application to receive updates regarding parking space left, position of parking, and other updates in real time real-time.

Keywords: Automatic number plate detection system, Camera scanning, Internet of things, RFID (Radio-Frequency Identification), Sensors.

I. Introduction

As the population is increasing, the need for more parking spaces like in Malls, hospitals, offices, Multiplexes, etc. is an essential problem with car parking. Sadly, with all those spaces getting more in numbers, the amount of time looking for a vacant one gets annoying. Thus, we need an automated way to manage the parking spaces which can automatically tell you the free spaces (or a lot of them to you), where you can park your vehicle. This saves us many times as wasting time looking for vacant spaces for parking can create jams, causing a lot of problems. And it becomes worst there are when multiple lanes with each having parking slots. Using this Smart Parking Management system will help to reduce the human efforts and time with additional comfort. In the proposed system, we will have a Display on the Toll System, where you can see your allotted spot for the parking, which will be done when you entry. This way, not only it saves time, but the software and hardware would also manage automobile check-ins and check-outs using RFID readers/tags, with extra capabilities such as automated invoicing and entry/exit data logging. We divided our system into 2 different parts:

- Toll System (RFID)
- Automatic Parking Management System

A. Toll System

For toll system, this system is using RFID method. RFID is a type of WIRELESS Communication system that uses Electromagnetic Coupling to identify something which, that can be Object, or even living beings. RFID is also one of the oldest systems, thus reliable too in a lot of cases. With RFID technology, manually performed duties will be significantly reduced [1]. It's very practical, and effective which can be used globally. And thus, increases efficiency. And it also plays an important role in inventory Checking [2].

B. Automatic Parking Management System

For this, we will be using Sensors, ANPR, and SQL for keeping the vacant and filled spots for parking in check.The database will be used to will be used to keep all the logs for the spots on the parking and also to give the closest spot for parking which is available, and to put the numberplate number there which will be obtained using ANPR. The sensors will be used to get the information that whether that area is empty or not, and also about the info that if the cars which it's allotted there or not.

II. Literature Survey

Smart parking [1] proposed a solution based on the Google Maps app. The data collected by the ultrasonic sensor is saved in the cloud. The Android app map displays user-friendly information about vacant spaces. Each slot has one LED display to help you find the best parking spot. An IOT-based parking system based on Google [1] was proposed to allow users to book a parking space. A mobile application is used to locate the current parking location. An infrared sensor is used in this method to locate a vacant space, which is displayed at the entry and exit gates. To gain access to a parking space, an RFID tag is issued. If the individual is authorised, a signal is given to open the gate [2]. Using Arduino and Raspberry PI, the Advanced CAR Parking System [3] detects available parking spaces. This system uses a web server and Google Maps with GPS for booking. The outcomes are graphically represented in the mark. It was demonstrated an efficient car parking system [4] with IR sensors and RFID tag identification. The ZigBee protocol is a wireless communication protocol. Android-based Smart Car Parking System [5] An Android application that searches for available unoccupied parking spaces. The Android app would include customer information such as location, state, and car number. The application allows the user to enter and exit times as well as choose a parking spot. The user information is saved in the MYSQL database. The LED indicates whether the parking spaces are empty or full. A camera is used to record the vehicle's licence plate and convert the image to determine whether the vehicle is an authorised user vehicle or not [5]. Smart Parking System Based on Embedded System [6] employs a smart parking system based on embedded and sensor networks, as well as applications for Android and Windows. A Raspberry PI is used in this system, and an infrared sensor is used to find an available parking space. The Android app would include customer information such as location, state, and car number. The app allows the user to enter and exit times as well as choose a parking spot. The user data is stored in the MYSQL database. The LED indicates whether or not the parking spaces are available. A camera is used to capture the vehicle's licence plate and convert the image to determine whether or not the vehicle is an authorised user vehicle [5]. Smart Parking System Based on Embedded System [6] employs a smart parking system based on embedded and sensor networks, as well as Android and Windows applications. A Raspberry PI is used in this system, and an infrared sensor is used to locate an available parking space. V2I (Vehicle to Infrastructure) contacts the driver, requests parking, and informs the user of the status of the reserved space. Parking spaces are reserved and directions are displayed using infrastructure-to-vehicle (I2V) communication. To exchange data, the JSON format is used. QR codes are used for security, and webcams read the codes and provide parking lot directions [6]. It was suggested that a Pay-by-Phone Parking System with Privacy Protection [7] be implemented. The parking system can be reserved over the phone. A credit card-accepting mobile application has been created. A new user can sign up and contact the system server to obtain new e-coins. Each e-coin has a time slot for parking. RFID searches on onboard devices are conducted by parking officers [7]. A smart parking guidance system [8] proposed the parking recommendations and information. The system provides driver information and parking spot availability via the VMS on the internet. This system is classified as off-road or on-road. Driving on rough terrain Pneumatic tube with a deducted loop, Pneumatic tube to subtract the presence of a vehicle, Acoustic sensor-noise level used to detect vehicle presence, piezoelectric sensor-vibration used to indicate vehicle presence, RFID used for security. Ultrasonic sensors on the road broadcast waves to detect vehicles, whereas infrared sensors produce reflected waves to determine whether or not a vehicle is present. To locate available parking spaces, American countries use the parking app or the Google Maps API [22]. Beginning in 2015, the Indian capital of New Delhi began collecting all necessary data regarding parking lots and parking areas' current infrastructure of parking spot ownership. A website or a mobile app is used to reserve a parking space [23]. Cars can be tracked and localised in real time using range-based or range-free techniques. [25] discusses various range-based / range-free algorithms. Parking spaces can be reserved according to their location. The importance of Intelligent Parking Lots in integrating electric vehicles into energy systems is discussed in the paper. It presents a two-stage scheduling framework that takes uncertainty into account and employs Information Gap Decision Theory. The study emphasises electric vehicles' potential to improve energy system efficiency and economy in energy communities [26]. This paper discusses privacy concerns with LoRaWAN smart parking devices, where variations in signal strength caused by metallic obstacles can reveal parking space occupancy. It demonstrates that attackers can estimate occupancy with high accuracy using machine learning techniques such as Neural Networks and Random Forest [27]. The paper addresses the issue of finding parking spaces in a world with a growing population and increased car ownership. It proposes an IoT-based smart parking system to reduce search time, fuel consumption, and user stress. For optimal parking management, the system employs sensors, cloud data processing, and access control [28].

III. Methodology

A. Toll-Crossing System

Radio-frequency identification technology enables efficient and automated vehicle identification and access control. RFID works in such a system:

i RFID Barcode

Each vehicle that wants to access the smart parking facility is equipped with an RFID Barcode in the slip received. These

Barcode can be active (with a built-in power source) or passive (powered by the RFID reader).

ii. RFID Readers

RFID readers are installed at various entry and exit points of the parking facility. These readers emit radio waves and communicate with RFID Barcode.

iii. Communication

When a vehicle approaches the entry point, the RFID reader sends out radio waves. If the vehicle has an RFID Barcode, the Barcode detects these waves and responds with its unique identification information.

iv. Data Transfer

The RFID reader captures the data from the RFID Barcode, which typically includes a unique ID number associated with the vehicle. This data is then transmitted to the central parking management system.

v. Access Control

The central parking management system compares the received RFID Barcode data with its database of authorized vehicles. If the vehicle is authorized, the gate or barrier at the entry point opens to allow access.

vi. Racking and Payments

Throughout the parking duration, RFID barcode can be used to track the vehicle's entry and exit times. This information is useful for billing purposes, as parking fees can be calculated based on the duration of stay.

vii. Exit Process

When the vehicle exits the parking facility, another RFID reader at the exit point reads the barcode and records the exit time. The system can then calculate the parking fee, if applicable, and open the exit barrier.

When the system is turned on, the LCD display displays information about the availability of slots. If the card number matches a previously saved number in the database, the Arduino will permit the automobile to park in the secured area. The information concerning slot occupancy is shown on the Display using IR sensors installed in each slot [3]. The display also shows a welcome message with the cardholder's name. As the automobile approaches, displaysinformation about the free spots, such as the free slot number. To prevent multiple admissions using a single card, another RFID reader and exit gate would be installed once the automobile exited the parking lot.

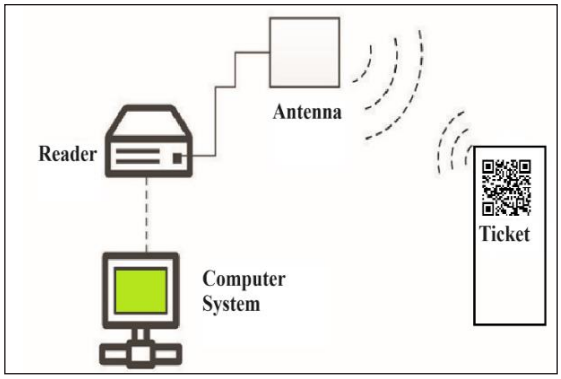

Fig. 1: RFID Working

This also prevents the entry of vehicles from the exit side. As the car leaves the parking lot through the exit, the number of available slots is updated and it displays the same on the display.

B. Parking System

After getting information related to the vehicle, it will get the information from the ANPR which will be placed on the entry gate, above the toll system (Check Fig. 2) , which will be the number on the number plate of the vehicle, and it will be saved into the database (SQL) in the nearest parking spot (or in SQL case, with the least serial number) The Said SQL will be containing sections like Sr. No. (for easy sorting for the nearest Slot), Slot number (That will be the area number for parking), Allocation available (Whether or not that slot is allocated or not), License Plate number (of the Allocated Vehicle if any), and lastly, presence (If the said vehicle has reached the Slot or not). after the number comes into the SQL, the system will search the Smallest Sr. No. with Allocation set as "No" using which the system will also be the closest parking slot, and the allocation will be set as "Yes". The data will be Transfer that same Parking spot to the display at the entry showing where's the Vehicle allotted to. After which the vehicle will go to the designated area told by the system. The "Presence" column will be changed to "Yes" when it will detect that The Vehicle left that Slot, it will be marked as "No", that triggers the Allocation to set back to "No", Stating that it's Empty and ready to be used.

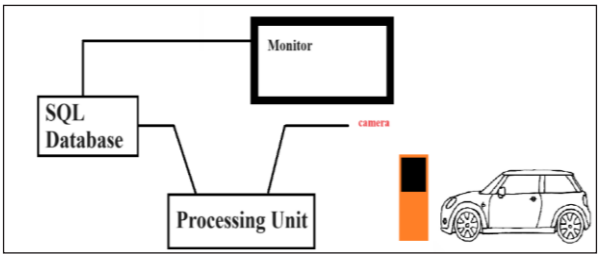

Fig. 2: Parking System

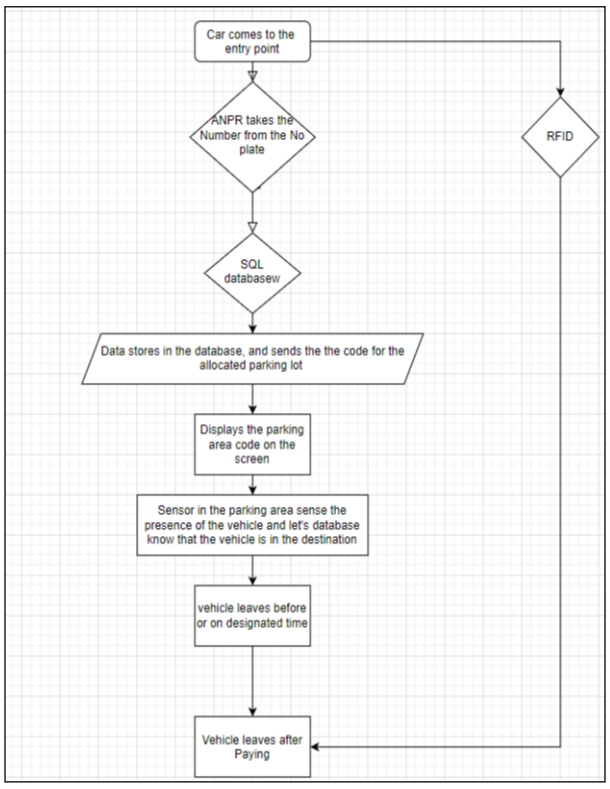

Fig. 3: Flowchart of Working of Parking System

As shown in the Flowchart in Fig. 3 for this system, all the different parts, from getting trigger from a vehicle entering, to Data getting registered into the database, Displaying the available slot to the user, making the slot available in-case a vehicle leaves the compound, all this is part of one System. Meanwhile the RFID serves for Payment and will not interfere with the system, it will only be at the entry point and the exit point.

C. ANPR

Automatic Number Plate Recognition system segments the license plate out of the image by cropping it and saving it as a new image. We can then use this image to detect the character in it. The resulting image is shown below. Normally added to cropping the image, we can also grey it and edge it if required. This is done to improve the character recognition. However, we found that it works fine even with the original image. Then it reads the number plate information from the segmented image. We will use this number to register into the SQL.

IV. Result and Discussion

For Demonstration and testing for this project, we used an Arduino RFID Machine.

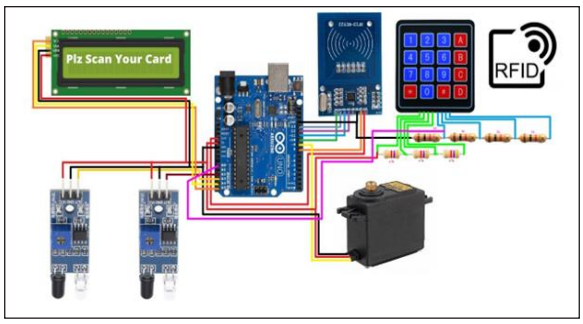

Fig. 4: Arduino RFID

The sensor as seen in Fig. 4 will detect the presence of a Vehicle, making it dispense a ticket with QR code generated on it. This ticket will be the way for them to exit the Complex too. It's also when ANPR system will also be activated and use the camera to detect the licence plate. After Detecting the number from licence plate as shown in Fig. 5 and Fig. 6, it will send the data to the database.

Fig. 5: Number from License Plate

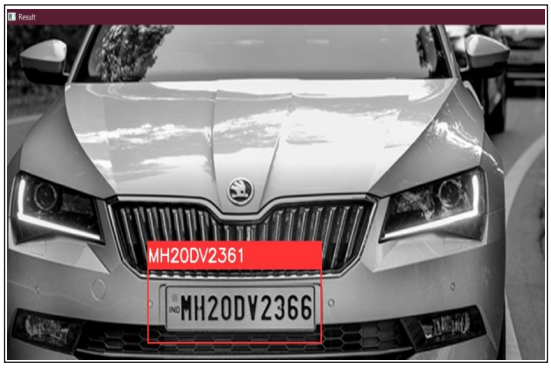

Fig. 6: ANPR Taking License Plate Image

After taking the Data from both the Sensors and the ANPR, the Parking system will be activated and the data will be stored in a database as shown in Fig. 7. In the database, it will search for the smallest Sr. No. as the smaller the Sr. No. is, the closest is the parking area from the Entry (the database will be set according to the parking area). And the first Empty slot found will be allocated to the vehicle and the Number from there licence plate will be saved in that slot. Once it's Allocated, the parking slot will be shown on the display at the entry Screen

(Fig. 8). After that, the driver has to park there vehicle to the allocated area, and the sensors at the location will let the system know that there is presence of the Vehicle in the allocated area.

Priority	Slot Number	Allocation	Number	Presence
1	A1	Yes	MH20DV2366	Yes
2	A2	Yes	NW22DX2544	Yes
3	A3	No		No
4	A4	No		No
5	B1	No		No
6	B2	Yes	HR20PH0021	No
7	B3	Yes	DL20RF2130	Yes
8	B4	Yes	DL20RF2153	No
9	C1	No		No
10	C2	No		No
11	C3	Yes	DL22RH2482	Yes
12	C4	No		No

Fig. 7: Representation of the Database

Fig. 8: Display of the Slot Reservation

After the vehicle leaves the area, the sensors will let the system know that the allocated area is vacant now and ready to take new vehicle for parking.

V. Conclusion and Future Scope

In this work, to implement a smart parking management system, work should be efficient, secure, reduce efforts and be easy to use. The design of a smart parking management system that combines recent-emerging technology, such as RFID, ANPR and WSN has been presented and used in this work tp demonstrate practically. Also, uses of the wireless network provides communication lane between database and on-site system, and RFID and ANPR manages entry-exit and recognise number plate into the database, where WNS confirm the slot book for the car have been arrived. The system manages real-time navigation from entry-exit and reduce man-work in the parking management. It also book the slot and provide a barcode for the entry-exit to reduce security issues. The system is easily applicable on existing parking lots can be adjusted to be deployed in outdoor parking.

Future Scope

A large scope to have improvement in this research. The concept of smart cities has always been a dream. The future work is to create a mobile application and integrate it with our smart parking management system so users can book their slots before boarding. Also whenever this parking lot is full, the application suggests nearby available parking lots. This work enhances with integrating Better connection between RFID Machine and The Parking system, In which when the Sensor detect that the Vehicle left the Slot, it will let the RFID know that the Slot is done. Hence saving the money of the user and making it more User Friendly. Currently ANPR Camera and RFID machine is different machines working together, in future, withthe integration of both systems together, lowers the costs of the system. The integration of UPI system for the Payment for the parking (A0) will also enhances it's efficiency.

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