International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-6, March 2020

# Smart Vehicular Parking System

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***Abstract:*** ***In today's world, ever growing population adds up increasing numbers of cars. Especially, in metro cities with limited spaces for parking, innovative measures are the need of the hour. Our paper focuses on this specific aspect of acute shortage of parking spaces. In this paper, we are proposing a smart vehicular parking model, that takes into account registered or non-registered users parking at the same time. Additionally, it also takes help of image processing to classify the available space based on the size of the vehicle, making it an optimized real-time parking prototype. Using RFID to authenticate each user, the model uses Internet of Things (IoT), cloud storage to makes it convenient for each and every individual to locate and remotely book a parking spot via a smartphone. It works to its full potential by securing cashless transaction via e-wallet. The efficiency of our prototype has been further established by improving parking area by 28 % under any given circumstance. Hence this novel idea excels in every aspect by providing an optimized parking space.***

***Keywords*****: *Smart Car Parking, Internet of Things (IOT), Sensors, Dynamic Parking, Radio Frequency Identification***

## I. INTRODUCTION

The United Nations Report on World Urbanization Prospects: The 2018 revision, the global urban population has increased from 30% in 1950 to 55% in 2018 and is expected to reach 68% by 2050 (Fig. 1) [1]. This rapid urbanization has led to an increase in automobiles on road which in turn has spiked demand for parking space. However, most metropolitan cities have limited space they can allocate for parking.

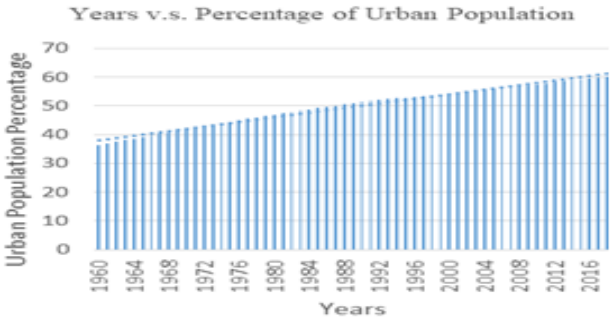


**Fig. 1 World Urban Population from 1960 to 2016**

The solution to this issue is a smart vehicular parking system which efficiently manages parking and provide users with information regarding nearest parking spots. These systems incorporate technologies such as Wireless Sensor Networks (WSN), Global System for Mobile (GSM), Internet of Things (IOT) couples with sensors like Radio Frequency Identification, CMOS Camera, light sensors, Infrared sensors and Ultrasonic sensors.

Parking Systems can be divided into categories like manual parking, smart parking and automatic parking. The parking spaces are segregated into slots and the sensors installed in these slots detect the occupancy based on the sensor readings. The system we have built is an amalgamation of various technologies. Image recognition is being used in our model to measure vehicle dimensions and it serves as a parameter for booking a parking spot. The paper is divided into different sections. In section 1, a comprehensive analysis of the current literature is done in order to better understand the problem at hand. In section 2 we are discussing the methodology that have used to solve the problem, this is followed by the results obtained in Section 3. Future scope of improvement followed by conclusion forms the later part of the paper

## II. LITERATURE REVIEW

In this paper the Author has presented a design based on a conveyor system used in warehouses [2]. The driver arrives at the parking area and is given a parking spot with a code to the cubicle where the car will be placed. The occupancy of the parking space is checked using a LDR sensor.

The idea of Parking Service Providers (PSP) which registers the parking lot in the cloud directory has been proposed in this study [3]. This information is conveyed to the user and the user can book a parking spot using the web interface. The PSP architecture is supported by IOT middleware which does the data analytics, provides cloud facilities for parking and does real-time processing. In the proposed study the system has been divided into three sections [4]. The first section is the parking which includes sensors nodes, on-street parking, microcontroller and smart car parking facilities.

Manuscript received on March 15, 2020.
Revised Manuscript received on March 24, 2020.
Manuscript published on March 30, 2020.
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The second section is the cloud system which is a mediator between the car parking and the user .The third is the user which is represented by the mobile application. This system used IOT, cloud, data filtering and aggregation to build up a parking system along with wireless sensor modules to provide data. The data is processed locally rather than on cloud to reduce data costs. Vacant spaces can be booked through app and the direction to nearest available parking spot is shown in the app. The implemented prototype model is based on IOT, wireless sensor networks and embedded system [5].

The system checks for availability of each and every parking spot using proximity sensor in every two minutes. If the spot is empty then the wireless sensors nodes transmit the location of the spot to the cloud, the user can then book the parking spot and pay online.

The Author proposes the use Image processing to locally manage the parking space [6]. A low cost camera captures images of 4-5 parking spots on regular basis and checks the availability of free space by comparing the captured image with that of a trained model. This model helps to reduce the cost as only one camera is being used instead of a sensor for every parking spot. The camera has to be installed once and then calibrated according to the location.

This paper implements the concept of autonomous vehicles [7]. The vehicles use parking algorithm like vertical and reverse parking to park the vehicle [6]. The vehicle with the help of on board ultrasonic sensors senses the parking space and uses the parking algorithms to park the vehicle.

In this paper the use of camera, cloud vision, centralized server and navigation system is to build the parking system [8]. Optical Character recognition (OCR) is used to identify vehicles at the entry and exit. The parking spot can be booked using an app and bill payment can be done online.

The parking system developed in the paper can be used in both open and closed parking spaces [9]. Status of all parking space is saved in the cloud. The centralized server manages the parking system information like number of empty slots, availability and gateways.

The Author has proposed a Car Parking Framework (CPF) along with integration of Wireless Sensor Networks and RFID Technologies [10]. Each user is provided with a RFID tag for entry and exit and availability of parking space is checked using ultrasonic sensor.

In this study the system uses Cloud as Platform as a Service (PaaS) and Wireless Sensor Networks (WSN) [11]. The architecture is divided into three layers

- The Wireless Sensor layer
- IOT middleware
- Front end layer

The wireless sensor layers consist of sensor and gateways. This layer is responsible for providing information like available space, spot vacancy. Zigbee protocol is being used to transfer data to the IOT middleware for further action. IOT middleware takes the data from Wireless Sensor layer and process it, the data is then stored in a NoSQL database. The RestAPI provides unique URL to every parking space for easy access. Front end layer provides the necessary abstraction and presents the data on a website using a dashboard through which the data can be accessed and visualized.

## III. METHODOLOGY

### A. Application Design

The User enters the login details in the app and selects the vehicle type as shown in Fig.3. The dimension of the vehicle are retrieved from the database and availability of space is checked.

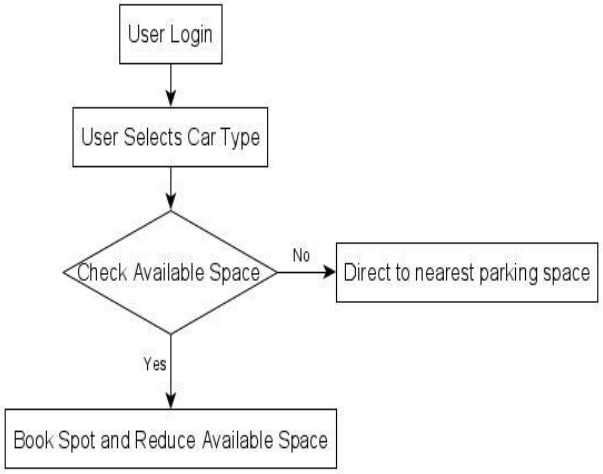


**Fig.2 Application Flowchart**

The user needs to enter the parking space within 10 seconds of the booking or else the booking gets expired (Fig. 4).

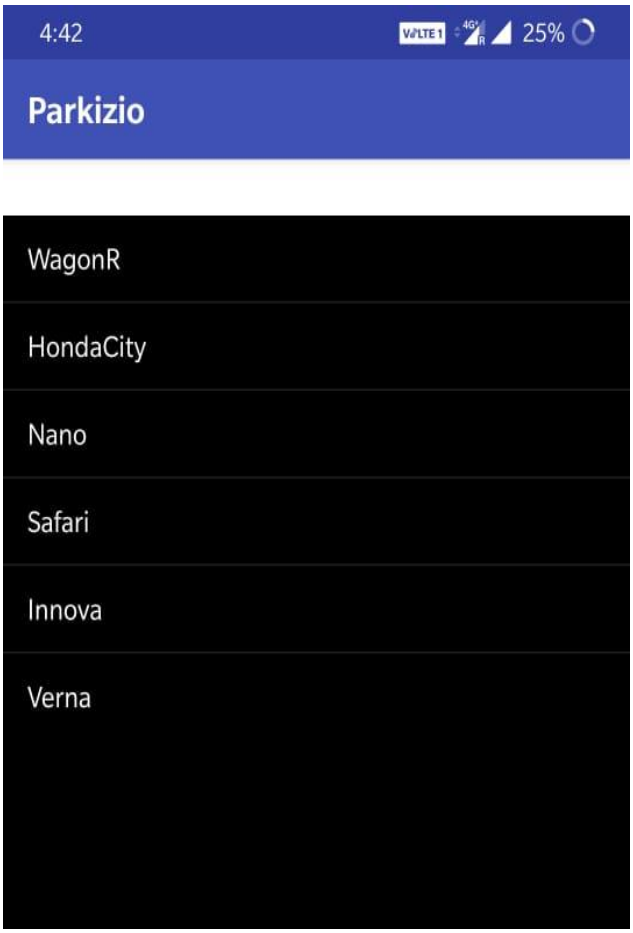


**Fig.3 Vehicle Selection**

The application has integrated Google Map API which helps the user in locating the nearest parking space in case the select parking is full (Fig. 5).

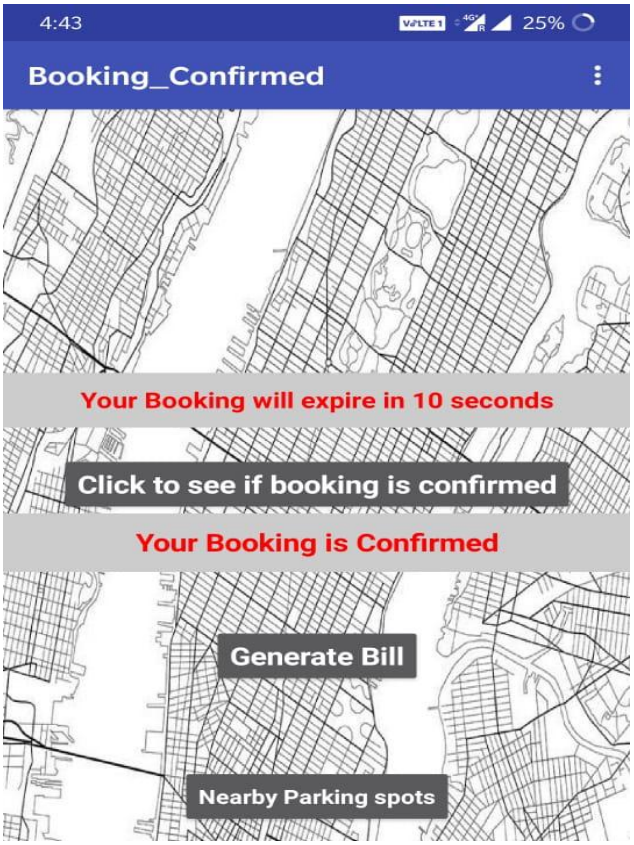


**Fig.4 Booking Screen**

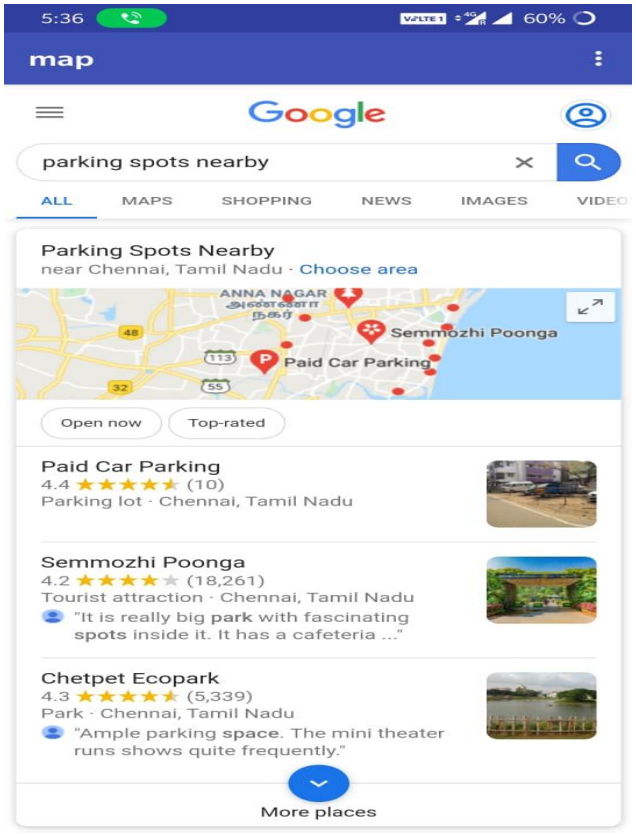


**Fig.5 Parking Spots Nearby**

### B. Dimension Detection

Dynamic Spacing calculates the space that the vehicle requires using Image Recognition and OpenCV. A camera module is placed on the entry of the parking system which captures the top view of the vehicle. Image Recognition used Canny Alogrithm for edge detection, the detected edges are and then dilated followed by erosion of edges to close any gaps and this is followed by contour mapping of the image to get the dimension. The flowchart of steps involved can be seen in Fig.6

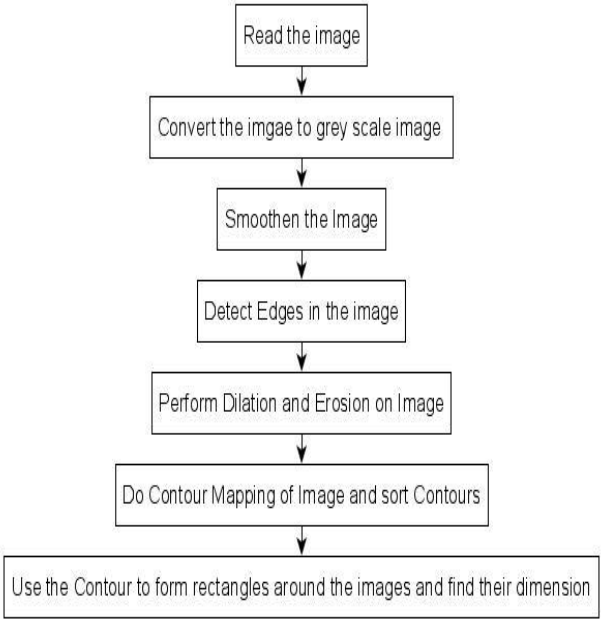


**Fig. 6 Image Recognition Steps**

The algorithm uses a reference object to find the dimension of the vehicle. The reference object is used for pixel scaling. The final output of the image recognition can be seen in Fig.7.

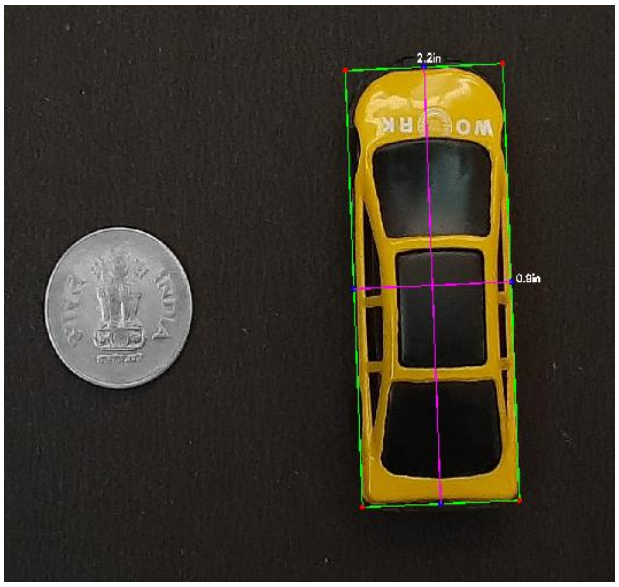


**Fig. 7 Image Recognition Output**

### C. Hardware Prototype

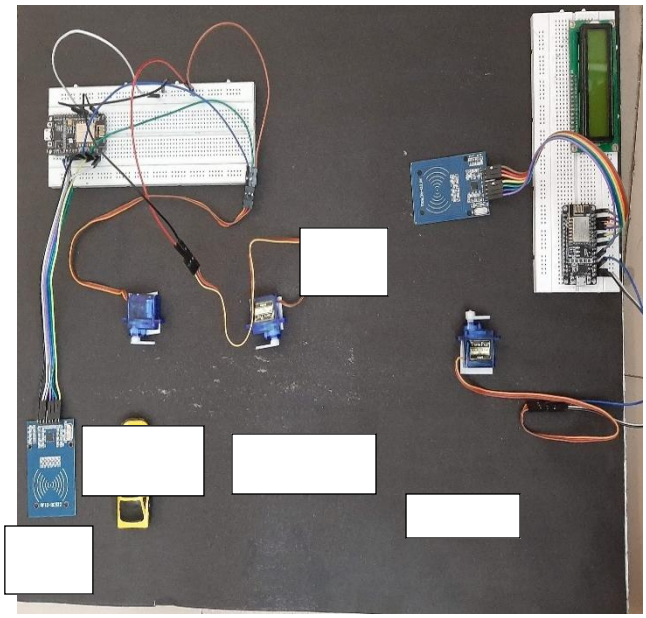

**Fig. 8 Prototype of Parking System**

Fig. 8 shows the prototype of the dynamic parking system
The RFID at entry captures the user tag and booking status is retrieved from the cloud to implement one of the scenarios mentioned below.
The parking system can have multiple scenarios

**Scenario 1: Registered user with booking through application**

1. User Enters and RFID is scanned
2. System checks for booking
3. Booking is available and user enters
4. RFID is scanned at exit
5. Total time the vehicle was parked is calculated
6. Bill is displayed on app (Fig. 9) and message is sent

**Scenario 2: Registered user without booking through application**

1. User Enters and RFID is scanned
2. System checks for booking
3. Booking is not available
4. System Read dimension of vehicle from database.
5. System checks for space availability.
6. If Space is available then user enters else "No Parking" is displayed.
7. RFID is scanned at exit.
8. Total time the vehicle was parked is calculated.
9. Bill is displayed on app (Fig. 9) and message is sent.

**Scenario 3*:* Un-Registered user**

1. User Enters and RFID is scanned.
2. System captures image and dimension are measured.
3. System checks for space availability
4. If Space is available then user enters else "No Parking" is displayed
5. RFID is scanned at exit
6. Total time the vehicle was parked is calculated
7. Bill is displayed on screen.

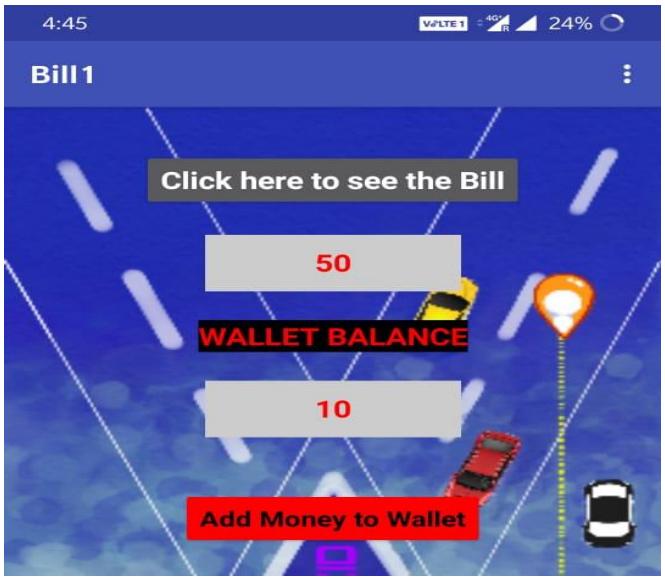


**Fig. 9 Billing Page**

## IV. RESULTS

Using sample data shown in Table 1 it was observed the parking system helps in increasing the number of vehicles that can be parked in the parking space.

Standard Width of Vehicles are

- SUV - 1950 mm
- Sedan - 1800 mm
- Compact hatchback - 1525 mm

**TABLE1: Standard and Dynamic Parking System Data**

| Parking Space Size | Standard System | Dynamic System | Increase |
|---|---|---|---|
| 19.5 mt | 10 cars | 12 cars | 20% |
| 97.5 mt | 50 cars | 63 cars | 26% |
| 195 mt | 100 cars | 127 cars | 27% |
| 390 mt | 200 cars | 255 cars | 28% |
| 585 mt | 300 cars | 383 cars | 28% |
| 975 mt | 500 cars | 639 cars | 28% |

## V. FUTURE WORK

The Vehicular Parking System can be improved further by using self-parking algorithm where the car gets the live feed of cameras places in the parking space. The current system assumes that all vehicles are parking in a linear manner with perfect alignment. The system can be made more accurate by capturing images of the parking space and using image recognition to exact the information off the available space.

## VI. CONCLUSION

The proposed smart vehicular prototype has the novelty to provide service to both registered and non-registered users. The android application designed, helps user in locating nearest parking space thus is
reduces the hassle of unnecessary searching of a parking slot. User can also book and pay for their parking space through the android application. Even, the provision has been made to assist the drivers to locate the nearby parking spot, in case the parking spot is full.

The system uses image recognition to capture vehicle dimensions. Thus, this helps in reducing space wastage and increase available parking spots by a minimum increase of 20%, to maximum of 28%. For any metropolitan cities this improvement is significant and noteworthy. The simple design approach also makes it practically viable and the low implementation cost makes it economical.

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