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# An Analysis of Intelligent Parking System Using Artificial Intelligence for IoT Applications

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**Abstract.** Nowadays, it has become a tedious task to control the traffic caused by the unplanned parking system. Many manual parking systems are used these days, which always don't provide accuracy. There is a huge wastage of fuel and time in the manual parking system. During any kind of emergency, it is highly impossible for anyone to wait all the way to the parking lot, which may lead to any kind of danger. Manual parking systems must be fast enough and the person should be attentive all day, which is also not so effective. To avoid such circumstances, it is essential to develop an intelligent parking system that utilizes the benefits of artificial intelligence and IoT-based systems for improving the applications. This paper examines various intelligent parking systems in depth and compares their efficiency to traditional methods. From the studies, it is evident that image segmentation and compression techniques provide better accuracy and provide reliable efficiency.

**Keywords.** Image Processing, IOT, Artificial intelligence, Space identification, character segmentation, vehicle recognition, vehicle parking, sensors.

## 1. Introduction

Nowadays, one of the most common problems is the manual parking system. Vehicles continue to outdo existing parking spaces, thus clogging roads. Survey results found that during busy working days, it takes a long time to search for free parking space and it leads to traffic congestion, wastage of time and money, car emissions, and pollution. Users can benefit from this by putting in place an intelligent parking system that uses AI and image processing, which is an effective and efficient parking system [1].

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Internet of Things (IoT) techniques can be used to solve parking problems and get the desired result. The system architecture consists of several modules such as image processing, device systems, and mobile applications. The image processing module is used for capturing the name plate and the entire system is developed using Node-RED and OpenALPR [1]. This parking system automation can be done using a few sensors at the entrance and exit of the parking yard. A computer system manages the whole process, and different installed digitized panels and lights help the driver in parking his/her car. The proposed system can be applied to any parking lot, such as apartments, universities, and malls [2] [3]. Whenever the driver enters the parking lot, the cameras will start their work by capturing the number plate of the arriving car using ultrasonic sensors. The captured image is then processed and identified by the recognition system [4] [5]. As the cameras get the number, the system starts to calculate the time and price. Each parking lot is considered a network node, and each customer's app is considered a feedback terminal. "Just by connecting every device, drivers will be notified about every bit of information they require to know" [6]. IoT sensors are used for the detection of vehicles that are inside or outside of the parking area. Identifying such vehicles and using this technique, the vehicles can be organized and the records will also be maintained in the database and can be used for future information retrieval [7]. The drivers can book their slot within seconds and they can organize the parking lot in a systematic manner. The security control will be almost automated using IoT devices such as sensors and appliances, so there will be less requirement for individual attention to control the parking lot manually by reducing time and fuel. The drivers will be connected to an app which will be used to get any information related to their respective vehicles [7][8].

## 2. Related Work

A deep learning technique using AI is proposed for object detection and identifies the vehicles. A few systems use some speech recognition techniques, natural language processing (NLP), and pedestrian detection techniques [1]. A parking management system is proposed for detecting such cars. It uses the methodology of image acquisition and image capturing techniques for recognizing license plates and their associated cars [2]. Rich feature hierarchies for accurate object detection and semantic segmentation are proposed using Deep Learning (DL). Various deep learning methodologies are used for image or object detection and for preparing proper semantics [3]. Real-time smart parking systems integrated with distributed systems for smart cities. In this method, various image processing techniques and a few IoT applications are deployed in such a way that each and every detail related to their respective vehicles will be available at any time [4].

A smart parking system using image processing and artificial intelligence is proposed. The input will be the images captured at various locations in the parking lot, and the output parameters will be the number of vacancies in the parking lot and the number of cars entering the lot [5]. Optimized image processing techniques for smart parking systems are proposed using image processing techniques. The main advantage of this is that optimization techniques are highly useful for optimizing the captured images, and the images can be used for threshold calculation and pixel count estimation [6]. A Smart Parking Management System using AI is proposed for detecting cars. In this paper, the authors have used a few of the techniques that will be used for connecting to the network

nodes and the application nodes. The network nodes, cameras, and the application work together to identify the empty fields in the parking area [7]. A real-time parking system based on deep learning is proposed to assist cars in finding empty spaces based on their arrival time [8].

## 3. Methodology Used

The methodology sections briefly explain different methods of parking systems, such as the deep recognition method, the circle-hough transformation method, and the IoT-based recognition system. The methods are discussed briefly in the following section.

### *3.1. Deep Recognition Method*

The proposed system shown in Figure 1 consists of three units such as the camera unit, image processing unit, and the output unit. As soon as the car arrives at the space allotted, the ultrasonic distance sensors will be activated, and it is used to tell if the car is parked or not. There will be a few cameras which will be used for capturing the parked cars and calculating the time and parking fee. Node-RED and OpenALPR are using the depth recognition algorithm to train cameras to recognize number plates. [9][10]. Initially, the image of the empty parking lot is captured to understand the overall picture of the car parking zone. The RGB value is used to identify the empty spaces in the parking lot. By identifying these spaces, the system will know where to place cars. The Hue Saturation Value (HSV) image is converted to grayscale format. Each pixel is compared with the threshold value and, based on that, the parking space is allotted.

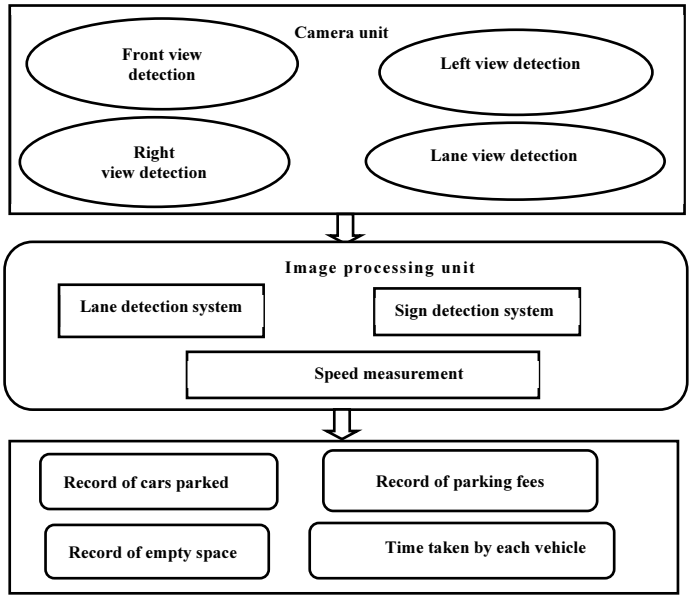


**Figure 1.** Deep recognition system

### *3.2. Circle Hough Transformation Method*

To identify the number plate, the proposed system utilizes number plate detection using the Circle Hough Transformation (CHT) method as shown in Figure 2. The parking lot image is captured using image acquisition, so that it would be easy to locate space for further use. The RGB value will be used to find the empty car spaces. The colour images are difficult to identify or process, so these colored images will be converted to HSV. The image is compared with the threshold value to identify the empty spaces. [10][11][12]. The empty space detection is carried out with the help of the CHT for extracting the circles from the images that represent the empty spaces. The equation for the CHT is given as in Equation 1. Using OpenALPR, the images are captured and converted to binary format. Followed by, identification of the characters in the number plate helps to recognize the number plate. [13].

$$(z-a)^2 + (p-b)^2 = \mathrm{x}^2 \qquad (1)$$

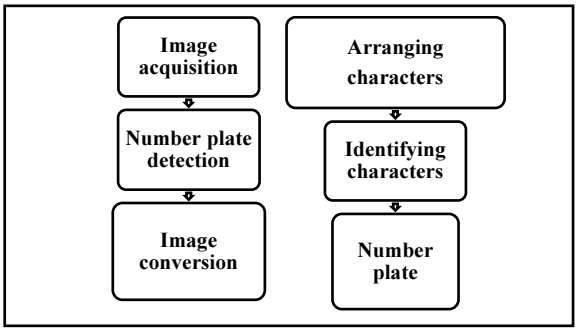


**Figure 2.** CHT based system

### *3.3. IoT Sensor based Recognition System*

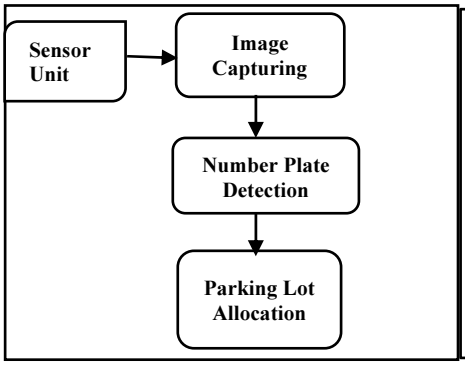


**Figure 3.** Parking lot detection

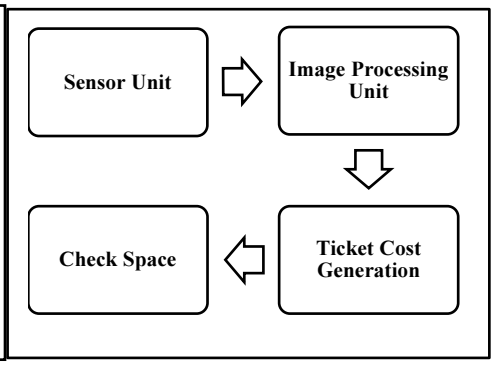


**Figure 4.** Parking Ticket generation

IoT-based recognition systems, as shown in Figure 3, use sensors [14][15] for identifying the number plate and generating the ticket for a particular car. Each car entering the parking lot will get its own ticket, and the cost for parking is calculated automatically

using the loT system[16] [17][18]. As shown in Figure 4, the sensors unit contains various sensors [19][20] [21] for identifying the vehicle in the parking lot and processing it to the image processing unit. The image processing unit will give its output to the ticket cost generation unit and allocate the space for the entering vehicle.

## 4. Results and Discussions

Table 1 provides the advantages and disadvantages of the various parking systems available in the literature studies. It provides a comparison of techniques along with the tools, dataset, and operating layer. Furthermore, the accuracy of the methods is compared and contrasted. From the comparative results, it is evident that both segmentation and image compression techniques provide 80% accuracy and can be readily used for smart parking systems.

**Table 1.** Comparison of parking system in the literature

| S.No | Methods | Advantages | Disadvanta-ges | Tools used | Data set | Layer | Accuracy |
|---|---|---|---|---|---|---|---|
| 1 | Segmentat ion [3] | Responsiven ess to changes in the target output. | Limited time and less resources | OpenCV | 8M Segments | Video level | 80% |
| 2 | Feature extraction [4][5] | Capable of dealing with different kinds of noise | Need to improve flexibility | Tensor Flow | Divere face images | 9-layer DNN | 75% |
| 3 | Image restoration [10][11] | Similar to customized impression | Needs further optimization | PyTorch | Sketch Transfer | Ada -FM | 75% |
| 4 | Image analysis [12] | Easy for image comparison | Original image can be tampered | EmguCV | ImageNet -A | WCS layer | 70% |
| 5 | Image compressi on [18][19] | High compression ratio | Needs further optimization | VXL | Waymo Open Dataset | Raster layer | 80% |

## 5. Conclusion and Future Work

In spite of the availability of various car parking technologies, intelligent solutions provide long-term benefits by using multiple technologies. The time and efficiency of the parking system can be enhanced using the intelligent parking system using AI, image processing, and IoT systems. The user can directly check the cost and various parking-related issues directly from the user app as the complete data gets updated into the database. This analysis report clearly investigates the existing parking system, and from

the studies, it is clear that the segmentation and image compression techniques provide maximum efficiency. As the methodology is developed using various technologies like image processing, IoT, and artificial intelligence, it potentially maximizes occupancy by allocating the correct ratio of vehicles in the parking zone. Hence, by deploying such system security, the efficiency of the smart parking system is enhanced and completely automated. It provides hassle-free services and benefits to the users without any interference in a timely manner.

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