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Automated parking system with automatic number plate recognition

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***Abstract*---**With the *growth* of population in urban cities, there is a rapid increase in the number of vehicles and hence there is shortage of parking spaces. In this paper we provide a novel idea of automatic number plate detection and recognition along with allotment of parking space. The parking space is allocated in an efficient manner as distance traveled will be less. The number plate detection is done by extracting the image from the video and the number is identified using Optical Character Recognition. The parking space algorithm uses sequential assignment of parking spaces; the algorithm is eventually improved to solve the real time parking allotment.

***Keywords*---**OCR, Number Plate Detection, automatic.

Introduction

Today, with the increase of vehicles and the scale of urban cities, parking plays a prominent role and so is the problem of parking spaces. As the route towards the parking lot increases it worsens the parking difficulties and also may result in minor accidents or collisions, apart from this can lead to the draining of one's energy and subsequently time. However, the main reason for parking difficulties could be more vehicles and fewer parking spaces available. Moreover, in search of parking spaces people can get less premium information about the parking space, and also there is a gap in managing parking lots to guide vehicle drivers to park accordingly. Also, there can be situations where the parking is still not organized as an industry. According to the experts, the solution to this can also be the GPS application system, but it only solves the outdoor parking guidance and not more to the indoor positioning and navigation. To work more efficiently, researchers are now exploring the indoor navigation problems as indoor navigation problems are equally important. However, the prime factor of indoor navigation could be guiding your driver where and how to park your vehicle appropriately. Also, bill generation plays an important role in it.

The problem can be addressed by using number plate recognition, which is now frequently used in traffic management to identify a car whose driver/owner violates traffic laws and to assist in the detection of stolen vehicles. It does not require any manual work. When a vehicle, such as a car, enters a parking lot, a digital camera with a sensor is installed, and a number plate recognition system recognizes the car's plate number. It also inserts the car's information and entering time, and it automatically calculates the parking fee at exit time. It is the most appropriate and effective method of avoiding labor employment. The automatic bill generation will help us to generate the bill according to the time duration of the parked vehicle.

Related Work

Automated parking system is the research area which is explored by many researchers. Holve et al. used the fuzzy rule control method to achieve autonomous parking for a model car[1]. The system intends to reduce the amount of time it takes to park a vehicle in an automated parking system. The proposed system makes use of the Breadth First Search (BFS) algorithm's mechanism. The study presents a mechanism that will assist users in finding unoccupied areas with the least amount of effort spent on it. It also includes suggestions for what to do in an emergency.

Derrick and Bernard began researching parking technology in early 1989 and published their findings in the field of parking [2]. The control of a nonlinear dynamic system can be learned by a neural network. The 'truck backer-upper' is a device that guides a trailer truck as it approaches a loading dock. The technique investigated should work for a wide range of nonlinear control issues. Seong Gon and Bart Kosko then conducted a study on fuzzy control theory-based parking control systems. [3] Based on the research, Inoue et al. developed an autonomous parking motion control method. Based on the constraints of a parking spot and

vehicle kinematics, Inoue et al. developed an automatic parking motion control algorithm.

With the rapid advancement of image processing technology, several parking specialists have begun to incorporate image processing into automatic parking systems. Inefficient parking planning procedures result in extra parking and increased motor traffic. Metered on-street parking and commercial parking should be preferred to free off-street parking. A well-designed parking management scheme can cut the amount of parking needed at a location by near to half. In 2008, Ozkul et al. investigated a fuzzy control automatic parking assist system based on visual data [4]. T. Litman gives a thorough parking management implementation guide that includes parking planning principles [5].

M. Idris' research looks at the evolution of parking space occupancy detection [6]. The parking management system can access the status of the parking place thanks to the detection technology. S. Zeitman invents a parking management system communication system [7]. They provide a means of communication between the municipality, the driver, and the parking places. S. Shaheen outlines the research and feasibility analysis that went into the development and implementation of a parking management field test [8]. The parking field test and its technology are described in depth in their report. R. Lu proposes a smart parking concept that takes advantage of vehicle communication [9].

Machine vision, target detection and recognition technology are also used in the intelligent recognition of parking spaces. Vehicle detection and recognition technology has become a major study area, with unparalleled applications in the field of vehicle detection and recognition, thanks to the rapid growth of intelligent transportation technology. The majority of available approaches are focused on visual aspects of the vehicle. To match an input vehicle image,J. Ferryman used a three-dimensional vehicle model[10]. The recognition and vehicle orientation results in the algorithm output. V. Petrovic presented a recognition method that involves matching the extracted regional eigenvalues and normalizing the corresponding regions of a vehicle [11]. L. Dlagnekov devised a vehicle recognition system that extracts vehicle tail features using the scale-invariant feature transform (SIFT) method[12]. T. Kato suggested a multi clustered modified quadratic discriminant function based recognition method [13].

Implementation

The first phase of the algorithm is detection of Number plate. In this phase the number plate is extracted from the input image by binarizing the image using Otsu's Thresholding technique.

Algorithm 1

1. Reading the number plate images
2. Convert the image into grayscale
   gray_img = rgb2gray(car)
3. Binarize the image
   thresh=threshold_otsu(gray_img)
   binary = invert(gray_img > thresh)

4. Label the binary image
   label_image = label(binary, connectivity=2)
5. Remove too large, too small regions
   if region_area > 15 and region_area < (0.2 * img_area)
6. Sort the regions by their X-axis distance. All numbers are read from left to right, so sorting in that natural order.
7. The largest region has the highest possibility of being captured as a number.
8. The identified numbers can be further passed into an OCR system to convert into text.

Fig. 1: Grayscale Image Input

Fig. 2: Applying Filter to find edges and contours

The algorithm starts by reading the number plate images or videos as an input. From the video input it captures the required frame for processing the number plate. The algorithm applies the filter and finds the edges for localization. For this the image is converted to grayscale. Fig. 1 gives the image taken from the video. Fig. 2 shows the edges and contours extracted from the image.

Fig. 3: Plate Detected from Contours

Fig. 4: Number Plate recognized

The extracted contours are then sorted on the basis of x-axis from left to right naturally. In the end, the largest region will have the possibility of having more numbers on the number plate image conveniently. The identified number will then be passed to the optical character recognition (OCR) to convert it into the text.

As the vehicle number is recognized the next phase is to allocate the optimal and nearest parking space for the vehicle. Algorithm 2 explains the allocation of the parking space.

Algorithm 2
Input: Total number of Parking Spaces in the lot.
Output: Matrix resulting in the number of vehicles that were provided the parking space.

1. Taking Input for the size of Parking (S)
2. From S calculating size of subset from parking lot
   i.e. S_sub = One-Tenth of S
3. Taking Parking Queries half of the size of S_sub
   i.e. P = S_sub/2

In the algorithm S is the size of Parking space. One-Tenth of S is the value after calculating the subset of S from the parking area. While taking the parking queries that is the vehicle that wish to park, as the half of are subset as P=S_Sub/2. The next steps depicts the Representation of the parking queries.

4. **Initialization**: c_{ij} = 0 for each c_{ij} belongs C;
5. index = 0
6. **for** each vehicle p_i **do**
7. $SET_P[index] = p_i$;
8. index = index + 1;
9. **end for**

Here in the algorithm distance matrix is initialized as cij which will be set to zero if the vehicle is parked or as one if the Vehicle is not parked. Also the index is initialized within the array and set to zero which will increase its value as index++ as soon as the vehicle is parked. SETp represents the array. It is used to detect the vehicle present in the parking lot.

10. index = 1;
11. **for** each parking space s_j belongs S **do**
12. $SET_S[index] = s_{j;}$
13. index = index + 1;
14. **end for**
15. **for** each vehicle p_i belongs P **do**
16. **for** each parking space s_j belongs S **do**
17. $c_{SETp\ [i]SETs[j]} = c_{ij}$;
18. **end for**
19. **end for**
20. **return** SET_P, SET_S and S;

Parking space allotment starts here the SETp represents a list for parking queries, where 1 in the list says the vehicle requires parking space. SETS represents a subset of parking spaces , where 1 says space is available for parking and the user can park the vehicle.According to the number of parking spaces available and the users that wish to park the matrix will get updated by count 1.

21. **Initialization** U=0, V=0
22. U denotes no of parking queries and V denotes no of parking spaces available
23. Count 1s in SETp and SETs i.e., M and N respectively
24. **Initialization** X = [ ]
25. If U is less than equal to V, every vehicle gets parking space.
26. Else if U greater than V, parking gets on the basis of FCFS (First come first serve) and all available spaces would be exhausted.

U and V are initialized to zero which denotes the number of parking queries that are the users that wish to park and V denotes the number of parking spaces available in the parking lot. When the user enters the parking lot it gets checked if the value of users that wish to park are less than the available parking space. Every vehicle that comes will get parked. Else if users are more than parking space available parking space will be allocated according to the first come first serve basis.

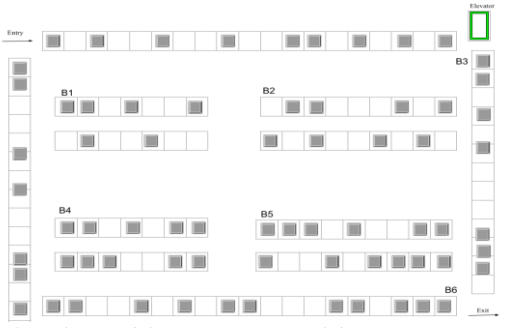

Fig. 5: Parking Space Guidance Layout

Let's take an example for this parking space:

If it's total capacity (S) = 1000 then with that we took a sub set (S_sub) = 100 and we took on 30 parking queries(P). Now, consider within S_sub there 50 spaces available and we have 30 parking queries, the vehicles will be parked as shown in Fig. 6. Fig. 7 shows how the parking space will be after all the slots have been completely filled up.

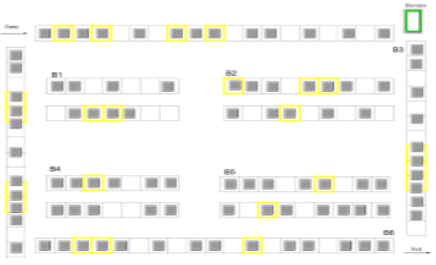

Fig. 6: Partially filled up spaces in Parking lot

Fig. 7: Complete allocation of parking spaces

Result and Discussion

Based on the results of the evaluation, one can conclude that the algorithm for parking area selection plays a large role in automated parking systems. The fact that it needs to work in real time complicates Automatic Number Plate Recognition even more. Consider the case of a toll road with an ANPR system installed. It must be able to detect each car's number plate, OCR the characters on the plate, and store the information in a database so that the toll can be billed to the owner of the vehicle. Finding a dataset to train a bespoke ANPR model is one of the most difficult aspects of ANPR because of several complicated issues.

Conclusion

As ANPR systems rely on complex optical, processing, and digitization capabilities, plate recognition may be slow. The ANPR solutions on the market do not provide a standardized set for all countries; instead, each company must be provided with a well-optimized system for various parts/regions of the world, as the same system developed is insufficient and must be designed according to the region where it will be deployed, taking into account all influencing factors. Often, OCR engines are tailored to a particular country. It is necessary to confirm that the required countries are supported by the camera's library or engine. Vendor-provided ANPR solutions have their own set of advantages and disadvantages. The best of these is the one that meets the demands of the region while also addressing the systemic issues that affect that area.

After completing this project, we will be able to put our notion of recognising permitted vehicles for various private parking, staff parking, and VIP zones using Easy OCR and Open CV image processing techniques. We came to the conclusion that using this project, one may organize parking for allowed vehicles exclusively and collect data on vehicle density as well as timing.

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