Smart Parking System for Locating Vacant Parking Slots

Akshay Nikam, Priyanka Patil, Shruti Shinde, Sippora Toppo

Abstract- **In urban cities finding the available parking slots is very difficult, due to increasing number of vehicles. This paper aims at presenting the concept of locating and detecting car parking slots using image processing. The images of the parking area are taken with the help of CCTV cameras and these images are processed using MATLAB. After the images are processed the data of slot availability is updated in the database. For showing the availability of parking slot to the user, an android app is used, where the user can see the slots available.**

*Keywords-***CCTV cameras, video frames, android application, image processing, parking area, parking slot.**

I.   INTRODUCTION

The substantial increase in the motor vehicles in the past few years is clearly visible in the form of traffic and the cost of parking space in the parking areas. In urban areas this problem occurs more and also we do not have efficient systems for car parking. The driver needs a lot of time to find available parking space in parking lot. And thus a lot of time and efforts gets wasted in search of parking space. It is very important to design and establish a system that can track parking space efficiently. This paper will provide a solution to solve the above problems, thus saving time and efforts need to be put in.

In the proposed system CCTV cameras is used to capture the images of the parking lot, and these images are processed to detect empty parking slots.

After image processing is done, the database is updated and this database is used by android app to show parking area information.

There are many methods using which this system can be implemented. This system can be implemented using RFID technology. But the chances of RFID failure are more, and so this system is discouraged[1]. Some of these systems make use of RFID as well IR sensors which increases complexity as well as the cost[2]. There are many systems which uses LCD as well which again makes system complex[3]. In [4], the authors have mentioned the use of image processing which is what we would be using.

II.   WORKING

This system consists of two main parts. The first is the base of the system, i.e., image processing and the second is android application for users. The system has a server, where the database is stored and the MATLAB code for image processing is executed.
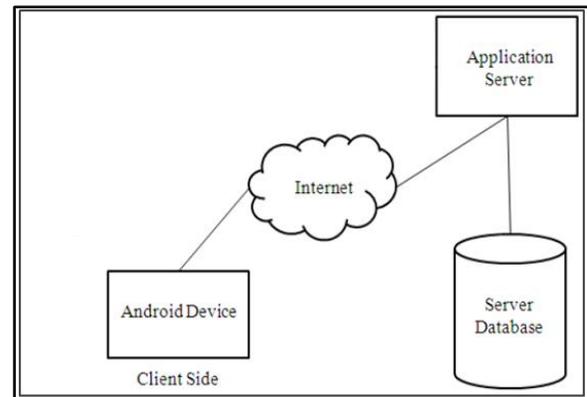

Fig. 1 Client Server Architecture For Application

The server has a MySQL database.

A.   Image Processing

At the server side the image of the parking area will be processed using MATLAB and the database will be updated. The parking slot information stored in the database will be updated after a specific time interval (for example, after every one minute) using MATLAB.
The processing of the image is divided into following steps:

1. System Initialization- Image of an empty parking lot is taken and the coordinate information is stored in database.

2. Image Acquisition- Capture and store the frame taken from CCTV camera footage after parking of cars starts.

3. Image Segmentation- Separate the objects from the background and differentiate the pixels for clarity.

4. Image Enhancement- Remove noise.

5. Image Detection- Determine the round and coloured image drawn at the lot.

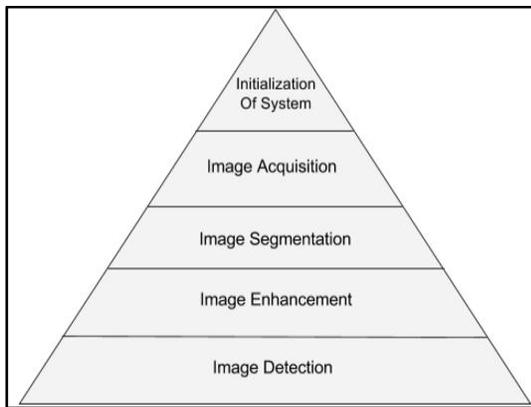The overall processing is illustrated in fig. 2 below:

Fig. 2 Image Processing Steps

The details of each step are described below:

1.   Initialization of System :

The system initialization is to be done only for the first time when this system is started. A colored(mostly green) circle is drawn on each parking slot manually. The purpose of this procedure is to uniquely identify location of every parking slot in the image. Also there is need for drawing lines separating the parking lots which should be visible and clear. The camera is assumed to be in a fixed position and facing a fixed direction all the time and also at a specific and same angle from where the whole or a part of parking lot is clearly seen without any obstacle.

The coordinates of the parking slot are to be stored in the database, and in these coordinates the circle is to be searched.
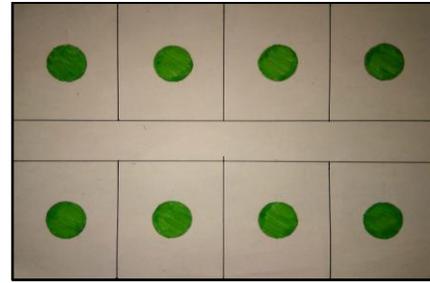

Fig. 3 System Initialization

2.   Image Acquisition :

Once system initialization is done, the image will be processed into the next step, i.e., the image acquisition step. In this step,the image of parking lot is captured from still camera which is fixed at a specific height. The software is running in real-time. Fig. 4 shows the image captured by the camera. Six green coloured circles are shown in the figure, which mean that, there are six available parking slot.

Fig. 4 Image Acquisition

3.   Image Segmentation:

In image segmentation RGB image captured from the CCTV camera is converted to grayscale image and a binary image is created. The following equation is used to convert RGB image to grayscale image.

$$Gray = 0.229R+0.587G+0.114$$

From the gray scale image that we have obtained, thresholding technique are used to create the binary image. The binary images contain all of theinformation about the position and shape of the objects of interest. It increases simplicity of the data andthe process of recognition and classification. Here, the basic thresholding technique is chosen. The

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threshold is defined as g(x,y)= {1 if x > T else 0}. The white color is the object detected and the black coloured background is the result after processing.
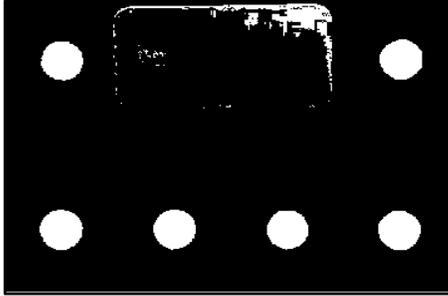

Fig. 5 Image Segmentation

4.   Image Enhancement:

In image enhancement step, the noise is removed and boundary of detected object is traced. Images that are taken by digital camera, will pick up the noise from variety of sources. To remove the noise, opening and closing operations of binary , which are the basic operations for noise removal. Opening removes small objects and closing removes small holes. For tracing the objects boundaries in image, dilation and erosion is used. Dilation incorporate pixels to the boundaries of object in image and the value of the output pixel is the maximum value of all the pixels in the input pixel's neighborhood. Erosion will remove pixels on object boundary.
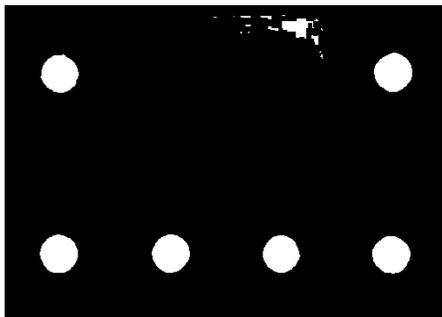

Fig. 6 Image Enhancement

5. Image Detection:

This step will determine which objects are circular in shape by estimating each object's area and perimeter. The below formula is used to indicate the shape of the image drawn at each of parking lot.

$$Shape = 4 \times pi \times area/perimeter^2$$

Here a threshold value of 0.9 is used for the circles on the image. The available parking slots are then detected and displayed.
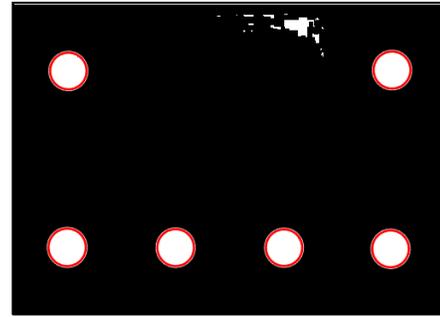

Fig. 7 Image Detection

After processing the parking area image the slot availability table in the database will be updated.

B. Android App

The information of the parking area will be shown to the the user using an android application. The app may have following activities:

1.   Starting the application:

The user needs to install the application on his Android device.

Fig.8   Application Launch

2.   Registration:

The user has to register when he/ she installs the app for the first time. This is a one-time process. The user has to enter details like name, gender, phone number, email-id along with vehicle details like vehicle type i.e. 2- wheeler or 4- wheeler and the vehicle number. All this data will be stored on the server side database.
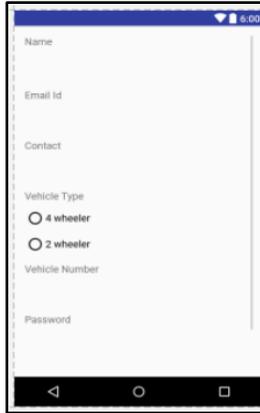
Fig. 9   Registration

3.   Login:

Once the user registers, he can use his email id and password to login in future. This authenticates the user.

Fig. 10   Login

4.   Adding new vehicle:

If the user has a different vehicle then the details of the same can be added.

Fig. 11   Add new vehicle

5.   Map Activity

At the server, the location coordinates(latitude and longitude) of various parking areas are stored. When the user logs in the nearby parking areas are shown to the user. The user's location is detected using GPS and this location is compared with the location coordinates(latitude and longitude) of parking areas stored in the database to find nearest parking areas. The parking area information will be shown to the user using a map activity of the app.
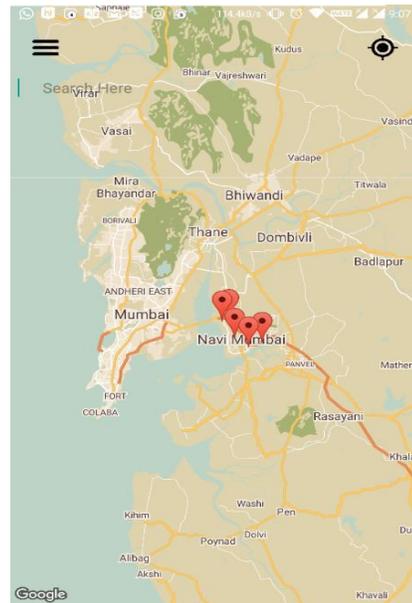

Fig. 12   Map Activity

6.   Parking area information:

When the registered user selects the parking area floater in map activity, the parking area details are fetched from the database and shown on the "Parking area information". The parking slots will be displayed on a virtual map. Color coding scheme is used to indicate empty, reserved and parked slots. Green indicates empty slots, yellow indicates reserved and Red indicates that currently the slot is unavailable i.e. some vehicle is parked.

Fig. 13   Parking slot availability

7.   Reservation of the slot:

Once the user check the availability of the slot, he may book or reserve desired parking slot by clicking on green coloured buttons in the "Parking area information" activity, and from there he will be directed to slot reservation activity. In reservation activity the user has to enter the arrival time and departure time. If the user don't reach to the parking area within the specified time(for example 25 minutes), the slot reserved by him will be revoked from the user.

III. CONCLUSION AND FUTURE WORK

The car parking system proposed is efficient scheme which help in reducing the parking problem. The problem of parking at crowdy places can be handled with a proper plan.

Using the image processing techniques of Initialization of system, Image Acquisition, Image Segmentation, Image Enhancement and Image Detection we get the information of parking area. Since the database at server side is updated at regular interval, the user of app would know whether the space is empty or not.

This parking plan saves the time of clients required for searching a parking slot in rush hours.

The proposed car parking system can be enhanced by adding payment module and OCR for recognising vehicle number on number plate.

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AkshayNikam, B.E. [Computer Engineering], Terna Engineering College.

Priyanka Patil, B.E. [Computer Engineering], Terna Engineering College.

ShrutiShinde, B.E. [Computer Engineering], Terna Engineering College.

SipporaToppo, B.E. [Computer Engineering], Terna Engineering College.