Smart Parking Space Detection Using MATLAB and Internet of Things

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***Abstract* - One of the major issues in metropolitan cities is searching for a parking space. In this paper we come up with a novel solution for parking slot detection based on image processing technique that can capture and process the image to find empty parking slots. The output obtained will then be displayed on a console. This system will reduce the time required to find vacant car slots and reduce wastage of resources. This system will also notify the registered user through various services over the internet, if a vacant parking slot is available at the destination. The proposed system has been developed using software and hardware platforms.**

***Keywords*: Image Processing, Internet of things, MATLAB, Notification Services, Parking slot.**

I. INTRODUCTION

In recent years parking is a serious problem due to increase of the private vehicles. Looking for a parking spot is a waste of time and other resources. For the driver's convenience a system needs to be designed which can notify availability of parking spot in the area over the internet. This would replace current manual system and therefore reduce man power requirement. Counting of free slots manually has created a problem.

In the recent years many research have been done on improving parking lots detection systems. Many systems using surveillance which is real time image sequences gathering and detection of parking slots [1]. Other researches may include keeping tracking and recording the movement of vehicles for finding the parking lot frees [2, 3]. In [4], the authors proposed the subtraction technique between consecutive images as a method to detect the car moving. In [5] the authors proposed the time differential image as a method to extract moving objects from stationary objects. However, the moving object is often as many regions in differential images [6]. Thus in the paper, the parking slot detection to identify if the car is present or not in the area and then the result is displayed on the console which can be a display unit or on the software screen as well. MATLAB software is used as software platform in the project.

The system uses a MATLAB software and complier for detecting if the car is present or not and the MATLAB gets its input from the camera which monitors the movement of the vehicles in the parking lot and gives this image for processing and the image processing techniques are then employed on image using the software and the output of the same is obtained. The system overview is shown in Fig.1.

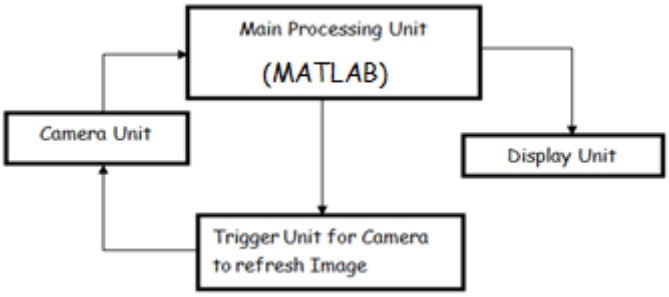

Fig. 1: Block Diagram for Parking lot detection

II. SYSTEM MODULES

Our project consists of five small units of processing. These blocks are built in the software which are shown in the Fig.2. In the first part the camera and the system is initialized and a procedure to automatically identify the location of every parking lot in the image. When the system initializes a reference image with no cars parked is captured and this image will act as reference image for the processing of other images. The image with cars parked are refreshed or changed after a certain interval. In the next block image acquisition is carried out where in the images are captured by the camera and this module gets connected to system processing unit that runs in MATLAB program.

After the image is captured then the system performs the operation making the image clear by filtering of the noise and then handling the image for further processing, in the next module image segmentation is carried out which separates the required object from the background and differentiates the pixels having nearby values for improving the contrast. The image captured by the camera is subtracted with the reference image if there is a change in the image if the change is noticed then further processing is carried out to know the changes in the parking lot numbers. The image is converted into black and white i.e. gray image. The last module is image enhancement. In this module, the noise generated is removed using morphology functions, which remove pixels that do not belong to the object of interest. The boundary objects in the image are tracing which is concentrated on the exterior boundaries. The last module is image detection which is used to determine the cars present in the image. The overall module is illustrated in Fig.2

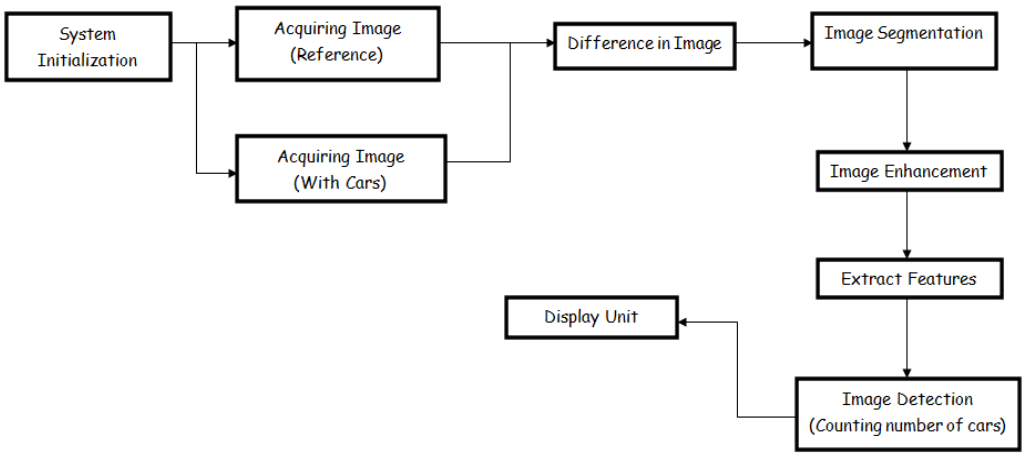

Fig.2: System Block Diagram

III. SYSTEM MODULE DESCRIPTION

A. System Initialization:

The module runs only for the first time when the system started. The initial image is captured which is the reference image is captured as shown in Fig. 3 where zero cars are present in the car park. The purpose of doing this is to identify each and every parking slot in the image. The lines separating each slot should be clear, visible and unobstructed for the reference image to be captured. The camera is assumed to be in the fixed position and facing a fixed direction all the time. This image is then used to analyze and determine available parking lot.

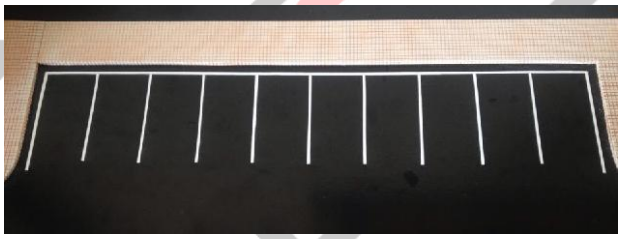

Fig. 3: System Initialization

B. Image Acquisition:

After the first step, the image will be processed in image acquisition module. Here the steps involved are image capturing and storing of digital images from the video cameras. The high definition camera is used for this purpose which is connected to the processing unit and supplies the data for the MATLAB software for processing which is running in real time situations. The aligning of the camera should be done with great care. The camera should be at good height to obtain clear and top view of the parking area. The Fig. 4 shows the image captured by the camera which shows the cars being parked in the area.

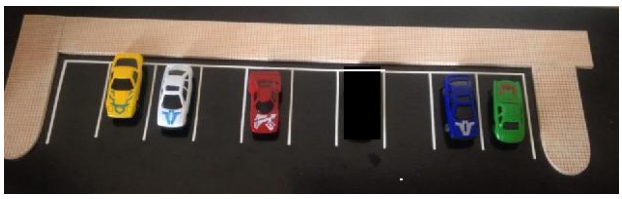

Fig. 4: Image shows the cars parked in the area

Fig 5: Difference in the Images

C. Image Segmentation:

The image acquired from the camera is in the form of RGB (Red, Green and Blue or Colored Image) which is further separated into RGB channels which is converted into grey scale image as shown in Fig. 6 and then creates the binary image in the segmentation module.

Fig. 6: Separation of the image into RGB channels

Equation [1] is used to convert RGB to grey scale image.

$$\text{Grey Image} = 0.229R + 0.587G + 0.114B \qquad \text{…. [1]}$$

Using the equation [1] the grey level image is obtained, thresholding technique can be used to obtain the binary image. The binary image contains all the information about the position and shape of interest. The threshold level is set in such a way that the objects of interest are made into white and the rest of the image black. This method will not only reduce the complexity and also simplifies the processes in processing the image. Thresholding methods are of various types such as basic, two band tile, optimal and adaptive. In this paper we have used basic thresholding technique is used. The thresholding is defined as:

$$g(x,y) = \begin{cases} 1 \; if \; x > T \\ 0 \; if \; x \leq T \end{cases} \qquad \text{…. [2]}$$

In equation [2] the threshold value is denoted by T is selected. Here since the RGB is obtained it is being converted into binary after which we separate them into the respective channel hence appropriate threshold levels are chosen. The threshold technique works as follows any value below or equal to T is classified as black (0) and the above threshold value is classified as white (1). The Fig. 7 shows the converted binary image in R, G, B channels and the summation of all the channels.

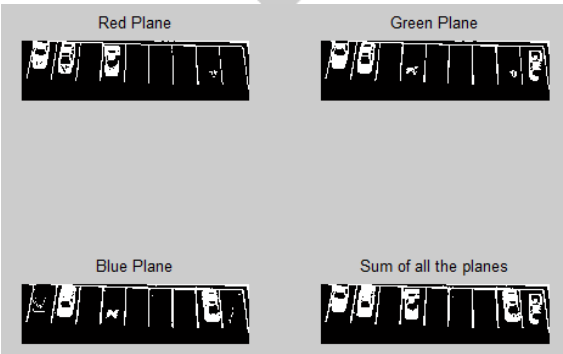

Fig. 7: Converted binary Image in RGB channels and the summation of all the channels

D. Image Enhancement:

The converted binary image will contain some amount of noise and trace the boundary of the object. In order to remove the noise which the image has got from the variety of sources will then be removed using morphological operation namely dilation, erosion, etc. In the paper we have used open and close operation on the binary image. This operation is basically used in the most of the image processing operations. The Fig. 8 shows the image after removing noise at detected object (white color). For tracing the boundaries of the car we focus only on the exterior boundaries.

In a binary image, if any pixel value is 0 then output is 0. Here the picture is enhanced by adding pixels to cover the holes and the pixels are removed to remove unwanted objects.

Fig. 8: Tracing the boundaries

E. Image detection:

When the boundaries are traced detection of number of cars present in the image is implemented. Here we find the eccentricity of the image and then make this to run in the loop. In this part where the car is present is detected and marked using square boxes and image output is produced and the same is also outputted on the MATLAB software. Fig 9 shows the number of cars that are detected by drawing a square parking slot. From the console the IFTTT (If This Then That) application gets triggered and the sends a SMS to users and also notifies people on the social media using the internet services.

Fig. 9: Parking Slot Occupied

IV. RESULTS AND DISCUSSION

The project was aimed in providing better and efficient way for parking vehicles by detecting the slots available and intimating the same to the user was successfully performed. The message posted on the internet social media such as SMS in Fig. 10. A smart parking slot detection is based on image processing have been tested and proposed in the paper. The results include parking detection until some cars were parked. The preview is shown in GUI in Fig. 11.

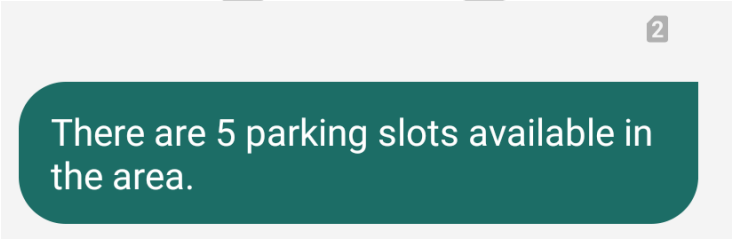

Fig 10: Alerting the user via SMS

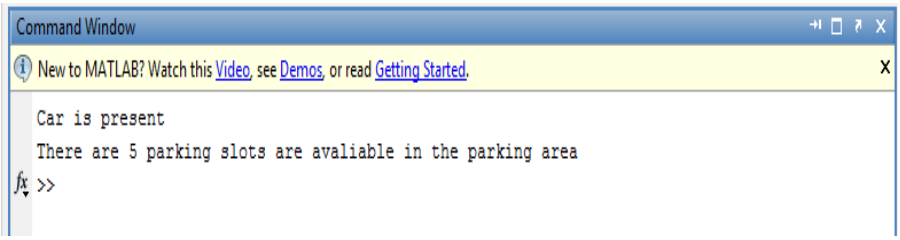

Fig 11: Outputs on the GUI

V. CONCLUSION

This paper proposes the idea of parking slot detection system based on image processing was designed and tested. It is an efficient way of comparing the reference image and the captured image which simplifies the system. The conceptualization of this paper is based on software instead of hardware which makes the system cheap to maintain and implement. This system also makes the system free from wire hassles. The future work could be complemented in providing secure parking and making the system work in various environmental conditions. The system can not only be used in cities but can also be used on highways, malls, etc. The feature of providing the internet messages can serve as an advantage for the system.

REFERENCES

[1] G.L.Foresti, C.Micheloni, and L.Snidaro, "Event Classification for Automatic Visual based surveillance of Parking Lots" *Proceeding of the 17th International Confrence on Pattern Recognition*, pp. 1051-1081.

[2] C.H Lee, M.G Wen, C.C Han, and D.C Kou, "An Automatic Monitoring Approach for Unsupervised Parking Lots in Outdoors" *Security Technology, 2005. CCST '05. 39th Annual 2005 International Carnahan Conference* 11-14 Oct. 2005 Page(s):271 – 274

[3] Masaki, I., "Machine-vision systems for intelligent transportation systems" *IEEE Conference on Intelligent Transportation System* 13-6 P:24 - 31 Nov. 1998

[4] K. Ueda, I. Horiba, K. Ikeda, H. Onodera, and S. Ozawa, (1991). An algorithm for detecting parking cars by the use of picture processing (1981), *IEICE Trans. Information and Systems.*vol.J74-D-I1. IO, pp. 1379-1389.

[5] M. Yachida, M. Asada, and S. Tsuji. Automatic Analysis of Moving Image. *IEEE Trans. Pattern Anal and Mach.Intell*. vol.PAM1-3(1) pp.12-19.

[6] Ms .Sayanti Banerjee, Ms. Pallavi Choudekar and Prof. M. K. Muju. "Real time car parking system using image processing," 2011. IEEE, pp. 99-103.

[7] http://www.mathworks.com

[8] Rafael Gonsalves, Richard Woods and Steven Eddins, *Digital Image Processing Using MATLAB* ®, 2nd Edition, 2016, Mc Graw Hill Education