

Design and Implementation of an Intelligent Parking Management System Using Image Processing

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Abstract—This paper aims to present a smart system that automatically detects the type of vehicle, directs it, counts the number of vehicles and identify the empty plot number at the parking area. This system uses image processing technique. Whenever a vehicle approaches the parking entrance, the image of the vehicle is captured. Based on the image acquired, the system detects the vehicle type. The types of vehicle used in this system are Bus, Car and Two-wheeler. Also, the image of the parking area is captured and the system counts the number of vehicles, the plot number and displays the parking status. If Bus is detected at the entrance, it is directed towards west and if Car is detected, it is directed towards the east and if Two-Wheeler is detected, it is directed towards north side of the parking area based on the availability of parking status. This proposed system can be effectively used in the parking area which involves the parking of different types of vehicles.

Index Terms—Vehicle detection, Vehicle counting, Parking space detection, Parking slot number identification, Image processing.

I. INTRODUCTION

The number of vehicles and the occurrence of traffic jam are very high in metropolitan areas. Hence the need for large number of parking areas is increasing. Even if the parking areas are more, people are facing lot of problems to find an available parking space due to the insufficiency of the proper status of the parking area. The major problem that occurs at the parking area is the wastage of time in looking for the available parking spaces. The drivers keep on circling the parking area to find out the empty space. This also causes congestion at the parking area. These problems can be eliminated by offering drivers with the relevant information about the status of the parking lot at the entrance of the parking area. If the status of the parking area is displayed at the entrance, the drivers can easily know the availability of the parking lots and can park their vehicles accordingly. In case if there is no availability of parking space, the drivers can move away without any delay in searching unnecessarily. Also, the direction of the vehicle helps the drivers to park the vehicle efficiently in the specified location. This is very useful in the parking areas which involve parking of different types of vehicles.

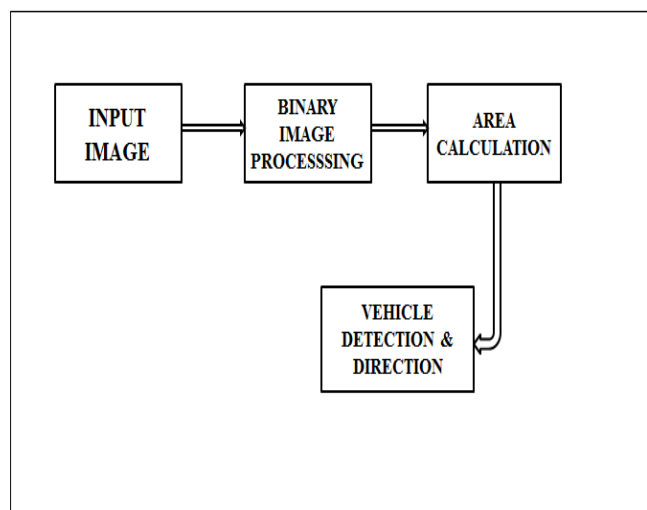
Thus in this paper, the parking lot detection is done by processing the images captured from both the parking lot and at the entrance using Web Camera. The image acquired from the entrance is used to detect the type of vehicle. Based on the

detection, the vehicles are directed. The image obtained from the parking lot is used to count the total number of vehicles and identify the empty slot number in the parking area.

II. PROPOSED SYSTEM MODULE

The proposed system involves 2 modules: Simulation part and the Hardware module. Simulation process involves the Vehicle detection and direction module and Slot number identification module. The vehicle detection and direction module is used for the detection and the direction of the vehicles. This involves the Image Acquisition, Binary Image Processing, Area Calculation and Vehicle direction. The Slot Number Identification module is used for counting the number of vehicles and identifying the individual empty slot number in the parking area. This involves the Feature extraction, Classification using ANN and the Output. The overall module is illustrated in fig.1 and fig.2.

VEHICLE DETECTION & DIRECTION MODULE



SLOT NUMBER IDENTIFICATION MODULE

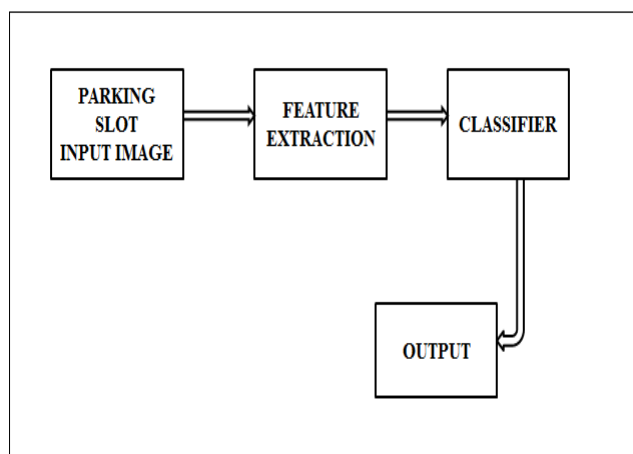


Fig 1: Block Diagram for Simulation



Fig 3: Input Image of Bus

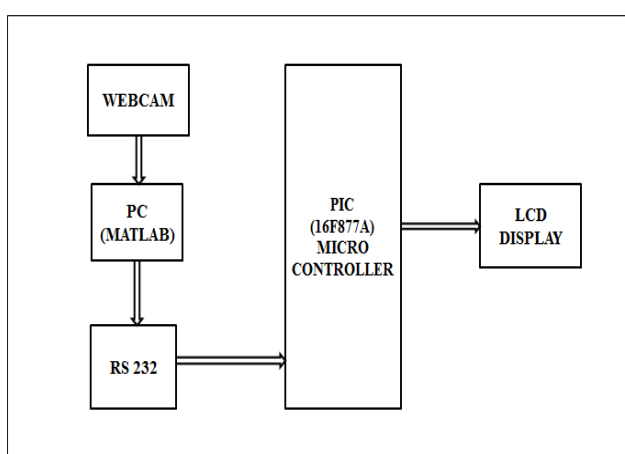


Fig 2: Block Diagram for Hardware



Fig 4: Input Image of Car



Fig 5: Input Image of Two-Wheeler

A. Vehicle detection & direction module

1) Image Acquisition

This module involves capturing and storing of the input images used for the detection of the type of vehicle. In this system, the vehicles that have been used are the Cars, Bus and Two-Wheeler. Hence the images of Cars, Bus and Two-Wheeler are used. These input images are stored in the system and are used as an input for the detection process. The image of bus is shown in fig.3 the image of car is shown in fig.4 and the image of two-wheeler is shown in fig.5

2). Binary Image Processing

The acquired images are large in size and occupy a large amount of storage. This becomes difficult for processing. Hence, these images are compressed and then stored to enhance the storage and processing speed. The Matlab code used for compression is given in the eqn.1.

$$I1 = \text{imresize}(I,[256\ 256]); \quad (1)$$

The image that is captured by the camera is the RGB Image. This RGB image must be converted to gray scale image for processing. Gray scale image represents the black and white image. The black and white image can be easily processed. Hence, the RGB image is converted to Gray scale image. The resulting output of this conversion is the binary image. This process of conversion is done in this image segmentation module. The equation that is used to convert RGB image to Gray scale image is given in the eqn.2 and the Matlab code for converting the input image to binary image is given in eqn.3. R1, G1 and B1 denote the values of red, green and blue color.

$$\text{Gray} = 0.229R1 + 0.587G1 + 0.114B1; \quad (2)$$

$$g = \text{rgb2gray}(I1); \quad (3)$$

The converted Gray scale images of bus, car & two-wheeler are shown in fig.6, fig.7 & fig.8.



Fig 6: Converted Gray Scale Image of Bus



Fig 7: Converted Gray Scale Image of Car

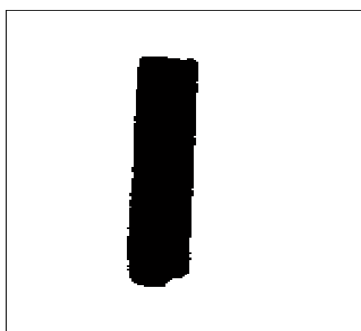


Fig 8: Converted Gray Scale Image of Two-Wheeler

The resulting binary image obtained involves the impurities. These impurities are termed as noise. This noise must be removed and the boundary of the detected image must be traced. This is done with the help of using binary morphological operation. The morphological operation involves the Dilation and Erosion processes. The holes in the gray image are filled by adding the pixels in the dilation process and the unwanted pixels that are present in the image are removed by the erosion process. The code for the morphological process is given in eqn.4. The enhanced images of bus, car & two-wheeler are shown in the fig.9, fig.10 and fig.11.

$$s = \text{strel}(\text{'disk'}, 2); \quad (4)$$

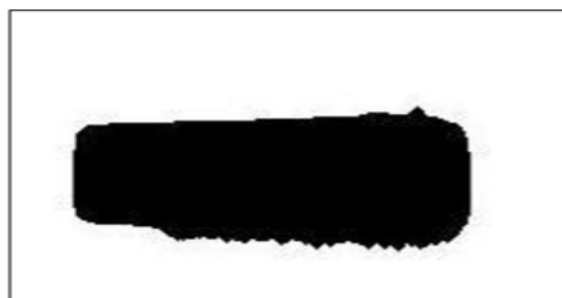


Fig 9: Enhanced Image of Bus



Fig 10: Enhanced Image of Car

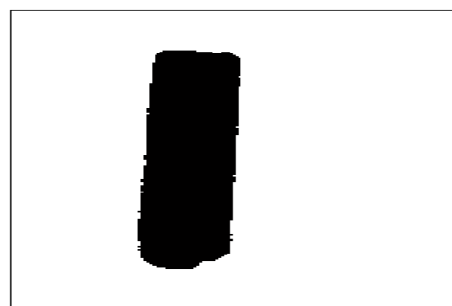


Fig 11: Enhanced Image of Two-Wheeler

3). Area Calculation

In order to detect the type of vehicle, the areas of the images must be calculated. The images of the car, bus and two-wheeler will be in black color and the background will be in white color. In order to determine the vehicle, the white areas of the images are calculated. Based on the values of the areas obtained, the image is identified as Car, Bus or Two-Wheeler.

4). Vehicle Detection & Direction

Based on the calculation of the white areas of the car, bus and two-wheeler reference images, the process of direction takes place. That is, the image with a least white area will denote the presence of a bus. The image with a larger white area when compared to the bus will denote the presence of a car. The image with the larger white area when compared to the car will denote the presence of two-wheeler. Thus based on the detection of the area of white areas of the images, the vehicle direction takes place. The cars are directed towards the east side of the parking area, the buses are directed towards the west side of the parking area and the two-wheeler are directed towards the north side of the parking area.

B. Slot number identification module

To develop this system, a prototype model of the parking area has been designed. This model consists of 6 parking lots; 2 parking lots to park the cars on the east side, 2 parking lots to park the bus on the west side and 2 parking lots to park the two-wheeler on the north side. The sample images of

the designed parking lot are shown below in the fig.12 and fig.13.

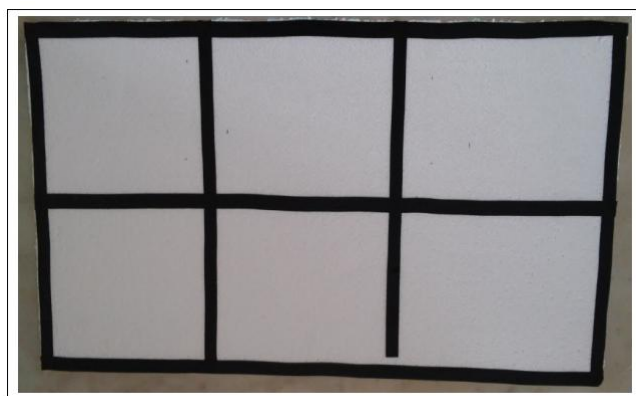


Fig 12: Empty Parking Lots



Fig 13: Filled Parking Lots

2) Feature Extraction

Transforming the input data into the set of features is called feature extraction. Feature extraction involves extracting the required details of the images. If the features extracted are carefully chosen it is expected that the feature set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. The input image is carefully processed and the required features are extracted from it.

3) Classification Using ANN

Neural networks are good when dealing with abstract problems, like those based on features and patterns. Feature detection is done by classifying an unknown input pattern by comparison to previously learned patterns. This ability is termed associative recall. The reference images are stored in the database. Neural network is trained to run based on these reference images. The advantage of neural network is, it can be trained for any number of inputs. The Matlab code used for training the neural network is given in eqn.3. Here x is the input, T is the target and $net2$ is the created target.

$$[net2] = \text{train}(net2, T, x); \quad (5)$$

4) Output

Thus the vehicle detection, direction and counting processes are carried out and their results have been tested and

simulated in the Matlab platform. Desired simulated outputs are obtained for vehicle detecting, directing and vehicle counting.

III. PIC CONTROLLER TO BE USED IN THE HARDWARE

A. Features

The PIC microcontroller is a 8-bit first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques. Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877. It is a package with 8K x 14 words of Flash Program memory, 368 x 8 bytes of Data memory (RAM), 256 x 8 bytes of EEPROM data memory. The operating speed is 20 MHz. The operating voltage is 2.5V to 5.5V. It has high performance RISC CPU, only 35 single instructions except for program branches which are two cycle, interrupt capability, eight level deep hardware stack, selectable oscillator options, programmable code-protection, In-Circuit Serial Programming (ICSP) via two pins. Low-power, high-speed CMOS EPROM/EEPROM technology; It involves Direct, Indirect and Relative addressing modes.

IV. SIMULATION, RESULTS AND DISCUSSION

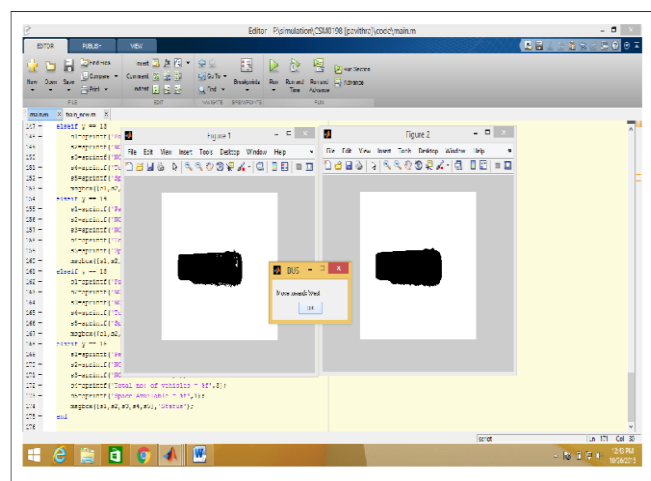


Fig 14: Simulated output to direct Bus

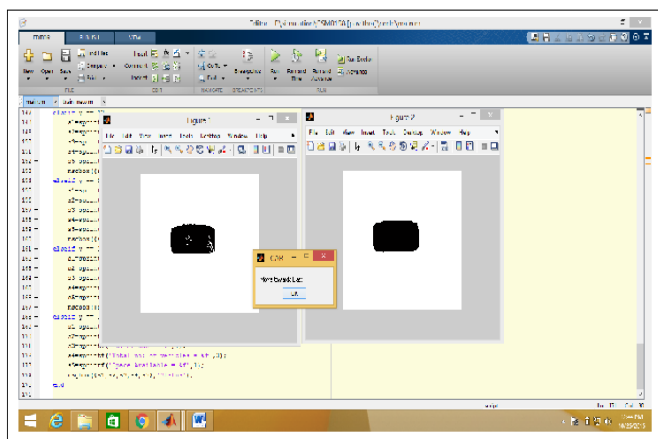


Fig 15: Simulated output to direct Car

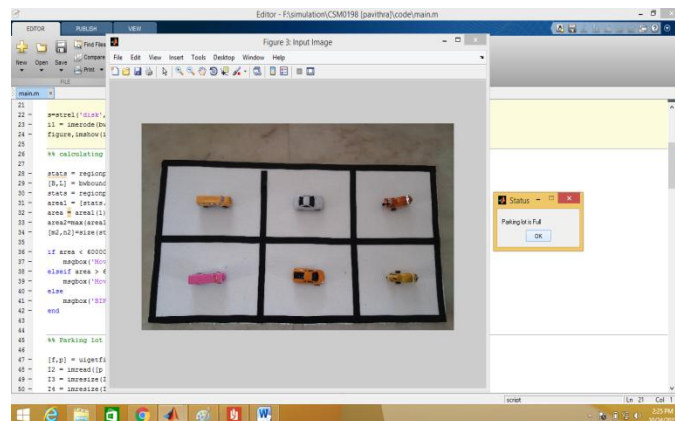


Fig 18: Simulated output when parking area is full

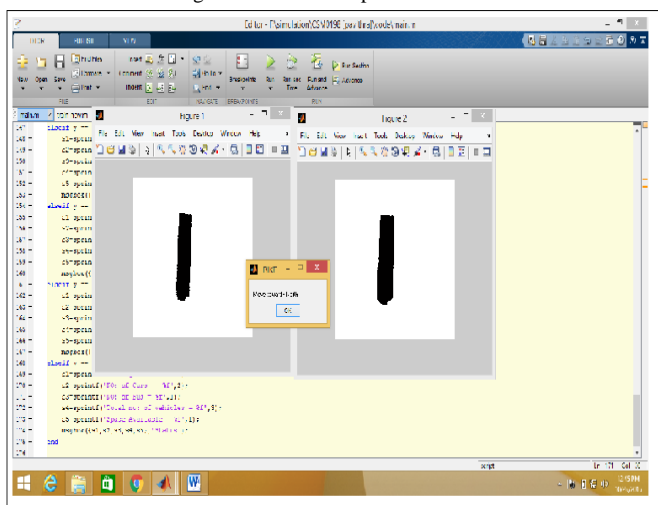


Fig 16: Simulated output to direct Two-Wheeler

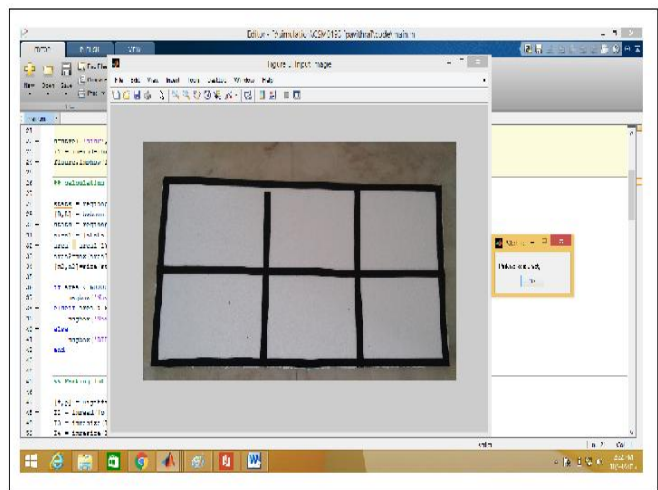


Fig 17: Simulated output when parking area is empty

V. CONCLUSION

Thus, based on the code written in the Matlab software, the system works in a smart way by processing the images obtained from the parking entrance and the parking area captured by the webcam. After processing the images, type of vehicle is detected. Based on the images of the parking lots, the total number of vehicles is calculated, thereby estimating the parking status. Based on this parking availability, the vehicles are directed to the specified path i.e. Bus is directed towards west side of the parking area, Car is directed towards the east side of the parking area and Two-Wheeler is directed towards the north side of the parking area. Future work will include a comparison with a laboratory experiments in order to compare simulation and experimental results.

REFERENCES

- [1] Thomas Moranduzzo, Student Member, IEEE, and FaridMelgani, Senior Member, IEEE, "Detecting Cars in UAV Images With a Catalog-Based Approach", IEEE Transactions on Geoscience and Remote Sensing, vol. 52, no. 10, October 2014, pp.6356-6367
- [2] Thomas Moranduzzo, Student Member, IEEE, and FaridMelgani, Senior Member, IEEE, "Automatic Car CountingMethod for Unmanned Aerial Vehicle Images", IEEE Transactions on Geoscience and Remote Sensing, vol. 52, no. 3, March 2014, pp.1635-1647
- [3] R. Yusnita, FarizaNorbaya, and NorazwinawatiBasharuddin, "Intelligent Parking Space Detection System Based on Image Processing", International Journal of Innovation, Management and Technology, Vol. 3, No. 3, June 2012, pp.232-235.
- [4] Ms. Sayanti Banerjee, Ms. PallaviChoudekar and Prof. M. K. Muju. "Real time car parking system using image processing," 2011. IEEE, pp. 99-103.
- [5] W. Yao and U. Stilla, "Comparison of two methods for vehicle extraction from airborne lidar data toward motion analysis," IEEE Geosci. Remote Sens. Lett., vol. 8, no. 4, pp. 607–611, Jul. 2011.
- [6] M Rama Bai, Dr V Venkata Krishna, and J SreeDevi, "A new morphological approach for noise removal edge detection," IJCSI International Journal of Computer Science Issues. vol.7 Issue 6, Nov 2010.
- [7] S. Singh, "Morphological image processing," A Seminar Report, University Of Science and Technology Kochi, October 2010.
- [8] S. Saleh Al-Amri, N. V. Kalyankar, and Khamitkar S, "Image segmentation by using thershold techniques," Journal of Computing. vol 2, Issue 5. MAY 2010, ISSN 2151-9617.
- [9] Z. Bin, J. Dalin, W. Fang, and W. Tingting, A design of parking space detector based on video image, The Ninth International Conference On Electronic Measurement & Instruments ICEMI 2009.

BIOGRAPHIES



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