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Vehicle Detection Using Image Processing and Fuzzy Logic

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ABSTRACT

Vehicles moving on road are of importance because problems like traffic congestion, economic waste, jamming on the underpasses and over-bridges (if the vehicle passing through is not of the permissible size) are associated with them. These problems can be dealt with; by using various morphological processes based image processing techniques to detect the vehicles. In this paper, the images of moving and still vehicles have been taken and an algorithm is used for vehicle detection which is based on image processing techniques and classification of vehicles in the form of natural description(in linguistic terms) based on fuzzy logic.
Keywords: Thresholding, Sobel Edge Detection, Erosion, Dilation, Membership Function

1. INTRODUCTION

Classification based on the sizes and shapes of vehicles is very useful in traffic management [1]. Image processing plays an important role in various real time applications ranging from medical imaging to pattern and object recognition for different purposes [2]. Thresholding and preprocessing steps are used as image segmentation techniques [3]. [4] It is proposed that edge detection is an important step for vehicle type recognition, especially Sobel Edge detection. Fuzzy logic control is well suited for classification of vehicles because it is capable of making inferences even under uncertainty [5]. It assists rules generation and decision-making. It uses set of linguistic Fuzzy rules to implement expert knowledge under various situations [6].

2. PRESENT WORK

The various steps used in the present vehicle detection and classification are discussed below:

2.1. Pre-processing

Reference image is the image taken once for the road without vehicles on it where no traffic is present. Current image is the actual image on which we want to detect the vehicles.

Gray Scale Conversion Using Thresholding

a. Each pixel of a color sample has three numerical RGB components to present the color by three 8-bit numbers for each pixel and thus three 8-bit bytes is called 24-bit color. But each pixel is only stored as one 8-byte in gray-scale image, so gray scale conversion is done.

b. A series of thresholding is applied one after the other on the reference and the current images.

Filtering

A median filter is used to remove noise if present on the generated image. At this point the image is ready to be further processed for vehicle detection after differencing and filtering.

2.2. Vehicle Detection Algorithm

Edge Detection

Sobel edge detection technique is used to create minimum number of edges and to connect boundary of the vehicle to bring it to a proper shape since the inner edges are irrelevant.

Binary Dilations and Filling of Holes

A series of linear binary morphological dilations are performed in three directions, horizontally, vertically and through 45 degrees. The result is that the vehicles become more prominent but at the same time, some noise objects become larger. Binary filling of the holes is performed because proper solid objects are needed for proper classification. Holes are a set of background pixels that cannot be reached by filling in the background from the edge of the image. Unwanted small objects did not increase in size as result of the filling operation.

Sometimes, a *second level dilation* is also required to ensure the connectivity of disconnected parts (if any) of the vehicles with the help of a diamond structuring element, which is one of the most efficient structures in morphological dilation and erosion.

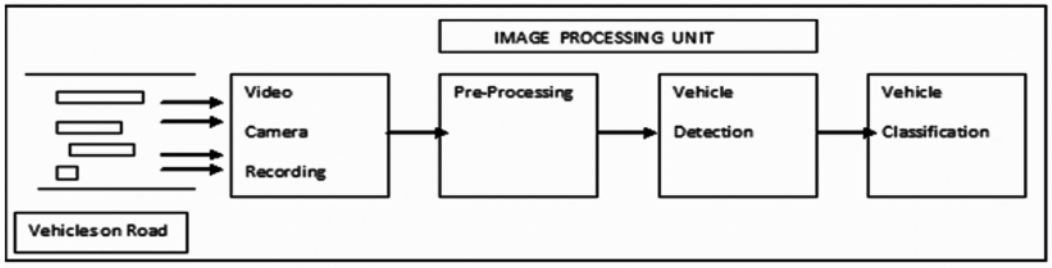

Fig. 1: Designing Steps of the Algorithm

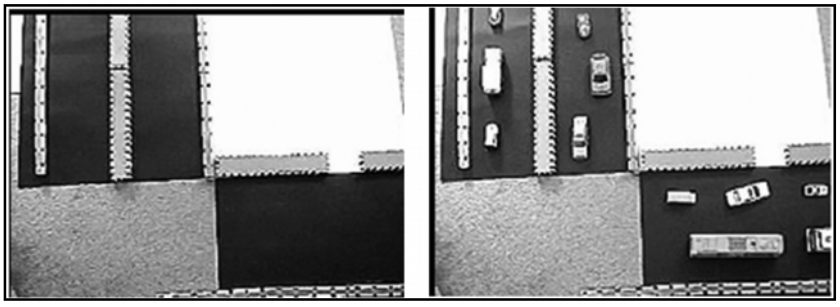

Fig. 2: Reference and Current Image (Input to the Pre-processing Phase)

Binary Opening

Binary open operation based on the size of the objects is used to remove small unwanted objects and the size of such objects depends on the camera height.

2.3. Vehicle Classification

a. *Isolation of Objects by Blob Analysis and Calculation of Convex Hull:* The vehicle classification starts with isolating each object and reshaping it into a near polygon shape so that it reflects the actual vehicle's dimensions from an aerial camera. The Convex Hull of each object is calculated and the objects are reshaped into near polygon shape and more structured than they were before this step.

b. *Classification based on Area and Circumference Using Fuzzy Logic:* To perform classification, fuzzification of area and circumference is done and each vehicle type (e.g. small, medium and big) is assigned a measurement range of values by designing fuzzy rules and finally defuzzification is done.

3. RESULT AND DISCUSSION

The work has been implemented using MATLAB version 7.6.0 (R2008a). There are originally 12 vehicles: 2 small, 4 medium and 6 big. After cropping, the top small car is discarded as a result of touching the boundary of the image beside the medium car on the right side of the road.

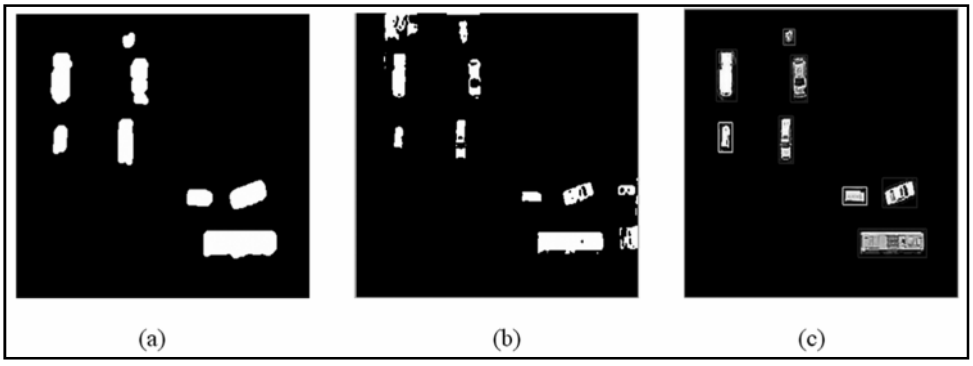

Fig. 3: Output (a) Pre-processing ; (b) Vehicle Detection Algorithm; (c) Vehicle Classification

Hence, the total number of remaining vehicles is 9: 1 small, 2 medium and 5 big vehicles which are properly detected and indicated using red, green and blue rectangular boxes around them for small, medium and big vehicles respectively.

4. CONCLUSION

In this paper, we have developed an algorithmic approach to vehicle detection and classification using fuzzy logic. This not only reduces the complexity of the system but enhances its use in the areas which are too

difficult to be detected by normal means. Further it is proposed that after detection objects can be classified using techniques like neuro-fuzzy etc so as supervised and unsupervised learning can be used to train the system. This algorithm can be applied on real time projects and further improvement can be the techniques mentioned above.

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