Color Features Integrated with Line Detection for Object Extraction and Recognition in Traffic Images Retrieval

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Abstract

This paper proposes a simple object extraction and recognition method with efficient searching for identifying and extracting the objects in a complex scene based on the color features. The background of the images is needed to be extracted and recognized in order to get the object of the interested in the images first. This can be achieved by getting the best separation line between building and road, followed by the interested objects (vehicles) on the road. The vehicle objects are represented by using Minimum Bound Rectangle (MBR) and the vehicle object representative points will be the left bottom coordinate of the MBR. The color of the vehicles will be used as the attributes of the objects. Experiments have been conducted to demonstrate that single and multiple known objects in complex scenes can be extracted by using this approach.

Keywords: *Content based Image Retrieval (CBIR), Object Extraction, Object Recognition.*

1. Introduction

Object detection in arbitrary scenes is an important and challenging research topic in computer vision [1] and object searching in a database of color images is a particular problem of color image retrieval similar to appearance-based object recognition [2]. Retrieving known objects from a complex scene is identifying and recognizing the known objects in the scene and determining the region occupied by these objects. In addition to object recognition and scene interpretation, the applications include associative retrieval, querying image databases with visual data, search and replace operations in multimedia retrieval.

Having an accurate object recognition algorithm especially for natural and complex images in the field of image retrieval is contributing to increase the accuracy in image retrieval besides it used as input for semantic features extraction to reduce the semantic gap in image retrieval.

2. Related Works

In the context of object recognition, one of the most widely used image features is the color histogram. It is robust with respect to distortions, including deformation, translation, rotation and scaling of the object. The processing of the color histogram [3] which characterizes the object requires a segmentation step in order to identify the pixels that represent the object. Since the color vectors of the pixels depend on the illumination, the color histograms of two similar images may be different. Therefore, the comparison between color histograms may fail to recognize the same object is illuminated under different illumination conditions [2]. Ref [4] then improved the color histogram approach and proposed an object recognition technique by analyzing their colors when their images are acquired under different illumination conditions. The chromatic co-occurrence matrices are used to characterize the relationship between the color component levels of neighboring pixels. Their matrices are transformed into adapted co-occurrence matrices that are determined so that their intersection is higher when the two images contain the same object is illuminated under different illumination conditions.

However, the above approaches were designed for the object recognition with images that contained one single object placed on an uniform background or multiple objects observed under uncontrolled illuminations. They are having problem when dealing with natural and complex background (with variety of color exist and color that are scatted). Image background may create confusion in recognizing object classes, the background can also provide useful cues to aid recognition, since many objects tend to occur in particular types of scene [5-7]. The use of color histograms is simple and fast, but it works mainly for non-cluttered scenes or for pre-segmented objects. Besides, the spatial distributions are not take into considerations for capturing the object that exists in the images and consequently it might always caused inaccurate or false objects detection.

There are several techniques proposed to integrate spatial information with color histograms for better and accurate object recognition. G.Pass et al [8] proposed Histogram refinement based on color coherence vectors. The technique considers spatial information and classifies pixels of histogram buckets as coherent if they belong to a small region and incoherent. Huang [9] proposes color correlogram for histogram refinements. Hsu et al. [10] integrated spatial information with color histograms by first selecting a set of representative colors and then analyzing the spatial information of the selected colors using *maximum entropy* quantization with event covering method. Ref M.Stricker et al. [11] partition an image into 5 partially overlapping, fuzzy regions, extract the first three moments of the color distribution for each region, and then organize them into a feature vector of small dimension. Smith and Chang [12] apply back-projection on binary color sets to extract color regions. Vinh Hong et al [13] proposed a color-based object classification. A color histogram is determined by the histogram type (e.g. relative vs. absolute), the color space such as RGB, and the quantization of the color space. The quantization is the process of partitioning the color space into disjoint sub spaces. It uses the nearest neighbour classifier (NN) which is based on a set of classified sample patterns representation of color histogram

Even though the color spatial features has been taken into consideration for better object identification for the above approaches [8-12], however, the object recognition using low level color features is still not fully addressed. In fact, current color features object recognition approaches are used either for Histogram Color Matching in term of similarity then evaluating the similarity between the scene histogram and model histograms or segmenting the image to capture the local features. Hence, it failed to reliably detect and recognize the object. Color Object Classification method [13] also classified object into certain categories based on their color similarity. So object recognition based on color features are needed instead of object matching similarity or object classification.

3. Proposed Solution

In this paper we proposed a strategy for identifying known objects and demarcating the approximate regions occupied by these objects in a complex scene using only color features. The proposed color object recognition can be divided into 2 main stages: Color Features Extraction and Object Identification and Recognition.

3.1 Color Feature Extraction

The Color Features Extraction process is used to extract the features of the images for object recognition purpose. The Color Features Extraction process has five stages and the data flow is shown at Fig.1

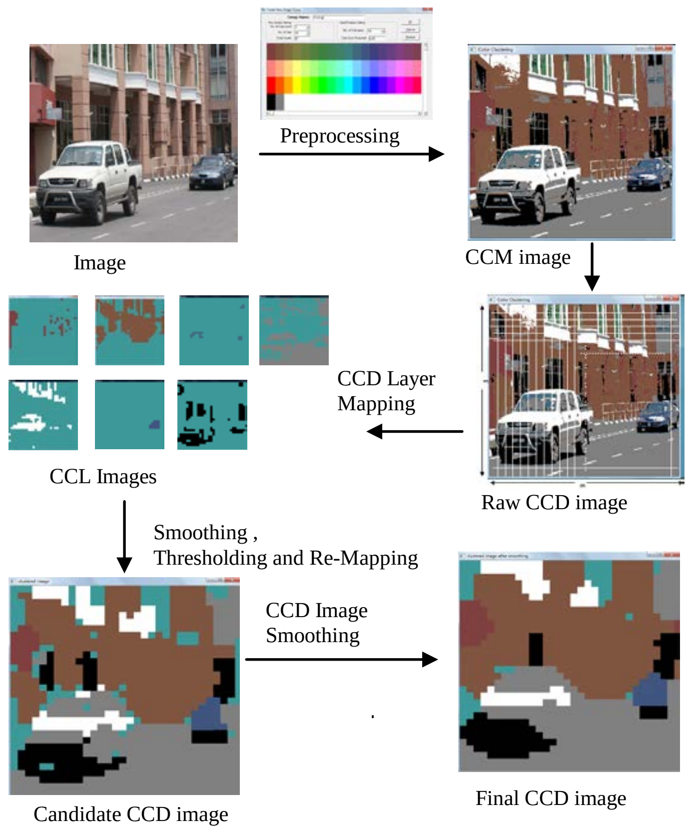


Fig.1: Feature extraction process data flow

3.1.1 Preprocessing

All images need to go through the preprocessing process where it needs to determine the color value of every pixel in the image and compute its distances to all the colors in the predefined color table. The pixel is assigned to the cluster color in the color table that has the smallest distance to the pixel. The output of the preprocessing process produces a Colour Cluster Mapping Image (CCM Image).

3.1.2 Image Sub Division

The CCM Image from the preprocessing process is divided equally into *m x m* sub areas. All the images go through the Image Sub Division process for the purpose of calculating the population of every colour that exists in each sub area. This process produces a raw Colour Cluster Distribution image (CCD Image).

3.1.3 CCD Layer Mapping

The raw CCD image is going to use for the CCD layer mapping process where the raw CCD image will be extracted and represented into *n* Color Cluster Layer images (CCL Images), where *n* is the number of colours**.** The CCL images then will be used as input for colour CCL smoothing process.

3.1.4 Smoothing, Thresholding and Remapping to CCD Image

All of the CCL images go through the Smoothing process to reduce the noise of the images. The smoothed CCL images will be used for thresholding process. The threshold value is used to identify the population of the color in the image that are needed to be removed as it is consider as a noise of the image. Next, the list of n candidate CCL images will be produced.

The regions that are smaller than an area threshold will be removed from the final segmentation where the results contain only contiguous sets of pixels that have a relatively uniform color distribution and the population of colours are large enough.

All candidate CCL images will be re-mapping and produce another image containing only the dominant clusters, namely Color Cluster Distribution Image (CCD Image).

3.1.5 CCD Image Smoothing

Same as CCL images, the CCD image will go through the CCD image smoothing. Window operation is applied to remove unnecessary noise to come out with a finalized smooth CCD image. The window operation in CCM image is different from CCL image where this CCM is based on few colors in image while CCL is each single color versus to background colour but the concept are the same. The output will be the Final CCD image.

3.2 Object Identification and Recognition

The Final CCD image will be used as input for Object Identification and Recognition process. Object Identification and recognition is needed to extract the object of interest in the images. The Object identification and recognition process has 9 stages and the data flow is shown at Fig.2

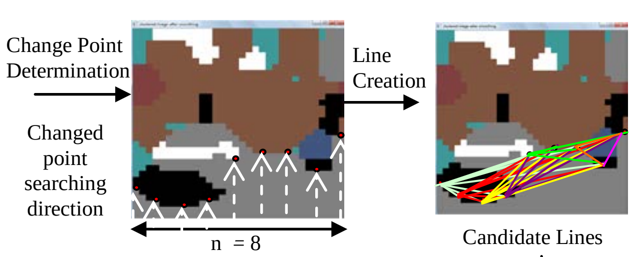


Fig 2. Object Identification and Recognition

3.2.1 Changed Point Determination

The final CCD image will be used for road and building extraction in the traffic images. Firstly, it needs to go into changes point determination process to determine the color changes point. The image is divided into m size at axis-x and the starting point is from the bottom left of the images. The changed point will be the first changes of color area based on the axis-x. This process is continued until get *n* of points, n is the number of changing points that predefined.

3.2.2 Line Creation

The road slope is used as the reference slope for getting the object of interest (vehicles). In the line creation process, all possible lines will be created based on the n points from the changed point determination process. List of lines will be created as output form the line creation process as shown in Fig.2

3.2.3 Line Verification

Line verification is needed to get the candidate lines by removing all the negative slope lines. All candidate lines will go into slope of line calculation process to get the value of the slope for each possible pair of line.

Since this research domain images are traffic images with perspective view. So, assumption has been made as below,

1. There is no negative road slope
2. The best slope value (reference slope) is approximate 0.20 (This value is obtained based on human perception judgment from collection of database images)

Given changed points of (x1, y1) and (x2,y2) of the angle between 2 lines, the slope of line, m can be calculated using formula below.

$$\text{Road Slope, m} = \frac{y2 - y1}{x2 - x1}$$

3.2.4 Best Line Drawing

All candidate lines with their slope values will be compared with the slope reference value. The line with slope value that is nearest to the reference slope value will be chosen as reference slope of the image.

So, the 2 coordinates of the reference slope will be used as 2 reference points to get the best line of the road that act as a z-axis due to the image view is slanted.

3.2.5 Color Cluster Group Identification

All Color cluster groups are identified based on all the color representatives that are available in the images. For each color cluster, two coordinates from axis-x and axis-y which are the nearest and farest from axis-x and axis y respectively will be chosen as the representative coordinate to form a color minimum bound rectangle that is used to represent the color cluster group.

3.2.6 Horizontal and Vertical Scanning

All the color cluster groups will be divided into an Individual Color Clusters (represented by red dotted box) by the horizontal and vertical scanning process.

3.2.7 Object Cluster Identification

The Individual color clusters will be used as an input for the object cluster identification process to get the candidate object clusters. The Candidate object clusters are classified into two groups which are region/object clusters and Reference object clusters. Since the object of interest is a vehicle. So assumption need to make that all vehicles will have black tyre and most of the time, there is a shadow below the vehicle. So, the black colour cluster will be used as reference objects to search for candidate object.

3.2.8 Object Cluster Verification

Object Cluster Verification is the process to verify the candidate objects. The object cluster and reference object cluster will be combined if they satisfied the predefined object distance and the road distance value. The combination of reference object cluster with object cluster will formed the list of objects clusters.

3.2.9 Object Identification

All object clusters (vehicle objects) will be represented by a MBR and left bottom of MBR will be used as reference coordinate of the vehicle objects and the color of the vehicle will be used as attributes for the car.

4. Experiments

The Objective of the experiment is to evaluate the accuracy and effectively of the proposed color object recognition method in recognizing the objects of interest (vehicles) in the domain of traffic images.

4.1 Experiment Setting

There are 3 parameters setting in the experiments which are the number of colour cluster that used as the colour representation of the image, the color cluster object distance value used for determining the value distance between color clusters are considered to be merged and also the road distance value that used for determining the distance value from the road slope to the color cluster are considered to identify as object as interest. In these experiments, there are 57 color cluster used as color representation of the image, color cluster object distance of 3 and road distance value of 2.

4.2 Experiments

To measure the accuracy of the object detection and recognition, the detected vehicles by the proposed color feature object recognition compared with vehicle outlines selected by a user on the same images. A successful detection is considered as detected and correct if the detected vehicles by the proposed algorithms are same as the vehicles selected and defined by users. If the prototype missed the detected cars that user defined, it is consider as missed car. For false detection, the prototype detected the car which is not defined by the users. Two experiments were carried out for single and multiple vehicles detection and recognition in complex and natural images.

4.3 Results and Analysis

The results of the experiments are summarized and shown in Table 1.

Experiments	Total vehicles	Detected vehicles	Missed vehicles
1 (single vehicles only)	100	97	2
2 (2 vehicles and above)	120	108	8

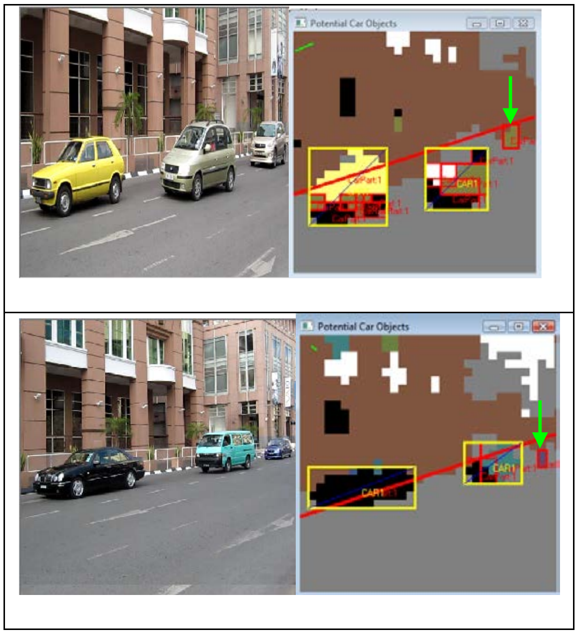
False Detection	Detection rate
1	97%
4	90%

Table 1. The experiment results of the proposed color features object recognition.

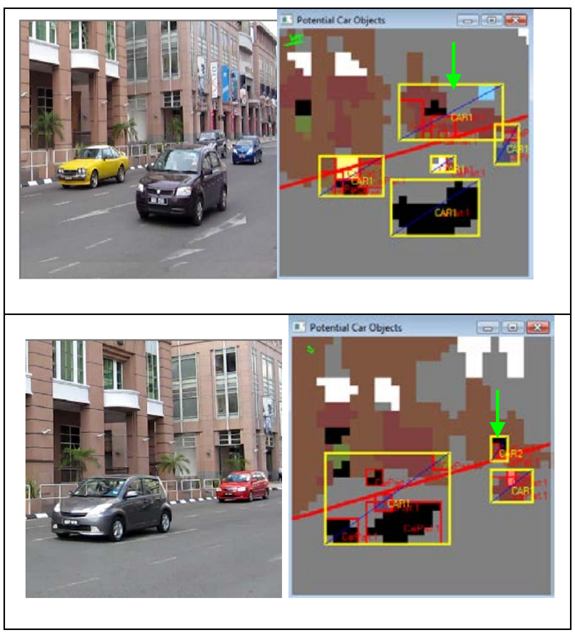
The proposed method has proven to be successful in detecting the vehicles. The results accuracy is 97% and 90% respectively for the detection of single and multiple vehicles in the images. So the proposed vehicle detection method is accurate and robust under complex and natural background and it also supports multiple vehicles detection and recognition. This technique has been used as input for Semantic object spatial relationships extraction and representation in our paper [14] in the area of Semantic based image retrieval.

Some of the object detection and recognition results from proposed method is shown in Fig. 3

(a) Detected vehicles (indicated using yellow MBR)



(b) Missed Car(s) (pointed by Green Arrow)



(c) False Detection (pointed by Green Arrow)

Fig. 3 Some results of the experiments

There are some missed vehicles detection (Fig.3(b)) due to the noise created from the smoothing process and also unable to get the black cluster as reference object. There are some false detection (Fig.3(c)) due to the variety color representative of the cars besides some noise created.

4. Conclusions and Future works

In conclusion, a simple object extraction and recognition method with efficient searching for identifying and extracting the objects in a complex scene based on the color features has been proposed and developed. Experiments have been carried out and it is proved that the proposed method works well in detecting both single and multiple objects in natural and complex background for traffic image retrieval. This method is designed especially for use in the automatic semantic object spatial relationship extraction and representation that designed in Ref [14]. This object detection method can be further improved by determining the type of the vehicles.

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