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Image Vehicle Classification

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Abstract: *Object detection means finding the location of the object and recognizing what it is. The techniques used for the object detection are feature matching algorithm, pattern comparison and boundary detection. The feature matching algorithm is used to find the best matching object in the knowledge base and to implement the reconstruction of the object recognized.*

*Our object detection is to detect the license plate detection of the car. To detect the license plate of a car first pre-process the image. The commonly license plate locating algorithms include line detection method, neural networks method, fuzzy logic vehicle license plate locating method. "**Connected component analysis**" is very easy technique than these techniques.*

In the pretreatment process we first crop the image. After this we convert the color image to gray level image. After converting into gray level that image is filtered using three different types of filters. They are Average, Median, Weiner filters. After deciding the good filter we will apply the segmentation process using edge detection. After finding the edges we will give the numbers to each connected component and store all the connected components in a matrix called labeling matrix. Extract the required connected component using the labeling matrix and store that in an image. Compare this template with our database using template matching technique.

Template matching technique uses the correlation procedure. We will find the correlation coefficient between the two templates. Depending upon the correlation coefficient we will find that how much the two templates are similar to each other.

Introduction

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subfield of digital signal processing, digital image processing has many advantages over analog image processing; it allows a much wider range of algorithms to be applied to input data, and can avoid problems such as the build-up of noise and signal distortion during processing. Image segmentation refers to the process of partitioning a digital image into multiple regions (set of pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyse. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in an image. In this thesis the various popular fuzzy techniques for image segmentation are studied. Various methods for better clustering and segmentation have been developed. The algorithms or methods developed are meant for online and real time applications like television, camera phone, etc An image may be defined as a two dimensional function, f(x,y) where x and y are spatial coordinates and the amplitude of f at any pair of coordinates(x,y)is called "Intensity" or "gray level" of the image at that point. The field of digital image processing refers to the processing digital images by means of a digital computer.

Problem Definition

Object detection means finding the location of the object and recognizing what it is. The techniques used for the object detection are feature matching algorithm, pattern comparison and detection. The feature matching algorithm is used to find the best matching object in the knowledge base and to implement the reconstruction of the object recognized.

There are two mainly two object recognition models

1. The structural description model

2. Image base model

The first one believe that the main goal of the object recognition is to reconstruct the three dimensional description of the object. The second one believe that the regional features on the object are not sufficient to represent a 3D object and requires normalization and then by means of matching with similar view of the object to finalize the reconstruction. Object recognition algorithms such as feature fitting, template fitting, and boundary matching could be thought as the application of the above models. However recognizing an object based on the regional feature appears unstable, since different objects may have similar regional features. Either the structural description model or the image based model appears lack of consideration of shape knowledge.

Our object detection is to detect the license plate detection of the car. To detect the license plate of a car first pre-process the image. The commonly license plate locating algorithms include line detection method, neural networks method, fuzzy logic vehicle license plate locating method. "**Connected component analysis**" is very easy technique than these techniques.

Literature Review

In general, it is possible to divide previous passive studies into 2 parts. The one using Artificial Neural Networks and others using other methods. In Neural network systems, each character is introduced as an input data to the system. The system learns these characters. After that, it compares the input data characters to the existing characters. As a result, the character which has very similar rate is activated.

In this study, [1] is used for Inductive Learning Based Method and SVM method. Inductive Learning Based Method is used to divide all classes into smaller groups. SVM method is used for classification of these groups. All these methods are applied on the plate characters. Then, a training process is used for each character.

This system [2] is a web based system. This system consists of three modules:

- Creating digital image form the video signals, using hardware for this;
- Using pattern recognition and artificial intelligence for plate recognition;
- Accessing to the database from web browser and run query for vehicles

In this system [3] morphological operators are used for preprocessing. After preprocessing, Template Matching is used for character recognition. This system is used for Macao-style license plates.

In this study, it is the first time that the plate image is normalized [4]. Scaling and cross-validation are applied for remove the outliers and find clear parameters for SVM method. Then use SVM method for character recognition. Correct recognition rate is higher than neural network systems.

This method [5] is applicable in camera-in-motion applications. Images are acquired via a webcam. The light conditions, background and position of the vehicle are not important for character recognition. This method can localize different sizes of the plate from the image. After localization of the plate, the characters are segmented. Multiple neural networks are used for character recognition. The correction rate is %95 in this method. This application was used in University of Malaga (Spain) in the entrance of the Computer Science building.

Sobel color edge detector is used for detecting vertical edges in this study [6]. Then, the invalid edge is eliminated. The license plate region was searched by using template matching. Mathematical morphology and connected component analysis was used for segmentation. Radial basis function neural network was used for character recognition. This system is also successful in night hours and daytime real conditions.

Plate location is found by using plate background and the character's color in this study [7]. For segmentation, the column sum vector is obtained. The Artificial Neural Network is used for character recognition.

This system is designed for Islamabad Computerized Number Plates [8]. SCAN_NP

algorithm is developed for plate extract. This algorithm can find candidate plates. The algorithm brings out these candidate objects which would turn out to be the plate characters. The objects have horizontal and vertical lines. This algorithm scans the image to remove the noises from the image. Neural Network and template matching is used for character recognition. The correction rate is %90 in this method.

This method [9] is used in off-line Thai license plate recognition. Hausdorff Distance technique is used for recognition. The correction rate in this method is %92.

This method [10] is used for Chine license plate recognition. The plate image is converted into a binary image. Then the noises are removed from the image. The skeleton is used for generating the feature of the character. Then the character is normalized to size 8*16 pixels. The plate image is processed in the Back-Propagation Neuronal Network for recognition after being normalized. Back-Propagation Neuronal Network is used for character recognition

This method [11] is not used to preprocess for recognition. Image transformation is applied for original license plate picture. After transformation process, in the database, the number of the input and the data increase. Convolution neural network is used for character recognition. The correction rate in this method is %98..

This method [12] has two modules: plate locating and plate segmentation modules. Fuzzy geometry is used for the first module. Fuzzy C mean is used as the second module. The correction rate for segmentation is %94.24

In this method [13] blob labeling and clustering are used for segmentation. The studies of Kirsch, Sobel, Laplacian, Wallis, Prewitt, Frei Chen on edge detectors are compared and contrasted, and Kirsch's edge detector is regarded as the most appropriate one among others. This method is used neural network for classification and recognition character.

Field-programmable gate array (FPGA) is used in this study [14]. Gabor filter, threshold and connected component labeling algorithms are used for finding plate location. After segmentation, a self-organizing map (SOM) neural network is used for character recognition. Hardware is used in this system. Then, the system spends less time than computer-based recognition system for does character recognition. Moreover, the system is mobile.

Two-layer Markow network is used for segmentation and character recognition in this study [15]. In this method "8" and "B" can be mixed. This study is made synthesising with Housdorff and Shape context methods.

A median filter is used for removing noises from plate image in this method [16]. Hough transform is used for rotating the plate image when it is necessary. Adoptive threshold method is used for binarization. Segmentation is applied after binarization. FFM (Filled Function Method)-BPNN (BP Neural Network) algorithm is used for character recognition. This method is used for Chine character. And can be use for fingerprint and retina recognition.

In this paper [17], they use a different algorithm which is developed for Italian Highway Company to control the traffic flow. Their classification algorithm has two stages. One of them is parameters setting phase and the other is character classification by embedded Generative Models with using covariance matrix. They search for 7.000 different images of license plates. In this research, correct classification is 98.1% with using their algorithm which is called Generative Models.

In this study [18] Robert edge detector and morphology operator is used for finding plate edge from the picture. Horizontal and vertical projections are used for rotating plate image when it is needed. Least squares support vector machines are used for character recognition.

This method [19] is used different method for finding plate location from the picture. White and black pixels have different weight according to this method. Hence, this method uses this feature for finding plate location. Hybrid neural network is used for character recognition. The correction rate in this method is %97.

This method uses is [20] Ostu Threshold algorithm for converting into binary level for plate image. Character coordinates are used for character segmentation. Improved patter matching

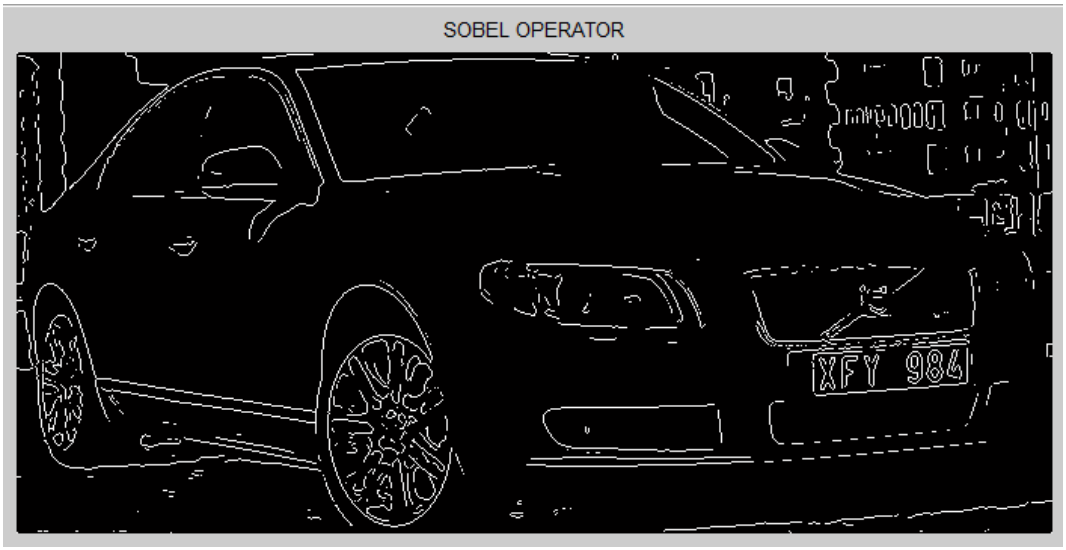
algorithm is used for character recognition. The correction rate is %98 in this method. Scanline checking is used for plate localization in this study [21]. Dynamic projection warping is used for character recognition.

This method [22] is about plate localization and character segmentation. AdaBoost algorithm is used for finding plate localization from the image. Vertical edge detection and horizontal projection histogram are used for upper and lower boundary disposal. Image binarization and vertical projection histogram are used for character segmentation. The correction rate is %96.4 in this method.

This method [23] uses composite colors for detecting the plate area of the image. Horizontal and vertical histograms are used for character segmentation. Artificial hippocampus algorithm is used for character recognition. The correction rate is %95 in this method.

This method [24] uses 2-level 2D discrete wavelet transform rather than conventional 1- level 2D discrete wavelet transform. The correlation rate in this method is 97% where is in conventional method is only 80%.

This method [25] uses the Histogram method for finding the license plate. License plate images for the characteristics, according to plate the distribution of grey changes in the law of peak and valley was to locate the boundary plates. The use of the methods is proposed in this article, in a variety of weather conditions (including morning, noon, night, sunny and rainy days, etc.) and under the conditions of different backgrounds and the license plate location is98.7%.



Component Connected Analysis

Image Segmentation

Segmentation of an image entails the division or separation of the image into regions of similar attribute. The basic attribute for segmentation is image amplitude- luminance for a monochrome image and colour components for a colour image. Image edges and textures are also useful attributes for segmentation. The result of image segmentation is a set of regions that collectively cover the entire image, or a set of contours extracted from the image.

Segmentation does not involve classifying each segment. The segmentor only subdivides an image; it does not attempt to recognise the individual segments or their relationships to one another.

There is no theory of image segmentation. As a consequence, no single standard method of image segmentation has emerged. Rather, there are a collection of ad hoc methods that have received some degree of popularity. Because the methods are ad hoc, it would useful to have some means of assessing their performance. Haralick and Shapiro (1) have established the following qualitative guidelines for “good” image segmentation:

(a) Regions of the image segmentation should be uniform and homogeneous with respect to some characteristic such as gray tone or texture.

Segmentation technique based on discontinuity property of pixels

Detection of Discontinuities

In this category, the approach is to partition an image based on abrupt changes in intensity, such as **edges** in an image three basic types of gray-level discontinuities that are mostly detected in a digital image are: points, lines and edges. The most common way to look for discontinuities is to run a mask through the image. For the 3x3 mask shown in fig. 4.1, this procedure involves computing the sum of products of the coefficient with the gray level contained in the region encompassed by the mask. That is, the response of the mask at any point in the image is given by

$$R = w_1 z_1 + w_2 z_2 + \ldots + w_9 z_9 = \sum_{i=1}^{9} w_i z_i \qquad (2.1)$$

where Z_i is the gray level of the pixel associated with mask coefficient W_i. As usual, the response of the mask is defined with respect to its centre location.

Point Detection

-1	-1	-1
-1	8	-1
-1	-1	-1

Using the mask shown in Fig. 4.1, we say that a point has been detected at the location on which the mask is centred if

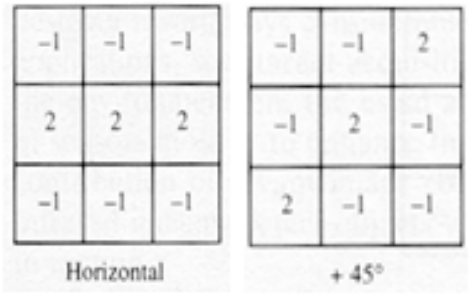
$$|R| \geq T \qquad (2.2)$$

Where T is a nonnegative threshold and R is given by (2.1).

Line Detection

Consider the masks in Fig. 4.2. If the first mask were moved around an image, it would respond more strongly to lines (one pixel thick) oriented horizontally. With a constant background, the maximum response would result when the line passed through the middle row of the mask. Similarly, the second mask in Fig. 4.2 responds to lines oriented at $+45^0$; the third mask to vertical lines; and the fourth mask to lines oriented at -45^0 direction.

Let R1, R2, R3, and R4 denote the responses of the masks in Fig. 4.2, from left to right, where R"s are given by equation 2.1. Let the four masks be run through an image individually. If, at a certain point in the image, $|Ri|>|Rj|$, for all $j \neq i$, that point is said to be more likely associated with a line in the direction of the mask *i*.



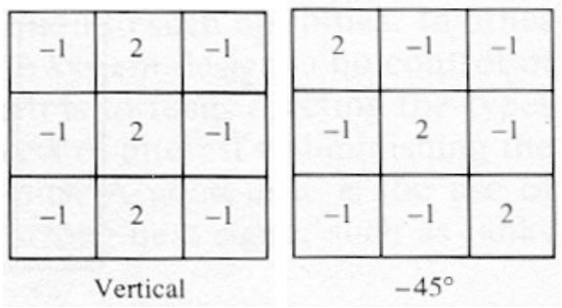


Fig 4.2. *Line detection masks*

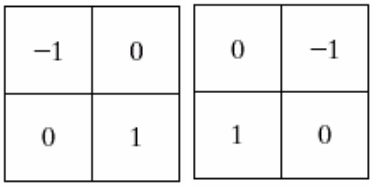
The above shown are line detection masks

Edge Detection

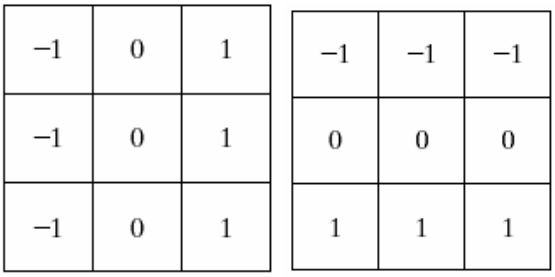
Edge detection is an important step for image segmentation. The goal of edge detection process in a digital image is to determine the frontiers of all represented objects based on automatic processing of the colour or gray level information in each present pixel.

To extract the edges from the images, derivative edge detection operators or gradient operator, such as Sobel operator, Prewitt operator, Roberts's operator, and Laplacian operators are commonly used. A 3x3 mask is used for edge detection using the mentioned operators.

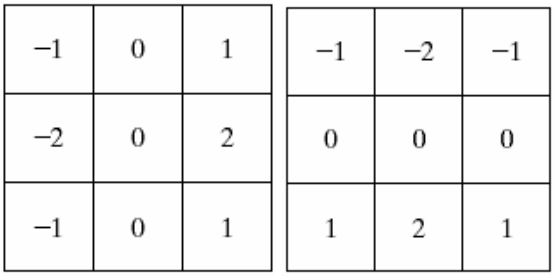
The reasons that Prewitt and Sobel edge detectors visually appear to better delineate object edges than the Roberts edge detector is attributable to their larger size, which provides averaging of small luminance fluctuations. The Sobel edge detector uses a weight of 2 in the centre coefficient. A weight of 2 is used to achieve some smoothing by giving more importance to the centre point. The Prewitt masks are simpler to implement than the Sobel masks, but the latter have slightly superior noise-suppression characteristics, an important issue when dealing with derivatives. Note that the coefficients in all masks shown in Fig. 2.5 sum to 0, indicating that they give a response of 0 in areas of constant gray levels, as expected of a derivative operator.



These are ROBERTS masks



These are PREWITT edge detection masks



These are SOBEL edge detection masks

Fig 4.3. *Edge Detection Masks*

Canny Edge Detector

The Canny edge detection operator was developed by John F. Canny [57] in 1986 and uses a multi-stage algorithm to detect a wide range of edges in images. The method can be summarized as follows:

1. The image is smoothed using a Gaussian filter with a specified standard deviation, s, to reduce noise.

2. The local gradient, $g(x, y) = [G^2 + G^2]^{1/2}$, and edge direction, $\alpha(x, y) = \tan^{-1}(G / G)$, are computed at each point. Any of the first three techniques Prewitt, Sobel or Log edge detector can be used to compute G_x and G_y. An edge point is defined to be a point whose strength is locally maximum in the direction of the gradient.

3. The edge points determined in (2) give rise to ridges in the gradient magnitude image. The algorithm then tracks along the top of these ridges and sets to zero all pixels that are not actually on the ridge top so as to give a thin line in the output, a process known as *nonmaximal suppression.* The ridge pixels are then thresholded using two thresholds, T1 and T2, with T1<T2. Ridge pixels with values greater than T2 are said to be "strong" edge pixels. Ridge pixels with values between T1 and T2 are said to be "weak" edge pixels.

4. Finally, the algorithm performs edge linking by incorporating the weak pixels that are 8-connected to the strong pixels.

The gradient-based edge detection method has been widely applied in practice and a reasonable edge map is obtained for most images. Nevertheless, they suffer from some practical limitations.

First, they need a smoothing operation to alleviate the effect of high spatial frequency in estimating the gradient. Usually this smoothing is applied to all pixels in the image including the edge regions, and so the edge is distorted and missed in some cases, in particular at junctions or corners. Secondly, the gradient magnitude alone is insufficient to determine meaningful edges because of the ambiguity caused by the underlying pixel pattern, especially in complex natural scenes. Thirdly, the gradient-based edge detection methods increase the computational complexity because calculations, such as square root and arctangent, to produce the gradient vector are required. Finally, for edge thresholding conventional gradient methods use one or two global edge thresholds for an input image. For example, the hysteresis thresholding proposed by Canny in many practical applications require not only the trial and error adjustment of two thresholds to produce a satisfactory edge result for each different input image, but also the validity of the pre-adjusted thresholds.

After the completion of filtering process we apply the above three operators. Figure 7 shows the edge detection using "canny" operator. Figure 8 shows the edge detection using" prewitt" operator. Figure 9 shows the edge detection using" sobel" operator.

Algorithm

A pixel „p „ at coordinates (x,y) has four horizontal and vertical neighbours whose coordinates are given by

$$(x+1,y),(x-1,y),(x,y+1),(x,y-1)$$

This set of pixels called the 4-neighbors of „p „ is denoted by (p).Each pixel is a unit distance from (x,y).The four diagonals of „p „ have coordinates are

$$(x+1,y+1),(x+1,y-1),(x-1,y+1),(x-1,y-1)$$

And are denoted by (p).

Connectivity between the pixels is a fundamental concept that simplifies the definition of numerous digital image concepts, such as regions and boundaries. To establish if two pixels are connected, it must be determined if they are neighbours and if their gray levels satisfy a specified criterion of similarity.

4-Adjacency: Two pixels p and q with values from V are 4-adjacent if q is in the set (p).

8-Adjacency: Two pixels p and q with values from V are 8-adjacent if q is in the set (p).

Steps in the Algorithm

•After the edge detection calculates the no. of connected components formed by 8- adjacent connectivity.

•Store all the connected components in a matrix called "Labeling matrix (L)".

•The matrix L contains the labels for the connected components in the segmented image. The elements of L are integer values greater than or equal to „0".

• The pixels labeled 0 are the background. The pixels labeled 1 make up one object; the pixels labeled 2 make up a second object; and so on.

• Find the total no. of connected objects in the Label matrix. Store that value in a variable "mx".

• Search each connected component of the license plate below the threshold value "mx" and store that in an image.

• Extract the license plate numbers and alphabets and compare with our database using template matching.

After getting the edges of the image we apply the above algorithm on different types of operators and extract the characters of the license plate directly. For finding the characters we apply the template matching.

Template Matching

After extracting the numbers and alphabets to read them we use template matching technique. Template matching is a technique in digital image processing for finding small parts of an image which match a template image. It can be used in manufacturing as a part of quality control, a way to navigate a mobile robot, or as a way to detect edges in images.

Template matching can be subdivided between two approaches: feature-based and template-based matching. The feature-based approach uses the features of the search and template image, such as edges or corners, as the primary match-measuring metrics to find the best matching location of the template in the source image. The template-based, or global, approach, uses the entire template, with generally a sum-comparing metric (using SAD, SSD, cross-correlation, etc.) that determines the best location by testing all or a sample of the viable test locations within the search image that the template image may match up to.

We find the matching between the two images by using the CORRELATION. Correlation finds the similarity between the two templates. The similarity between the two templates can be found by using the CORRELATION COEFFICIENT. The range of correlation coefficient is from „-1" to „+1". If the value of the correlation coefficient is near to „+1" then the two templates are nearly same otherwise they are different. We found the correlation between the template and with our dataset.

Conclusion

In the above analysis I used three different types of filters to eliminate the noise. They are

MEDIAN, AVERAGE and WIENER filters. By seeing the figures 4, 5 and 6 we come to a conclusion that among median, average and wiener filters MEDIAN is the best one.

And I used three different types of operators to extract the number plate characters. They are CANNY, SOBEL AND PREWITT operators. The threshold value used is 0.85.To compare "9" the values of correlation coefficients are 0.8981, 0.8120 and 0.8071 respectively. To compare "8" the values of correlation coefficients are 0.8952, 0.8257 and 0.7985 respectively. To compare "4" the values of correlation coefficients are 0.0.9113, 0.8256 and 0.7368 respectively.

Similarly the alphabets are also compared. To compare "X" the values of correlation coefficients are 0.8962, 0.8345 and 0.7845 respectively. To compare "F" the values of correlation coefficients are 0.8867, 0.8301 and 0.7523 respectively. To compare "4" the values of

correlation coefficients are 0.9102, 0.8213 and 0.7653 respectively.

So for the CANNY operator the value of correlation coefficient is greater than 0.85. So that among the three operators CANNY operator is the best one.

The proposed connected component analysis technique is very easy to implement and we are getting 85% to 90% best results using this technique.

Limitations

The above technique is not applicable for figure shown in **fig.18**.Because that image is extracted when the car is in motion. We cannot find the good connectivity between the edges of that image after the edge detection.

If any other number is present at any part of the image we cannot detect the number plate exactly. This is the main disadvantage of this method.

Future Work

In this work I have done the total process in the offline mode. The scope of future work is we can do it by online mode. If any other number is present at any part of the image we cannot detect the number plate exactly. This is the main disadvantage of this method. This can be eliminated in the future work.