Feature Extraction Techniques for Number Plate Detection

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***Abstract*—Vehicle identification plays important role in Intelligent Transportation System. Vehicle is identified uniquely by its number plate. It is used for applications like identification of authorized vehicles, providing controlled access to restricted areas, and law enforcement.Number plate detection is the most important step of vehicle identification. The result of vehicle identification depends on number plate detection. Feature extraction is the important step in pattern recognition. The performance of the system depends upon feature extraction technique. It is necessary to select and extract relevant features for improving the performance of the whole system.The proposed system will use feature extraction technique using Histogram of Oriented Gradient and Hough Transform. The system will check the performance of these algorithms for number plate detection.**

***Index Terms*— Feature Extraction, Histogram of oriented Gradients, Image Processing, Number Plate Detection, Pattern Recognition.**

I. INTRODUCTION

Vehicle identification plays important role in intelligent transportation system (ITS)[1]. A vehicle number plate isattached to vehicles for official identification purposes. The identifier can be used for uniquely identifying a vehicle. There are numerous reasons why it is necessary for individuals or organizations to identify a vehicle and thus its owner. Examples are law/police enforcement, traffic control, and access to restricted areas, electronic toll collection or checking parking permissions purposes[2]. In some of the applications like traffic law enforcement, road monitoring and expressway toll system, where number plate recognition is used, it is necessary to process a large number of vehicles in a short time. In daily life there is huge traffic on roads, in this scenario application has to do very fast processing. Otherwise, violators and criminals can escape.

The detection of a single number plate and the recognition of its characters in a reliable way is an expensive task, since it relies on special license plate recognition cameras. Dedicated systems have been developed for this purpose using special ANPR (Automatic Number Plate Recognition) cameras [3].

There are certain areas where these systems are not practical, too heavy or too expensive to use. There are many challenges involved in number plate recognition. The number plates may differ in size, shape, text format and color. Also the environmental factors such as light, illumination, dirt affects the result.

Three main steps of ANPRare number plate detection, character segmentation and character recognition [4]. Number plate detection is the most important step as it affects the accuracy of whole system. Therefore it is necessary to locate the number plate correctly in a given video sequence. Input to the number plate detection is the car frame captured from video and output is the portion of the frame containing the number plate. In character segmentation step the characters are divided into separate images. After character segmentation, character recognition is done to recognize the number plate.

Feature extraction is the important step of pattern recognition. The result of whole system depends upon feature extraction step[1]. Therefore it is necessary to select and extract relevant features for improving the performance of the system. The main motivation of this work is to analyze the features which are extracted from imagesfor detection of number plate. The frame involves ample of features which needs to be carefully selected for accuracy purpose. These features are provided to classifier for classification purpose.The paper is organized as follows. Section II discusses the related work, section III describesproposed work for vehicle number plate detection, and section IV describes the number plate detection with result. The paper concludes in section V.

II. RELATED WORK

In the literature many number plate recognition algorithms have been proposed. It is still a challenging task to locate the number plate from different angle and with varying environmental conditions. In the entire procedure of number plate recognition most important and difficult step is reliable detection and isolation of the number plate from complex scene. The detailed survey of the number plate recognition is given in [1].

Rob G. J. Wijnhoven et al., presented a novel system for automatic identification of vehicles for garage door opening. Here recognition of both car and character is done using shape descriptor and linear classifier. Features are extracted from images using Histogram of oriented Gradients and provided to classifier for classification purpose.The accuracy of 90% is achieved using this approach [2].

Kumar Parasuraman et al., proposed the number plate recognition algorithm for Indian number plates. Here morphological operations are used for detection of number plate. For segmentation purpose they used filtering, thinning and horizontal and vertical projection [3].

S.Kranthi et al., proposed the feature based number plate localization system to recognize the vehicle number plates. Their study focuses on two main algorithms they are edge finding method and window filtering method for the better development of the number plate detection system [4].

DhirajAhuja et al., proposed number plate recognition using wavelets and neural network. Here different wavelets are used for license plate detection and feature extraction of license plate characters. Using different wavelets shape features of license

plate characters are extracted and analysis of wavelets is done on the basis of recognition rate and time [5].

SubhradeepKayal et al., proposed automatic number plate detection using Gabor filter and cross cuts. Here the input image is first convolved with a 2-dimensional Gabor Filter with a vertical orientation so as to filter out the vertical edges. Then a method of 'cross-cuts' is adopted to effectively separate the actual plate region from any region with characters or letters [6].

C. Nelson KenndyBabu et al., proposed a method for vehicle license plate identification on the basis of a novel adaptive image segmentation technique. Here a novel method for license plate localization based on texture and edge information is proposed [7].

V. Swetha et al., proposed the system to provide security to the restricted areas. The algorithm consists of vehicle detection, extraction of number plate, classification of vehicle and recognition of character. Here for extracting the plate region smearing algorithm is used [8].

P.Vijayalakshmi et al., proposed the number plate recognition algorithm which uses the Genetic algorithm at two levels for vehicle detection and for number recognition. Here detection is based on contour and shape information. Finally, a feature based matching is adopted for character recognition [9].

Shuang Wang et al. proposed a system using video cameras to perform vehicle identification. They reconstruct an input by using multiple linear regression models and compressed sensing, which provide new ways to deal with feature extraction and robustness to occlusions and misalignment [10].

C.N. Anagnostopoulos et al., proposed algorithm for vehicle license plate identification on the basis of a novel adaptive image segmentation technique i.e. Sliding Concentric Windows and connected component analysis in conjunction with a character recognition. The probabilistic neural network is trained to identify alphanumeric characters from car license plates based on data obtained from algorithmic image processing. Here overall accuracy of 86% is achieved [11].

AnishLazrus et al., proposed the system for number plate recognition of Indian number plates. Here the images of various vehicles have been acquired manually and converted in to gray-scale images. Here the system achieves the accuracy of up to 98% [12].

FatihKahraman et al., proposed license plate character recognition based on the Gabor transform and vector quantization. Gabor filter gives the plate boundary location. Then binary split tree is used in order to extract the exact boundary of number plate. After segmentation is done so that characters become ready for the optical character recognition [13].

III. PROPOSED SYSTEM

Feature extraction is the first step in many object detection algorithms. It is the process of generating features to be used in the selection and classification task [4]. Different feature extraction techniques are available for extracting features from frames captured from videos which are used to train the classifier for classification purpose. Different feature extraction methods have been developed in the context of vehicle number plate detection. The proposed system will compare the performance of feature extraction technique such as Histogram of Oriented Gradients, Hough Transform features for vehicle number plate detectionprovided to classifier for classification purpose. Vehicle identification is generally divided into three steps: Number plate detection, character segmentation and character recognition. After character segmentation step the features of character are extracted for recognition purpose. Figure 1 shows the block diagram of the proposed system.

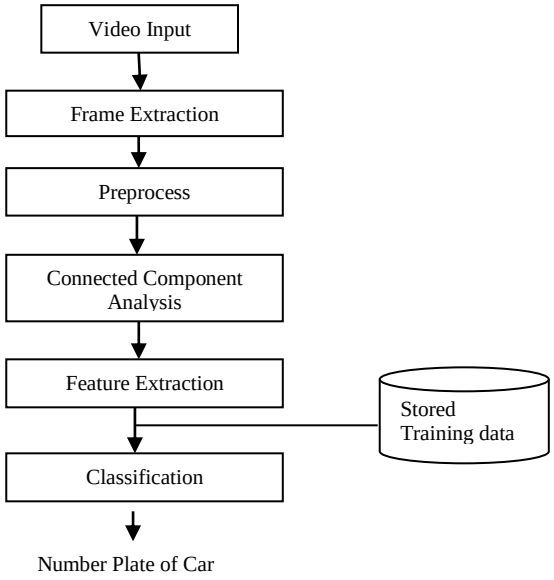


Fig.1. Block diagram of Proposed System

From the given video input, the frame is extracted which contains the car. After frame extraction, preprocessing of the frame is done to remove the noise from frame. After preprocessing, connected component analysis is done to find possible location of number plate. Next step is extracting the features, here we apply histogram of oriented gradients (HoG), and Hough Transform which is explained as follows.

A. Histogram of Oriented Gradients(HoG)

Histogram of Oriented Gradients has many advantages in number plate detection because it is relatively invariant to local geometric and photometric transformations[2]. In HoG, the image is divided into cells of fixedsize. For each cell we compute the local 1D histogram of gradient directions over the pixels of the cell. The combined histogram will form the descriptor. After that the contrast normalization will be performed for making the descriptor invariant to illumination and shadows. Figure 2 shows the steps of HoG. Here the gradient map can be computed by applying 1D point mask in both horizontal and vertical direction. The filter mask [1 0 -1] is used in both horizontal and vertical direction. Next step is to create the cell histogram. Input pixels are spatially quantized into cells of n*n pixels where n is the cell size [2]. Each cell will result in one orientation histogram. To allow for small spatial and orientation shifts, linear interpolation is used in both two spatial and the gradient orientation dimension. To achieve the contrast normalization the cells are grouped into larger spatial blocks and normalize the contrast of each block separately.

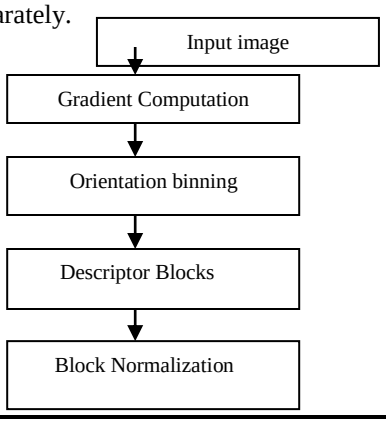


Fig.2.Steps of HoG

B. Mathematical Model

Let S be the proposed system

S= {s, e, I, Op, DD, NDD, F_s, F_f, succ, fail,| ϕs }

where ϕs represents constraints of the system such as number plates are of Indian cars and video is captured from fixed angle,

s = start of system,

e = end of system.

Input video I is represented as {b, r, s, F} where b is bit rate of video, r is frame rate of video, s is the size of frame in pixel dimension format, F is the set of frames in video represented as {c, h, bs}where c is the count of frames in a video, h is the histogram of frame and bs is the bit stream of frame represented as {psc, ts, f_type, G} where psc is picture start code, ts is the time stamp of frame, f_type is the type of frame i.e. I, P or B frame, G is the group of blocks in a frame represented as {gs, gn, M} where gs is the start of group, gn is the group number and M is the macroblock of frame represented as {ad, mv, b} where ad is the address of macroblock, mv is the motion vector and b is block layer which contains the information on the coefficients of pixels. Op is the output which is number plate of a car. DD is the deterministic data such as aspect ratio of number plate is within the range of 2 to 5.4, frame rate of the video is 25 fps. NDD is the nondeterministic data which is environmental factors such as rain, snow, dirt which affects the result. $F_s$is the system function which finds the number plate of car from the video.

F_s: I->Op.

F_f represents the set of friend functions as {F_1, F_2, F_3} these functions are described as follows.

F_1 is the frame capture function,

F_1: I -> f

F_2 is the preprocessing function which removes the noise from the frame.

F_2 is the function to convert the color frame to gray scale frame represented by following equation,

F_2 = 0.299*R + 0.587*G+ 0.114*B (1)

where R, G, B are Red, Green and Blue components of the corresponding pixels.

$F_3$is the vertical edge detection function which is given by following equation,

g(x,y)= sobel(f(x,y))

wheref(x,y) is a input image, g(x,y) is the output image.

Succ is the success which is achieved when number plate of the car is detected correctly. Fail is the failure when the car number plate isnot detected correctly because of damaged plates or due toenvironmental conditions like rain, fog, dirt etc.

IV. NUMBER PLATE DETECTION

Number plate detection is the key step of vehicle identification system. It affects the result of whole system. The goal of this phase, given a frame captured from input video is to produce the region with high probability of containing the number plate area. We have performed the experiments using QT tool and OpenCV image processing libraries.The version of Qt used is 4.7 and of OpenCV 2.4. QT is a cross platform application framework used for developing application software. It runs on major desktop platforms and some mobile platform. Figure 3 shows the input frame captured from the video for number plate detection.

A. Preprocessing

Preprocessing of frames involves removing the noise from frames. When the input frames are captured from video,it may involve noise which affect the recognition accuracy. This noise should be removed before further processing. Preprocessing improves the quality of frames by removing the noise [16]. Preprocessing involves conversion of color frame to gray scale frame and applying the median filter. The following equation is used to convert color image to gray scale image.

Gray(i) = 0.299*R + 0.587*G+ 0.114*B

B. Vertical Edge Detection

Edges helps to characterize the boundaries thereforethey are important for processing images. Edges arepresent in areaswhere strong intensity contrast are present [16]. In this system we have used the Sobel vertical edgedetection [15] to find out theregion which has high pixel varience.

C. Morphological Operation

The main objective of this step is to find out the rough location of number plate. It looks for objects having specific size and aspect for each connected component in the image. Here two algorithms called Erosion and Dilation [15] are used. The order between these algorithms is very important since the reverse process would give a completely different result [14]. The output of this step is to find all the possible location of number plate area in image.

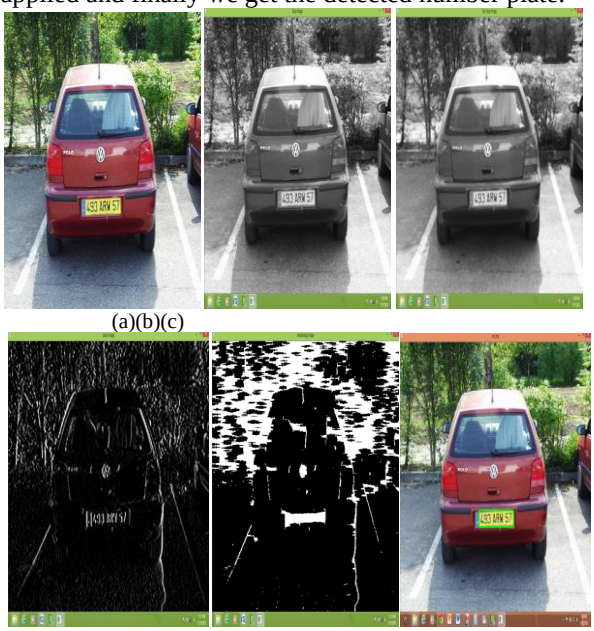
D. Connected Component Analysis

Connected component analysis is used to find the exact location of number plate. The number plate of car has certain properties which can be used to detect the number plate. Properties such as aspect ratio, width of number plate and total number of pixels present in the number plate can be used to extract the number plate area [14]. Here we have used aspect ratio of number plate. Aspect ratio of number plate is defined as ratio of width of number plate to its height. Inverse of aspect ratio for any number plate should be less than one for any number plate. Hence all the regions that do not satisfy this property can be rejected and we get the exact number plate location. This number plate location can be further used for character segmentation and character recognition to identify the car.

V. EXPERIMENTAL STUDY AND RESULTS

We have performed experiments using Qt tool and OpenCV libraries. The version of Qt used is 4.7 and of OpenCV 2.4. Qt is a cross platform application framework used for developing application software. It runs on major desktop platforms and some mobile platform. OpenCV is the library of programming functions which focuses mainly on image processing. For experimentation we have used the database of large number of images of dimension 512×409. Figure a shows the original image used for number plate detection. Figure b is the result after converting to gray scale image. Figure c shows the result of median filter. Figure d is the result after applying sobel vertical edge detection. Figure e is the result after applying morphological operations. Figure f shows the final result, it shows the identified number plate area. Table 1 shows the values of number plate of the car from different input images. This table shows height, width and aspect ratio of number plate. Aspect

ratio is defined as the ratio of height to width which is used for detecting number plate. First color image is converted into gray scale image, after that median filter is applied, after sobel vertical edge detection is applied, after morphological operations are applied and finally we get the detected number plate.



(a)(b)(c)

(d)(e) (f)

Figure 3a) InputImage 1, b) Gray Scale Image, c) Median filtered Image d) Edge Detected Image,e) After applying Morphological operations,f) Plate Detection.

Table.1 Data of Number Plate Feature Parameter (Data in Pixels)

Frame No.	Height	Width	Aspect Ratio
1	40	129	3.22
2	42	133	3.16
3	46	144	3.13
4	47	145	3.085
5	47	147	3.12
6	49	149	3.04
7	43	141	3.27
8	43	139	3.23
9	44	139	3.15
10	44	140	3.18
11	43	141	3.27
12	41	129	3.14
13	48	149	3.10
14	49	150	3.06
15	48	147	3.06
16	47	146	3.10
17	43	124	2.88
18	43	126	2.93
19	43	127	2.95
20	48	130	2.70

VI. CONCLUSION

Feature extraction is the key point of pattern recognition. A reliable feature extraction technique is required for improving the accuracy of classification. The system proposes the number plate detection system for car identification. The number plate area is detected correctly using different algorithms. In the future we are planning to use KNN classifier for classification purpose and checking the performance of feature extraction algorithms.

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