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Feasibility of Efficient Number Plate Recognition using Morphological Dilation and Support Vector Machine

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Abstract: ***Intelligent data acquisition of vehicle number plate plays a significant role to recognize a vehicle and it automatic parking, traffic movement and scheduling, tracking of stolen vehicle, and many more. Although different methodologies of automatic number plate reading have developed alongwith their algorithms, still an efficient number plate recognition technique for better segmentation and recognition of the captured number plate using Morphological Dilation and Support Vector Machine (SVM) are expected to be helpful. In this paper, we present a modified method for recognition of contents of number plate using morphological dilation and SVM. We have compared our results with those from the existing models using Wavelet Transform and Artificial Neural Network techniques. Superiority of present methodology is established using parameters like image segmentation and recognition.***

Keywords: ***Automatic Number Plate Recognition, Morphological Dilation, Support Vector Machine (SVM), Segmentation Rate, Recognition Rate.***

I. INTRODUCTION

A. Background

Automatic License Plate Recognition (ALPR) is an established method to recognize contents of license plate which are extracted from an image device. A quick detection and recognition of number plate are the key points in most of the traffic related applications. Major components of such recognition involve extraction of plate area, segmentation of characters and their recognition. Different techniques for ALPR have been suggested in this field to diminish various restrictions like rotational angle, character type, line number and format [1]. Feasible approaches which may be insensitive to environmental changes, modification in illumination of characters and geometric changes like image rotation due to change in a view point have been suggested [2, 3]. Process of vehicle identification begins when a vehicle passes from a sensor field of view which detects presence of a vehicle and suitable signal is sent to a video recording of the related image. Recorded image is transmitted to computer machine where license plate number (LPN) is reproduced by a software. The LPN can be recorded in database together with its related information [4]. LPN recording can also be processed and be employed to control exit systems like opening a gate in a parking or security centre. Images captured from a video camera are processed though a software which facilitates ANPR. The License Plate Recognition (LPR) system operates in four major steps, as given below [5, 6]:

(i) *License Plate Acquisition:*

This is the beginning phase in a LPRS which is obtained by an acquisition technique for image [7]. A high resolution digital camera is employed to acquire the input vehicle image which can be captured from distance of 4-5 meters of vehicle from the acquisition system [6]. One can also use a video camera for capturing of this beginning image.

(ii) *License Plate Image Processing:*

This is to accomplish image processing, help to improve features of captured input image and matches it next image processing steps [8]. Noise level during image acquisition is filtered out to convert the digital colored image into grayscale image using different color transforming and filtration techniques.

(iii) *License Plate Segmentation:*

It is also known as the Character Separation wherein one has to find characters in the license plate image and recognize them properly [6]. In the segmentation, the license plate image is converted into binary image and thereafter characters are divided into segments of essential parts to obtain the characters separately [9]. In fact, for a clearest detection of characters, the extracted plate is divided into number of images for each isolated character. The plate characters are separated out.

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(iv) *License Plate Recognition:*

It relies on character recognition, which is an important step in image processing task [10, 11]. This task is undertaken with the matching of each and every character. These characters are matched with the stored dataset conclude either each character is categorized as matched label or unmatched label.

In context of number plates in India, it is seen that Indian citizens use variety of the number plate templates which poses a major challenge for a quick and accurate reading of number plate data. Although, Indian government has tried to restrict the consumers to follow standard templates with prescribed characters and numbers, still problems such as low recognition rate, high recognition time, creation of template and detection errors are commonly seen.

B. Earlier work done

Among earlier work, Yu and Kim [10] has proposed a seed filling algorithm in which vertical edge matching algorithm is suggested to recognize license plate of different shapes and sizes of number plates. To reduce the cost, these authors have suggested implementation of recognition unit of LPR system in their software. Chang et al. [12] have presented LPR technique with two modules based on license plate location using fuzzy logic and identification of number plate using neural network. Duan et al. [13] have presented an automatic vehicle recognition system which read license plate number on traffic tolls. Their system contains three modules namely (a) VLP detection (b) license plate number segmentation (c) License plate recognition. For detection they have used boundary analysis using transform and contour algorithm. For segmentation purposes horizontal and vertical projection are used to separate number plates. While the used NPR OCR module was based on Hidden Marcov model. Anagnostopoulos et al. [14] have presented an algorithm which is based on novel adaptive image segmentation and component analysis is based on neural network. Authors have also used probabilistic neural network to identify the alphanumeric characters of License number plate of vehicle. Jiao et al. [1] have presented a new approach for recognition of multistyle license plate with quantitative parameters like character style and format, plate rotation angle, plate line number. In their recognition approach they have discussed algorithm to manage plate rotation, plate line segmentation, recognition of characters and matching format, etc. Sang et al. [15] elaborated a method of license plate detection which is based on gradient information and cascaded detection framework. Their method comprised of three modules namely (a) image pre-processing (b) license plate detection (c) license plate confirmation. In the image pre-processing part took Chinese number plate and gradient image to join plate through image processing. In second module for plate detection of license plate, cascading of AdaBoost classifier is suggested. In the license plate confirmation module voting based techniques and heuristic judgment strategies are used. Sharma et al. [16] have presented a scheme for license plate recognition which is based on wavelet transformation and artificial neural network. They have claimed for improvement in recognition time and recognition rate of license number plate. Ng et al. [17] have proposed an algorithm to recognized Malaysian vehicle number plate which consist of italic or cursive or small alphanumeric characters majorly based on SIFT (Scale Invariant Feature Transform) feature points. Li et al. [18] have discussed deep learning networks for reading car license plates and reported uniqueness of their method under different environmental conditions. They highlighted main advantage of their methodology which is segmentation free.

Puarungroj and Boonsirisumpun [19] have proposed a approach employing deep learning technique. They have undertaken experiments on different angular orientations of license plate and reported accuracy and character recognition rate of their scheme. Xiang et al. [20] have also proposed a method for license plate detection with the help of fully convolutional network and they found good accuracy rate, fact detection with low computational costs.

II. PRESENT METHOD INVOLVING MORPHOLOGY AND SVM

In the present work, we have used a new efficient technique for LPR using morphological boundary extraction and Support Vector Machine (SVM). In particular, morphological boundary extraction is employed for tracing the boundary of image and SVM is used for recognition of standard Indian license plate.

The proposed efficient license plate recognition method meets out the basic requirements of pre-processing of license number plate and character segmentation and recognition of license number.

The following algorithmic steps have been adopted for the present investigations:

Algorithm: Algorithm for license plate recognition.

Step 1: Input image of vehicle with number plate.
Step 2: Convert input image RGB (Red Green Blue) to Gray scale.
Step 3: Apply median filter on image to facilitate removal of noise.
Step 4: Set threshold value to find binary image.
Step 5: Extract image boundary values by using morphological dilation process.
Step 6: Use Sobel edge detection method for edge detection and fine tuning.
Step 7: Use SVM method for number plate segmentation and recognition.
Step 8: Extract license number plate.

A block diagram to incorporate above steps is shown in figure 1.

Representative example of present LPR system:

To highlight the working mechanism of our method, we have captured an image of car by a camera. Various steps are given below:

Input image of car with standard license number plate is loaded (Fig. 2).

Gray Image of number plate is extracted by converting RGB image to gray image as shown in Fig. 3. Pre-processing is done on captured RGB (Red, Green, Blue) image for clearing and enhancing the features of image. RGB image is converted into gray image with the help of gray weighted average [21] as shown in the (1).

$$0.2989 * R + 0.5870 * G + 0.1140 * B \quad (1)$$

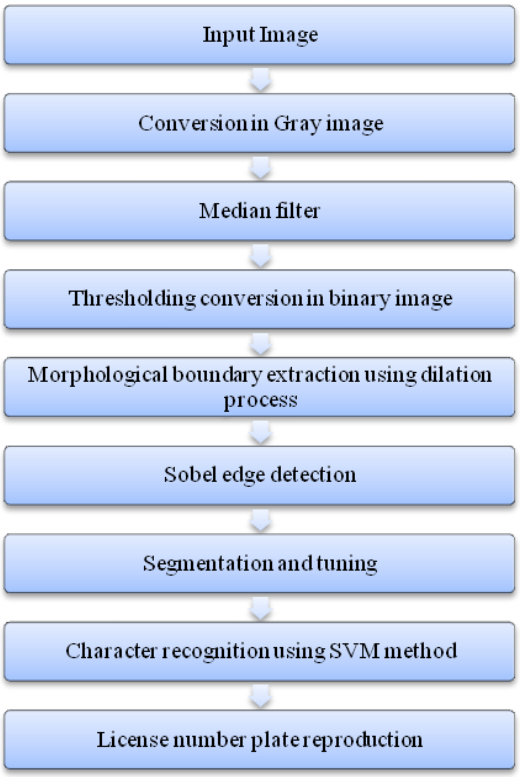

Fig. 1. Scheme of present License Plate Recognition (LPR) system

Fig. 2. Input Image

Fig. 3. Gray Image

Fig. 4. Median filtered image

Fig. 5. Threshold image

Median Filter which is a sliding window spatial filter removes the noise from input image as shown in Fig. 4. This is employed on binary image for removing the "Salt and Pepper" type noise.

After removing the noise, Thresholding process is used to convert gray image into binary image (Fig. 5).

In Fig. 6, morphological boundary extraction is shown to extract image boundary values by using morphological dilation process. In fact, morphological operations were performed by specifying the location of target characters periphery. Dilation operation was applied on objects in a binary image to perform operations like ‘grows’ or ‘thickens’ for completion of broken characters. This mathematical operation is represented in (2) [22].

$$A \oplus B = \{ P \in I^2 \mid P = a + b \text{ for some } a \in A, b \in B \} \quad (2)$$

In Fig. 7, application of Sobel Edge Detection to detect edges of number plate is depicted.

SVM based character segmentation and recognition is shown in Fig. 8. Character recognition through SVM can be divided into two main components.

The first component is training process which probes the features of character images and stores them into database. Then the second component namely character recognition is performed after extracting the principal features of test character image.

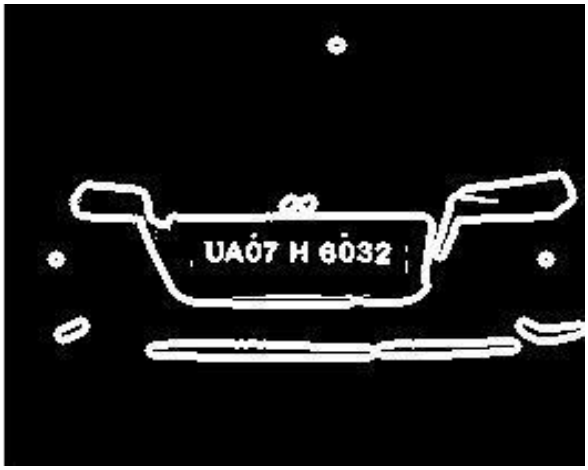

Fig. 6. Morphological boundary extraction

Fig. 7. Sobel edge detection image

Training Process:

It is know that each character has some key features which can be extracted out and trained for creating the database. The root-cause feature may be color of character image, shape, texture or descriptors, etc. Each character has a class in which number and style of image are stored of single character. After extracting the feature of each character, we provide them the training and thereafter store into the database. We have employed statistical methods to extract the feature of characters. Same method was also applied for taking out the features of unknown segmented character because matching cannot be accomplished directly.

Character recognition:

After training cycle, database remains available for character recognition. Before the compression process, we segment each character which distinct from each other. It is vital to extract the feature of unknown character image which enable extraction of feature through statistical methods and then undertake the matching job between unknown characters with trained image feature which is stored in the database. Close agreement between database images and unknown character leads to character recognition.

Finally extracted License Number plate is shown in a dialogue box (Fig. 9.)

Fig. 8. Character segmentation image

Elapsed time for recognizing the characters of number plate is found to be 1.923546 seconds.

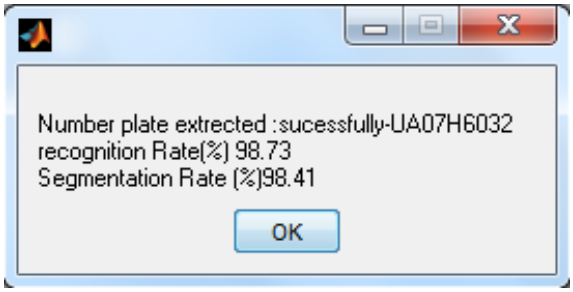

Fig. 9. Character segmentation and recognition rate as visualize through present method

III. ANALYSIS OF RESULTS AND DISCUSSION

In Fig. 10, we have compared the histogram of present algorithm before filtration and after filtration. All other results are shown in tabular and graph forms. Our investigations clearly show that filtration of noise levels related to red, green and blue channels on application of LPR scheme. Both red and green channels are reduced upto 33%. The reduction of noise further makes the recognition faster.

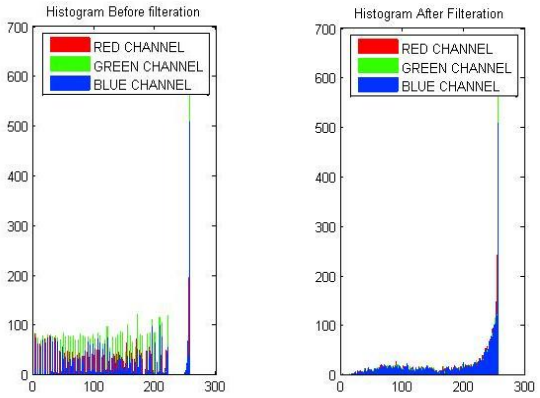

Fig. 10. Histograms of present algorithm before and after filtration

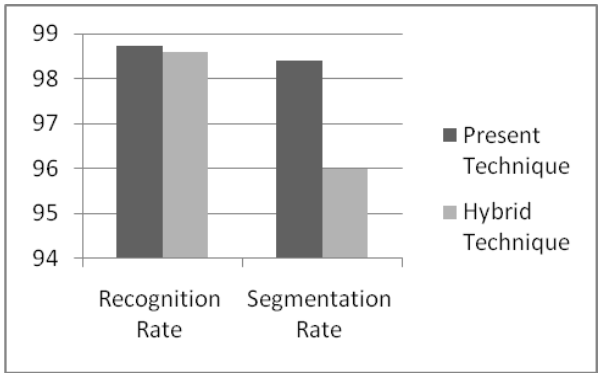

Fig. 11. Comparison of Recognition and Segmentation rates

Table -I: Recognition and Segmentation rates

METHOD	RECOGNITION RATE (%)	SEGMENTATION RATE (%)
PRESENT TECHNIQUE	98.73	98.41
HYBRID TECHNIQUE	98.60	96.00

In Table I, we have compiled the recognition and segmentation rates using presently suggested technique and those reported by other workers. It is seen that present recognition rate is slightly higher than available hybrid technique while segmentation rate is above 2.4% higher than the available hybrid technique [16].

IV. CONCLUSIONS

In the present investigations, we have proposed an efficient technique leading to high degree of accuracy in recognizing number plate on Indian vehicles. Automatic number plate recognition system is composed of four components namely pre-processing, segmentation of number plate, registration of number plate and recognition of number plate. It is seen that SVM which is a machine learning methodology leads to better results of classification and pattern recognition. Therefore, the suggested method can be employed for automatic number plate recognition applications, such as parking, law enforcement, journey time measurement, access control, border control and many more. Present results on recognition rate and segmentation time are compared with available data based on wavelet transform and artificial neural network techniques and it is seen that the combination of morphological dilation and SVM leads to remarkable results.

The present method can be extended to segment the character of non-standard license plate and reorganization.

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