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The Automatic License Plate Recognition(Alpr)

Rinku Solanki*, Rajesh Kumar Rai* Teena Raikwar*

*(M.tech student,digital communication, NRI-IST, Bhopal, Madhya Pradesh, India)
*(Professor, Head of the Department of E.C, NIRT, Bhopal, Madhya Pradesh, India)
* Assis. Prof. Electronics & Communication Dept. (NRI-IST), Bhopal, Madhya Pradesh, India,

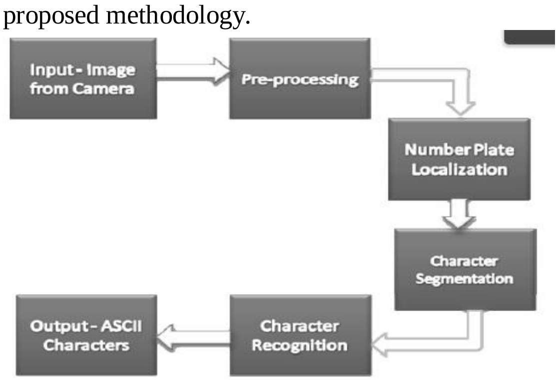
ABSTRACT
Every country uses their own way of designing and allocating number plates to their country vehicles. This license number plate is then used by various government offices for their respective regular administrative task like- traffic police tracking the people who are violating the traffic rules, to identify the theft cars, in toll collection and parking allocation management etc. In India all motorized vehicle are assigned unique numbers. These numbers are assigned to the vehicles by district-level Regional Transport Office (RTO). In India the license plates must be kept in both front and back of the vehicle. These plates in general are easily readable by human due to their high level of intelligence on the contrary; it becomes an extremely difficult task for the computers to do the same. Many attributes like illumination, blur, background color, foreground color etc. will pose a problem.
Keywords - : Automatic license plate recognition (ALPR) system, proposed methodology, reference.

I. INTRODUCTION

The purpose of this paper is to provide researchers a systematic survey of existing ALPR research by categorizing existing methods according to the features they used, by analyzing the pros/cons of these features, and by comparing them in terms of recognition performance and processing speed, and to open some issues for the future research.

Basic block diagram of the ALPR system is shown in **fig 1**.for above steps different techniques used by different author which are studied in literature review.An example of the number plate extraction is given .by this figure block diagram is easily understand, in this figure all steps of block diagram is shown by indicating numberA,B,C,D.

Automatic license plate recognition (ALPR) applies image processing and character recognition technology to identify vehicles by automatically reading their number plates.and this system mainly devide in three steps:all ateps are better explain in proposed methodology.



FIGURE(1)BASIC BLOCKDIAGRAM OF ALPR SYSTEM

The **variations of the plate types** or environments cause challenges in the detection and recognition of license plates. They are summarized as follows:

1) Location: Plates exist in different locations of an image.
2) Quantity: An image may contain no or many plates.
3) Size: Plates may have different sizes due to the camera distance and the zoom factor.
4) Color: Plates may have various characters and background colors due to different plate types or capturing devices.
5) Font: Plates of different nations may be written in different fonts and language.
6) Occlusion: Plates may be obscured by dirt.
7) Inclination: Plates may be tilted.
8) Other: In addition to characters, a plate may contain frames and screws.

Environment variations:

1) Illumination: Input images may have different types of illumination, mainly due to environmental lighting and vehicle headlights.
2) Background: The image background may contain patterns similar to plates, such as numbers stamped on a vehicle, bumper with vertical patterns, and textured floors.

II. PROPOSEDMETHODOLOGY

Vehicle license plate (VLP) constitutes an unambiguous identifier of a vehicle participating in road traffic. Reading a license plate is the first step in determining the identities of parties involved in traffic incidents. An efficient automatic license plate recognition process may become the core of fully computerized road traffic monitoring systems, electronic fee collection solutions, surveillance devices and safety supervision systems. It is important that the recognition accuracy of such a process is very high. Tracking and registering dangerous behavior in traffic may be used for prosecuting offenders.

License-Plate Recognition System consists of three main modules:

(1) License plate detection,
(2) character segmentation
(3)Character Recognition (CR).

Step(1)image acquisition, in image acquisition explained that from where images are acquire Image can be input to the system by different methods by analog camera,or by digital cameras, but nowadays digital technology has their advantages so better input method is by digital cameras or by direct digital photos.

(1)License plate detection

by whole capturing image we having license plate covered by background of vehicle body,so by this step only plate are is extracted from whole body. our task now is to identify the region containing the license plate. In this experiment, two features are defined and extracted in order to decide if a candidate region contains a license plate or not , these features are

(I)Preprocessing: Since we have assumed that the license plate has a yellow background , the first step is to identify the regions in the image that contain the intensity of RGB corresponding to the color yellow. We Filter the yellow colored part from the image using values obtained by experiments on the 10 sample images. (i) - (a< R< b) && (p< G< q) && (x< B< y) Where R is the intensity of the color Red , G of Green and B that of Blue.Based on this condition we obtain a BinaryImageWe change yellow to white and non-yellow to black.

(II) Morphological Operations:

These are Non-linear filters, with the function of restraining noises, extracting features and segmenting images etc The following morphological operations have been used

Fill (MATLAB function – *imfill*): fills holes in the binary image. A hole is a set of background pixels that cannot be reached by filling in the background from the edge of the image.

Open (MATLAB function – *imopen*): performs morphological opening on the grayscale or binary image with the pre-defined structuring element .

Dilate (MATLAB function – *imdilate*): dilates the grayscale, binary, or packed binary image returning the dilated image

(I)On Applying these morphological operations on „im1.jpg‟ we obtain the Image.

(III) Horizontal Segmentation

Once the Preprocessing is over, the next step is to segment the license plate candidates from the image. We first do a horizontal segmentation of the image
using the histogram method.

Steps:-

For this we calculate the horizontal and vertical projections of intensity.Then we find the mean of the local minimas of horizontal projection plot .Based on the threshold calculated from the above local minimas, we findx locations of the segmented regions.In order to locate the right and left edges of license plate from candidate region, the vertical projection after mathematicalmorphology deal is changed into binary image. The arithmetic for doing this is:

$$f_T(L_T) = 1 \quad f_T \geq T$$
$$f_T(L_T) = 0 \quad f_T < T$$

where f_T (1,i) is the vertical projection after mathematical morphology, T is the threshold. Then scan the function of f_T (1,i) and register the portions where values change from 0 to 1 and from 1 to 0 in stack1 and stack2 respectively. So the candidate position of the left and right edge of the license plate are in stack1 (1,i) and stack2(1,i) respectively, and the candidate's width of the license plate is calculated by: width(1, i) stack2(1, i) - stack1(1, i) respectively. So the candidate position of the left and right edge of the license plate are in stack1 (1,i) and stack2(1,i) respectively, and the candidate's width of the license plate is calculated by: width(1, i) stack2(1, i) - stack1(1, i) These give the x coordinates of the potentially candidates regions

(IV) Getting Potential Candidates

After getting the horizontal segments of the candidate regions, we would now want to get the vertical coordinates, in order to extract the exact area from the image For each of the horizontal segments, in order find the vertical location, we once again use the vertical projections of intensity. Then converting to a binary image using the threshold as discussed in the previous section we get the desired vertical coordinates. Now we have all our candidate regions. An candidate regions obtained from our sample image „im1.jpg‟ are :

figure(2)Candidate regions

(V) Identifying the License Plate:

Out of the many candidate regions that we have obtained from the so far mentioned procedure, our task now is to identify the region containing the license plate. In this experiment, two features are defined and extracted in order to decide if a candidate region contains a license plate or not , these features are

1. Aspect ratio
2. Edge Density

Even though these features are not scale-invariant, luminance-invariant, rotation-invariant, but they are insensitive to many environment changes.

Aspect ratio

The aspect ratio is defined as the ratio of the width to the height of the region.

Aspect Ratio = width/height

Since the minimum enclosing rectangle(MER) of the object region can be computed via rotating the region in previous section, the dimension of the object‟s MER can be taken as the width and the height of the region.

Edge density

Applying the above feature to filter the segmented regions, a lot of nonlicense plate regions can be removed. However, there are still many candidate regions left which take similar rectangularity and aspect ratio features as the license plate regions do, such as often the head lights. Considering that the license plate regions generally take higher local variance in its pixels‟ values due to the presence of characters, an important feature to describe license plate region is local variance, which is quantized using the edge density. The edge density is measured in a region R by averaging the intensities of all edge pixels within the region as

$$D_R = \frac{1}{NR} \sum_{m,n \in R} E(m,n)$$

Where E(i,j) represents the edge magnitude at location (i,j), and NR is the number of pixels in region R. License plate Sets used for training to calculate *aspect ratio* and *edge density*: We used 24 license plates as training data. They are contained in the directory named "edge_density_and_aspect_ratio_t raining _images".

After performing this experiment, we found the average values of the above mentioned features as follow:

aspect ratio = 4.4912 edge density = 0.1359

On using the above mentioned features we are able to drop the incorrect regions and get the final result as the extracted license plate from the input image.

For the candidate images shown above, above tests rules out the first candidate and gives the following output –

figure(3)Number Plate

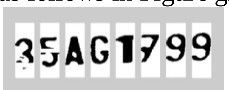
(2)SEGMENTATION

this step characters on license plate are segmented and identify. This step is the most important step in license plate recognition because all further steps rely on it. This is the second major part of the License Plate detection algorithm. There are many factors that cause the character segmentation task difficult, such as image noise, plate frame, rivet, space mark, plate rotation and illumination variance.We here propose the algorithm that is quite robust and gives significantly good results on images having the above mentioned problems.for the segmentation preprocessing is required by conversion to gray scale and binarization. Different algorithms are used for segmentation which are explained further later in literature review.

In the segmentation of plate characters, license plate is segmented into its constituent parts obtaining the characters individually. Firstly, image is filtered for enhancing the image and removing the noises and unwanted spots. Then dilation operation is applied to the image for separating the characters from each other if the characters are close to each other. After this operation, horizontal and vertical smearing are applied for finding the character regions. The result of this segmentation is in Figure given below.

figure(4)Locations of plate characters

The next step is to cut the plate characters. It is done by finding starting and end points of characters in horizontal direction. The individual characters cut from the plate are as follows in Figure given below.



figure(5)Number plate characters

(3)CHARACTER RECOGNITISON:

automatically locate license plates by principal visual word (PVW), discovery and local feature matching. Observing that characters in different license plates are duplicates of each other, we bring in the idea of using the bag-ofwords (BoW) model popularly applied in partial-duplicate image search. Unlike the classic BoW model, for each plate character, we automatically discover the PVW characterized with geometric context. Given a new image, the license plates are extracted by matching local features with PVW. Besides license plate detection, our approach can also be extended to the detection of logos and trademarks. Due to the invariance virtue of scale-invariant feature transform feature, our method can adaptively deal with various changes in the license plates, such as rotation, scaling, illumination, etc. Promising results of the proposed approach are demonstrated with an experimental study in license plate detection. we formulate license plate detection as a visual matching problem. For each character, we collect SIFT features falling into the character region and generate PVW by unsupervised clustering. The amount of PVW for each plate character is determined automatically Besides SIFT descriptors, each visual word contains some geometric information, such as orientation, ratio of scale to character height, and relative position in the character region. Those geometric clues will be used to filter false feature matches and estimate the character and plate size. In testing, every valid match votes a support for plate location, and all supports are unified to discover potential license plates.Due to the invariance virtue of SIFT feature, our method can adaptively deal with various changes of license plate, such as distortion from observation views, scaling, and illumination. Multiple license plates in a single image can also be automatically detected.

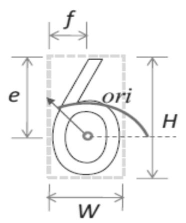
In visual word matching and license plate locating, we compare the extracted SIFT features of the test image with all discovered PVW, and locate the license plate based on the matching results. Let us denote the PVW set as $\{D, G\} = \{(di , gi), i = 1, . . . , N\}$, where *di* denotes appearance descriptor, and *gi* denotes the geometric clues, *N* denotes the visual word number. Once the PVW of an object category is discovered, we can use it for detection in a new image. Given features $F = \{ fi \}$ for a test image, the probability that the test image corresponds to a sign of interest is

$$p(0 \setminus d_i, g_i) = \frac{p(d_i, g_i \setminus 0) \cdot p(0)}{p(d_i, g_i)} \alpha \; p(d_i, g_i \setminus 0) \quad \text{.............................(1)}$$

where *p(O)* is prior of plate. The likelihood *p(di , gi |O)* is deduced as

$$p(d_i, g_i \setminus 0) = \sum_j p(d_i, g_i \setminus f_j, 0) \cdot p(f_j \setminus 0) \quad \text{........................(2)}$$

where *p(di , gi | f j , O)* is modeled by matching feature *f j* to the descriptor *di* of the PVW.



Figure(6)Illustration of a PVW (red arrow) in the character "6."

Consequently, by searching for the local maxima of the likelihood function given by (1) for all PVW, we can find the initial hypotheses for license plate location. Some other prior heuristics can also be imposed to remove potential false positives. In the following subsections, we will discuss PVW generation and local feature matching to extract license plate in detail.

A. PVW Generation

There are a certain number of sorted characters in license plates, each with the same format, but maybe undergoing illumination change or affine transformation. Since SIFT feature is invariant to changes in scale and rotation, and robust to illumination change and affine distortion [2], some repeatable and distinctive SIFT features to each character exist, called PVW. As shown in Fig., a PVW is denoted as *V* (des, ori, rat, pos), where des is the 128-D SIFT descriptor, ori is the SIFT orientation ($-\pi \le$ ori $< \pi$), rat = *H/s* (*s* is the SIFT scale), and pos = *(f/W, e/H)* is a 2-D vector denoting the relative position of the key point in the character region. Both des and ori are originated from the standard SIFT features [2] des captures the local visual appearance with a concatenation of 8-D orientation histograms from 4 by 4 subpatches around local interest point. ori denotes the dominant directions of local gradients around a key point. Relative to ori and des is represented to achieve invariance to image rotation changes . Ideally, for a feature with high repeatability in a certain character, rat shall be identical. Given this specific SIFT feature with scale *s*, we can estimate the corresponding character height as rat · *s*. Given an image patch of the character with height, *v*, we can also derive the scale of the SIFT feature as *v*/rat. We collect many training images, each containing one or more license plates. License plates in the training images are all upright, with little affine distortion. Each character in the license plate is annotated and all SIFT features in each character region are extracted. Usually, many noisy features also exist. To discover the PVW of each character, we need to cluster the local features of each character and discover the most representative cluster centers as the PVW.

which can be found automatically in the clustering process. In affinity propagation, a similarity matrix of samples shall be defined. We first give the distance metric, which will be used to define the similarity metric. The distance between two feature samples *V j* and *Vk* is defined in (3)

$$d_{j,k} = \alpha \cdot D_d + \beta \cdot D_O + \gamma \cdot D_r + \delta \cdot D_P \quad \text{..........(3)}$$

where *α*, *β*, *γ*, and *δ* are constant weighting factors, *Dd* ,*Do*, *Dr*, and *Dp* are the distance of descriptor, orientation, height-scale ratio, and position, respectively, and are defined as follows:

$$D_d = \frac{1}{\sigma} \sqrt{\sum_{i=1}^{128} (des_i^j - des_i^k)^2} \quad \text{.................(4)}$$

$$D_O = \frac{1}{\pi} \cdot \min\left(\left| ori^j - ori^k \right|, 2\pi - \left| ori^j - ori^k \right| \right) \quad \text{...............(5)}$$

$$D_r = \frac{1}{N}\left|rat^j - rat^k\right|$$
…………..(6)

$$D_p = \frac{1}{2}\sqrt{\sum_{i=1}^{2}(pos_i^j - pos_i^k)^2}$$
………………....(7)

where σ and N are normalization factors to make sure that both *Dd* and *Dr* range from 0 to 1.

The similarity metric is a decreasing function of the distance metric. There are many choices for it. In our implementation, the pair wise similarity between two feature samples *V j* and *Vk* is defined as

$$S_{j,k} = -(d_{j,k})^n,\ (n > 0)$$
……………(8)

In affinity propagation, the diagonal elements in the similarity matrix are referred to as exemplar preference, which will influence the number of identified clusters. Generally, without any priori, we set it as the median of the input similarities, After clustering, we need to discover the most representative clusters. For each cluster, we count the number of image patches which contain at least one feature falling into the cluster. Then an image-number histogram is built. To select those representative clusters, a threshold thresh shall be specified on the histogram. Any cluster with image number above thresh will be selected. In each selected cluster, the PVW are defined as the average of all samples falling into that cluster. In our experiments, we set thresh = 0.6·Num, where Num is the total sample number of the specific character. Fig. illustrates the feature clustering results of three characters: "0," "6," and "9." In each character, the PVW are highlighted in red color on the patch with its geometric information: ori, rat, and pos. The PVW of characters from "0" to "9" are shown in Fig. while those of characters from "A" to "Z" excluding "I" and"O" are illustrated in Fig. 5. There are no PVW of character "I" and "O" as these two characters are not found in any training plate.

Modification in proposed method:

Instead of visual word matching we can implement by template matching methodology, which takes less efforts and calculations. Method explain below,Template matching is used for the character recognition. Before the matching process, the input image must be resized in order to be equal-sized with the template. After that, the isolated character can be identified by comparing with the ones in the template and the best similarity is measured. To measure the similarity and find the best match, a 2-dimension correlation method is used. Two perfectly matched characters will have a correlation which is equals to 1. Finally, the license plate number will be recognized and saved in database.

Template Matching

The developed program used template matching to identify the segmented character. Template matching method must have character images as template stored in memory [6].The segmented character will be identified by calculating the correlation coefficient. The idea behind the implementation of a correlation based identification scheme is when two template pools, one consisting of all the possible values of letters, and of all values of the digits, are constructed. Generally, once the license plate has been segmented into the several characters, each image that containing a single character is evaluated. The correlation coefficient between the image of the character and the appropriate template pool is computed. The template that yields the highest coefficient will indicate what character is depicted in the input images.

For matching characters with the template, input images must be equal sized with the template's characters.In this program, the characters are fit to the size of 24 x 42.The extracted characters are obtained from plate and the characters on database are now equal sized. After that, the character image is compared with each component in the database and the best similarity is measured.the template which consists of 24alphabets and 10 numerals with the size of 24 x 42. The template formed is based on the real font of the license plate. To measure the similarity and find the best match,a 2-dimensional correlation coefficient is used. This method measures the correlation coefficient between a number of known images with the same size unknown images or parts of an image with the highest coefficient between the images producing the best match. The equation for calculate the coefficient is as shown in Equation :

$$r = \frac{\sum m \sum n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{(\sum m \sum n (A_{mn} - \bar{A})^2)(\sum m \sum n (B_{mn} - \bar{B})^2)}}$$

,where $\bar{A}$ is the mean value of A, $\bar{B}$ is the mean value of B

One of the segmented characters. The developed program will calculate the correlation coefficient between the input image and the images in the template.The value of correlation coefficient is then return . Since the template created consists of 9 images, thus there are 34 values of correlation coefficient were calculated and return under the position of the images in the template respectively. The measured values of correlation coefficient allow the developed program to find the best match for the input character.

The position of the images in the template will be arranged sequentially.This means that the character 'A' will be placed at position1, character 'B' at position 2 and so on. There are 34 images in the template and hence the maximum number of the position is 9.

Program will find the maximum value of the correlation coefficient as shown in Figure 11. Then the program will locate the location of the maximum value of the correlation coefficient. The location of the correlation coefficient will feed as the recognition result and store in the database.

ALGORITHM:

Training:

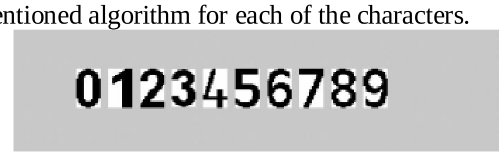
The program is first trained with a set of sample images for each of the characters to extract the important features based on which the recognition operation would be performed.

Our program is trained on a set of 10 characters with 10 samples of each. The training algorithm involves the following steps

1. Preprocessing :

Before preparing the template for each of the characters for further use, we need to do some processing on the images. The following are the operations that are performed:

- Binarization.
- Inversion of intensity of the characters.
- Finding the connected component that represents the character
- Finding the smallest rectangle enclosing this connected component
- Normalization of the image to size 15 X 15.
- Storing the intensity values using the below mentioned algorithm for each of the characters.



fig(7)Database characters

2. Creating the template

In order to create the template for each character we do the following operation. For every white pixel we insert the value 1 and for every black pixel 0. We do this for all the 10 training samples for each character and calculate the weights to get the template.

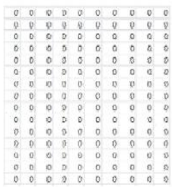


fig8(a)Empty template

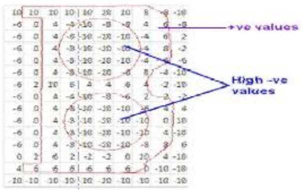


fig8(b) Template after one sample of „B

Fig8(a)Empty template, (b) Template after one sample of „B

Recognition:

1. Preprocessing:

The image obtained after segmentation is Grayscale. Follow the preprocessing steps used for the training of the characters.

2. Calculate the score for each of the characters:

We calculate the matching score of the segmented character from the templates of the character stored by the following algorithm.We compare the pixel values of the matrix of segmented character and the template matrix,

In order to create the template for each character we do the following operation. For every white pixel we insert the value 1 and for every black pixel 0. We do this for all the 10 training samples for each character and calculate the weights to get the template.

We compare the pixel values of the matrix of segmented character and the template matrix, and for every match we add 1 to the matching score and for every mis-match we decrement 1. This is done for all 225 pixels. The match score is generated for every template and the one which gives the highest score is taken to be the recognized character.

Character sets used for training the OCR: This is contained in a directory named OCR_Training_Data‟ The output of OCR on the segmented license plate shown above is given in result below.

EXPERIMENTS AND RESULTS:

We have tested our software on a sample of 47 images contained in the directory named Input Images. The efficiency of the algorithm implemented here is as follows (Measured in terms of correct output obtained in Images out of sample of 47)

SR. NO	Algorithm	Correct Output	Accuracy
1	License plate area extraction	46	97.87 %
2	Character segmentation	45	95.74 %
3	Character Recognition	44	93.61 %
OVER ALL SYSTEM EFFICIENCY			95.74%

Fig(9)table of result analysis

III. CONCLUSION

In general, an ALPR system consists of three processing stages. In this paper I have use morphological operation, horizontal, vertical segmentation use for plate extraction. for character segmentation smearing and image enhancement algorithm is used,for the recognition I have use correlation technique and getting 95.74% of system efficiency.

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