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ADVENCED TRAFFIC MANAGEMENT SYSTEM USING AUTOMATIC NUMBER PLATE RECOGNITION SYSTEM

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Abstract - *In this new era, the use of vehicles has become very important for human prosperity and development. However, the use of vehicles in various crimes, kidnapping, terrorist activities also have become an unwanted evil for the humanity. The traffic on the roads is increasing day by day. There is dire need of developing an automation system that can effectively manage and control the traffic on roads. The traffic data of multiple vehicle types on roads is also important for taking various decisions related to traffic. A video based traffic data collection system for multiple vehicle types is helpful for monitoring vehicles under homogenous and heterogeneous traffic conditions.*

Fake number plate of a vehicle is not identified using vehicle tracking systems like GPS or cameras. In this situation we use ANPR system. In some case police want the details of a vehicle based upon the number and model. For that this system is useful. This system is based upon the image processing technology which involves a number of image processing algorithms. Using edge statistics and morphological process license plate region from an image is identified and using OCR and Template Matching technique characters from the number plate is recognized. Type of the vehicle is identified using CNN method. Based on this extracted number and type and using the RTO data base we can check the number is fake or not using the RTO database. If number is fake an alert is sent to police headquarters. Police also have a wanted number database. This database number is directly compared with the recognized number. If it is same an alert is sent to the police headquarters.

Keywords: CNN, OCR, Template matching

1. INTRODUCTION

In recent year people income and life standard have increase dartingly, their for there is a considerable increase in the number of vehicle owners. The automobile not only a pointer identity but also a tools of transportation and necessity for people. So vehicles organization of parking lots, electronic toll compilation management of highway, locating vehicles stolen and monitor of road and so on, all become new safety demand for people with vehicles management and vehicles stolen avoid. License plate recognition system, we can not only tracking the go through vehicles but also save most of manpower to improve recognized efficiency. The automatic number plate recognition system can find out the stolen vehicle, also track the uncertain vehicles to reduce the violation of traffic road.

In today's world number of threads increases progressively. It varies from the pilferages to acts of terrorism. As a response many countermeasures are taken. In most of metro cities observation systems are installed. They considerably reduce the number of acts of damage, robberies, car stealing etc. On the other hand many cameras in the city remain unused, due to the fact that the acquired image must be processed by the operator. The police do not have enough staff to watch everything at the same time. There is also another difficulty of such systems. Stock up the video from all cameras necessitates tremendously high capacities. The solution of this problem might be replacing the human operative by an intelligent classification system that analyzes the obtained image. As far as the vehicle robbery difficulty is worried, the observation system without mentioned disadvantages can be urbanized.

In India vehicle fake number plate cannot be detected directly. RTO database is only accessed by the police control room. When the number is identified the tracking of the vehicle is done in separate module and is more time consuming and more man power is needed. So we need an automatic system for fake number plate detection. When the police want the information about the route of a particular vehicle this system is helpful. And in case of automatic toll collection this method is applicable. By using this RTO database we can get the vehicle complete information of vehicle.

Generally, the scheme is planned to distinguish all types of license plates. The variety of them is huge. They are of dissimilar figure and colors, letters can be prearranged in more than one row. For instance in India license plate is white background with black letters. Now the High Security Registration Plate Scheme (HSRP) Scheme was launched in 2011, different from the old format. It has chromium-based hologram with 'IND' in blue is emblazoned using hot stamping foil and a unique Permanent uninterrupted Identification Number [3]. In this work only the solitary row plates with black letters on white background are assumed as the accurate only. The vehicle number plate in India consist country code, state code, district code, type of vehicle and finally the actual registration number.

The proposed method uses real time traffic data such as video and image of the vehicle and using this check the number plate and type of the vehicle. This project combines both vehicle number, type identification and verification tasks in a single system. The system is implemented using OCR and template matching technique for number plate identification and CNN for vehicle type identification.

2. LITERATURE SURVEY

2.1 License Plate Detection

License Plate Location is an integral and inseparable part of the system, as it locates the plate that encloses the license plate numbers. The whole concept depends on the edges of the license plate only because there are a huge data in the image. The extraction of multiple license plates from an image with a complex background is the main factor. Different processes are performed to extract the license plate. The extractor gives its output to the segmentation part Edge statistics and morphological process.

2.1.1 Edge Statistics and Morphological Process

Techniques based upon combinations of edge statistics and mathematical morphology [1], [2] featured very good results. In these methods, gradient magnitude and their local variance in an image are computed. They are based on the property that the brightness change in the license plate region is more remarkable and more frequent than otherwise. Edge based methods alone can hardly be applied to complex images, since they are too sensitive to unwanted edges, which may also show a high edge magnitude or variance. To overcome this situation we used the combination of edge statistics and morphological process. When combined with morphological steps that eliminate unwanted edges in the processed images, the license plate extraction rate is relatively high and fast compared to other methods. Mathematical morphology consists of 2 algorithm erosion and dilation process. Erosion is a morphological process that can be obtained by dilating the compliment of the black pixels and taking the compliment of the resulting point set. The average accuracy of locating a vehicle LP is an impressive rate of 99.6.

2.1.2 Connected Component Analysis

Connected component analysis (CCA) is a vital technique in binary image processing that scans an already bi- Fig. 1. Architecture of ANPR binaries image and labels its pixels into components based on pixel connectivity (either 4-connected or, usually, 8- connected). Once all groups of pixels have been determined, each pixel is labeled with a value according to the component to which was assigned. Extracting and labeling of various disjoint and connected components in an image is basic to many automated image analysis applications, as many helpful measurements and features in binary objects may be extracted. Spatial measurements such as area, orientation, and aspect ratio (AR) are just few of the features frequently integrated in image processing algorithms for LP detection [3], [4]. Then, using simple filtering techniques, binary objects with measurements that exceed the desired limits can be eliminated in the next algorithmic steps. [5] text is detected from complex background image is also possible in this method. Text regions have been successfully extracted irrespective of the text font and size.

2.1.3 Wavelet Based Transform

A wavelet transform-based method is used in [12] for the extraction of important contrast features used as guides to search for desired license plates. Applying wavelet transform to an image and projecting the acquired detail information a wave crest that indicate position of a license plate will generated. [13] propose a multi-wavelet with EMD analysis for identifying the license plate. It is useful for detect license plate under various condition from various countries. The major advantage of wavelet transform, when applied for license plate location, is the fact that it can locate multiple plates with different orientations in one image and it can also detect blurry image Nevertheless, the method is unreliable when the distance between the vehicle and the acquisition camera is either too far or too close. EMD analysis will mistakenly detect the wave crest that indicate the region containing the similar contrast feature instead of the true wave crest.

2.2 Segmentation

License plate segmentation, process is also called as the Character Separation. After the license plate images are extracted from a picture, and then find individual character in the license plate to recognize it. In the segmentation of license plate characters, license plate is first converted into binary image then characters divided into segments to essential parts obtaining the characters separately. License plate Segmentation is useful to the license plate in arrange to outline the individual characters. License Plate Segmentation, which is referred to as Character Isolation takes the region of interest and attempts to split it into individual characters.

2.2.1 Projections and Binary Algorithms

Reviewing the literature, it was evident that the method that exploits vertical and horizontal projections of the pixels [14], [6], [15], [16] is the most common and simplest one. Obtaining a binary image, the idea is to add up image columns or rows and obtain a vector (or projection), whose minimum values allow us to segment characters (see Fig1).CCA is also intensely involved in character segmentation, in conjunction with binary object measurements such as height, width, area [1], and orientation [17] [18]. In other cases, CCA is supported by

either VQ or mathematical morphology. Usually, the CCA method labels the pixels into components based on 8-neighborhood connectivity, but the binarized image is decomposed into 4- neighbor connected components.

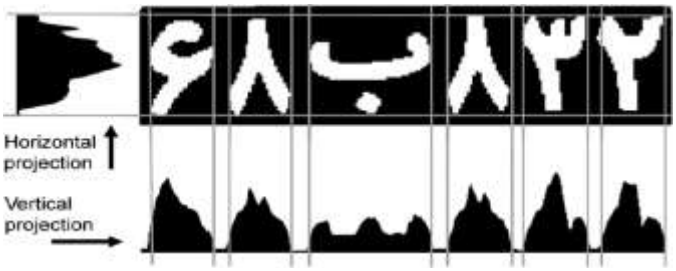


Fig 1: Character extraction using the horizontal and vertical projection method

2.2.2 Histogram and morphological process

The work in [15] proposed a novel adaptive approach for character segmentation and feature vector extraction from seriously degraded images. An algorithm based on the histogram automatically detects fragments and merges these fragments before segmenting the fragmented characters. A morphological thickening algorithm automatically locates reference lines for separating the overlapped characters. A morphological thinning algorithm and the segmentation cost calculation automatically determine the baseline for segmenting the connected characters. Basically, this approach can detect fragmented, overlapping, or connected characters and adaptively apply one of three algorithms without manual fine tuning. The results are very promising and encouraging, indicating that the method could be used for character segmentation in plates with not easily distinguishable characters during off-line operation, but since the algorithm is computationally complex, it cannot be proposed for real-time LPR.

2.3 Character Recognition

License Plate Recognition is the last step of the LPR system. This step is the main part of the recognition process which decides the accuracy and recognition rate of the system. This Recognition involves about to recognize the characters of the license plate numbers and character. Before the recognition the license plate characters are normalized. Normalization is to improve the characters into a block containing no added white spaces (pixels) in all the four sides of the characters. In this stage, the license plate character images that are taken out from the license plate image have to be recognized. It is actually the process of the character recognition of the license plate characters. The character recognition of the license plate can be find out through Neural Network, Template matching, Hough Transform, Radial Basic Function.

2.3.1 Classifiers

Statistical/Hybrid Classifiers

When hidden Markov models (HMMs) are employed, the recognition begins with pre-processing and parameterization of the ROIs detected in the previous phase (character segmentation). Based on [28], the recognition result in [15] was reported to be 95.7complex procedure of preprocessing and parameterization for the HMMs: one for every character. The authors also reported that the width of the plate in the image after rescaling lies between 25and 600 pixels). This reveals the necessity for good character analysis when implementing HMMs, which poses a restriction on the effective distance of the plate recognition system. This prerequisite is also featured in [25], where the recognition results reached 92.5 Furthermore, the authors in [27] designed a system that implements SVMs and reports an impressive average character recognition rate of 97.2character recognizers were applied to recognize upper characters, upper numerals, lower characters, and lower numerals on the plate.

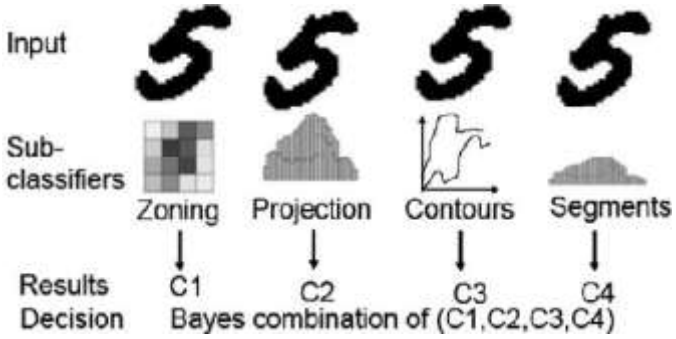


Fig 2: Statistical classification stage combining four sub-classifiers using the Bayes method

Many researchers integrate two kinds of classification schemes [21], [18], multistage classification schemes [26], or a parallel combination of multiple classifiers [23][8]. Pan et al. [25] proposed a two-stage hybrid recognition system that combines statistical and structural recognition methods to achieve robust and high recognition performance. Initially, skew images of car plates were corrected and normalized. In the first recognition stage, four statistical sub-classifiers (SC1, SC2, SC3, and SC4) independently recognize the input character, and the recognition results are combined using the Bayes method [83]. Sub-classifier SC1 uses the zoning density. SC2 uses the vertical projections, SC3 calculates the contour profile, and SC4 counts line segments in each row and column (see Fig. 2). Finally, if the output of the first (statistical) stage contains characters that belong to prescribed sets of similar characters, the second (structural) stage is initiated as a complement to the first. Structure features are obtained and are then fed into a decision tree classifier. The success ratio reached 95.41,huge testing data set of more than 10 000 plates. Alternatively, coarse-to-fine

classification is an efficient way to organize object recognition to accommodate a large number of possible hypotheses and to systematically exploit shared attributes and the hierarchical nature of the visual world. The basic structure is a nested representation of the space of hypotheses and a corresponding hierarchy of (binary) classifiers [32]. A scene is processed by visiting 15 non overlapping 5 x 5 blocks, processing the surrounding image data to extract spread edge features based on the research conducted and classifying this sub image according to the coarse to- fine search strategy. There are 37 classes defined by the prototypes (bit maps), shown at the top of Figure 5, which correspond to the 36 alphanumerical characters plus the special character. Special emphasis was given to pair wise competition between any two similar interpretations of a character (e.g., S/5 and J/U). The algorithm was evaluated on 520 plates. The correct character string was found on all but 17 plates. However, the classification rate per symbol was much higher: more than 99.

2.3.2 Template matching

The template matching technique is a suitable technique for the recognition of single-font, not-rotated, and fixed-size characters. It is a technique to identify the segmented character by finding the small part in image that match with the template this method need character image as their template to store in the database. Template matching requires a library of a wide variation of character fonts and thicknesses. In order to create the templates for each character 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 50 training samples for each character and calculate the weights to get the template. Template matching is an effective algorithm for recognition of characters. The character image is compared with the ones in the database and the best similarity is measured. Calculate the matching score of the segmented character from the templates of the character stored algorithm. 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 miss-match we decrements 1. This has done for all pixels. The match score is generated for every template and the one which gives the highest score is taken to be the recognized character. The character template that best matches the input characters are then displayed. Finally, the Hausdorff distance is a method of comparing two binary images (or two sets of active pixels). The method possesses all the mathematical properties of a metric, and its recognition rate is very similar to that obtained with neural network classifiers but slightly slower. On the basis of the research conducted in [25] and [26], Martin et al. concluded that the Hausdorff distance may constitute a complementary recognition method if real-time requirements are not very strict.

2.3.3 Artificial Neural Network (ANN)

Artificial Neural Network (ANN) sometimes known as neural network is a mathematical term, which contains interconnected artificial neurons. Several algorithms such as [27], [6], [28], [29], are based on ANN. In [27] two layer probabilistic neural network with the topology of 180-180-36. The character 16 recognition process was performed in 128ms. In [30] multi layered perceptron (MLP) ANN model is used for classification of characters. It contains input layer for decision making, hidden layer to compute more complicated associations and output layer for resulting decision. Feed forward back-propagation (BP) algorithm was used to train ANN. BP neural network based systems are proposed in [29], with the processing time of 0.06s. In [31] HNN is applied to reduce ambiguity between the similar characters e.g. 8 and B, 2 and Z etc. The authors claim to have more than 99% recognition rate.

2.3.4 Kernel method

Kernel methods, including support vector machines (SVMs) [32] primarily and kernel PCA, kernel FDA, etc., are receiving increasing attention and have shown superior performance in pattern recognition. Kernel methods use a kernel function to represent the inner product of two patterns in expanded nonlinear feature space (possibly of infinite dimensionality). Both training and classification are performed via the kernel function without explicit access of the nonlinear space. An SVM is a binary classifier with discriminant function being the weighted combination of kernel functions over all training samples. The weights (coefficients) are learned by quadratic programming (QP) with the aim of maximizing the margin in feature space. After learning, the samples of non-zero weights are called support vectors (SVs), which are stored and used in classification. The maximal margin criterion of SVM learning leads to good generalization performance, but the resulting large number of SVs brings about heavy storage and computation in classification. For multi-class classification, binary SVMs can be combined in two ways: one-versus-all (one-against-others) or one-versus-one (pairwise). The pairwise combination scheme was shown to outperform one-versus-all when using linear kernel. When nonlinear kernels are used, the one-versus-all scheme per-forms sufficiently. In recent years, many results of character recognition using SVM classification have been reported, mostly for small category set problems like numeral recognition. The results shows that SVMs indeed yield higher accuracies than statistical and neural classifiers, but the storage and computation of large number of SVs are expensive. A strategy to alleviate the computation cost is to use a statistical or neural classifier for selecting two candidate classes, which are then discriminated by SVM [32]. Dong et al. used a one-versus-all scheme for large set Chinese character recognition with fast training. They speed up the

recognition by using a coarse classifier for candidate selection, but cannot avoid the problem of storing large number of SVs.

3. PROPOSED SYSTEM

The purpose of the system is to identify the fake vehicles with less man power. Mainly it has 2 parts license plate character recognition and vehicle type detection. Using the camera we get the video sequence and from that video the frames containing the images of the vehicle are extracted. These images are the input of the ANPR system. License plate is extracted using edge statistics and morphological process and characters are recognized using OCR and template matching techniques. Type of the vehicle is identified using convolutional neural network. Over all architecture of the system is shown in fig 3. Input is the image or video. When input is video, image frames that contain the vehicle image is extracted. This is passed to license plate detection and vehicle type identification algorithms. We can extract the number and type of the vehicle. It is recorded in the recognition result database with the number, type and time that are detected. This result is compared with the RTO database. If the recorded number and type is correctly matched with the RTO database no further process is done. Otherwise it is recorded as the fake number plate and an alert is send to the police headquarters.

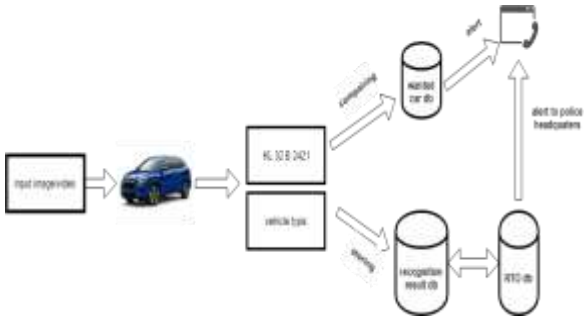


Fig -3: System Architecture

The recognized number can be used to retrieve owner information from RTO database. The system stores another database called wanted car database provided by the police headquarters. The recognized number from the license plate is compared with the wanted car database. If a match occurs an alert is sent to police.

Step wise description of system architecture

1. Input the image or video

2. Extract the frame from the video if the input is video

3. Pre-processing of the image

   a. Resize image

   b. Convert input image to gray scale image

   c. Noise removal using morphological filters

4. Localization of number plate

   a. Extracting the number plate using morphological operations

5. Segmenting the character

   a. Calculate the number of connecting components

   b. Perform bounding box technique to segment the connected components

6. Recognition of the characters

   a. Using OCR

   b. Using template matching

7. Vehicle type identification using CNN Resnet 50 network

8. Store the vehicle number, type, and time of detection in recognition result database

9. Alert is sent to police headquarters when

   a. If the number and type is not correctly matched with the RTO database

   b. Number is not registered in the RTO database

10. Set a wanted car database, it contain the number of the wanted vehicle

11. If the identified number and type in the recognized result database is correctly matched with any of the entries in the wanted car database an alert is send to police headquarters

3.1 Vehicle Number Identification

For the comparison of the efficiency here we use 2 algorithms for number plate recognition, namely OCR and template matching technique.

3.1.1 Optical Character Recognition

The optical character recognition is a recognition method in which the input is an image and the output is string of character. OCR is a process which separates the different characters from each other taken from an image. Template matching is one of the approaches of OCR. The cropped image is compared with the template data stored in database. OCR automatically identifies and recognizes the characters without any indirect input. The characters on the number plate have uniform fonts then the OCR for number plate recognition is less complex as compared to other methods.

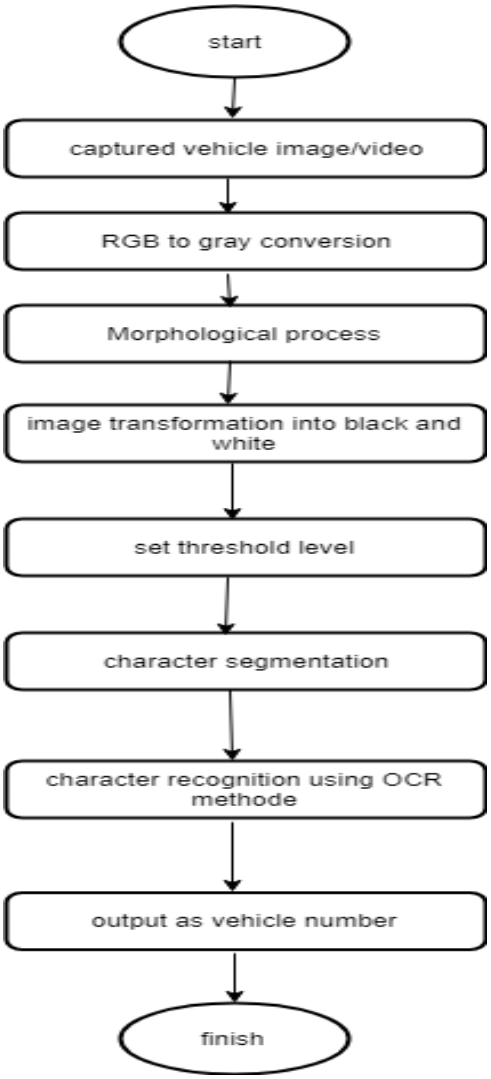


Fig- 4: Flow diagram of OCR method

3.1.2 Template Matching Technique

Template matching is one of the best Character Recognition techniques because it is easily implemented. The very first thing that is done in the template matching is to give a template that has to be matched with the image. This process of finding the location of the sub image (template image) is called as the template matching. The image inside a image is found to be localized. Template matching shows the similarities between a given template and the image that should be matched with it. It works by pixel-by-pixel comparison of the image and the template for each possible displacement of the template. This process involves the use of a database of characters or templates. There exists a template for all possible input characters. Templates are created for each of the alphanumeric characters.

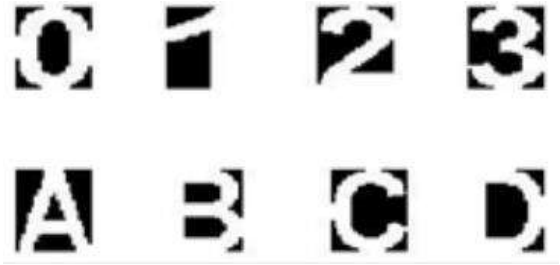


Fig- 5: Template for character recognition

3.2 Vehicle Type Detection

Vehicle type testing is an important part of intelligent transportation systems. Its function is to detect the type of vehicle and provide information for road monitoring and traffic planning. Here we are using vehicles of different type such as car, bus, bike, auto rickshaw for classification. For the type detection we are used a convolutional neural network method.

3.2.1 Convolutional neural network

CNN is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other CNN image classifications takes an input image, process it and classify it under certain categories (Eg., Car, Bike, Bus, Auto rickshaw). Computers sees an input image as array of pixels and it depends on the image resolution. Based on the image resolution, it will see h xw x d(h = Height, w = Width, d = Dimension). Eg., An image of 6 x 6 x 3 array of matrix of RGB (3 refers to RGB values)and an image of 4 x 4 x 1 array of matrix of grayscale image.

Fig - 6: Neural network with many convolutional layers

Convolution Layer
Convolution is the first layer to extract features from an input image. Convolution preserves the relationship between pixels by learning image features using small squares of input data. It is a mathematical operation that takes two inputs such as image matrix and a filter or kernel.

Non Linearity (ReLU)
ReLU stands for Rectified Linear Unit for a non-linear operation. The output is ***f(x) = max(0,x)***

Pooling Layer
Pooling layers section would reduce the number of parameters when the images are too large. Spatial pooling also called subsampling or downsampling which reduces the dimensionality of each map but retains the important information. Spatial pooling can be of different types:

Fully Connected Layer
The layer we call as FC layer, we flattened our matrix into vector and feed it into a fully connected layer like neural network. Feature map matrix will be converted as vector (x1, x2, x3, ..). With the fully connected layers, we combined these features together to create a model. Finally, we have an activation function such as softmax or sigmoid to classify the outputs as bus, car, bike.

4. IMPLEMENTATION AND RESULT ANALYSIS

The project was implemented using MATLAB and ASP.NET. Vehicle number and type is identified using MATLAB and tracking of the vehicle is done using ASPNET. MATLAB provide operations like matrix manipulations operation, plotting graphs and data, creating user interface, and interfacing with programs written in other languages. The GUI required for project was done by using MATLAB.

We have developed a system for combining both number plate detection and vehicle type identification. We used the real time traffic dataset such as image and video. For the type detection we are using the training set of different type of vehicle such as car, bike, bus, auto rickshaw etc. For the number plate detection we had used 2 techniques OCR method and Template matching technique. Efficiency of these 2 methods is compared using our system. For the analysis purpose we can divide the system in 2 ways

4.1 CNN and OCR

In this system for number plate detection we have used OCR technique. Using OCR technique we can easily identify the numbers of different number plate formats in different background conditions.

Input image

Cropped image

PB02BS1734

Recognized characters

OCR technique is very fast method for character recognition and the accuracy of the system is high. But it can detect the noise from the image. That is name of the vehicle is also detected using OCR technique.

Fig- 7: vehicle model using CNN and number plate recognition using OCR

Here 4 class of vehicles are used as training set for vehicles type identification such as car, bike, bus, auto rickshaw. When an image/video is given as the input we can get finally the result as type and number of the vehicle. The result is passed to the recognition result database. It is compared with the RTO and wanted car database. If the number is fake an alert is sent to police headquarters. Also if the number is present in the wanted car database alert is sent to police headquarters.

4.2 CNN and Template Matching

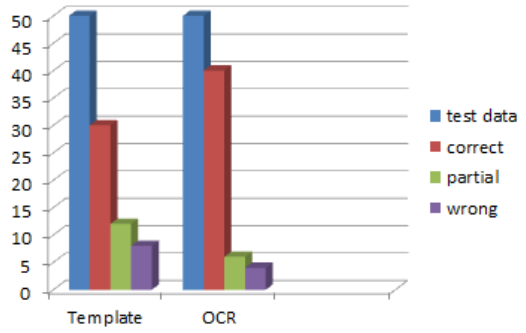
In this system for number plate detection we have used Template matching technique. Using Template matching technique we can identify the number plate with only 1 line of characters. The accuracy of the result is less compared to OCR method. The amount of noise detected is less in this case. Here I had used the template as the characters and numbers of different format. Characters are A,B,..Z and a, b,..z numbers are 1,2,..9,0.

Fig-8: Number plate identified

Fig -9: characters are recognized using template matching

4.3 Result

For the analysis we have used 100 images of vehicle data and the accuracy of the vehicle number plate detection using 2 different methods, OCR and template matching is calculated.



Here we can conclude that OCR method gives more accuracy compared to template matching technique. Template matching technique gives less accuracy and speed for the recognition is less. But the OCR method suffered from large no of noise. OCR gives better result in different lightening conditions

5. CONCLUSION

The automatic number plate recognition system described above detects vehicle type and number and checks whether the given number is fake or not. OCR and Template matching techniques are used for license plate number recognition and CNN for vehicle type identification. Video sequences and image data from the traffic are used as the dataset. RTO database is used for vehicle authentication and owner information retrieval. MAT lab and ASP.NET is used for the implementation. Fake number plate detection is made easy using this project. From our results we conclude that OCR technique is more accurate method for vehicle number plate recognition Template matching technique takes more time for recognition so it is not used for real time application. OCR method is the fast method for recognition but it is more affected by noise within the image. CNN gives high accuracy for vehicle type detection. This system is useful for our government vehicle management.

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