ANPR Indian system using Surveillance Cameras

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***Abstract*— Number Plate Recognition technique is widely used in identifying vehicle identity across the world where a standard plate size and font are maintained which makes recognition easy. For implementing number plate recognition specifically in India a lot number of issue comes up like hundreds of different forms of fonts being used, size of plate not maintained, five different color number plate, double line number plate etc. All these problems are being taken care while developing a software for Indian number plate recognition and is tested in real Indian road conditions. Support Vector machines are trained & used for detection of number plate contours. ANN is used for character recognition from number plate and various algorithm for plate enhancement, noise reduction and ultimately neural networks are most efficient for result with erasing lot of camera constraints. The ANPR software is designed in C++ using Qt for GUI designing, OpenCV as image processing libraries and SQL as database management thereby making it a complete software implementation of idea.**

Keywords—image processing, Artificial neural network,, Support vector machines, graphical user interface, Indian vechicle number plate, ANPR, ALPR, machine learning;

I. INTRODUCTION

Due to increase in the automobile traffic on roads, traffic management and monitoring is on high demand. And with advancement in technology, nowadays traffic monitoring can be done by computers using image processing and machine learning. It not only saves manpower, but can also accomplish some complex and tedious tasks like database management, counting vehicles on road, parking violation alert, stolen vehicle alert, blacklisted vehicle alert etc. This makes ANPR (Automated Number Plate Recognition) Software very popular solution to these problems.

Few Automatic number plate recognition (ANPR) systems are already there for Indian system. These system works fine with various constraints which uses more resources in terms of hardware, fixed distance and detection rate. However these constraints have been removed in the current design of the system which makes most judicious use of resources at the same time making system reliable and more efficient. Design of the system is such that which could be implemented with surveillance cameras and some specific ANPR cameras. Since with ANPR cameras majority of problems flush out provided it parameters are kept constant in controlled environment. We have developed our own system that has capability to detect most of the Indian number plates and recognize them for further analysis. Our Indian number plate detection algorithm uses SVM (Support Vector Machines) which has been trained to highly fine-tuned data set for most of Indian number Plates. A detailed analysis has been done before making these SVM which is the first step to finalize if any of the region in the video frame has number plate or not and if it has it will select the exact one excluding all false plates. Recognized number plate is then segmented for each character. Highly trained ANN (Artificial Neural Network) is used for recognizing each segmented character. The process in detail is explained further in the paper.

II. SYSTEM DESIGN

A. Software Design

The ANPR software is designed to use for real world purpose specifically where cameras are installed. ANPR software has the capability to trigger the siren and also provide detailed information regarding Number plate like location of Car, date and time of detection, number of times it is detected and additional details like if it stolen car or blacklisted car. A set of searching capability to the user has been given where using a search query it can search for any type of detail from the whole super set of data. A Blacklisted and wanted list of number plates have been included which can be appended accordingly. Proper graphical user interface has been designed for more efficient use of number plate database. The whole software graphical user interface is designed in Qt [1] open source and image processing in done using OpenCV [2] library in C++.

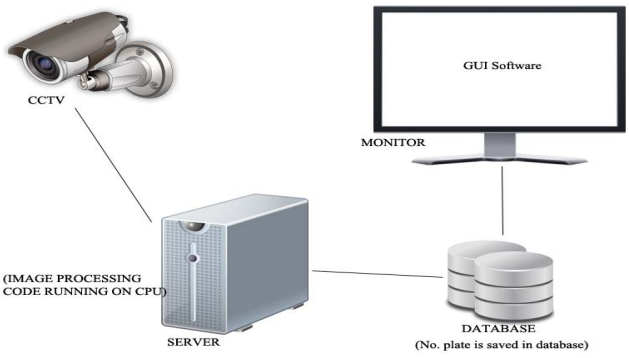

Fig. 1: ANPR System Architecture

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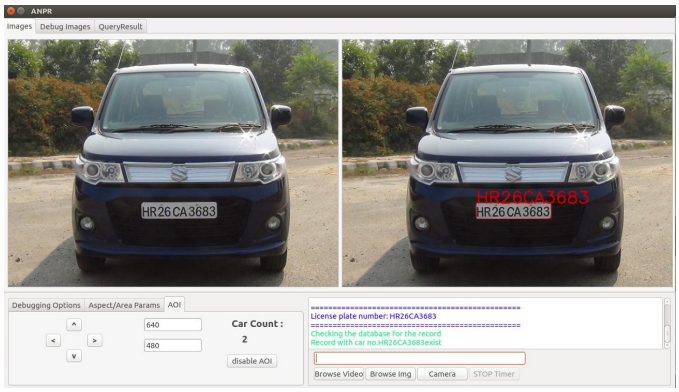

Fig. 2: ANPR System Software Design

B. *Algorithm Design*

The algorithm used in the whole software is divided into various modules that are very efficient. The whole algorithm is designed for real time video stream from cameras. This algorithm uses SVM for recognizing genuine Indian vehicle number plate and ANN for recognizing characters from number plate. This smart algorithm also ensures that segmented image matrices are checked for area and aspect ratio before fetching it to SVM or ANN function. This reduces the processing load. Detailed processes involved in the algorithm are shown in Fig 3.

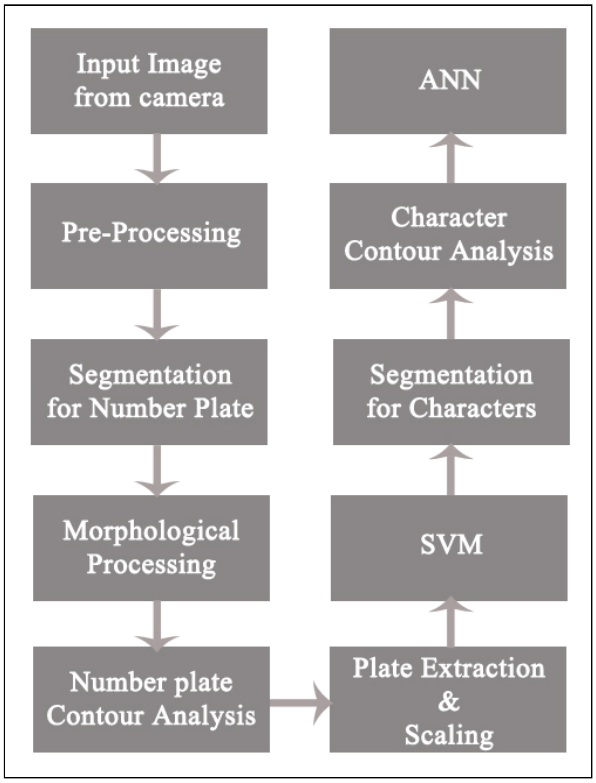

Fig. 3: Algorithm Design

III. ALGORITHM

The processing of frames in software has multiple steps that has in depth image processing algorithms. Each algorithm has been tested with every available condition and variables to find out best result. The algorithms have been divided into several different modules where each module has been designed to provide best possible result for the next module without compromising performance. Algorithm starts with Video capturing from camera and videocapture [3] function use live feed for frame capturing which uses each frame for pre-processing. The algorithm are explained onwards:

A. *Prepropcessing*

Preprocessing [4] module has been introduced before segmentation so as to prepare the image for segmentation. The first step in preprocessing is to convert the RGB image matrix into grayscale image to reduce its color levels. But this image still contains noise which needs to be removed. For removing unwanted values across the image we have used Gaussian blur filter [5] of kernel size 5x5.

B. *Segmentation for Number Plate*

Segmentation [6] is a long process where image is partitioned into its constituent parts. In this step, system does segmentation for detecting number plate location in the image. For that, image is first passed via a Sobel edge detection filter which finds horizontal edges in the images. The idea behind horizontal edge detection is that number plate has more edges horizontally than it is vertically, due to the fact that number plate characters are horizontally aligned on number plate. After edge detection, we threshold the image using Otsu [7] algorithm, which picks up the threshold value as the foreground pixel and background pixels. Now the image is converted into binary image which is now passed though series of morphological operations.

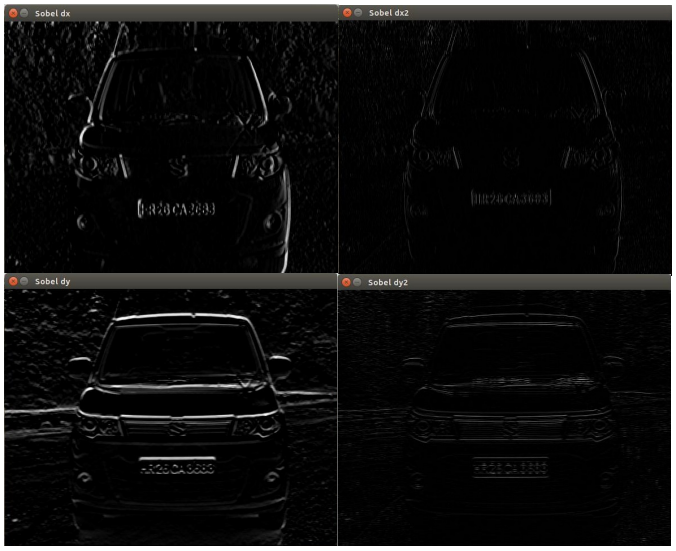

Fig. 4: Edge detection Sobel Filtered Image (a) horizontal single derivative (b) horizontal double derivative (c) Vertical single derivative (d) Vertical double derivative.

B. Morphological Processing

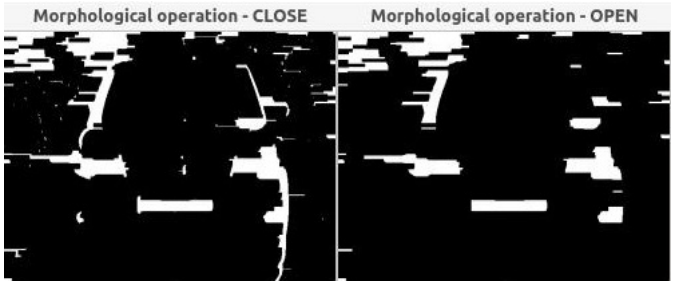

Fig. 5: Morphological Operations

Morphological operations such as close and open are performed. Close morphological operation which is dilation followed by erosion, fills all the disjoint spaces and holes. Close morphological operation with rectangular structuring element of size 34x6 is performed followed by open morphological operation with rectangular structuring element of size 17x3. As it is clearly seen in Fig. 5, number plate and all the similar looking structures are segmented.

D. Number Plate Contours Analysis

The system finds contours in the image that is got after morphological operations. Minimum rectangle for each contour is calculated and this rectangle is then passed through area and aspect ratio constraint. As vehicle number plate must lie in a range of aspect ratio and area, any rectangle lying outside that range is discarded. Hence by this constraint we reduce huge sets of contours to few.

E. Plate Extraction and Scaling

Fig. 6: Contours constraints

All the rectangular contours which were left after area and aspect ratio constraint are cropped and saved in an array of image matrix. All these matrices are corrected for tilt and shear. Finally we scale all the rectangles to 144x33 for passing it to SVM (Support Vector Machines).

F. SVM (Support Vector Machines)

SVM is a discriminative classifier formally defined by a separating hyper-plane. After Number Plate Contours Analysis, the left over contours are passed to the SVM [8] which will detect and recognize correct Indian vehicle number. For making it possible to recognize Indian style vehicle number plate, SVM is trained extensively using 540 positive number plate samples and 300 negative number plate samples. The sample dataset comprises of different types of number plates like white, yellow, black, single line and double line number plates. All this trained data info is saved in xml file and can be accessed later at any time.

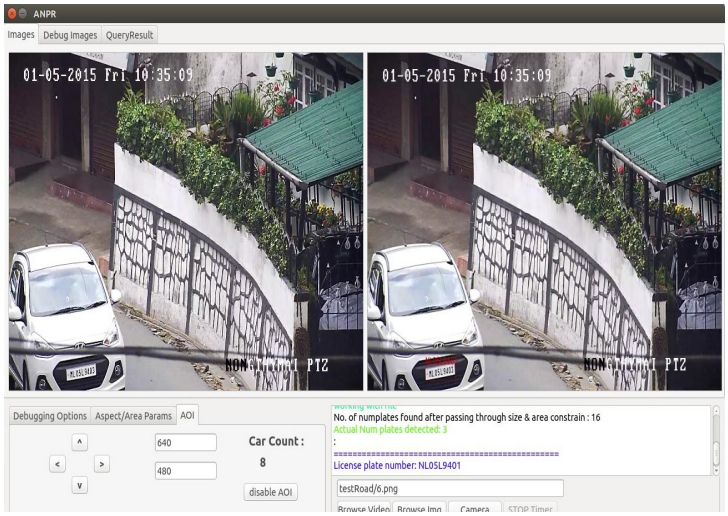

Fig. 7: Rotated Number plate detection and recognition

G. Character Segmentation

The SVM block fetches our system the true Indian vehicle number plate. Image histogram equalization followed by Thresholding is applied on the number plate image. This gives us the binary black image having characters written on it with white. Again system finds contours and the corresponding rectangular area for each character in the image.

H. Character Contours Analysis

In character contours analysis we analyze each contour for area and aspect ratio. Characters too have a range of aspect ratio. So all the detected contours which are lying outside the defined constraint are rejected and the remaining are cropped out from the number plate image. This step ensures that unwanted pixels like screws, dashes, company logo drawn on the number plate and any unwanted text written on number plate should get rejected. This step gives us an array of cropped image matrix containing actual characters.

I. ANN (Artificial Neural Networks)

Artificial neural networks [9] are a family of statistical learning models inspired by biological neural networks and are used to estimate or approximate functions that can depend on a large number of inputs and are generally unknown. These neural networks are used to predict the characters printed on number plate. The array of segmented characters is fetched to ANN function which is trained using 200 samples of each alpha-numeric character. Similarly like SVM, we have made an xml file of the trained data for ANN.

IV. SOFTWARE FEATURES

The whole software is written in C++ and designed in Qt which is open source. The software has real time processing capability which also alerts when any wanted or blacklisted number is found. SQL has been added as Database management system saving and retrieving number plate data. The system can detect tilted and sheared number plates. Area of Interest can be adjusted in the video, so that processing of unwanted area gets reduced. Camera can be also calibrated according the lightning condition of the area. Capability of software has been increased by being able to detect and recognize white, yellow and black number plates.

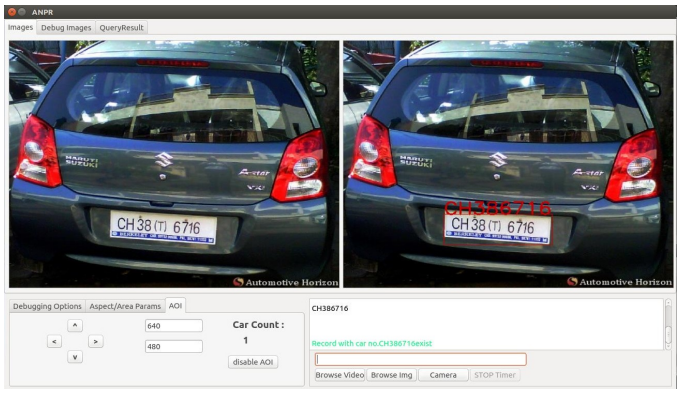

Fig. 9: Main Window of ANPR software

Debug option is also kept in the software as in Fig.10 which shows how all the steps give a proper result and each module output value is shown for better understanding of accuracy of result.

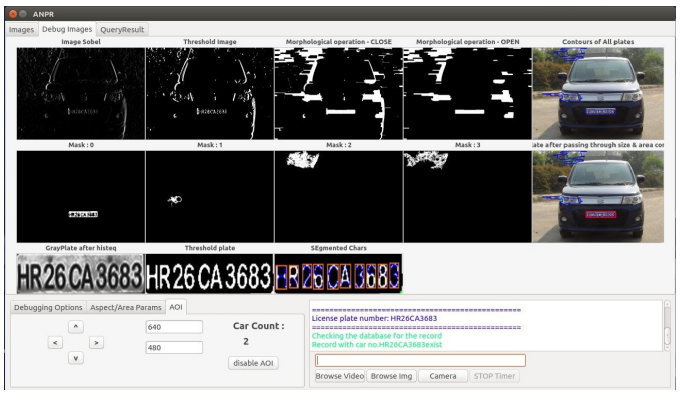

Fig. 10: Debugging process of ANPR software

A database has been integrated which keeps details of all Indian blacklisted vehicles. Any query can be made for searching any vehicle number plate that has been recorded in database which has date, time and location as primary detail.

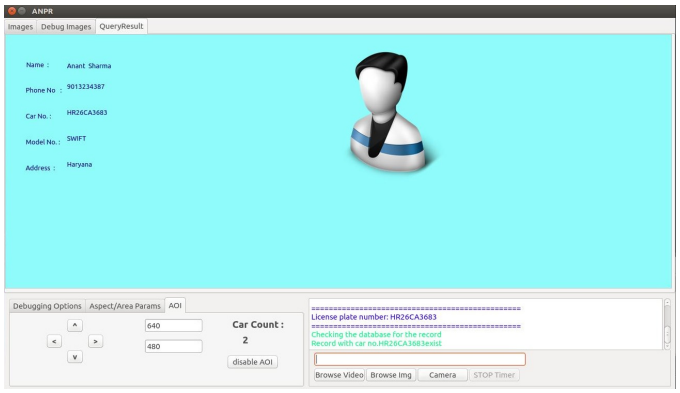

Fig. 11: Database details window of ANPR software

V. CONCLUSION

We have tested our software with IP camera for video stream at 30fps HD resolution 1920x1080 dpi which is processed at 10 frames per second with the car number plate detection rate of 98.5% and character recognition rate of 90% in worst condition including camera motion blurring, vehicle motion and lightning condition. The rate calculation includes all tampered and non-tampered number plates as they are there in the trained dataset for SVM. The system has high performance and accuracy rate as it can recognize even rotated and sheared number plates.

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