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License Plate Detection and Recognition Using a HOG Feature Based SVM Classifier

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ABSTRACT: License plate detection and recognition is a useful application of vehicle surveillance using computer vision. It is used in areas like traffic monitoring, speed monitoring in highways, Parking lots in big shopping malls and centres. Usually the license plate localization is done using shape analysis using contour methods and different bounding box based algorithms. But these methods has less accuracy and there are false positives all the time. Object detectors are used for detecting an object of interest in an image. HOG feature based SVM object detectors are one of the best methods for creating detectors with high accuracy but training them is a daunting task. It is usually used for face detection and human detection. Here an HOG feature based object detector is trained for license plates and this helps in localizing the license plate part of the image. The license plate number is recognized using Tesseract OCR library.

KEYWORDS: Histogram of Gradients(HOG), SVM, Tesseract, OCR

I. INTRODUCTION

Computer Vision is the acquiring, analysing and processing of an image to find important characteristics and properties from the image and extract useful visual information for the automation of the machine to do vision related tasks like a human. Computer Vision aims to replicate the human Visual capability. One of the major ability of an human visual system is the ability to detect, identify and recognize different objects. Computer Vision also targets to achieve this by using various techniques as it is an important part for the automation of visual tasks.

Human can detect a car and localize a license plate as we are trained to do so. We can easily read the license plate number of a vehicle. The same task is quite complex when it comes to computers. Computers first need to identify the vehicle and from the vehicle they have to somehow manage to localize the license plate area and from that the text portion should be extracted and an Optical Character Recognition Classifier should be trained to recognize the characters.

The Advantage of using a computer for detecting and recognizing license plate is that they can work tirelessly and accurately than a human and the cost is also pretty low. Also the computer can automate many tasks and perform extra tasks with the data it acquires. It can store the license plate number and can be used to find how many times a vehicle visited the area, or it can send an alert to the respected authority if any anomalies are suspected with the vehicle behaviour.

There are many techniques for detecting objects of interest in an image like haar cascades,contour detection etc.,but one that is proved more reliable and accurate is HOG feature based SVM object detector. It is pretty difficult to train the HOG based detector but it is way better for detecting objects of particular shapes than any other object detector. The HOG based SVM detector has been used for detecting faces and humans but it has not been used in license plate recognition. Here a HOG feature based SVM classifier is trained which helps in detecting and localizing the license plate so that it can be easily recognized using an OCR software. The detected license plate is prepared using some image manipulations and the text is sent to Tesseract OCR library which recognizes the text in the image.

II. RELATED WORK

In the paper "Histograms of Oriented Gradients for Human Detection" Navneet Dalal and Bill Triggs proposed a hog based object detector for detecting humans is proposed.The method is based on evaluation of well-normalized local

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histograms of the gradient orientations of the image in a dense kind of grid. The basic idea is that local objects appearance and their shape can often be characterized rather well by the distribution of local intensity gradients or directions of the edge, even without the very peculiar knowledge of the corresponding gradient or edge positions. This is implemented in practice by dividing the window of the image into smaller spatial regions called cells, for each cell accumulating a local 1-D histogram of gradient directions or orientations of the edge over the pixels of the cell. The combined histogram entries form the representation. For better invariance to illumination, shadowing,etc., it is also useful to contrast-normalize the local responses before using them. This can be done with the accumulation of the measure of the energy of local histogram over some larger spatial regions (blocks) and using the results to normalize all of the cells that are in the block. This normalized descriptor blocks is termed as Histogram of Oriented Gradients (HOG) feature descriptors. Tiling the detection window with a dense grid of HOG descriptors and using the combined feature vector in a conventional SVM based window classifier gives our human detection chain.

In paper "License Plate Detection and Character Recognition System for Commercial Vehicles based on Morphological Approach and Template Matching" the license plate recognition is done using template matching techniques. Template matching is done by first securing the images of the characters that are usually seen in the license plates and is stored in a database. The license plates that are extracted from an image is subjected to image segmentation to make the text visible clearly. The characters are then extracted using contour method and these characters are matched using template matching method with the templates in the database and the recognition is successfully done.

III. PROPOSED SYSTEM

SYSTEM DESIGN

The image of the vehicle whose license plate is to be recognized is send to the HOG feature based SVM Detector that has been trained to detect the license plates. The classifier will detect the area containing the license plate and will draw a rectangle bounding box around it. The area is then cropped with the dimensions of the bounding box and we get the localized license plate area. Now the license plate foreground which contains the text and background have different colours. Thresholding is done to extract the text from the license plate. The thresholded text is then send to the Tesseract OCR library and the text is recognized and the license plate is printed out on the screen which can be stored for different purposes.

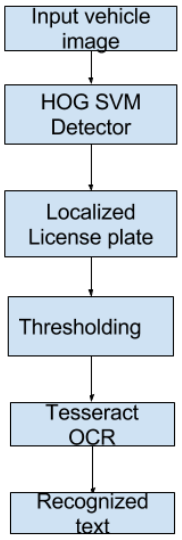

FIG 1 SYSTEM DESIGN

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HOG + SVM Classifier:

The main part of the paper is the training of the HOG feature based SVM object detector(classifier) for detecting license plates. The following steps are done to train the classifier.

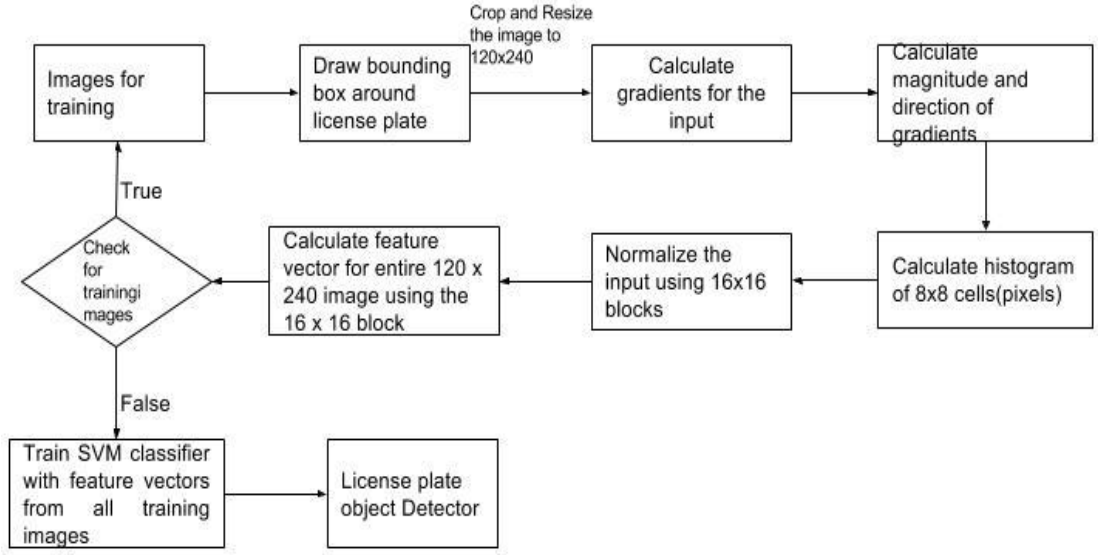

FIG 2 HOG SVM Classifier Design

The images for training are the images of cars with license plate numbers clearly visible. After selecting the training images the images are one by one prepared and its hog features are calculated.
First a bounding box is drawn near the object of interest(license plate) and the image is cropped to that region as a 120x240 image patch. The next step is calculating gradients of the image patch, gradients are the derivatives in the x and y direction of the image. The magnitude of the gradients are calculated using the equation $\sqrt{gx^2 + gy^2}$ and direction using the formula $\theta = \arctan \frac{gy}{gx}$
For every pixels there are two values for gradients the magnitude and the direction. The next step is to calculate histogram of the gradients, for this the image patch is divided into 8x8 cells. The histogram is a collection of bins of equal length the equal length is the direction from 0 to 180 degrees. So 9 equal bins are created which are 0,20,40,60,80,100,120,140,160. The magnitude value that we calculated for the pixels are matched to the corresponding direction values of the pixel and is send the corresponding bin. At last after considering all the pixels we get histogram of gradients for the 8x8 cell. Like that we calculate for all the pixels. The next step is normalization, normalization is done so that the detector works on all lighting conditions. The image is considered as 16x16 blocks, each block contains 4 8x8 cells ie.. 4 histograms. There are 9 bins in each histogram which gives a total of 36 x 1 feature vector when concatenated. The normalization is done by finding the square root of sum of squares of the 36 features and dividing all the features by this value. The 120x240 block contains 7 blocks in the horizontal direction and 15 in vertical direction. So there are a total of 36x7x15=3780 dimensional vectors. The process is repeated for all the remaining images, when the HOG features of all the images are calculated a SVM classifier is trained with all the feature vectors. The SVM classifier after training acts as the object detector.

IV. IMPLEMENTATION

The implementation was done using two libraries in python programming language. The library used for image manipulations was opencv which is an open source computer vision library available in many programming languages and is free of cost. The library has all the required image processing and machine learning algorithms in it. The HOG + SVM classifier was trained using the help of a library called dlib. It is a library focusing in machine learning and deep learning.

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The training images where downloaded from google images using requests library in python. The dlib library has a tool called imglab for drawing bounding boxes around objects of interest. The images folder is given as input to this tool. The bounding boxes are drawn around images and the images are saved as an xml file. The xml file is then used to calculate the histogram using dlib library. After calculating histogram an svm classifier is trained using SVM in dlib library. The trained SVM classifier will be outputted as a .svm file.

The opencv library and dlib are then combined for the real time detection purposes. The image or video containing a car with license plate is read using opencv library and then the svm classifier trained with dlib is used for detecting the license plate. The detected license plate area is then cropped and the image is thresholded to make the text clearly visible. The thresholded image is then send to the tesseract OCR library and the license plate number is stored in a txt file.

V. RESULTS

The HOG SVM classifier is applied to images of different vehicles using opencv. The images are fed to the classifier and the classifier detects the number plate portion of the image. The images used are of optimal quality with number plate clearly visible. The Classifier detects the license plate with good accuracy and a rectangle is drawn around the detected license plate.The license plate detected image is shown in Fig 3.

Fig 3. Plate Detected using HOG + SVM Classifier

The next step after the license plate localization is to extract the plate. The plate is cropped by using the points obtained from the classifier detection. The license plate is cropped so that it will be easier for recognition using OCR.The cropped plate is shown in FIG 4

Fig 4. Plate cropped after Detection

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The license plate images after cropping is subjected to a thresholding algorithm so that the license plate number can be extracted out from the image completely without any other part. First a text detection algorithm using connected component analysis is applied to the cropped image and from this the text only portions are extracted and thresholding is done on this result. FIG 5 is the thresholded image containing only the text to be sent to the OCR for recognition.

Fig 5 Text after thresholding

The thresholded image is sent to the OCR. Here the OCR used is Tesseract and the OCR can now easily recognize the images as the cropped text is of good quality and size. The OCR uses its already trained classifiers and recognizes the text. The recognized text is shown in FIG 6.

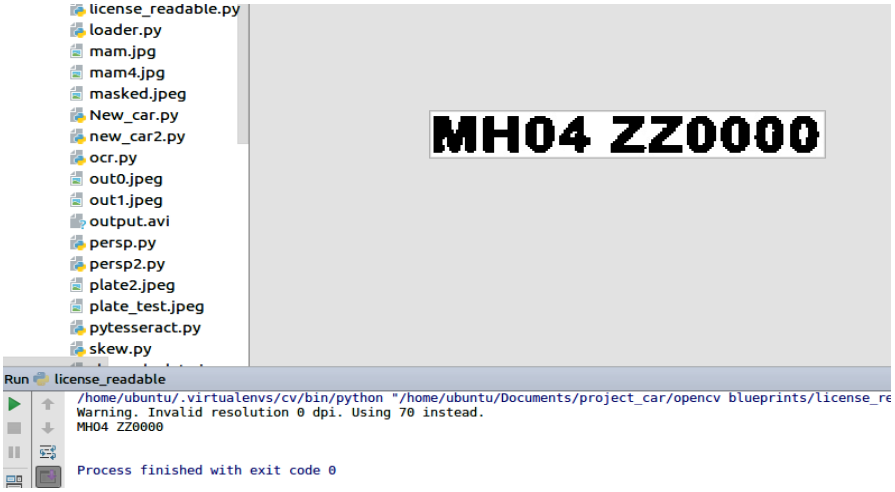

Fig 6 The recognized text output from OCR

VI. CONCLUSION AND FUTURE WORK

The custom HOG based SVM classifier was trained successfully with the help of many training images. The License plate was successfully detected and localized using the custom classifier created by using the HOG features. The localized plate text was then read using the Tesseract OCR engine and the recognition proved to be higly accurate. The classifier can be further improved to detect taxi license plates with yellow background and black text colors. The OCR accuracy can be improved using training different fonts that are usually used for license plates.

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