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Methods ofAutomaticLicensePlateRecognition: A Review

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ABSTRACT

Automatic vehicle number plate recognition is the most interesting and challenging research topic from past few years in India. In India, study indicates that the number of death toll in road accidents has gone up in recent past. Identificationofvehicle and its ownerwho violets traffic rules hasbecomevery important. This is necessary in order to maintaintraffic in control and to minimizing road accidents.Manually it is almost unmanageable to control thisprocess.Itishighly impossibletotracktheowner whoarebreakingthetrafficrulesandpunishthem.Thusbyautomatingthis process,we can catchthe realownerofdrivenvehicle andwith the help ofcomputerizedsystemwecanable tocatchthe currentactivitiesandlocate the license plate numberusingdifferentimage processing techniques. Thisautomatedsystemof recognizing and characterizingthelicense platenumberofmoving or stillvehicle is calledas a LicensePlateRecognition (LPR)systemorAutomaticNumberPlateRecognition (ANPR)system.This systemisconsistingoffourmainphasessuchasimage capturing, image preprocessing, character segmentationand characterrecognition.According to rules and regulations the license plate varies for country to country.It may vary informats and color.According to rules and regulations each country has their own ANPR system.RightnowthissystemisimplementedinUS,UK,Australia,Japanroadconditions, butyet to done realtimeworkforIndian road conditions.Inthispaperour objectiveistopresentthe reviewofdetailedprocessesand methodspresentedforLPRsystem. LPRsystemisbased completelyon real time imageprocessing.

Keywords:- LicensePlate Recognition, LicensePlate,AutomaticNumber PlateRecognition, Imagecapturing, Imagepreprocessing, Character Segmentation, Character Recognition.

1. INTRODUCTION

Intelligent transportation system (ITSs) are playing most important role in analyzing and handling the vehicles on the roads. India needs very intelligent traffic management system for handling the traffic on the roads day by day and in thisANPRis playing veryimportant rolein variousreal life applicationssuchasparking lot payment,toll payment (access control) and law enforcement.Due to use of suchautomatedsystemshelps to reduce manyoverheadsas comparedtomanual systems. Theprocess of LPR iscomposedof 3taskssuch as imagepreprocessing,license platedetection, character segmentationand characterrecognition.The Complexity increases when we are working with different view and angles i.e. when we are thinking of implementing the same system for the different applications for making it very much application oriented. Manyofthe LPRsystem are minimizingthe complexity by puttingsome constraintsoverthe distance andpositionof camerafor vehicleanditsinclinedangles.In our consideration ofdifferentangles and viewsof cameras, thentherecognitionratesincreasessignificantly and our overall system becomesstronger and in addition to it there are some otherfeatures such as illumination intensity and geometric background usingwhich we canincreasethe accuracy of LPR system.Inthispaper we focused on howANPRsystem worksand explainingit'severystepbriefly and along with it wearediscussingthe different methods presented for each phase.

2. REVIEWOF LICENSE PLATE RECOGNITION METHODS

ANPR system is composed of following tasks or phases as shown in fig. We are explaining it one by one in brief and various methods incorporated for each phase by the various author.

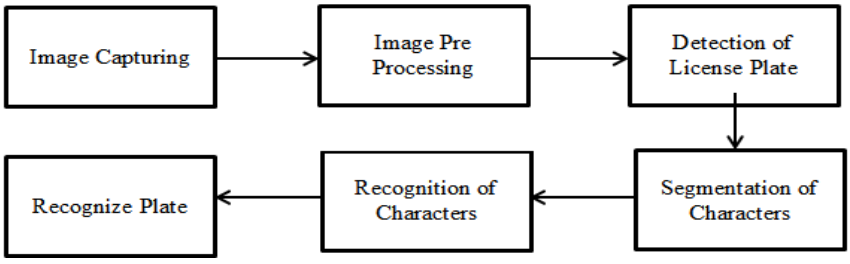

Fig 1: Architecture of License Plate Recognition.

2.1 Image Capturing

The first task or phase of ANPR system to which we provide vehicle image as an input. These images are captured fromthe moving either from moving videos or still cameras. The qualities of images are depending upon the quality of cameras. The images are always in different sizes, different orientations and directions etc.

2.2 Image Preprocessing

The second phase of ANPR system is Image preprocessing in which vehicle image is improved by converting it into grey scale and transforming to binary ,also smoothening and sharping are carried out. In image preprocessing qualityof image is improved by removing shadows and noise. In this various algorithms are used. In next section we are discussing preprocessing algorithms. In [1], Otsu binarization method is used for preprocessing. The imagegets segmented into several sub- regions or parts for each part, type and maximum threshold value arecalculated. In[4], pre-processing can be performed to locate the Region of Interest (ROI) .This ROI can be helpful to detect the license plate in night or in ambient illumination conditions. By using image masking, binarization with Sauvola method.We can be able to detect RROI.For converting image from grey scale to binary we are adopting adaptive thresholding.For setting the threshold we have to think about range,variance and surface parameters. In the case of badly illuminated areas, calculated threshold value will be low. In [5], binarization can be done on the image for highlighting characters and suppressing background. By incorporating variable thresholding method we can able to reduce information loss from the images .This technique isproposed by Nakagawa and Rosenfeld [5]. In this technique, a local optimal threshold value is determined for each image pixel so as to avoid problem originating from non-uniform illumination. Locally adaptive thresholding method cannot completely able to remove information loss but it at least preserves the information that may be lost while we are using a simple constant binarization method. According to Anton SatriaPrabuwono [6], a global threshold value should be set up.For preserving aspect ratio down sampling should be carried out.According to G.Sun et al[7],preprocessing should be divided into luminance adjustment and image enhancement. These two tasks can be achieved by changing luminance curve and top-hat transform respectively. Hat transform helps to enhance hot region by suppressing the other regions. According to T.Duan et.al. [9],by performing pre-processing we canenriching the edge features. For enriching this features various algorithmsare used.they are grayingi.e. converting the image from RGB to grey, normalizing and smoothening andhistogram equalization. Histogram equalization helps to improve the contrast of image, which in turn improves results of edge detector.According to [13] preprocessing can be done with the help of sobel edge operator.According to WenjingJia [11], image de-noising helps to remove noises from the images. In this procedure, subtle fractures can be linked and tiny abrupt changes can be softened. By increasing the contrast between ROI and other regions, we can able to prevent destruction of edges of images and its outline. In [10], improved Bernsen algorithm can be usedfor effectivelyremoving the shadows from the image by converting it into a binary image. For converting it into binary we have to calculate two threshold values they are original image threshold and gauusian filter image threshold. Each pixel of the original image is compared with these threshold values to convert it to a binary image.

2.3DetectionofLicensePlate Candidate

After first phase of thepreprocessingstep,thenextistodetectthe edges of licenseplatewith the help of horizontal and vertical projections we can able to locate license plate through search window. If above method fails then original image is inverted and bottom of the licenseplate should be scanned. For this scanning projection histograms are used,as LPs are located at the bottom. On this thehorizontalsegmentation and verticalprojectionare carried out. According to You-ShyangChen andChing-Hsue Cheng [2],densevertical edges region can be segmented asa candidateplatewhichis also known as ROI(Region of Interest). Inthelocationprocedure, verticalSobel edgefeatures areprimarily extracted.Thena skeleton extraction algorithmon edgemapisperformed.Thereisapossibility thatdensepixels aretext region and isolated edgepixels are oftennoises. So densitybasedregion growing method is used to locate candidate LP regions. To extract license plate characters in Indian roadcondition Ch.Jaya Lakshmi et al. [12] proposed anapproach based on texture characteristics and wavelets [13]. In this paper morphological operation [14] for better performance in complicated background is used. Sobel operator is used to detect vertical edges. In [16], license plate character extraction for video is discussed. As per Yuntao and Cui, localization means finding text in the images. The authors considering license plate with light background and characters with dark back ground. For localization, spatial variance method is used for finding text regions and non-text regions are found out by high variance. To detect license plate from moving video or fromCCTV footage, ConnectedComponent Labelling(CCL)isusedforLicense plate detection [3], [4].CCLis used for scanning the image andlabelling it according tothepixel connectivity.Thereexist two types of connectivity:-4 and8 connectivity. In [3],a feature extraction algorithmisused to countthe similarlabelstodistinguishit asaregion. Theregionwithmaximumareais considered asapossiblelicenseplateregion andthisregionis forwardedtothesegmentationprocess.ButAccording to FikriyeÖztürk andFigenÖzen[10], two different detectionmethod scan be carried out in which first task is identification of white frame and second is black character identification. For this CCL technique is used, as it issensitive to the edges. For determining the candidate frame aspect ratio, width of characters and height of characters should be considered.Further,thepenetration times for LP are alsocalculated. In [4], after the successful CCL on image, measurements such as orientation, aspect ratio, Euler number for every binary object in the image should be taken into consideration. Criteria such as orientation, aspect ratio and Euler number are

considered as candidate plate regions in [4]. But this method fails in dark background In [5], for locating the LP, fuzzy logic is used. For this fuzzy functions and vertical plate positions rules. But it is very sensitive to the color and brightness and takes longer processing time compared to conventional methods. In [6], For locating the edges of LP vertical edge detection method is very useful.In this very many changes in intensity shouldbe considered as a plate zone. Image pixels are convolved with the horizontally oriented filter. The last step of plate localizing is horizontal projection. In [11], after applyingthe Sobel edge detectionmethod, finding the column range and detecting row range.After these steps,license platecandidate willbe obtained. In [9],Houghtransform and counter algorithmis appliedtodetectthe LPcandidate region.Counter algorithmis appliedto detectthe closedboundariesofobjects which next can be applied to though coordinateforfinding interactedparallellines.To filteroutthe candidate plates,the aspectratioofthe LP andthehorizontal cross cuts areused. Skew Correction Method: While we are taking the pictures it is highly impossible to avoid tilt while clicking it.When we are expecting the highest successful recognition rate,for this tilt correction should be carried out.In [6], Random Transform (RT) can be carried out for removal of skew or tilt in image. But this RT method has alarge computation cost.For reducing the cost, RT should be replaced by faster Hough transform.In [10], the horizontalandvertical correction is done.

2.4SegmentationofCharacter

Afterdetectionlicense platelocalization,the next phase of processissegmentationof characters.Character segmentationistheprocedure of extractingthe characters from thelicense plateimage. In [1], [3] and [10] horizontal andvertical projection are used to segment the characters. In [8],vertical andhorizontalscanningisusedtodigoutthe characters. Width betweenthefirst andlast columnis computed and each character isseparated from theplate background andstoredin separate array sothatitisusedforhorizontalscanning. Horizontalscanning can be performedto eradicatethe extra upper andlower regionfromtheimage. In [2],differentmethods are usedfor charactersegmentation. First task is a gray-levelquantization andmorphology analysis isperformedtoobtainthe candidate characters.Operator chosenwas (1,0.2×H) pixelsinX andYorientationswhere Hrepresentstheheight ofROI.Toimprove the results of segmentation procedure,abovemethodshould be combinedwith binarization method.

2.5RecognitionofCharacter

Character recognition helps in identifying and converting image text into readable text.Almost all LPR systems are usingdifferent typesofArtificialNeuralNetwork(ANN), neural networksbasedon organizedfeature maps which are implementedin [5]. After recognizing anunknown aminor comparisonbetweentheunknown character andthe classified characteris performed partsinthe neural networkliterature. Anagnostopoulos et al. [4] introduced ProbabilisticNeural Networks(PNNs) comparisons. There are two PNNs,i.e.,onefor alphabet recognition andtheotherfornumberrecognition.Therecognitionrates reportedintheliterature arevery encouragingwhen PNNs aretrained andtestedinnoisy,tilted, anddegradedenvironments.TheOpticalCharacter Recognition(OCR) systemisatwolayerProbabilisticNeural Networks PNN withatopologyof108-180-36nodes.It showed results of up to89.1%. In [1]it usesbackpropagationneuralnetwork(BPNN)forrecognizing characters.The26vertical projectionsand50horizontalprojectionsof the normalized26×50pixellicense plate image. It should now feed into 76 inputnodesof BPNN. BPNN is very efficient for recognizing the characters. In [10], Support VectorMachine(SVM)ismostly usedfor characterrecognition.Local-Direction Contributively Density (L-DCD) and Global-DirectionContributively Density(G-DCD) are used for extracting features before training and testing data sets. In [8],templatematchingmethodis usedfor characterrecognition. It can be also used for detection of objects generally in face detection or face image processing and medical image processing. It is divided in two parts. They are featuring based matching and template based matching. Feature based approach is useful in case of template image has strong features otherwise template based approach can be useful. Each characteris matched with thestored template character. Priorityis assigned for each template so that exact character is found as a result. To differentiate the similar characters from character pairs such as (8, B) and (O, D) the authors predefined a set containing the characters 0, 8, B and D and each template. After the unknown character is classified as one of the characters in the ambiguity set, a minor comparison between the unknown character and the classed character is performed. Eachsegmented characteris matchedwiththestoredtemplate.While matching the characters the priority should be assigned to highest level than the lowest one.Numbertemplates are assignedhigherprioritiesbecause chances of occurrences of alphabets areless than thenumbers. In [3],(SOM)neuralnetwork is usedto identify the characters. An ordinary SOM consists of two layersi.e.an inputlayer and computationlayer. The computationlayerhas itsown processingunits andhardware designed calculatesthe hammingdistancebetweeneachneuron andtheinputimage character. The recognitionrate is 90.93%. In [6],two typesoftemplate matrix areextracted. They areObjectThinned Representation (OTR) andCharacteristicsBackgroundSpots (CBS). OTR representsthecharactershape while CBSreflectthemapoftheimage background.

3. CONCLUSION ANDFUTURE WORK

In this review paper we presented the detail LPRsystem, which is composed of four tasks.ANPR can be further extended as multilingual ANPR to identify the language of characters It can provide various benefits like traffic safety enforcement, security- in case of suspicious activity by vehicle, immediate information availability- as compare to searching vehicle owner registration details manually .It should be cost effective and easy to use. It can be used by any developing and developed country.Another point that should be considered i.e. it should be application oriented that at the sametime we can used it for the access control,traffic law enforcement and road patrolling .While we are thinking of ita much application oriented we also thinking of the quality of resulting image it should be more and more clearer. Different rotation anglestilt and pan should also be considered.

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