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Development of a Hand-Held Device for Automaticlicense Platerecognition

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ABSTRACT
In the last few years, Automatic Number Plate Recognition (ANPR) systems have become widely used in the safety, the security, and the commercial aspects. Forethought, several methods and techniques are computing to achieve the better levels in terms of accuracy and real time execution. The details of development of a hand-held security device to help the security people at the entrances of big institutions/industries/apartments. The security people can scan the number plate of vehicles come at the entrance using this device and the device will display whether the vehicle is authorized or unauthorized to enter to the premises. Provision is given to add/remove the registration number to/from the database. This device is designed around onboard computer, which is commonly termed as Raspberry Pi. The optical character recognition technique (OCR) implemented on this device is used for the identification of the registration number. This project aims to recognize the license number plates, OpenCVhas been used to identify number plates and python to extract characters and digits from the number plates. OpenCV is an open-source machine learning library and provides a common infrastructure for computer vision.
Key Words:Raspberry pi, Automatic license plate recognition(ALPR), Optical character recognition (OCR), RGB colored, Morphological output.

I. INTRODUCTION

In smart cities, security is a real concern and smart methodsforensuringsecurityaretobeimplemented.Monitoringvehicles entering into restricted areas such as institutions,industries, apartments etc. are a real concern. Checking theauthenticityofthesevehiclesforsecuritypurposesisadifficult task as the number of vehicles to be monitored isvery large. It is time consuming for a security person tophysicallycheckeveryvehicleanditiserrorprone.Automatic license plate recognition (ALPR) algorithms areusedforthispurpose.Itbecamemuchinterestduringthelastdecadealongwiththeimprovementofdigitalcamera technology and the computational processing. ALPR can beused in many places such as vehicle entry and exitgates,Parking,Tollboothetc.ALPRisanimageprocessingtechnology used to identify vehicles by their license plates.The system uses a camera to take the image of the vehicle,then an image processing software analyses the images andextracts the number plate information. The extracted numbercan be usedformonitoring,authenticationetc.

Many license plate algorithms have been proposed in the literature.Althoughlicense plate recognition methods have been studied extensively for many years, it is still a challenging task due to different factors involved in it which would effect is end result, have developed an android application which can extract license plate number in machine-encoded text type from image captured by mobile camera. Another implementation of ALPR system on android mobile phone can be seen.

The literatures talk about an algorithm implemented for vehicle plate localization, segmentation and recognition in real life scene. An edge based multistage approach to the license plate localizationfrom video snap shots of registered vehicles is presented. Different methods for license plate recognition in Indian vehicles are described. Most of the studies in the literature talk about a computer- based implementations. Very few attempts have been for implementing such algorithms in hand held devices. The commonly available implementation for making a hand-held device for license plate recognition is to implement the algorithm on mobile phones. But it is studied that even though possible to achieve an accuracy of 90%, the processing power of mobile devices is still less compared to PC based systems. Processing time can be of concern in such systems. Another way of developing a portable

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device is to implement on single board computers. A portable device for automatic license plate recognition will definitely help security people. In this device, license plate of vehicle is captured by using Pi camera. The status of authorization of vehicle will be displayed on TFT screen by comparing extracted number with an available database. Provision is given to add numbers to the database, if needed.

II. PROPOSED SYSTEM ARCHITECTURE

The block diagram to depict the construction of realtime Hand-held device for Automatic License PlateRecognition shown in Fig 1. It consists of a powersupply, camera module, P10(1r)-v706 LED display, anEthernet shield. The main component used here is theRaspberrypi3.0

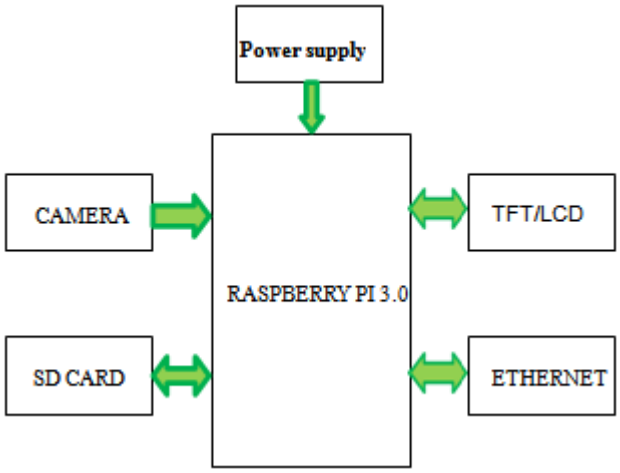

Fig 1. Block diagram

1.1 Methodology

It is proposed to design a hand-held device for the use of security persons for automatically recognizing the license plates of vehicles in front of them. The system is implemented based on raspberry pi-3 board. A Pi camera and a TFT touch screen are attached to this. The general block diagram of the system is shown in the above figure. In this device, license plate of a vehicle is captured using Pi camera. This captured image is processed to extract the number. The status of authorization of the vehicle is displayed on the TFT screen by comparing the extracted number with an available data base. Provision is given to add number to the database when unauthorized vehicle detected.

Raspberry Pi acts as core of the Hand-held SecurityDevice. The device is designed around this on-boardcomputer,whichcanefficientlycommunicate with the input and output modulesattachedtoit.Theimageofthenumberplatedetails is fed as input to the processor. TheProcessor takes responsibility to check theauthentication details of every vehicle. Allremaining hardware components are connected tothisboard.Whenever a vehicle arrives at the entry gate of the Institute, its authorization was checked using this device by taking the image containing its license plate. It is to be noted that, an option to add an unauthorized number to the database is also given in the GUI. When this option is pressed, a higher official will be notified the detection of an unauthorized vehicle through cloud communication. He will be able to add the number of this vehicle into the data base of authorized vehicles.

1.2 Working Principle

The functioning process includes 3 main process, namely, Pre-processing, Extraction of Characters and Recognition using template matching.

1.3 Pre-Processing

Pre-processing has RGB to grey conversion, Morphological process, Convolution and Thinning of images. And then the characters are extracted by OCR technique and compared.

1.3.1 RGB to Grey

There are a number of commonly usedmethodstoconvertanRGBimagetoagrayscale image such as average method andweightedmethod. The Average method takes the average value of R, G, and Basthe grayscalevalue.Grayscale= (R+ G+ B) /3.

Theoretically,theformulais100%correct.But

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whenwritingcode, you may encounter overflow error. The average method is simple but doesn't work as well asexpected.Thereasonbeingthathumaneyeballsreactdif ferently to RGB. Eyes are most sensitive to green light,lesssensitivetoredlight,andtheleastsensitivetoblu elight.Therefore, the three colors should have different weights inthedistribution.Thatbringsusto theweightedmethod.

Theweightedmethod,alsocalledluminositymethod,wei ghsred,greenandblue accordingtotheirwavelengths.Theimproved formula isasfollows: Grayscale=0.299R+0.587G+0.114B.

Thistransformationisusefulindetectingblobsandfurther reduces the computational complexity. Thecritical task is to find a suitable threshold. Therearetwomainmethods, namely local and global thresholding.

1.3.2 Morphological Image Processing

It is a collection of non- linear operations related to the shape or morphology of features in an image. morphological operations rely only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images. Morphological operations can also be applied to greyscale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest. Morphological techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels. Some operations test whether the element "fits" within the neighborhood, while others test whether it "hits" or intersects the neighborhood.

1.3.3 Convolution

Convolution is a simple mathematical operation which is fundamental to many common image processing operators. Convolution provides a way of `multiplying together' two arrays of numbers, generally of different sizes, but of the same dimensionality, to produce a third array of numbers of the same dimensionality. This can be used in image processing to implement operators whose output pixel values are simple linear combinations of certain input pixel values.

In an image processing context, one of the input arrays is normally just a gray level image. The second array is usually much smaller, and is also two-dimensional (although it may be just a single pixel thick), and is known as the kernel. Figure 2, shows an example image and kernel that we will use to illustrate convolution.

Fig 2, An example small image (left) and kernel (right) to illustrateconvolution. The labels within each grid square are used toidentify eachsquare

The convolution is performed by sliding the kernel over theimage, generally starting at the top left corner, so as to movethe kernel through all the positions where the kernel fitsentirelywithintheboundariesoftheimage.(Notethati mplementationsdifferinwhattheydoattheedgesofimage s,asexplainedbelow.)Eachkernelpositioncorresponds to a single output pixel, the value of which iscalculated by multiplying together the kernel value and theunderlying image pixel value for each of the cells in thekernel,andthenaddingallthese numberstogether. So, in our example, the value of the bottom right pixel in theoutputimage willbe givenby:

$$O^{R1} = I^{R1}K^{11} + I^{R2}K^{12} + I^{R3}K^{13} + I^{G1}K^{21} + I^{G2}K^{22} + I^{G3}K^{23}$$

I_{11}	I_{12}	I_{13}	I_{14}	I_{15}	I_{16}	I_{17}	I_{18}	I_{19}
I_{21}	I_{22}	I_{23}	I_{24}	I_{25}	I_{26}	I_{27}	I_{28}	I_{29}
I_{31}	I_{32}	I_{33}	I_{34}	I_{35}	I_{36}	I_{37}	I_{38}	I_{39}
I_{41}	I_{42}	I_{43}	I_{44}	I_{45}	I_{46}	I_{47}	I_{48}	I_{49}
I_{51}	I_{52}	I_{53}	I_{54}	I_{55}	I_{56}	I_{57}	I_{58}	I_{59}
I_{61}	I_{62}	I_{63}	I_{64}	I_{65}	I_{66}	I_{67}	I_{68}	I_{69}

K_{11}	K_{12}	K_{13}
K_{21}	K_{22}	K_{23}

1.3.4 Thinning of Image

Thinning is a morphological operation that is used to remove selected foreground pixels from binary images, somewhat like erosion or opening. It can be used for several applications, but is particularly useful for skeletonization. In this mode it is commonly used to tidy up the output of edgedetectors by reducing all lines to single pixel thickness. Thinning is normally only applied to binary images, and produces another binary image as output. The thinning operation is related to the hit-and-miss transform, and so it is helpful to have an understanding of that operator before reading on.

1.4 Extraction of Characters

Imagecanbecapturedindifferentilluminationc ondition. So, if text images are captured in differentillumination effect. It is not possible to read the textinimageformat.Hereweuseimageprocessingtools toextracttextfromimage.Themainaimistoextractthecha ractersinvariousilluminationconditions.Textwillbeinpr intedpaper.Wewillcapturetheimageofprinted paper. We use effective algorithm to extractcharacters from printed paper. This system scans thetext by evaluating each and every line. System willextractwordfromimageusingimageprocessingtoolb ox. As image is captured by webcam or camera.So,imageismorepronetonoiseandotherenviron

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mental interference.

Fig 3, Image after Thinning process

In order to extract text from image we will be using thresholding method. Image pre-processing steps are applied on images. Unwanted objects are removed. Bounding boxes is applied to text extracted. These texts are in image format. These images are converted to characters. System uses optical character recognition to extract characters from image. Character and number images are stored in directory. The extracted text image is separated by bounding box. Each bounding box will contain each character or number. Each character or number is resized to image stored in directory. Extracted image and existing character image feature is compared. After comparison characters are detected. Finally detected characters are shown in text format. Optical character extraction is used to extract text from image. Here we will extract text from image at any lightening condition.

1.5 Recognition Using Template Matching

In the pattern matching process using thetemplatematchingmethod,tomakethepatternmatchingonthevehicleplatenumber. Before doing the pattern matchingprocess,first,useadatatemplate(reference).ThisreferencedataisalphabeticallettersrangingfromAtoZandnumbersrangingfrom0to9,whichwillbeusedlaterincomparisonwithobjectdata,tobe able to recognize and match the value ofeachcharacterfromtheobjectdata,inordertogetmaximumresults,andbythevalueofeachcharacterfromtheobjectdata. To avoid mistakes in the process, iftherearevehiclesthathaveninedigits,theninthismatchingtemplateprocess,ninedigitsareusedasareferenceforthenumberofdigits,forthedifferenceineachletterandnumberonthevehicleplatenumber. After determiningthenumberofdigits,thenentering the reference data in the form oflettersofthealphabetandnumbersintoeachdigit,tofacilitatetheprocessofcomparisonbetweenobjectdatawithreferencedata.

III. ANALYSIS AND OBSERVATION

Actual plate	Predicted plate	Mismatched characters	Accuracy
KA04JY4411	KA04JY411	0	100%
KA41MB3313	KA41MB3313	0	100%
KA09W2187	KA09W2181	1	90%
KL41Q9587	KC41O9587	2	88%

Table 1

Effiency Table

Total number of vehicles tested	Successful extraction by first trial	Successful extraction by multiple trial	Total successful extraction	Success Percentage
40	21	13	34	85

Table 2

Summary of test result of Automatic license plate recognition (ALPR).

IV. CONCLUSION

Thedesignedhand-heldsecuritydeviceis evaluatedbytesting the authorization of approximately 70 vehicles whichincludes both two wheelers as well as four wheelers. The listcontains bothprivatevehicles andtaxies as theirlicenseplatesaredifferentincolor.Wheneveravehic learrivesattheentrygateoftheInstitute,itsauthorizationw ascheckedusingthis device by taking the image containing its license plate.The result is summarized in the table I. Some numbers weredetected in single trial whilesome others needed multipletrialsforsuccessfuldetection.

Itistobenotedthat,anoptiontoaddanunauthoriz ednumberto the database is also given in the GUI. When this option ispressed, a higher official will be notified the detection of anunauthorized vehicle through cloud communication. He willbeabletoaddthenumberofthisvehicleintothedatabas eofauthorizedvehicles. It is seen that the success of the result depends on the qualityof the image. Some of the factors which can affect quality ofimage are identified as: Different fonts between the licenseplates,blurredandskewedimages,lightingconditi ons,modified license platesetc.

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