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Automatic Number Plate Recognition System

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Abstract—*Automatic Number Plate Recognition (ANPR) is an image processing technology which uses number (license) plate to identify the vehicle. The objective of this paper is to design an efficient automatic authorized vehicle identification system by using the vehicle number plate. The type of system can be used at parking lots, toll plazas and traffic lights. The developed system first detects that a vehicle is incoming and then using the camera captures its image. Image segmentation is used to extract the region of vehicle's number plate. Optical character recognition technique is used for the character recognition. The resulting output is vehicle's registration number in text format. This registration number can now be used to get more information about the vehicle like Vehicle's owner, address of the owner etc.*
Keywords*: Number plate recognition; vehicle identification; Optical character recognition; Image segmentation.*

1. INTRODUCTION

The Automatic Number Plate Recognition (ANPR) was developed decades ago in UK by the Police scientific development branch. But its capability was limited due to computational capability and image quality of cameras. Recent advances in digital cameras ANPR has gained interest. It is basically a system with the ability to automatically extract and recognize a vehicle number plate's characters from a captured image. In essence it consists of a camera that captures the image of incoming vehicle, find the license number in the image and then extract these characters for OCR tool to translate the pixels into readable character. ANPR can be useful to government authorities, military and transport department in various areas to monitor traffic and car parking management.It can also be used in military zones and high security areas around government buildings. This system can detect and prevent a wide range of criminal activities. The system is computational power required by this system is very less as compared to the other ANPR systems.

This paper presents a system for vehicle identification which is light weight and can run in real time to recognize standard number plate. The earlier methods used Hough transform and other feature based approaches which were computationally expensive and required large training data since they used artificial neural networks.

This paper is organized as follows. Section II describes the project objective. The hardware and the software model is explained in Section III. Section IV discusses the OpenALPR design. Experimental results are discussed in Section V. Finally the conclusion is concluded in Section VI.

2. PROJECT OBJECTIVE

Capturing of Vehicle number plate details using camera.

Usage of image authentication technology.

Authentication and alerting

System Model

The whole ANPR system model can be divided into two categories, the software and the hardware model. Both the models are discusses in detail in this section.

Hardware Model

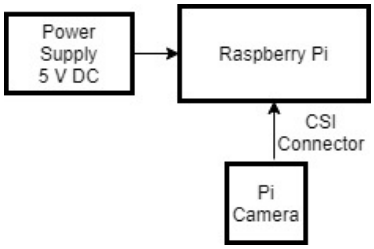
The hardware used in this project consists of a Raspberry Pi 2 and 5 MP pi camera module.

1. Raspberry pi – Raspberry pi is a small sized computer developed by Raspberry Pi foundation. The hardware specifications of Raspberry pi are :
    - SoC: Broadcom BCM2836 (CPU, GPU, DSP, SDRAM)
    - CPU: 900 MHz quad-core ARM Cortex A7 (ARMv7 instruction set)
    - GPU: Broadcom VideoCore IV @ 250 MHz
    - Video input: 15-pin MIPI camera interface (CSI) connector
    - Video outputs: HDMI, composite video (PAL and NTSC) via 3.5 mm jack

- Audio input: I²S
- Audio outputs: Analog via 3.5 mm jack; digital via HDMI and I²S
- Storage: MicroSD
- Network: 10/100Mbps Ethernet
- Peripherals: 17 GPIO plus specific functions, and HAT ID bus
- Power source: 5 V via MicroUSB or GPIO header

3. PI CAMERA MODULE – PI CAMERA IS AN OFFICIAL RASPBERRY PI FOUNDATION PRODUCT. IT PLUGS DIRECTLY INTO THE CSI CONNECTOR OF RASPBERRY PI. THIS PROJECT UTILIZES 5 MP VERSION OF IT WITH THE FOLLOWING SPECIFICATIONS :

- Fully Compatible with Both the Model A and Model B Raspberry Pi
- 5MP Omnivision 5647 Camera Module
- Still Picture Resolution: 2592 x 1944
- Video: Supports 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 Recording
- 15-pin MIPI Camera Serial Interface - Plugs Directly into the Raspberry Pi Board
- Size: 20 x 25 x 9mm
- Weight 3g



Software Model

The aim of this project is to develop an ALPR system using an open source C/C++ library called OpenALPR. OpenALPR has various dependencies which include:

1. OpenCV – Open Source Computer Vision library was developed to analyze images by computer vision at Intel Research Center. It is written in Optimized C/C++ and can take advantage of multicore processing. Various operating systems like windows, Linux, Unix support OpenCV. OpenCV supports variety of image operations like detecting foreground/background regions, classifying, filtering and convolution
2. Leptonica – It is an open source image processing and image analysis application library. Various featured operations of leptonica include Rasterop, Affine transformations, Pixelwise masking, blending, enhancement, arithmetic ops, etc.
3. Tesseract OCR – Tesseract is an open source OCR engine developed available under the Apache 2.0 license. It has the ability to recognize more than 100 languages out of the box and can also be trained to recognize other languages. It works on a machine learning technique to convert images with text into actual text format. API's are available that can be directly used to extract text from an image. The images given to tesseract should be pre-processed to improve accuracy.

SMTP – Simple Mail Transfer protocol is an Internet standard for email transmission. It is required to send the email to the vehicle's owner as an acknowledgement of authentication. SMTP is a text based protocol in which communication is done using command strings and supplying data over a reliable stream channel typically TCP (Transmission Control Protocol). An SMTP transaction consists of following command sequence:

- **MAIL** – to establish return address.
- **RCPT** – to establish recipient.
- **DATA** – to signal beginning of message.

4. OPENALPR DESIGN

OpenALPR operates as a pipeline. Input as an image is goven to first stage of the pipeline and the output from last stage is the plate number in the image.

Detection

The detection for each input image using the LBP algorithm (used for face detection) happens for one time. LBP finds possible license plate regions (x,y, width, height). Each of these regions is sent to the next pipeline stage.

The detection phase is the most computationally expensive stage. GPU acceleration can be used to improve performance

Binarization

This phase (and all subsequent phases) occurs multiple times -- once for each possible license plate region. Multiple binary images for each plate region are created in this phase. This gives us the best possible chance of finding all the characters. If the image is too dark or light a single binarized image may miss a character. Binarization uses the Wolf-Jolien method as well as the Sauovola method with various parameters. Each binary image is processed in further stages of the pipeline.

Character Analyisis

This stage finds the character-sized regions in the plate region. Firstly it finds all the connected blobs in the license plate region. Then blobs that are roughly the width and height of a license plate character and have tops/bottoms that are in a straight line with other blobs of similar width/height are found.

It looks for small characters and then gradually looks for larger characters. This is done multiple times in a region

If nothing is found in the region then no further processing takes place and region is rejected. If characters are found the region is saved for later stages of processing.

Plate Edges

The next step is to detect the license plate edges. The detection phase only identifies where licence plate may exists and often provides a region larger than the plate. Precise edge detection is done in this stage.

The first step is to find all of the hough lines for the license plate region. platelines.cpp processes the plate image and computes a list of horizontal and vertical lines. Plate-corners use this list as well as the character height (computed in Character Analysis) to find the likeliest plate line edges. It uses a number of configurable weights to determine which edge makes the most sense. It will try using a default edge (based on the ideal width/height of the plate) to see if that makes a good match.

Deskew

Remapping the plate region to a standard size and is done at the deskew stage. This provides us with a correctly oriented plate image (no rotation or skew).

Character Segmentation

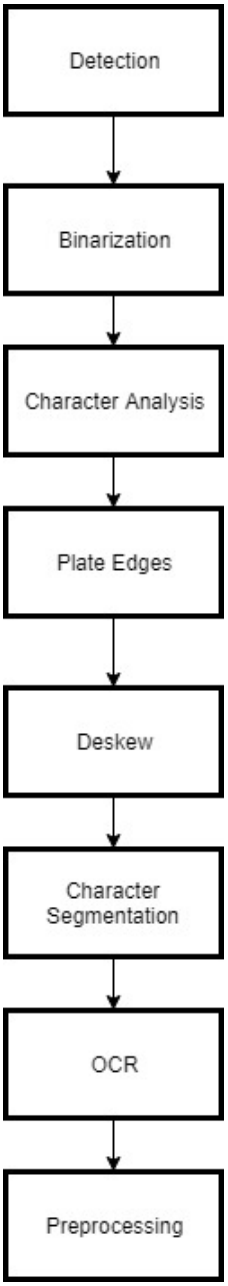
Isolation of all the characters that makeup the image is done at this stage. To find gaps in the plate characters vertical histogram is used. By removing small, disconnected speckles and disqualifying character regions that are not tall enough all the character boxes are cleaned. To prevent the edge of license plate being identified as 1 or I this stage removes the edges.

OCR

Each character is analyzed independently in OCR. All possible characters and their confidences are computer in this stage.

Post Processing

Best possible plate letter combination is determined using all possible OCR characters and confidences. All characters below a particular threshold are disqualified. A soft threshold is also present. Characters below this soft threshold will also be added to the possible list.



5. RESULTS

Test 1 : Input image captured:

OpenALPR gives 10 possible results with the confidence percentage of accuracy of that result. The output with maximum confidence percentage stands correct.

	Plate	Confidence
-	6GDG486	92.382927
-	6GDG4B6	84.769516
-	6G0G486	84.131607
-	6GOG486	84.024086
-	6GQG486	83.841934
-	6GBG486	83.239258
-	6GD6486	80.185555
-	6GD0486	80.154373
-	6GD8486	80.108505
-	6GDB486	79.725800

This output number plate is then used to authenticate vehicle from a preregistered database and an email is sent to the registered email address of that vehicle.

6. CONCLUSION

This paper presented a real-time ANPR system using OpenALPR API on Raspberry Pi platform. The system works on images captured by Pi camera module without any additional sensor input. OpenALPR library proved to be quite stable and ready to use for these type of applications. The system operates autonomously and can be customized according to the needs of the applications. Specific country wise detection is also possible. The system has training capabilities for new datasets which increases the overall accuracy.

Obtained results are accurate and meet the expectations.

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