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Implementation: Security through Automatic Recogition of Number Plate with Notification

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Abstract: *The growing effluence of urban India has made the ownership of vehicle a necessity. This has resulted in an unexpected civic problem that of vehicle identification and security. Security of vehicle has become overstressed due to growing numbers of vehicles.Automatic Number Plate Recognition (ANPR) is an intelligent system which has the capability to recognize the character on vehicle number plate. It is a combination of hardware and software designed to offer the optimum reliability. Since the past decades, many researchers have been proposed to recognize the vehicle number plate and implemented it in various access control, law enforcement and security, including parking management system, toll gate access, border access, tracking of stolen vehicles and traffic violations. However, previous researches implemented ANPR system on personal computer (PC) with high resolution camera and high computational capability. On the other hand, not many researches have been conducted on the design of ANPR in Android smartphone platform which has limited camera resolution and limited computational power. The main challenges of implementation ANPR algorithm on smartphone are higher coding efficiency, lower computational complexity, and higher the scalability. The objectives of this research is to design ANPR with notification on Android smartphone, including graphical user interface (GUI) design and database design. First, a comprehensive survey on the pre-processing, segmentation, and optical character recognition is conducted. Secondly, proposed system development and algorithm implementation is explained in more details. Results show that our proposed design can be implemented effectively in Android smart phone*

I. Introduction

Vehicle's license and number plate recognition (LNPR) system has been an important area of research interest in image monitoring and processing systems. With the advent of high-tech cameras, number plate recognition system has numerous applications for traffic management applications. LNPR system has many applications such as border crossing control, identification of stolen vehicles , automated parking attendant, red light camera, petrol station surveillance, speed enforcement, security. For many of these applications, most of the basic processing algorithms remain the same. The LNPR system works in three steps, the first step is the detection and capturing a vehicle image, the second one is the detection and extraction of number plate in an image. The third step uses image segmentation technique to get the individual character and optical character recognition (OCR) to recognize the individual character with the help of database stored for each and every alphanumeric character.

The automatic number plate recognition (ANPR) considerably can be used for those reasons. As an intelligent tool, ANPR has the ability to detect and recognize the vehicle's number plate and provide the information regarding the vehicle properties. The ANPR is an image processing technique to extract the image of license plate on vehicle taken by camera or taken by either a colour, a grey scale camera or an infrared camera and identified the vehicles by their number plate through optical character recognition. The ANPR system recognizes characters on license plate through the combination of various techniques and algorithms, namely image pre-processing, object detection, and character recognition. It consists of a camera to detect the number plate object and processing unit to process and extract the characters and interpret the pixels into numerically readable characters. It became much exciting in the last decade along with the improvement of digital camera technology and the computational processing. Nowadays, the ANPR system has been used in traffic law enforcement, including speed trap, stolen car detection and border monitoring.

It can be used also for the building management, such as parking lots and gate control. Many researchers have proposed and published various methods and algorithms on ANPR. ANPR system commonly deployed by one of two basic methods: one accomplished the entire process real-time at the track location and the other transmits all the images from many paths to a remote computer location then performs the OCR process at some later point in time. For the process at the track location, it requires high resolution camera to capture the number plate image. In the transmitting and processing at server, it needs a reliable network and a

large number of PCs to handle high workload, high bandwidth connection and processing the number plate image. Although many researches on ANPR has been conducted, but not many researches are focused on the smartphone platform. In this paper, ANPR algorithm is designed and implemented in the low resolution camera and low processing power of smartphone.

The ANPR system, as seen in Figure 1, generally can be composed of the following five stages.The first stage is image acquisition which capture the image of license plate using a camera by considering the camera resolution, orientation, shutter speed and lighting condition. The second stage is image pre-processing, such as normalization, brightness and contrast adjustment, and skewness correction of the captured image.

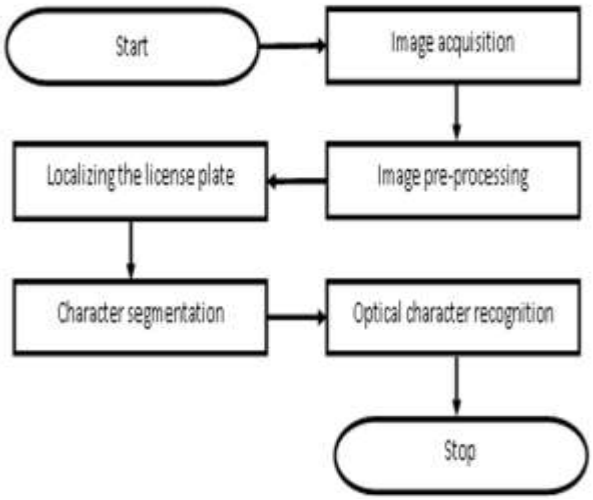

Figure 1. General Flow Chart of ANPR System

The third stage is localizing the license plate to extract the license plate from the whole vehicle image based on some features, such as the boundary, the colour, or the presence of the characters. The fourth stage is character segmentation to segment the characters on the license plate by locating and identifying the individual character on the license plate image.

The final stage is optical character recognition to recognize thesegmented characters by pattern matching or classifiers, such as artificial neural networks (ANN), fuzzy logic, and template matching. The overall performance of an ANPR system is depending on the performance of each individual stage. The output of ANPR system i.e. recognized plate number can be connected to other applications or databases. ANPR used a sequence of image manipulation methods to detect, normalize and improve a license plate image and optical character recognition (OCR) to recognize the alphanumeric of license plate. During the last decade, it became much interesting alongside due to the enhancement of digital camera technology and computational processing. It also can be used to detect, secure, maintain the record of vehicle and also prevent criminal activities.

II. Android Platform

Android is a software environment made for mobile devices such as smartphone and tablet. It has to be stated that Android is not a hardware platform. Android consists of a Linux kernel-based OS, a rich UI, end-user applications, code libraries, application frameworks, multimedia support, and much more. Android was founded by Open Handset Alliance (group of over 30 companies led by Google) in July 2005. In the next sections, Leptonicalibraries will be discussed.

3.1. Leptonica

Leptonica is an open source C library which is useful for efficient image processing and image analysis applications. The library is developed since 2001 by a Google employee, Dan Bloomberg, and it is licensed under a Creative Commons Attribution 3.0 United States License.

This library can be downloaded from http://www.leptonica.org.The library supported following operations, including rasterops, binary and grayscale morphology, convolution, scaling, rotation, affine transformations, seed filling and connected components, and various image enhancement algorithms.

III. Proposed Design Of ANPR System On Android Smartphone

To implement ANPR algorithm on Android smartphone, it requires system development environment and system design. System development environment used as the development tools which consist of hardware and software. In this section, hardware and software used for the development are presented. The system design explains the prototyping design of all ANPR subsystems including graphical user interfaces (GUI) design and database design. It provides advantages for the developer as guidance to develop and implement the ANPR system on any Android platform.

3.1. Hardware and Software Environment Development

The Android smartphone used in this research is Samsung GT-S5830 code name Galaxy Ace also known as Galaxy Cooper which is mid-end smart phone family released by Samsung. It has 800 MHz 1 Core ARM v6 of processor with 278.34 MB of RAM. The screen resolution is HVGA (480 x 320) ~165 ppi pixel density and 5 mega pixels of camera resolution.

The ANPR system is constructed using Java Development Kit (JDK), Eclipse IDE (Integrated Development Environment), Android SDK (Software Development Kit) and Android Developer Tool (ADT), i.e. an Eclipse plug-in. The minimum Android API (Application Programming Interface) used for the constructing of the ANPR system is Android API 16 to develop application for Android 4.1 version (Jelly Bean).

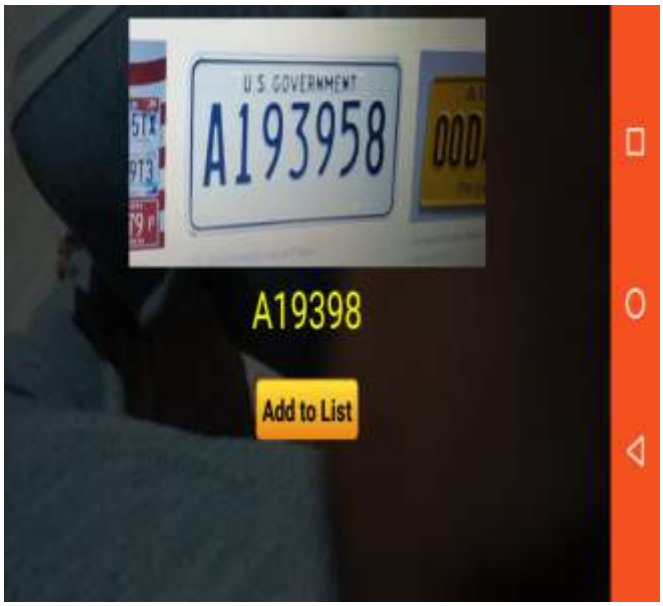

Figure 2: Capture page

4.2 Graphical User Interface Design

User interface design helps the developer to the concern on how the system presents the information to user. It is very important since user need the easiest way and simple to operate the system.

4.2.1. Database Design

In this research, database is designed to support the ANPR system. It aims to record the data collection of vehicle number plate. The database is required by ANPR system in order to record and retrieve some information related to the number plate such as owner information, vehicle information, and position information of the vehicle.

The description of this relation is that info table set as info table for the vehicle information. It does not need to be changed frequently and the data will remain the same as the data during vehicle registration except if there is new update like changing ownership.

Table 1. Detail of Table info

Column Name	Data Type	Length	Description
number_plate	VARCHAR	100	Primary key
Owner	VARCHAR	100	Vehicle owner name
reg_date	DATE		Vehicle registration date
vehicle_type	CHAR	1	
Email	VARCHAR	100	Owner's email

The info_collection table will be updated frequently as the data received from the ANPR system in Android smartphone. It has many relations due to the required capability to record many data for the same number plate as foreign key which represents the number plate as the primary key in info table.

The second table is info_collection table as shown in Table 3. It records the data which are sent from the ANPR system in Android smartphone. For the purpose of this research it contains only three fields, including create_time,create_date, and info_number_plate. It includes date and time when the number plate was taken and the number plate in string as the string format.

Table 2. Details of Table info_collection

Column Name	Date Type	Length	Description
info_number_ plate	VARCHAR	10	Foreign key
create_date	DATE	100	Dateof taken number plate image
create_time	TIME	100	Time of taken number plate image

3.2.2. Email Interface

There is a function to send an e-mail. To send mail, first the information about the email address and SMTP server must be set up. An acknowledgement about time and date when the vehicles entered or exit the campus is sent by this interface to the registered mail ID with an attached time, date and license plate number of vehicle if the number plate is available in the database.

IV. Algorithm For Proposed System

Step 1: With the help of camera, the number plate of vehicle will be captured.
Step 2: The number plate of the vehicle will be processed using an image processing technique.
Step 3: Once the license number is extracted from the overall image, it will be compared and searched in the centralize database and the respective vehicle owner's details will be fetched.
Step 4: Along with the details, it will also check whether the owner of the vehicle is registered user.
Step 5: If the owner of the vehicle is registered user then the system will send notification about the timing of vehicle enter or exit.
Step 6: Else if the owner of the vehicle is not registered user then the system will only store the detail in database.
Using the proposed system mentioned above, the problem of vehicle's thefts will be minimized.It will also provide an email/message notification to particular responsible person.

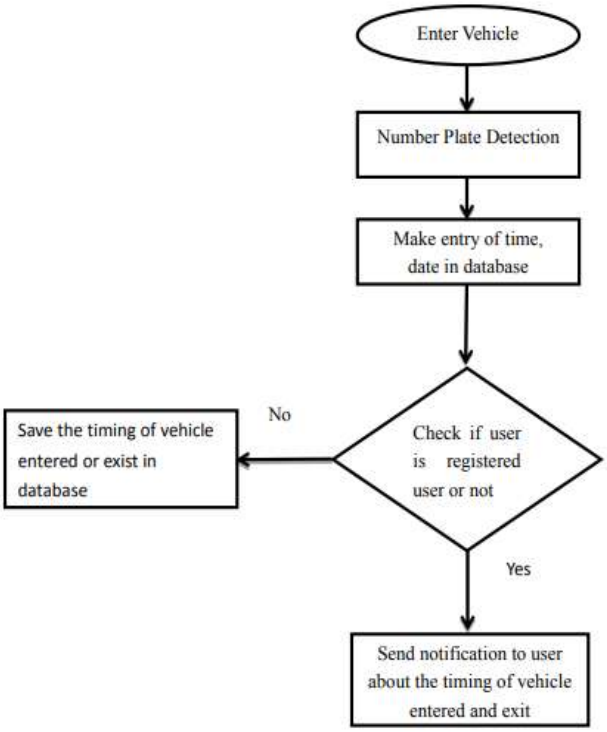

Figure 3. Flow diagram of vehicle monitoring system with notification

V. ANPR Algorithm Implemetation

In this section, the implementations of ANPR system on Android smartphone are presented. There are various methods for every step in ANPR algorithm. The selected algorithm in every step of the development of ANPR will be discussed in more details.

5.1. Acquisition of Number Plate Image

The first phase of ANPR system is acquisition of number plate image. The number plate image is captured using camera that is available in Android smartphone. The Android smartphone used in this research has a camera with 5 mega pixel resolution, which has capability to produce maximum of 2592x1944 pixels image and minimum of 640x480 pixels. In this research, the captured images sizes were 640x480 pixels to reduce the use of storage resources and also to reduce computational complexity. Figure 4 shows the sample of image captured by Android smartphone's camera.

Figure 4. Image Acquired by Android Smartphone's Camera (640x480 pixels)

5.2. Image Pre-processing

The next step of ANPR system is image pre-processing. This step is a significant process for the ANPR system. This step will produce an image that should be easily used to perform character segmentation. It means that the captured images need to have minimum noises and high contrast between character and its background.

5.3. Character Segmentation of the Number Plate Image

Generally, the number plates contain the characters which are having the equal width or fixed pitch. It will be easier to perform the character segmentation. The method that we used in this step is fixed pitch detection and chopping as proposed by Ray Smith for the Tesseract OCR engine. The fixed pitch method tests the number plate's text lines to determine if they are fixed pitch. If fixed pitch text found in number plate, the fixed pitch method chops the number plate into characters using the pitch. Those characters are ready for the recognition.

5.4. Character Recognition of Numbers Plate Image

The final step in ANPR system is recognition of numbers plate. A main task of this step is to identify the characters' image. There are numerous of methods have been proposed for the recognition process. ANN is dominating the feature extraction techniques for pattern recognition, while template matching is among the most selected method for number plate recognition. In this research, template matching algorithm is chosen due to its better recognition rate compare to other algorithmsand its simplicity. This arrangement is selected due to its impression on the overall performance of the ANPR systems.

VI. Proposed System Advantages

LNPR system has some advantages as follows:

- Easier vehicle's arrivals/departures to/from a campus.
- Increasing security in the area.
- No need to install additional equipment on vehicles for recognizing them (like different cards, etc.)
- Automatic opening the gate to authorized vehicles immediately upon recognizing their license plate and manual opening of the gate by the guard and issuing permission for specific vehicles as well as registering their license plates
- Recording the entry/exit date and time for the vehicles
- Sending notification about the time and date of vehicle entered/exit to the authorized person and while storing the time and date of vehicle entered/exit in the database for the unauthorized person.
- Storing vehicle information for an unlimited time.

VII. Conclusion

This paper has discussed comprehensive literature review on ANPR algorithms, including pre-processing, localization, character segmentation, and optical character recognition. Leptonica library was used for efficient image processing and character recognition. The system design, including GUI, process, and database design, has been discussed in details. The proposed ANPR algorithm was implemented and results show the effectiveness of our proposed design. More thorough performance evaluation including the recognition rate of ANN versus template matching algorithms needs to be conducted. Moreover, the proposed design could be further optimized to balance the processing requirement with the accuracy.Further research includes performance evaluation of the proposed ANPR algorithms using template matching based OCR. Also users can have the information of vehicle incoming and out coming time with the help of notification. System will automatically make entry of vehicle. And User will be ensuring that their vehicles are safe within the campus.

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