Universal Vehicle Identification and Classification System (UVICS) Using Image Processing

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Abstract

In this new era, the use of vehicles has become very important for human prosperity and development. However, the use of vehicles in various crimes, kidnapping, terrorist activities also have become an unwanted evil for the humanity. The use of vehicle in suicide bombing, vehicle ramming on innocents by the psychopaths and terrorists has been increased drastically. Therefore, there is an urgent requirement of a reliable system that can track and further neutralize the attempt of the vehicles ramming onto the crowd, important building like schools, universities, banks, government institutions and high security zones like military establishments. Thus, we have devised a very simple mechanism to identify and classify the vehicles entering or leaving into any establishments as authenticated military and civil vehicles. Our proposed research basically uses the simple image processing method to detect vehicle number plate from a live video captured by a camera installed at the entrance of such buildings or restricted zones. This research could also provide a great assistance to identify the authenticity of a civil vehicle from the database of state or country traffic department.

Keywords: License Plate Recognition, Character Segmentation, Template Matching, Military and Non-Military Vehicle Categorization

1. Introduction

Modern technology has blessed us with many new inventions and one of the most promising inventions is the license plate recognition system by digital image processing. A license plate is used for uniquely identifying a vehicle [1]. In recent years, security has become a major issue worldwide. Vehicle ramming, suicide bombing attacks, terrorist attacks and other illegal activities have become a daily scenario. According to [14], a license plate recognition (LPR) system plays an important role in numerous applications, such as parking accounting systems, traffic law enforcement, road monitoring and security systems. Priti Rajvanshi [13] mentioned that Automated Number Plate Recognition System would greatly enhance the ability of police to detect criminal activity that involves the use of motor vehicles. Thus recognizing license plate can be a vital key to ensure proper security of vehicles, to prevent unauthorized vehicle entry in restricted areas, to identify the traffic rule breakers as well as reduce crimes.

The Azor attack by Palestinian terrorists in 2001 was considered to be the earliest ramming attacks and a new militant tactic which proved to be more difficult to prevent than suicide bombings [15]. Many similar incidents took place such as the Jerusalem truck attack, Edmonton Attack and the Barcelona attack in which a 22 year old drove a van over pedestrians killing 13 people and injuring 130 people. That is why vehicle identification has become a necessity. The proposed system takes an image as an input, converts color image to grayscale image, binarizes the image and applies Unwanted Line Elimination Algorithm (ULEA) to remove noise and enhance the binarized image. Binarization is performed mainly to highlight characters and to suppress background [2]. Then it separates the vehicle from the background through Vertical Edge Detection Algorithm (VEDA), and afterwards it applies Highlight Desired Details (HDD) to highlight license plate, Candidate Region Extraction (CRE) and finally applies Plate Region Selection (PRS) to extract the actual region of interest.

Various countries use various formats in categorizing civil and military vehicles, for example Bangladesh uses an arrow at the beginning and Bengali numerals after that to identify a military

vehicle and Bengali alphabets followed by Bengali numerals for civil vehicles. India and Pakistan use special symbols at the beginning of the number plate of their military vehicles and English alphabets and numerals for civil vehicles, Thailand uses a special symbol followed by four to five Thai numerals for military vehicles and Thai civil vehicles use Thai alphabets followed by English numerals [16]. Thus the level of complexity of license plate recognition system is different worldwide [1]. The main purpose of Universal Vehicle Identification and Classification System (UVICS) is not only to identify license plate to prevent terrorism but also to find a common way through which military and non-military vehicles of various South Asian countries such as Bangladesh, India, Pakistan, Thailand can be categorized.

We organize the rest of our paper as follows. A brief description of related work is given in section 2. The proposed method is given in section 3, in section 4 we have shown the experimental data and results. Finally, section 5 concludes the paper.

2. Related Works

There are many researches done in the field of license plate recognition system using image processing. This section briefly mentions some of the related studies in order to provide a clear concept of how the system actually works. The great impact of license plate recognition and vehicle classification has been discussed by various studies. In 2001, Remus Brad [12] discussed about the endless possibilities that lies in this field. He mentioned that this technology has a wide range of application starting from parking management, traffic control as well as public security. According to Nikolaos and Ioannis [3] extraction, segmentation and recognition of characters are three main steps of any license plate recognition algorithm. They mentioned these tasks to be very challenging as various vehicles have various license plate formats. These tasks become more complex when license plate images are from various angles and the images consist of noise. Thus they suggested that an accurate and fast processing system is required. [4] used three techniques which are morphological operation, histogram manipulation and edge detection. All these three techniques help in license plate localization and segmentation of characters. In this paper they used Artificial Neural Network for recognizing and classifying the characters. The limitation of this paper is that it works with standard Egyptian license plates only.

Robert F.K and Surendra Gupte [5] used segmentation, region tracking, vehicle identification, vehicle tracking and vehicle classification. Region is tracked by observing multiple images of the vehicle. Various parameters like height, width, length are obtained by applying 2D projection. [6] and [7] followed the similar approach like [4]. The first paper modified the morphological operation by modification of Hough Transformation. They used feed-forward back propagation Artificial Neural Network. The second paper printed the extracted characters in a text file with the help of MATLAB. They also proposed and algorithm for Parking Management System besides the license plate recognition. Ragini and Bijender [8] used Sobel Edge Detection and Morphological operation. They used bounding box method for segmentation. The paper [9] developed algorithm for vehicle color detection and trademark (logo). They did color classification using fuzzy sets and morphological operation was used for logo segmentation. The results for correct color classification for this system are just 32.71 percent.

[10] conducted experiments using image data collected in Thailand. Histogram of Oriented Gradient (HOG-based BOF) and linear support vector machine (SVM) were adopted for a detector. They mentioned that robustness against illumination or environmental change can be achieved with HOG, and robustness against various types of fonts can be achieved with BOF. There are certain limitations in this system. In some cases the license plate is not detected from vehicle image. With the help of this literature review, we can find that though several studies have been done in the field of license plate recognition but there is no paper that has done successful classification of vehicles that are of various formats and languages all together.

2. Proposed work

The overall scenario of how the system works is represented with the flowchart in the Figure 1 and the block diagram in the Figure 2.

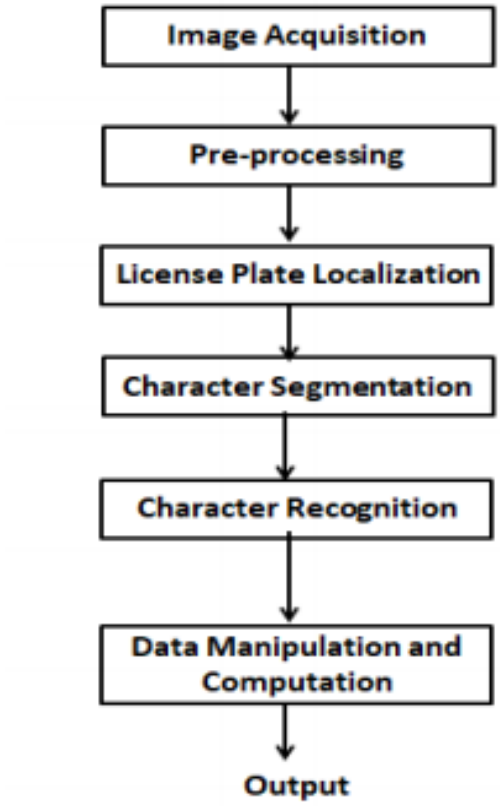


Fig. 1. License Plate Recognition System Flowchart

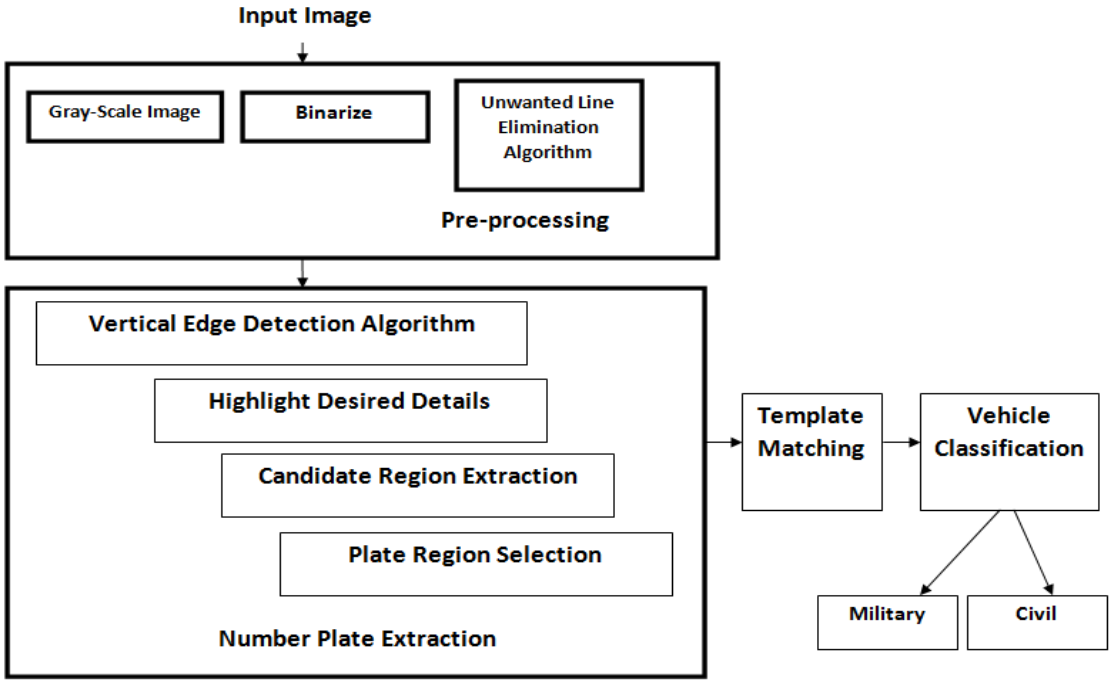


Fig. 2. License Plate Recognition System Block Diagram

3.1 Pre-processing

At first, a color image of a vehicle, captured from the camera installed at the entrance of any building or establishment, is taken as input. Color images can be represented by three or four

components for each pixel such as red, green, blue, cyan, magenta, etc. This color image is converted to grey-scale image which is shown in Figure 3.

Fig. 3. Color Image to Gray-scale Image

In the grey-scale image the intensity of a pixel is represented as a range starting from 0 for black to 1 for white. Then the picture is binarized so that it contains only two values that are 0s and 1s. The unwanted line elimination algorithm then enhances the binarized image. The entire process starting from color image input to ULEA image is known as Pre-processing stage.

3.2 Edge Detection

The edge information is quite helpful to obtain shape information. At first the edges are detected and after that the sharpness is increased to make the image clearer. The process of classifying and placing sharp discontinuities in an image is called the edge detection [11]. The Vertical Edge Detection Algorithm differentiates the number plate details from the background. It basically reduces the amount of data to be manipulated and thus makes the further process faster. Each character has two edges, one is the starting edge consisting of two pixels and another is the ending edge which is of one pixel.

3.3 Highlight Desired Details

It takes the VEDA output and highlights the desired details such as the number plate.

3.4 Highlight Desired Details

There are multiple candidate regions. This method gives regions that have larger darkness ratio. The candidate regions are separated from each other with upper and lower lines. Morphological filtering is used as a tool for extracting image components and so representing and describing region shapes such as boundaries. Candidate region is extracted in this method.

3.5 Plate Region Selection

It extracts the actual region of interest such as the license plate region. It relies on the output of candidate region extraction. The region with maximum black pixel is considered to be the desired license plate region. The process described is shown in the figures 4 and 5.

Fig. 4. Input Image and Dilated Image

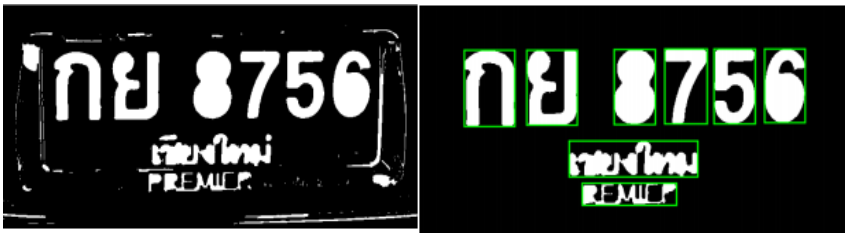


Fig. 5. Plate Region Selection and Segmented Image.

3.6 Template Matching

Template Matching is a technique through which image is compared with predefined images that might be stored in database. Optical Character Recognition system is a widely used approach of template matching. Template Matching could be a methodology in digital image processing to identify little components of a figure which match a template image [11]. The template data for our system is shown in the Figure 6.

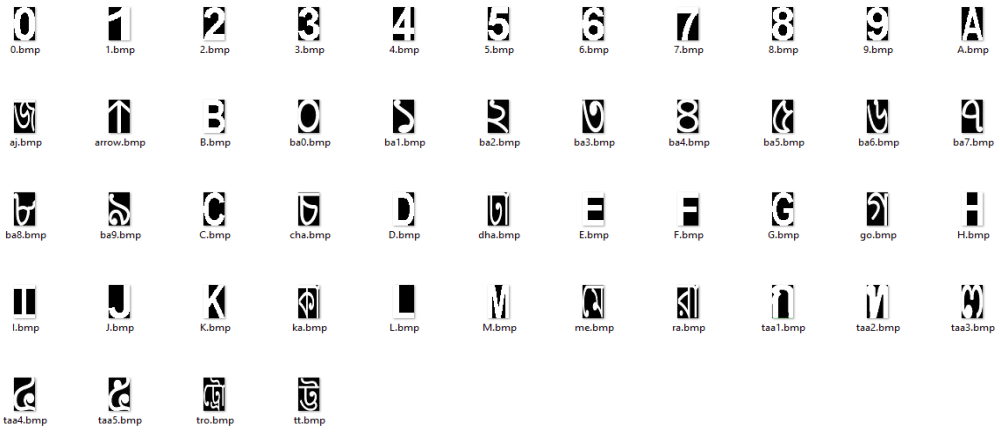


Fig. 6. Template Data

4. Experiments and Results

The experiment takes an image of military and non-military vehicles of Bangladesh, India, Pakistan and Thailand and applies all the required steps that are mentioned in the figures 1 and 2 to get segmented image and matches the image with the template images. Various logical conditions are applied to differentiate between the military and non-military vehicles of the different countries. Bangladeshi civil vehicles consist of Bengali alphabets followed by Bengali numerals and military vehicles have up arrow before Bengali numerals. Indian and Pakistani civil vehicles consist of English alphabets and numerals but military vehicles consist of special symbol such as an up arrow and only English numerals. So, if the segmented image has special symbol then it the output is a military vehicle otherwise non-military.

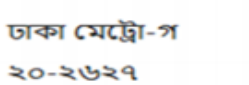
Country	Original Image	Segmented Image	Output
Bangladesh			
Bangladesh			

Fig. 7. Results for Military and Non-military vehicles of Bangladesh

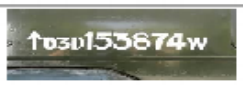
Country	Original Image	Segmented Image	Vehicle Type
India			
India			

Fig. 8. Results for Military and Non-military vehicles of India

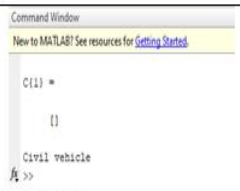
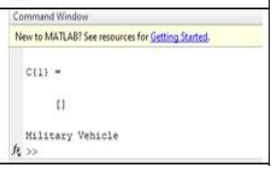
Country	Original Image	Segmented Image	Output
Pakistan			
Pakistan			

Fig. 9. Results for Military and Non-military vehicles of Pakistan

The military vehicles of Thailand consist of special symbols followed by 4 to 5 Thai numerals. On the other hand, Thai non-military vehicles have Thai symbols followed by English numerals. Thus logic is applied that if the number plate consists of English numerals then it is a non-military vehicle and if it consists of Thai numerals then it is a military vehicle. The result of the following experiment is shown in the figures 7, 8, 9 and 10 for military and non-military vehicles of Bangladesh, India, Pakistan and Thailand respectively.

Country	Original Image	Segmented Image	Output
Thailand			
Thailand			

Fig. 10. Results for Military and Non-military vehicles of Thailand

5. Discussion and Conclusion

The entire system is implemented in MATLAB. The images of military vehicle have been taken from public domain (INTERNET) due to unavailability and no direct access of the armed forces vehicles from India, Pakistan and Thailand in Bangladesh. However, the pattern and number format of the read images of the military vehicles used in experiments are correct as actual. The images and number plates of military vehicles used in this project are unclassified in nature. However, UVICS can also be added with a module which can identify the vehicles of specific target group form military domain. Furthermore, UVICS can also be a very useful tool at UN Missions where vehicles from different countries generally get involved together for a combined goal of human safety and progress. In future UVICS can be attributed to identify the civil vehicles' authenticity and ownership up to the hierarchy of particular countries' state, division and district level by connecting the system with the national database of traffic department of the target country. This will allow the security agencies or guards deployed at various important places to identify the vehicle well in advance and can avoid or stop any ramming or suicide bombing situation. The method is devised for universal acceptance across the nations. This research will further be introduced to identify and classify vehicles from USA, Europe and South-East Asian countries. UVICS can also be used to track down the stolen vehicles on road. Moreover it can play a vital role in ensuring security of individuals by preventing vehicle suicide bombing and vehicle ramming situations.

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Authors Biography

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Naresh Singh Chauhan was born in New Delhi, India in year 1982. He received the Bachelors of Technology degree in Computer Science and Engineering from Kuruksherta University, Haryana, India in 2005 and Masters in Computer Technology from Indian Institute of Technology Delhi (IIT-Delhi) in year 2012. From year 2005 to 2006, he was an IT Administrator and IT Security consultant with PNVF Ltd at New Delhi, India. From 2006 to 2015, he has been posted at various technical training institutions of Indian Navy as Lecturer and Assistant Processor in Computer Science and Engineering Department.

He has guided more than 14 projects at graduate level at Indian Naval Academy, Ezhimala, India. He has three IEEE Publications. His research interests include computer vision, image processing, digital signal processing, cloud computing and computer network security. He is currently posted as Assistant Professor in the Department of Computer Science and Engineering at Military Institute of Science and Technology (MIST).