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Dynamic Vehicle Management System Using Fast Optical Character Recognition Technique

Aditya Rawat*[1] and Suvigya Awasthi[2]

[1] Computer Science Engineering, Manipal Institute of Technology, Manipal University, India
[2] Electronics and Communication Engineering, Manipal Institute of Technology, Manipal University, India
adityrawat009@gmail.com, suvigya.a@gmail.com

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***Abstract*—**Vehicles have become one of the most common commodities that the masses have adopted during these modern times. Tracking all such vehicles and regulating their inflow and outflow at any institution/organization is still a labor intensive task. With the development of technology, every day we come across one or the other situation where technology is skillfully replacing all such labor orientated tasks with faultless automated systems which are in most situations cheaper and more efficient. The proposed system in this paper elucidates a similar elegant automation solution for the mentioned situation. This system has the ability to register and deregister a vehicle from a database, identifying it based on its number plate which is fed dynamically to the system. Further this proposed technology makes use of a fast optical character recognition system to map the dynamically obtained characters from the license plate by the system to alphanumeric characters used by standard license plates across the country and eventually registers/deregisters users to automate the tedious gatekeeping process, as we know it today.

***Keywords*—**Vehicle management system; License plate recognition; Digital Image Processing; Optical Character Recognition; Machine vision; Machine Learning; Automation Systems; Vehicle Parking Automation Systems;

I. INTRODUCTION

With the escalating need for automation systems in every field of work, fittingly reasonable from the accuracy and robustness they offer, a number of systems that earlier used to be labor intensive have changed to merely an automated system installed in their places. Some common examples of such systems include automation of production lines, use of next generation robotics for assembly and painting of cars etc. Widely used techniques involved in the development of such systems are digital image processing and optical character recognition. In the proposed system we present these techniques to construct a robust and flexible vehicle management system which makes use of image processing to locate the license plate of a particular vehicle followed by an OCR process to recognize these characters from the image and covert them to plain text. Further, this plain text can be checked against a set of permitted vehicles and the flow of vehicles can be regulated in similar fashion. This system aims at reducing the labor intensive job of managing such routines manually.The entire idea behind such a system is based on the concept of machine vision and the ability of a machine equipped with the appropriate hardware, to regulate such systems on its own.

The documentation is divided into 4 sections. The second section talks about the several techniques used in the development of such a system. After which the third section deals with the in-depth explanation of the methodology employed at different stages of the development to completely build the system. The fourth and the last section demonstrates the various results obtained from the test cases used to bulletproof the system of any pitfalls which is followed by a brief conclusion to the documentation.

II. CORE CONTENT

A. Preliminary work

1) Region of Interest Extraction-A *region of interest* (often abbreviated ROI), is a particularsubdivision of models within a dataset recognized for a specific purpose. The notion of a ROI frequently comes up in many application based systems and research areas as described in [1] and [2]. For example, the most recent and upcoming technological benefits of such techniques can be seen in the field of medicine to localize the boundaries of a tumor in an image or in a volume, for the primary purpose of accounting for its size and even volume in some cases. In geographical information systems (GIS), a region of interest can be reservedfactually as a geometric range from a regular 2D

map. In computer vision and optical character recognition, the ROI outlines the edges of an entity under contemplation as in [3].
In the proposed system, we have considered the license plate of a vehicle to be the region of interest. This area is extracted with the help of color properties of the pixels at various segments in the image. The system makes use of RGB properties and filter out the non ROI portion of the image using and experimentally determined threshold value. Our system considers yellow license plate to be ROI for the further processes and crop out the same given a test case image.

2) Image Segmentation-In computer vision, *image segmentation* is the procedure of separating a digital image into numerousdivisions and subdivisions (sets of pixels, sometimes called assuperpixels). Segmentation is done to simplify and/or change the representation of an image into something that is more significant and easier to scrutinize. Image segmentation is naturally used to locate objects and boundaries (lines, curves, etc.) in images. More accurately, image segmentation is the method of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. Segmentation techniques are either *contextual* or *non-contextual*as in [9]. The latter take no interpretation of spatial relationships amongst features in an image and group pixels together on the basis of some global attribute, e.g. grey level or color. Contextual techniques additionally exploit these relationships, e.g. assembling together pixels with alike grey levels and close spatial locations. This system makes use of non- contextual image segmentation due to the relative simplicity of the process and ease of implementation, the spatial arrangement of each character in the test image is taken care of through line and character segmentation isolating the pixels belonging to one character together with a better algorithmic process as highlighted in [1].

Segmentation helps us to deal with the complete picture in small segments of pixels or super pixels in order to obtain the correct end result. Image Segmentation follows different processes which includes line by line segmentation followed by character by character segmentation. *Line Segmentation* is the process to isolate all the independent lines or sequence of words present in a digital image to individual images so as to process them separately. This segmentation helps us to isolate all the characters present in a single line to their boundary pixels row-wise and then dissect them using character segmentation leaving us with just the character cropped to the minimum size. *Character Segmentation* refers to the process of isolating characters present in a single line to independent images so as to ease the process of template comparison. Each character is individually compared against the stored font template and the maximum correlation match is mapped to the respective text character to obtain the image in the text format.
3) Optical Character Recognition-It is the mechanical of electronic adaptation of images to typewritten or published text into machine-encoded transcripts. It is extensively used as a form of data access from printed paper data records, whether passport documents, testimonials, bank statements, computerized receipts, organizational business cards, or any suitable documentation. It is a common technique to digitize printed writings so that it can be electronically manipulated, searched and stored more compactly. OCR or Optical Character Recognition is the field of examination in pattern recognition, artificial intelligence and computer visualization.

OCR engines have been developed into many kinds of object oriented OCR applications, such as receipt OCR, statement OCR, legal billing document OCR.They can be used for data entry for corporate documents, e.g. payment through check, passport identification, as mentioned earlier invoice, bank statement and daily receipts, Automatic number plate recognition as in [1],[2] and [9], Automatic insurance documents key information extraction, Mining business card information into a connection list, Rapid conversion of textual versions of printed books, e.g. e-book scanning and development for Project Gutenberg, Make electronic images of printed documents digitally manipulatable, e.g. Google Books, Converting handwriting in real time to regulate a computer (pen computing) defeating CAPTCHA anti-bot systems against increasingly efficient image recognition and automatic form filling systems, though these are specifically designed to thwart OCR, assistive technology for blind and visually impaired users such as text to audio converters.

In the proposed system, we use the segmented characters obtained from the image segmentation process and match them against the template font by the help of correlation calculation between the two images. Correlation calculation gives us a distinct set of values for all the alphanumeric characters and hence we are able to map the input segmented character image to an actual text character which is further concatenated with the other character segments of the image to form the complete license plate number. The obtained text can be checked against a database to verify the permissibility of that particular vehicle.

B.Methodology
The process involved in the development of the system involves the following stages:
Phase I: Extract the Region of Interest from the image and filter the unwanted objects from the image to obtain the desired output.

Figure 2. Phase IIProcedure

Figure 1. Phase I Procedure

*Phase II:*After we have obtained the ROI and all the unwanted objects are filtered out, we proceed to image segmentation, which generates all the characters present in the image as separate image files.

Phase III: After obtaining all the characters of the license plate as separate image files stored in a cell array, we use the process of Optical Character Recognition, which maps the image to an alphanumeric character which has the highest correlation match with the template font.

The documentation hence forth describes how the different components were brought together to complete the overall system and their purpose for the same.

1)Extracting yellow pixels-One of the very first step in the process of license plate recognition system is to extract the license plate out of the given input image. We have tested the proposed system with test images involving yellow license plate of any kind. Hence, the system begins by examining each pixel of the image and filters out all the non-yellow pixels out. This process makes use of the RGB components of an image. Any pixel which is close to being yellow comprises of a high red and green component and a relatively low blue component. The system thus makes use of a threshold value which was obtained by multiple test cases giving the desired output. All the pixels with red and green components higher than the obtained threshold and blue component lower than the given threshold were removed from the image producing the output image containing only yellow pixels. As shown in Fig. 3, for the given test images containing vehicles with yellow license plates on them, the output was just the yellow region of the license plate which is the region of interest for the proposed system.

Figure 3. Output image after yellow pixel extraction

2) Determining the Region of Interest-Determining the precise region of interest involves separating the licenseplate from the input image. This involves removal of all the borders, boundaries and other unwanted noise. The system starts by calculating the sum of pixels present in a row and the row having the sum less than a minimum threshold is made zero. This insures that we do not have any unwanted lines or borders present in the image. After this process we have an image with all the horizontal rows made zero which have sum less than the threshold. The same process is repeated column-wise to as to remove vertical lines that are unwanted in the processed image. All this process is done in order to obtain the first and the last pixel which will be included in the region of interest of our license plate in the given RGB image.

After the removal of all the unwanted horizontal and vertical lines, we calculate the region which contains the license plate by determining the first white pixel in the image and the last white pixel in the image. Our region of interest is lies between all the pixels coming in between these two pixels. With the help of the co-ordinates of these pixels we calculate the height and width of the new image and crop out the region of interest from the original RGB image. Note that we might have some pixels omitted in place of the characters that should be present but that is compensated by cropping the image from the original RGB image and not the extracted image. The output of this process is the license plate cropped out of the image which can be further processed to extract the characters.

3) Binarization and filtering unwanted pixels-Binarization is the process of obtaining images which contains only 1 or 0 as its pixel value instead of the 0-256 values presenting different shades of white and black. In a binarized image the white pixels or *the foreground pixels* are represented by 1 and the black pixels or *the background pixels* are represented by the value 0. It is a crucial process in extracting information from digital images as it is easier for the system to evaluate pixels based on a 2 values representation rather than a 256 values representation. In the proposed system, we have filtered all the values below a certain minimum to black and the remaining pixels as white pixels as shown in Fig 4.

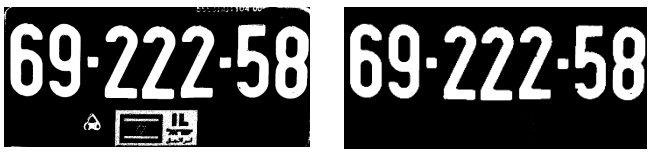

Figure 4. Output image after binarization and filtering

Figure 5. Output image after row segmentation

4)Line segmentation-Line segmentation refers to the process of separating different blocks of words i.e. all the words that are present in a single line as separate image files. This method is instrumental in the process of license plate recognition system as the license number on a number plate might be divided into multiple line or the license plate might have some extraneous information such as information about the state to which the vehicle belongs etc. Our job is to extract only the relevant information present in the input image and feed it to the character recognition system in order to avoid the extra irrelevant information.
In this process, the line segmentation is done by calculating the sum of all the rows, the rows with their sum equal to zero are the rows which are not needed in the output image line i.e. are irrelevant. The system iterates through all the row sums of the input image and stops when it encounters the first row with sum of its pixels equal to a non-zero value. This row is marked as the starting point for the line. The system again iterated through the remaining row sum to obtain the first zero row sum and marks the previous row number as the ending point for that particular line. With the starting and ending row numbers obtained through this process we extract only that image part which strictly contains the relevant pixels row-wise as shown in Fig. 5. This process is repeated till the end of the rows is obtained and the separate lines of the input image are stored as separate output image file to be processed at a later stage in the system.
5) Character segmentation-After we have clipped off the top and bottom pixels that are not required for the classification of the license plate image, the next step involves clipping each character one by one so that we can have individual comparison of these characters with the font template that we have calculated beforehand for the OCR. This step is very essential for the OCR to correctly recognize the character that the respective image represents. Character segmentation follows a similar procedure as line segmentation. The image is scanned for columns containing only relevant pixels. This is achieved by calculating the sum of all the pixels present in one column. The sum is then equated to zero, if true the whole column in marked for removal else the column stays in the output image. During the column wise iteration when the system first detects the non-zero value column, it marks it as the starting column of one of the characters present in the image. When the next zero sum column in encountered, the column previous to that is marked as the ending point for the respective character. This same procedure is repeated over and over again until we recognize all the characters present in that particular line which is denoted by reaching end of the columns in a given image. The output of this process, as shown in Fig 6, is all the characters separated out from the image as individual alphanumeric letters.

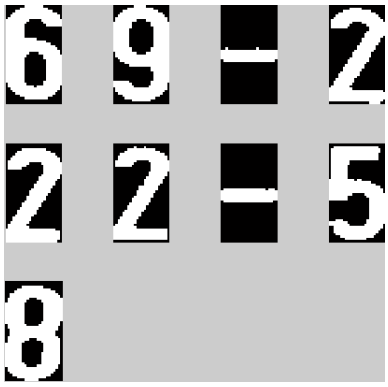

Figure 6. Output image after character segmentation

6) Feeding characters to Optical Character Recognition (OCR) system-The system has thus generated a sequence of images which contains all the characters which are present in the input image and are relevant to the optical recognition system. The generated characters are stored in a cell array which can be accessed by the subscript procedure and hence facilitating iteration over these images through a single cell array variable. The last and the most crucial step in the recognition of character stream from the license plate image is the actual mapping of every character image to an alphanumeric character that is readable and human recognizable. The procedure for this step is as follow: a) Iterate through the obtained character stream one by one. b) Finding the correlation of the image currently under processing with the template font images that is already present in the system. c) Return the index of the image that has the maximum correlation with the current image. d) Map the character image to an actual letter with the help of this index value. This process is demonstrated in Fig. 7.

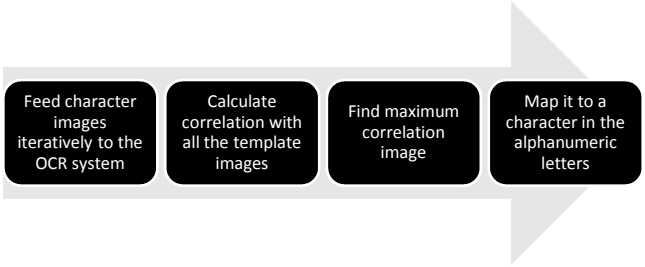

Figure 7. OCR system for character recognition

The character images when fed into the OCR system returns a single character, which is the best possible mapping of that image as seen, the system. This returned value is concatenated to a final string value, which at the end of all the iteration contains the desired output i.e. the license plate number in textual form of the vehicle whose input image was fed to the system in the beginning of this procedure.

III. RESULTS

The license plate recognition system was tested against multiple test images, under different light conditions and altering other influential factors that can affect the performance of the system. The results are demonstrated as follows in Table 1.

Input Image	Characters Segmentation	Text
		699-222-58
		J98257
		OE95960
		KA20B3941

Table 1. Demonstrates result of the working system

IV. CONCLUSION AND FUTURE WORKS

The proposed system offers a full proof method to detect any vehicle that carries a yellow number plate. The OCR system used for the detection of characters in the above mentioned system has shown high accuracy rate and is prone to failure on recognizing the characters correctly. This completes the system as a whole and puts it forward for use in multiple areas. The system thus developed has a tendency to be flexible and can be adapted to the needs of any organization or can be used to develop further applications of recognition systems.

The obtained registration number can be used for multiple purposes which includes entry regulation at institutions or organizations with high security demands, permitting only restricted amount of vehicles to enter the premises. Another useful application of this system can be in parking lot management which currently are regulated by actual workers. This system can be used to feed the license plate number to a regulation database which removes the license number when the respective vehicle exits the premises. It can also be modified to work for a video feedback to monitor and register vehicles passing a specific checkpoint which can be used for further security analysis.

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AUTHORS PROFILE

Aditya Rawat is a student of Manipal Institute of Technology, Manipal, India currently pursuing his degree in Computer Science Engineering. His areas of interest include algorithmic problem solving, security analysis and cryptographic systems. Recent work includes automation systems and scalable data analysis.
Email-adityarawat009@gmail.com
Tel-9740380063

Suvigya Awasthi is a student of Manipal Institute of Technology, Manipal, India currently pursuing his degree in Electronics and Communication Engineering. His areas of interest include Image Processing, Digital Signal Processing, Embedded Systems and Sustainable Energy.
Email-suvigya.a@gmail.com
Tel-9886545925