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Automatic Vehicle Number Plate Detection System Using Machine Learning

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Abstract*— Automatic number-plate recognition is a technology that uses optical character recognition on images to read vehicle registration plates using OpenCV and Tesseract OCR Engine. It can be used on existing closed-circuit television, road-rule enforcement cameras, or cameras specifically designed for the task. Using Selenium web driver, number plate recognized is parsed to the government website vahan.nic.in along with the solved captcha and the vehicle details can be accessed for further Inference and analysis. The crawled information is converted to structured and unstructured data and stored in Firebase and MySQL for data analysis and live dashboard. Through the dashboard the notification triggers can be set if a vehicle defaults any of the rules, an SMS will be sent to the mobile phone of the authority. Tested on 1500 Indian Number Plates gave us a success rate of 64% which is better than the current existing systems. As well as, successfully retrieve vehicle information from secure government website with a success rate of 75%.

***Index Terms*—Food additives, preservatives, optical character recognition, image processing, food packaging.**

I. INTRODUCTION

Automatic Number Plate Recognition or ANPR is a technology that uses pattern recognition to 'read' vehicle number plates. In simple terms ANPR cameras 'photograph' the number plates of the vehicles that pass them. This 'photograph' is then fed in a computer system to find out details about the vehicle itself. ANPR consists of cameras linked to a computer. As a vehicle passes, ANPR 'reads' Vehicle Registration Marks – more commonly known as number plates - from digital images, captured through cameras located either in a mobile unit, in-built in traffic vehicles or via Closed Circuit Television (CCTV). The digital image is converted into data, which is processed through the ANPR system. We proposed a method mainly based on edge detection, OCR operation and Finding Rectangles in a Vehicle Image.

Owning a vehicle today is not merely a symbol of luxury but has become a necessity. However, considering vehicles, any catastrophic situation can take place. Therefore there is always an urgent need to arrange appropriate measures to increase the safety, security as well as monitor the vehicles to avoid any mishap. It would help us in the situations such as: Instantaneously obtain vehicle details using image processing. Allowing an agency to detect the location of its vehicles. Automatically notify the user if there are traffic violations registered to the vehicle. One such measure is the use of a vehicle tracking system using the GPS (Global Position System). Such a tracking system includes a mechanized device that is equipped in a vehicle. Using software present at an operational base, it helps track the location of the vehicle. This base station is used for monitoring purposes. It is accompanied by maps such as Google maps, Here maps, Bing maps etc for the representation of the location.

ANPR can be used to store the images captured by the cameras as well as the text from the license plate, with some configurable to store a photograph of the driver. Systems commonly use infrared lighting to allow the camera to take the picture at any time of the day. A powerful flash is included in at least one version of the intersection monitoring cameras, serving both to illuminate the picture and to make the offender aware of his or her mistake. ANPR technology tends to be region specific, owing to plate variation from place to place. The acquisition of digital image usually suffers from undesirable camera shakes and due to unstable random camera motions. Hence image enhancement algorithms are required to remove these unwanted camera shakes. Python is used as the main programming language.

We have connected to the http://vahan.nic.in with the ANPR system to extract all the vehicle and owner details.We extract the information and save the data in JSON format for further processing and analysis.

II. LITERATURE STUDY

A. Existing system:

1. Online ANPR framework: In an online ALPR framework, the limitation and elucidation of tags occur promptly from the approaching video outlines, enabling Real-time tracking through the surveillance camera.
   Example:OpenALPR CloudWatch
2. Offline ANPR framework: A logged off ALPR framework, interestingly, catches the shovel, dumper number plate pictures and stores them in a concentrated information server for further preparation, i.e. for translation of vehicle number plate
   Example:OpenALPR Library

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Looking at the works of other countries pushes and inspire us to try to solve the challenges that we face in our country and also motivates us to use ANPR in all facets.

B. United States

Mobile ANPR use is widespread among US law enforcement agencies at the city, county, state and federal level. According to a 2012 report by the Police Executive Research Forum, approximately 71% of all US police departments use some form of ANPR. Mobile ANPR is becoming a significant component of municipal predictive policing strategies and intelligence gathering, as well as for recovery of stolen vehicles, identification of wanted felons, and revenue collection from individuals who are delinquent on city or state taxes or fines, or monitoring for "Amber Alerts".

C. United Kingdom

The Home Office states the purpose of automatic number-plate recognition in the United Kingdom is to help detect, deter and disrupt criminality including tackling organised crime groups and terrorists. Vehicle movements are recorded by a network of nearly 8000 cameras capturing between 25 and 30 million ANPR 'read' records daily. These records are stored for up to two years in the National ANPR Data Centre, which can be accessed, analysed and used as evidence as part of investigations by UK law enforcement agencies.

D. Saudi Arabia

Vehicle registration plates in Saudi Arabia use white background, but several vehicle types may have a different background. United States diplomatic plates have the letters 'USD', which in Arabic reads 'DSU' when read from right to left in the direction of Arabic script. There are only 17 Arabic letters used on the registration plates. A Challenge for plates recognition in Saudi Arabia is the size of the digits. Some plates use both Eastern Arabic numerals and the 'Western Arabic' equivalents. A research with source code is available for APNR Arabic digits.

E. Turkey

The system has been used with two cameras per lane, one for plate recognition, one for speed detection. Now the system has been widened to network all the registration number cameras together, and enforcing average speed over preset distances. Some arteries have 70 km/h (43 mph) limit, and some 50 km/h (31 mph), and photo evidence with date-time details are posted to registration address if speed violation is detected. As of 2012, the fine for exceeding the speed limit for more than 30% is approximately US$175.

F. Canada

The police service in Ontario uses automatic licence-plate recognition software [21] to nab drivers behind the wheels of vehicles with Ontario number plates.

G. Challenges in the existing system:

In the created nations the qualities of the vehicle number plate are entirely kept up. For instance, the measure of the plate, shade of the plate, text style face/size/shade of every character, dispersing between ensuing characters, the quantity of lines in the vehicle number plate, script and so on are kept up particularly. A portion of the pictures of the standard tags utilized as a part of created nations. In most academic institutions and car parks, the ongoing car park entry registration process for visitors, staff or students entering the institution involves a security guard having to confirm membership details by checking for membership sticker on the windscreen of the vehicle or by checking the driver's identification card. This process of writing is tedious and time consuming and is prone to inaccurate recordings, furthermore the backup and sharing of this vehicle information is difficult because the data is hard copy.

H. Automatic Number Plate Recognition

A city like Bangalore has multiple apartment complexes and societies, most of them also verify by checking for membership sticker on the windscreen of the vehicle. If a stranger or unknown vehicle enters, they are required to register which is time consuming. Most complexes even consider it unsafe as once a vehicle enters it is hard to track the movement of the members of the vehicle.

Security issues are the main drawback with many cars being stolen, especially when they are left at parking lots even if for a few hours, it is hard to keep a record of all the vehicles entering/exiting at peak usage times.

Thus keeping in mind these drawbacks of the traditional system we aim to get a step ahead and address each of them individually when building our solution.

Automatic license plate recognition has two major technological requirements:

1. The quality of the license plate recognition algorithms.
2. The quality of the image acquisition (camera and the illumination conditions) The better algorithms are:
   2.1 Higher is the recognition accuracy.
   2.2 Faster is the processing speed.
   2.3 Wider is the range of picture quality it can be used on.
3. Varying Indian Number Plate Formats

By and large, one LPR program can read plates from one specific nation just. This is on the grounds that the geometrical structure of the plate and introduction, text styles, and grammar were imperative parts of the LPR system. Without the earlier information of the plate geometry (character distribution, character spacing, plate colour, dimension ratios etc.), the algorithm may not even find the plate in the captured image.

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III. PROPOSED METHODOLOGY

Automatic Number Plate Recognition using an efficient OCR engine like Pytesseract along with major and vast libraries of OpenCV for image processing. As we have seen so far ANPR covers as a solution to most of the problems we have posed. We would like to dig a bit deeper now and highlight the scope of the project and the extent to which we can push the boundaries. The main issue that is usually recognized when it comes to number plate detection is the noise that is added to the image in the process of capturing the image or due to the environment around, taking that into consideration we can say that using our system, we can implement it in all environments, be it rain or even in the dark. Usually when any new system is proposed to possible clients, their main concern is the addition of new features into their existing system. Keeping this in mind we can say for sure that our system can be integrated to the pre-existing infrastructure of most clients.

Using a web crawler, number plate recognized is parsed to the government website vahan.nic.in along with the solved captcha and the vehicle details can be accessed for further Inference and analysis. Also showcase the vulnerabilities in the security of the government websites and privacy issues in government website. Also provide analytics and solution on the extracted data.

A. Advantages of the proposed system:

- To perform successful and efficient preprocessing on the raw RGB image • To exploit the high performance and effectiveness of OpenCV and Pytesseract framework to detect and recognize LP of vehicles to improve our system reliability.
- To correctly determine the number plate based on Indian Number plate Standards • To Successfully extract the information from Government vehicle information database • To Show the security vulnerabilities on vahan.nic.in

B. Algorithm to Recognize the Number Plates

The sequence of processes associated with Number plate recognition is given below. The file upload process is initiated by the data owner entity.

Input: Uploading the image file from camera

Output: Vehicle number plate in characters

1) Read the original image or Capture the image
2) Resize the image
3) Convert it to grayscale.
4) Apply Bilateral Filter. What is a bilateral filter? A bilateral filter is a non-linear, edge preserving, and noise-reducing smoothing filter for images. It replaces the intensity of each pixel with a weighted average of intensity values from nearby pixels.
5) Identify and store the Canny edges. What are Canny edges? The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images.
6) Find the contours in from the edges detected and sort the top 30 contours.
7) Get the perimeter of each contour and select those with 4 corners.
8) Automatic Number Plate Recognition
9) Mask all other parts of the image and show the final image.
10) Read the text using Tesseract OCR
11) Standardize the text to Indian vehicle number plate format
12) Stop

On upload of the image file to the system, the number plate recognition system performs its functions to provide the output.

Algorithm to Extract Vehicle Information from Vahan.nic.in

The sequence of processes associated with extracting the vehicle information from vahan.nic.in . The information is extracted from the website

Input: Vehicle Number plate characters

Output: Vehicle information

1. Initialize the Selenium web driver
2. Open the (vahan.nic.in) url in the web driver
3. Find the Captcha Element
4. Captcha Element is then converted to string
5. Captcha is solved based on the written rules
6. Captcha Solution is determined
7. The Vehicle Number and Captcha Solution are sent to their input field using Keys function 7. The Search button is pressed using the click function in Selenium
8. The Vehicle details are then extracted as text
9. The text is converted into JSON data and stored in a database

Data selection, pre-processing, transformation into a structured and understandable format, dataset balance, application of supervised learning algorithms, and evaluation of machine learning performance are all essential steps in the methodology used.

The very first step in the system we are trying to propose is to detect the number plates from the image we are passing. Consider the Number plate as an object and to recognise it we have to use different object detection algorithms. There are two different concepts which come into picture which are object classification and localization. Classification is nothing but classifying the type of object like a car, bike or a person and localization is locating where the particular object is in the image by drawing lets say a bounding box over it. Object detection is a combination of both classification and localization of the object in the image. The GPU centric, efficient algorithm we are proposing to use to detect the object area from the image is the YOLO algorithm (You Only Look Once).

Character Recognition: After detecting the number plate area it needs to be cropped from the video frame and feed

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forward to a character recognition network. Before that the cropped number plates need to be pre-processed to get a more accurate output.

Once the image has been pre-processed, the system will look for potential plates within it. Once the plates have been located, image contours can be determined, and then any characters present in the scene can be identified. As a first step, the programme locates all possible contours; then, it only includes those that could potentially be characters. The next phases involve attempting to recognise each group of matching characters as plates, given a list of all available characters.

Every set of matched characters will first be detected and recognised, and then an extraction attempt will be made. When everything is said and done, the plate information will be printed on the Original image fed into the system and made available in text form. The current object detectors are known to be slow when actually used for training our models because they require more GPUs for training and also train with huge micro batched size. This type of model is sometimes unfeasible because of the lengthy training process. To address this problem, YOLOv4 advocated employing a single GPU and a reduced micro batched size to do object detection. which means training on a single 1080Ti or 2080Ti GPU is lightning quick. When the algorithm is effective, it's important to make sure the photos we're using are high-quality enough to aid the algorithm and improve the entire model's accuracy in countries like India. Some of the things we may think about include the camera's iris size, shutter speed, angle, and position to see if we can improve the camera's performance. It's also possible to think about the lens size and the brightness of the surrounding light.

Before detecting bounding boxes, YOLO divides the image into 13x13 cells (the bounding box is the rectangle which encloses the object). The algorithm's level of certainty that the object to be detected is contained within the bounding box is represented by the confidence score YOLO provides. The score does not identify the item type, but rather the degree of certainty with which one can state whether or not an object is within a given bounding box. We can calculate the total number of bounding boxes as n*n*5 = 185, given that there are n*n grid cells and each detects n*n bounding boxes. For instance, if there are 845 bounding boxes and the grid has 13x13 cells, and each of those cells detects 5 bounding boxes, the total bounding boxes is 13*13*5 = 845. The beauty of this method, as suggested by its name, "You Only Look Once," is that all 845 boxes were predicted simultaneously.

Data selection, pre-processing, transformation into a structured and understandable format, dataset balance, application of supervised learning algorithms, and evaluation of machine learning performance are all essential steps in the methodology used. Identifying license plates in the viewed image is the initial stage of the method we are proposing. In order to recognise a license plate, it is necessary to employ several object detection methods. Object classification and localisation are two distinct ideas that must be considered. Classification simply identifies the object type, such as a car, bike, or human, while localization pinpoints the exact location of that object within an image by tracing a box around it. Object detection involves two distinct but related processes: picture categorization and object location. Specifically, we propose using the YOLO algorithm, a GPU-centric, efficient algorithm for detecting the object area in an image (You Only Look Once).

After the license plate region has been identified, it must be extracted from the video frame and fed into a character recognition network for processing. It is necessary to pre-process the cropped license plates in order to achieve a reliable result.

The first step in putting the idea into action is to bring in the necessary python libraries and tools. A total of four libraries—OpenCV (for images), Numpy (for math), Matplotlib (for image plotting), and Pytesseract (for OCR)—were brought in (OCR). Once the necessary libraries have been loaded, I then import the image by specifying its location, saving it in a variable with the same name.

In preprocessing, a coloured image is defined as one in which the red, blue, and green values of a pixel's scalar are individually set. Class M*N*3 array. It takes m*n*3 bits to save a single pixel of an RGB colour image, whereas it only takes m*n bits to store a single pixel of a grayscale image. Therefore, storing a grayscale image will require 33% more memory than storing a full-color image. It is far simpler to manipulate a single-layered (grayscale) image than a three-layered (colour, transparency, and intensity) one, making grayscale images ideal for use in a wide range of applications (RGB colour image). Additionally, when working with a single-layered image, it is simpler to identify individual details. Our next step, after grayscaling, is to blur the resultant grey image to lessen the overall visual impact of the noise. Passing a picture through the kernel of a low-pass filter creates a blurred effect. Effectively eliminating unwanted sounds is a major benefit. It filters out the image's high-frequency information. Thus, this process does result in blurred edges, though other blurring methods exist. The grey image can be blurred in a variety of ways. When this is complete, we can go on to Step 2 and employ the double threshold technique to establish connections and identify edges. The Canny edge detector is a good approximation of the operator that maximises the sum of the localization and signal-to-noise ratio. Because of its optimal output, well-defined edges, and precise detection, we will utilise the Canny edge detector to extract the edges from the blurred image. The first derivative of a Gaussian is typically used for this purpose. From an image with edges extracted, we will then extract the image's contours. Image objects' contours are the smooth, uninterrupted lines or curves that enclose their entire periphery. Soon after we locate contours, we will begin categorising them. The ability to sort contours is very helpful in the field of image processing. We will employ area to sort

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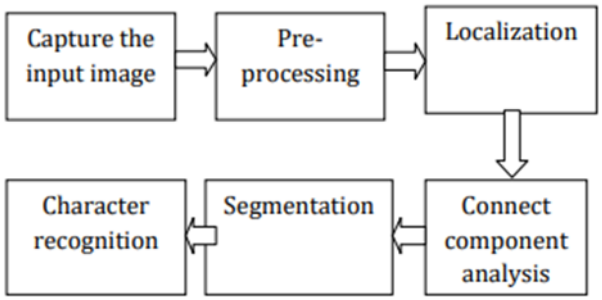
contours, eliminating small, noise-generated contours in favour of larger ones that carry license plate information. Given that we are only working with the frontal view of the car, and since we can reasonably assume that the area of the number plate covers most of the region in an image, we will select the top 10 contours to locate our number plate. After we're done sorting the contours, we'll create a new variable called "plate" and assign the value "none" to it, since we haven't been able to locate the number "plate" using rectangle coordinates. As soon as we find a car's license plate, we'll run tesseract on it to decipher the characters. OCR (optical character recognition) in Python is possible with python-tesseract. Simply put, it can decipher and read words from within photos.

IV. FLOW CHART



V. RESULT & VALIDATION

Testing is the process of checking whether the actual results obtained meet the expected results and to ensure that the software system is free from any kind of defects. It involves execution of a software component or system component to evaluate one or more properties of interest. Software testing also helps to identify errors, gaps or missing requirements in contrary to the actual requirements. It can be either done manually or using automated tools.

Testing is an important phase in the development life cycle of the product. Testing performs a very critical role for quality assurance and ensuring the reliability of the software. Each test has a different purpose, all work to verify that all the system elements have been properly integrated and perform allocated functions. The testing process is actually carried out to make sure that the product exactly does the same thing that it is supposed to do. Testing is the final verification and validation activity within the development environment.

The system was successfully tested on 1500 Indian number plates where we found that, Out of the 1500 Number plates, 948 number plates could be recognized perfectly. Whereas it failed for the rest of the 552 case. Failure occurred in differentiating characters like M and N, P and R, 8 and B.

Out of the 948 Successful Number plate recognitions. 715 number plates had records in Vahan.nic.in. Rest 233 number plates can be deemed as fake or a record doesn't exist with the government. 73 Number plates were to be found with inactive RC or do not have the permission to be used

The success rate in evaluating the captcha was 99%. The algorithm efficiently determined solution at all the given test cases. It also shows the vulnerability in government websites.

VI. OUTPUT

Fig. 1. Number plate detection

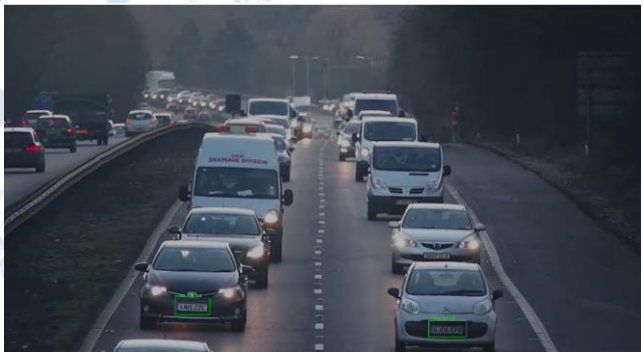


Fig. 2. Number plate Detection through video

VII. CONCLUSION & FUTURESCOPE

Through this project it is possible to recognise Vehicle registration numbers through digital image processing. From this system we have effortlessly obtained the various results such as • Whether the vehicle which is registered is blacklisted or not.

- This also enables one single user to effectively monitor the traffic, and can easily locate the traffic violated vehicle.
- The data can be easily stored and transferred which makes the system more efficient.

The system has been designed using a modular approach which allows easy upgrading and/or substituting of various sub-modules thus making it potentially suitable for a large range of vision applications. The performances of the system makes it a valid choice among its competitors especially in

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those situations when the cost of the application has to be maintained at reasonable levels. Furthermore, the modular architecture makes it extremely flexible and versatile.

The earlier methodologies which have been implemented have not been as accurate and efficient as the designed Recognition system, this is because of the implementation of digital Image Processing which gives an accuracy of 90% under normal conditions

This Project is based on automatic vehicle license plate recognition, in which it is observed that the existing techniques don't pay much attention towards improving the system's efficiency in terms of its power consumption. As the objective in our proposed design is to reduce power consumption of the system, with the successful implementation of the same it will play a very important role in traffic management and security systems such as automobile theft prevention, parking lot management etc. implementations of the software algorithm have shown promising results. The system can be made more robust if high precision cameras can be used to increase overall accuracy if this system is implemented in real time applications. Also a sensor can be designed to allow the camera to capture the image only when required to save power.

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