AUTOMATIC NUMBER PLATE DETECTION

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Abstract:

The increase in the number of vehicles on Indian roads has grown at a progressive rate to prompt the need for an automated system to keep records of vehicles for different uses. The proposed project for this dissertation is to develop an effective technique to identify Indian vehicle number plates from the recorded images and also it is designed to be cost-effective, with a lower cost compared to todays advanced systems. Practicality the proposed system is able to handle on noisy, low illumination, cross angled and non standard font number plates. The pre-processing that occurs in the system is morphological transformation, Gaussian smoothing, Gaussian thresholding, Sobel edge detection. After this, number plate segmentation, contours are applied by border following, and on the basis of character dimensions and spatial localization of the contours they are further filtered. Last but not the least, the extracted characters are subjected to Optical Character Recognition (OCR). The identified texts are saved to the database and can be filtered and made searchable from this area. This type of system finds one of its major uses in controlling the entry of cars into individual apartments and housing societies by automating the management of the same. This means that when the number plate details are stored in a database, then the security checks will not frequently be needed and this will enhance the level of security, ease and efficiency in handling the number plate checking system while at the same time saving on the employees who have to complete the security checks.

Keywords: Indian vehicle number plates, image processing, morphological transformation, Gaussian smoothing, Sobel edge detection, Optical Character Recognition (OCR), database management, security enhancement, automation.

1. INTRODUCTION

Automatic Number Plate Detection practically incorporates innovative image processing to the smart cities and IoT systems. It has the significant function of updating urban infrastructure related with the automation of the integrated identification and analysis of vehicle registration plate data. Especially in India where population as well as numbers of vehicles are rapidly growing, ANPD has a potential to increase the efficiency in every domain. There are several complex steps in ANPD systems and one of them is real time image acquisition, with the help of high resolution cameras. Filtering operations such as morphological operations and Gaussian filtering enhance the quality of images, which is very important for the segmentation of the number plates. This process helps to eliminate the unwanted influence of different environmental conditions on the given plates and, as a result, guarantees their optimal performance. Alphabetic characters are also interpreted by character recognition made possible with the help of OCR where cramped numbers on the plates are expanded to locate state or union territory codes, details of the regional transport office, or the personalized vehicle registration number. This proposed system is simpler and therefore a low cost system compared to today's advanced ANPD systems. This makes it a suitable solution for small Institutions, individual apartment and housing societies where the demand of an efficient vehicle management is rising. Our system is designed to suit the needs of these communities, which could undoubtedly become their regular and effective tool to manage vehicles' entrance and parking. From this study, it is seen that with the integration of this system, the small Institutions or individual apartments or the societies can boost the security standards and can also cut down the additional physical efforts that are mandatory for making a house as a residence for a human being.

2. PROBLEM ANALYSIS

Absence of Advanced Machine Learning Techniques: Depending on the font and lighting conditions, other methods are less accurate in identifying text in regular, let alone difficult, positions. Merging machine learning particularly CNNs into the automation process can help in improving the flexibility and accuracy. Complexity of Number Plate Formats: Different style and format of number plates found in India further make it difficult in detection and OCR. The use of adaptive algorithms along with the character-level classification will help in improving the accuracy. Scalability and Performance: Higher image resolution or dataset can actually cause the deterioration of its performance. Algorithms can be further optimized and high-performance computing can help in increasing the speed and scalability of a solution. Verification and Error Handling: Some of the applications cannot afford to be off in any way; hence this calls for high accuracy. There are ways to maximize reliability such as doing error correction, human verification and further improvement in the chosen procedure. Deployment and Maintenance Challenges: Policy application in real

life entails changes regarding regulations and different setting. Long term high performance is therefore maintained through field testing and constant update.

3. SYSTEM REQUIREMENTS:

3.1 Hardware Requirements:

Processor	: intel i3
Memory (RAM)	: 4 GB
Hard disk	: 256 GB
Camera	: A camera is essential for capturing clear images of Indian vehicle number plates.

3.2 Software Requirements:

Operating System	: Windows 10
Programming Language	: Python 3.7
IDE	: PyCharm
Libraries	: sys, os, glob, numpy, cv2, PIL, pytesseract, re

3.3 Libraries Explanation:

sys: Provides access to some variables used or maintained by the Python interpreter and to functions that interact with the interpreter. It's used for system-specific parameters and functions.

os: Provides a way of using operating system dependent functionality like reading or writing to the file system. It allows the ANPD system to interact with the underlying operating system.

glob: Used to retrieve files/pathnames matching a specified pattern. It is helpful for file management, such as loading images from a directory.

NumPy: A core Python package for scientific computing. It supports large multidimensional tables and arrays and mathematical functions to work with these tables. In the ANPD system, NumPy is used for numerical operations on image data, such as tabulation and mathematical calculations.

OpenCV (cv2): An open-source computer vision and machine learning software library. It includes several hundred computer vision algorithms. For the ANPD system, OpenCV is used for image processing tasks such as reading images, applying filters, edge detection, morphological transformations, and more.

Python Imaging Library (PIL)/Pillow: A fork of the Python Imaging Library that adds some user-friendly features. It is used for opening, manipulating, and saving many different image file formats. In the ANPD system, Pillow is used for image manipulation tasks like resizing, cropping, and converting images to different formats.

pytesseract: A Python wrapper for Google's Tesseract-OCR Engine. It is used to recognize and read text embedded in images. In the ANPD system, pytesseract is crucial for extracting text from number plate images, enabling optical character recognition (OCR).

re: The regular expressions library in Python. It provides tools for matching strings or substrings, allowing for complex text processing and pattern matching. In the ANPD system, re is used to validate and format the recognized text from number plates, ensuring it matches expected patterns for vehicle registration numbers.

4. METHODOLOGY:

The proposed methodology consists of four major phases: pre-processing, detection, recognition, and searching. While recognising number plates on the Indian vehicle, it is necessary to prepare the dataset which consists of the images where the number plate is visible. In the pre-processing phase, the image is first cleaned up to remove any noise or unnecessary details that may be present in the image. This is done to ensure that the image is smooth and clear, making it easier to work with and analyze.

The cleaning process involves removing any unwanted marks, spots, or blemishes that may be present on the image, resulting in a much clearer and more refined image.

Next, the image is converted from color to black and white, which simplifies the image and makes it easier to analyze. This step is important because it allows us to focus on the changes in intensity in the image, which is crucial for detecting edges and identifying objects.

By converting the image to black and white, we can eliminate any distractions caused by colors and focus on the underlying patterns and shapes in the image. After that, the edges in the image are detected using a special technique that calculates the rate of change in intensity at each point in the image. This helps to identify the boundaries of objects in the image, making it easier to distinguish between different objects and features.

The edge detection process is a critical step in the methodology, as it allows us to identify the shapes and patterns in the image and extract meaningful information from it.

Additionally, a special filter is applied to the image to enhance the brightness and darkness of certain objects, making them stand out more clearly.

This step is important because it helps to highlight the features of the objects in the image, making it easier to identify and analyze them. The filter works by adjusting the contrast and brightness of the image, making it easier to distinguish between different objects and features.

In the detection phase, the number plate is identified and isolated from the rest of the image. This is done by tracing the contours of the objects in the image and identifying the ones that match the characteristics of a number plate.

The detection process involves analyzing the shapes and patterns in the image and identifying the ones that are most likely to be a number plate. This is done using a combination of algorithms and techniques that are specifically designed to detect number plates. Once the number plate has been detected, it is then resized to a suitable size to make it easier to process.

This involves adjusting the dimensions of the number plate to make it easier to analyze and extract information from it. The resizing process is important because it allows us to focus on the key features of the number plate, such as the characters and numbers, and extract meaningful information from it.

In the recognition phase, the characters on the number plate are recognized and extracted using a special technique called Optical Character Recognition (OCR).

The OCR process involves analyzing the characters on the number plate and identifying them using a database of known characters. The extracted characters are then stored in a database, where they can be searched and retrieved as needed.

Finally, in the searching phase, the stored characters can be quickly retrieved and matched against a database for applications such as vehicle identification, access control, and monitoring within individual apartments, housing societies, and small institutions. This comprehensive approach ensures accurate and efficient number plate recognition, making it a robust solution for these specific environments.

5. SYSTEM ARCHITECTURE

The system architecture of our automatic number plate detection system is meticulously designed to ensure efficient and accurate recognition and searching of number plates. It consists of four major phases: pre-processing, detection, recognition, and searching.
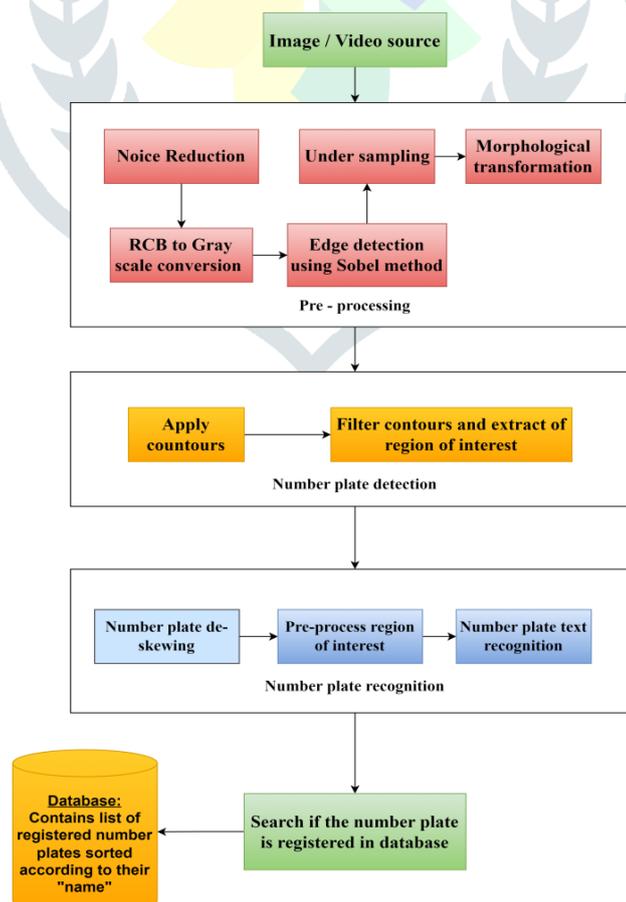
5.1 Dataset Preparation : While recognizing number plates on the Indian vehicle, it is necessary to prepare the dataset which consists of the images where the number plate is visible. These images form the basis of the training as well as the validation process of this system. The dataset shall depict various situations such as various lighting, angles, and different number plates for additional security.
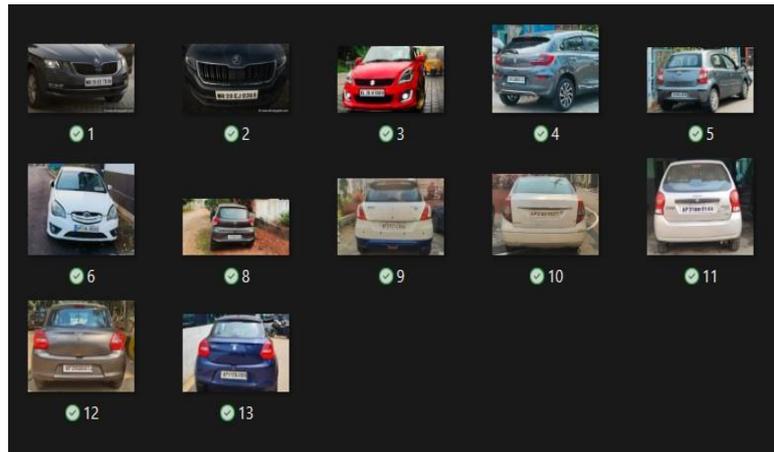
5.2 Pre-processing

Pre-processing is crucial for enhancing image quality and isolating the relevant features of the number plate. This stage prepares the image for subsequent steps by improving its clarity and focusing on important details.

5.2.1 Noise Reduction (Gaussian Smoothing): Subsequently, the input image undergoes a processing step in order to reduce the noise present in the image and unwanted details. To reduce this effect, the technique known as Gaussian smoothing is performed in order to reduce the influence of noise. This filter minimizes the amount of noise that tends to blur up the image by averaging the pixels, this makes the number plate to contrast well with the background more than before.

Noice-reduced Image

5.2.2 RGB to Grayscale conversion: This is to convert the images from colored ones into a grayscale mode for simplifying the processing and reducing data to be processed. This enables us process them easily than color images because they have only one-color channel.

Grayscaled Image

5.2.3 Edge detection using Sobel method: The image edges are detected by use of the Sobel method applied in order to extract and identify plate region boundaries. In identifying lines, vertical and horizontal edges through two 3×3 kernels of the Sobel operator which starts at a specific point on each axis. The image is then divided into regions of interest (ROIs) by creating a binary mask that represents areas with high gradient magnitudes on the original image as white pixels and others as black pixels. This method calculates the image intensity gradients that directly correspond to brightness changes present along object edges such as characters on the number plate.

Edges Detected with sobel filter

5.2.4 Under-sampling: order to decrease the resolution and eliminate redundant information, the image is subjected to under-sampling. High-resolution images are down sampled to fall within a required resolution threshold for efficient computing resource management. This operation reduces the size of an image while keeping the crucial details needed for further processability.

Under Sampled Image

5.2.5 Morphological transformation: The image is subjected to morphological transformations that enhance lighter and darker objects in it. In this case, top-hat and black-hat morphological operations have been applied to increase contrast between the number plate and background. The first one highlights bright features on dark backgrounds while the latter conversely makes the registration mark distinguishable from other parts of an image. By using these filters, noise can be removed as well as enhancing its contractiveness.

Morphologically Transformed Image

The output of this phase is a pre-processed image that is ready for detection. The pre-processing phase is critical because it sets the stage for the rest of the system. If the image is not properly pre-processed, the detection and recognition phases may not work correctly.

5.3 Detection

In this phase, the number plate is detected and extracted from the pre-processed image. This involves several steps:

5.3.1 Application of Contour: The algorithm that generates Contours is also called Border Following or Contour Tracing. An equal intensity points link along the boundary is called a contour. Thus, finding contours in OpenCV appears like discovering white object out of black background for instance during Adaptive Gaussian Thresholding phase Inversion operation needs to be carried out.

5.3.2 Filtering and Extracting ROI: Contours assist in identifying small regions within images such as sharp edges or noise outliers. At first all the individual contours will have their bounding boxes drawn around them and then filtering criteria are set up such as minimum area, width-height ratio and aspect ratios. This process effectively separates number plate candidates from irrelevant contours thus leading us closer to detecting it.
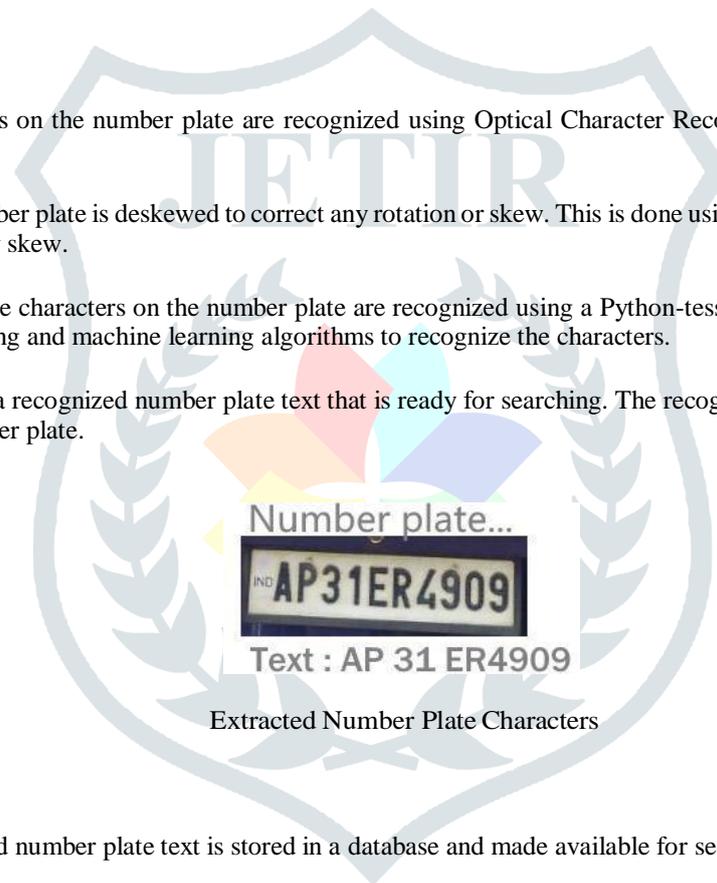

Detected Number Plate

5.4 Recognition

In this phase, the characters on the number plate are recognized using Optical Character Recognition (OCR) techniques. This involves:

5.4.1 Deskewing: The number plate is deskewed to correct any rotation or skew. This is done using a deskewing algorithm, which rotates the image to correct any skew.

5.4.2 Text recognition: The characters on the number plate are recognized using a Python-tesseract OCR tool. This tool uses a combination of image processing and machine learning algorithms to recognize the characters.

The output of this phase is a recognized number plate text that is ready for searching. The recognition phase is critical because it extracts the text from the number plate.

Extracted Number Plate Characters

5.5 Searching

In this phase, the recognized number plate text is stored in a database and made available for searching. This involves:

5.5.1 Database creation: A database is created to hold the recognized plate texts. The database is designed to hold the plate texts in a fast and scalable way.

5.5.2 Sorting: The database is sorted using quick sort to make searching fast. This is to make the database searchable fast.

5.5.3 Searching: A new image is passed through the system, the recognized plate text is searched in the database using binary search. This is to check if the plate is in the database or not.

The output of this is a yes or no result. This phase is important because it allows the system to search plates fast.

The following screen shows the detected number plates

```
HELLO!!
Welcome to the Number Plate Detection System.

Detected plate number: MH20EE7598
Detected plate number: AP31BE9507
Detected plate number: AP31BW8144
Detected plate number: AP39GBE813
Detected plate number: AP31ERZ999
Detected plate number: MH20EJ0365
Detected plate number: KL26H5009
Detected plate number: AP40BR9L33
Detected plate number: AP28CL2678
Detected plate number: AP31B9009
Detected plate number: AP39GF2349
Detected plate number: AP3ICY2334
```

Detected Number Plates

The following screen shows the sorted number plates

```
The Vehicle numbers registered are:-
AP28CL2678
AP31B9009
AP31BE9507
AP31BW8144
AP31ERZ999
AP39GBE813
AP39GF2349
AP3ICY2334
AP40BR9L33
KL26H5009
MH20EE7598
MH20EJ0365
```

Sorted Number Plates


```
The car number to search is: AP31BW8144

The Vehicle is allowed to visit.
```

Searched – output

(Image)

Searched – output

6. CONCLUSION:

This project introduces a robust and innovative solution for Automatic Number Plate Detection specifically tailored to handle the nuances of Indian vehicle number plates using cutting - edge image processing techniques. Through the seamless integration of morphological transformations, Gaussian smoothing, thresholding, Sobel edge detection, and Optical Character Recognition (OCR), the system adeptly tackles the inherent challenges posed by noisy, poorly illuminated , and non - standard font number plates . These techniques collectively enhance the clarity and accuracy of plate recognition, ensuring reliable performance across diverse environmental conditions. In practical applications, spanning domains such as individual apartments, housing societies and small institutions, the system has demonstrated unparalleled efficacy. By automating the labor - intensive task of vehicle identification and management, it not only streamlines operations but also significantly reduces dependency on manual oversight, thereby enhancing operational efficiency and reducing costs. The scalability and adaptability of the developed ANPD system are particularly noteworthy, facilitating its seamless integration into existing urban infrastructures and IoT frameworks. Its capability to consistently deliver precise results underscores its reliability in real - world scenarios, contributing to enhanced security measures, optimized traffic management, and improved user experience across urban landscapes.

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