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Monitoring and Detection of Tampered Number Plate Recognition

Shreyas MS[1], Yamini Rathore[2], Vivek Kumar[3], Vanukuri Prasant Reddy[4]

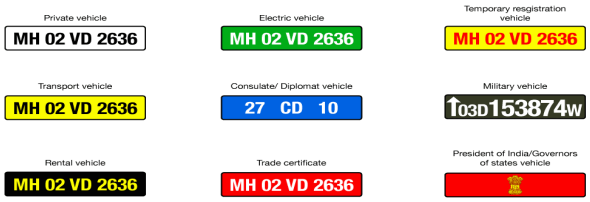
Abstract: ***The growing incidents of tampered and damaged vehicle number plates present significant challenges to law enforcement and intelligent transportation systems, as these alterations allow offenders to evade identification and accountability.This project, Detection and Monitoring Defective Number Plate System, aims to enhance traditional ANPR systems by incorporating automated detection and classification of tampered and damaged plates, offering a more comprehensive solution for traffic law enforcement and public safety. The system utilizes a combination of deep learning models, including YOLOv3 for real-time number plate detection and a Convolutional Neural Network (CNN) for classifying plates as tampered, damaged, or intact.***

I. INTRODUCTION

There are large number of vehicles in todays generation around the world. So it is very important to keep track on vehicles. In todays world we can use computer to keep track any vehicles without manually looking keeping track on vehicles because of which there will be better accuracy. Thus vehicle number plate recognition system is a technology used which identifies the number plate from video captured by the camera. It uses methods like extraction of number plate, segmentation, character recognition,etc. This system is a combination of hardware plus software which uses the number plate and then sends this number plate to convert it to image. This technology can be used in any gate entrances. Thus this system can be accurate if image extracted from the number plate captured by camera is clear and visible. The image used should be of very good resolution

1) Automated Number Plate Recognition(ANPR):

Discuss the evolution and importance of ANPR systems, widely used in smart cities, traffic monitoring, toll collection, and security enforcement. Explain how these systems have been implemented in various settings, such as traffic lights, toll booths, and parking lots, to identify vehicles based on license plates.



2) Technologies in Image Detection andClassification:

Describe how advances in deep learning, especially Convolutional Neural Networks (CNNs) and object detection models like YOLO (You Only Look Once), have revolutionized object detection and image classification tasks. This background introduces readers to the methods the project will use.

II. PROBLEM STATEMENT

Number plates can also be damaged naturally over time, due to factors like harsh weather, accidental scratches, or fading paint. These conditions make it difficult for ANPR systems to read the plates accurately, reducing the effectiveness of vehicle identification.

The project aims to address these challenges by developing a solution capable of:

1) Detecting tampered and damaged plates in real time through video footage.
2) Classifying plates as either tampered, damaged, or undamaged, with high accuracy.
3) Recognizing readable characters on plates despite the tampering or damage.

Figure 1 Broken Number Plate

III. LITERATURE REVIEW

A. *Intelligent System for Vehicle Number Plate Detection Using Convolutional Neural Networks*

1) Methodology:

- Image Acquisition and Preprocessing
  - ➢ Images are captured using a camera in real-time.
  - ➢ RGB images are converted to grayscale for faster processing.
  - ➢ A template matching algorithm is used for detecting the number plate region.
- Super-Resolution Techniques
  - ➢ A learning-based super-resolution method enhances low-resolution images.
  - ➢ This is essential for recognizing blurredor low-quality number plates.
- Segmentation
  - ➢ The Bounding Box method is applied to extract individual characters.
  - ➢ It segments the city name, vehicle type, and registration number.
- Feature Extraction & Recognition (CNN-based Approach)
  - ➢ Convolutional Neural Network (CNN) is used for character recognition.
  - ➢ Uses AlexNet, a CNN model that extracts 4096 features per character.
  - ➢ The Rectified Linear Unit (ReLU) activation function handles vanishing gradient problems.
  - ➢ The model was trained using 700 number plate images from the Bangladesh Road Transport Authority.]

2) Key Findings

- CNN performed better than traditional methods like SVM and ANN.
- The super-resolution technique improved recognition rates in poor-quality images.
- The system achieved 98.2% accuracy in detecting number plates and 90.9% accuracy for character recognition.

3) Strengths

- Works well with low-resolution images.
- High accuracy (98.2%) due to deep learning.
- Robust against variations in lighting and angles.

4) Weaknesses

- Computationally expensive due to CNN.
- Training requires a large dataset.
- Performance may drop in real-time, high-speed conditions.

B. *Automatic License Plate Recognition Using Extracted Features*

1) Methodology:

- License Plate Detection using Vertical Edge Detection Algorithm (VEDA):
  - ➢ VEDA is used to detect vertical edges of the number plate.
  - ➢ It is 7-9 times faster than the Sobel edgedetector.
- ImageNormalization&Enhancement

- The image is converted to grayscale and enhanced.
- Small unwanted edges are removed using statistical and morphological techniques.
- Segmentation
- The binary image transformation method is applied.
- Connected Component Analysis (CCA) is used to separate characters.
- CharacterRecognition
- Uses Template Matching-based Optical Character Recognition (OCR).
- Cross-correlation is used to compare characters with stored templates.
- Normalized cross-correlation helps minimize errors.

2) Key Findings

- The system works well under various lighting conditions.
- Achieved 84.8% accuracy on a dataset of 500 real-world images.
- Execution time: <0.5 seconds, making it faster than CNN-based models.

3) Strengths

- Fast processing time (0.5s per image).
- Works well under different lighting conditions.
- Efficient for real-time applications like toll booths and parking.

4) Weaknesses

- Lower accuracy (84.8%) compared to CNN-based methods.
- Not robust to tilted or distorted plates.
- Cannot handle blurred images well.

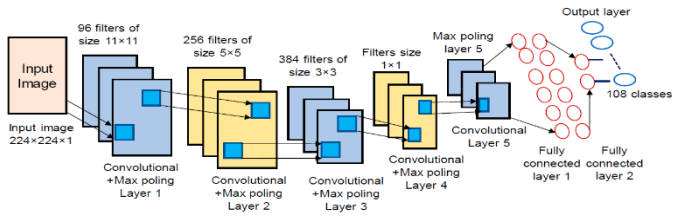
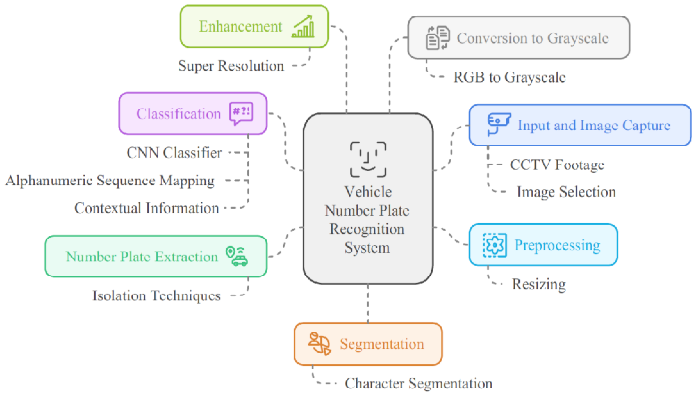


Figure 2 convolutional neural network (CNN) architecture for vehicle number plate recognition

Figure 3 Types of Number Plates in India



Overview of a vehicle number plate recognition using Neural Networks

IV. PROPOSED SOLUTION/APPROACH/WORK

In this section, you would describe the proposed system designed to address the identified gaps and challenges. This system will be a comprehensive, real-time monitoring solution that can detect, classify, and recognize tampered or damaged number plates effectively.

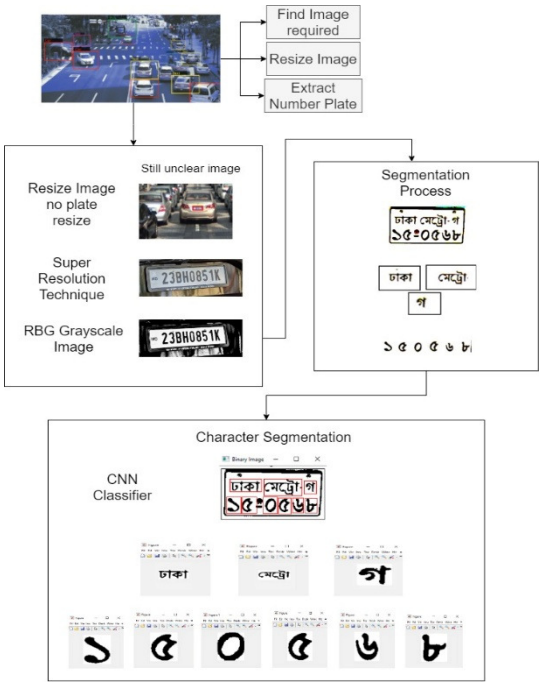


Figure 4 A project flowchart methodology

A wide array of proposed systems and approaches for vehicle number plate detection and recognition, addressing various challenges and leveraging different techniques.

A. Proposed Solution:

1) YOLOv7 for Real-Time Detection:

To detect number plates in video streams, YOLOv7 will be used due to its high accuracy and speed. YOLOv7's architecture is well-suited for detecting small objects like number plates even when vehicles are moving or partially occluded.

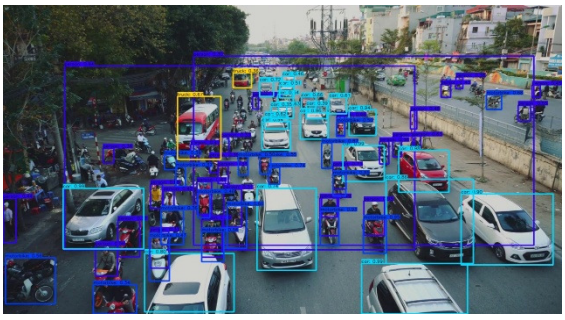


Figure 5 YOLOv7 for image recognition

2) CNN-Based Classification for Tamper and Damage Detection

A Convolutional Neural Network (CNN) will be trained to classify detected plates into categories of tampered, damaged, or undamaged. By training the model on a labeled dataset of tampered, damaged, and clean plates, the system can learn patterns that indicate tampering (e.g., altered characters, partial covering) and damage (e.g., scratches, fading).

3) OCR for Character Recognition:

The system will integrate Optical Character Recognition (OCR) to read and record the characters on number plates. A custom CNN-based OCR model, trained specifically on license plates, can be used to improve recognition accuracy, even on partially damaged plates.

4) Real-Time Monitoring and Alert System:

To facilitate timely response by authorities, the system will include a **real-time alert feature*. When a tampered or damaged plate is detected, an alert will be issued to notify law enforcement or traffic management personnel. This feature is essential forproactive security and compliance enforcement.

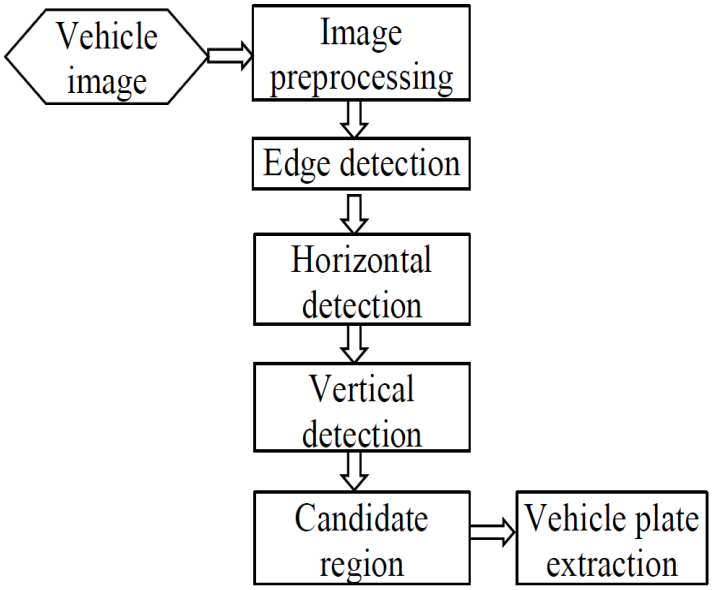


Figure 6 Block diagram of the proposed method

V. METHODOLOGY

A. Algorithms/Techniques/Approaches

The diagram below will summarize the steps to identify and separate license plates from clips:

First from the clip, we will cut each photo frame from the input clip to process and separate the number plate. In the scope of this project, the main idea is to recognize the number plate from the sudden change in light intensity between the license plate and the surrounding environment, so we will remove the RGB color data by switching to a gray image. Next, we increase the contrast with the two morphological operations Top Hat and Black Hat to further highlight the number plate in the background, supporting the later binary processing. Then, we reduce the noise with a Gauss filter to remove noise details that can affect the recognition process, and at the same time speed up processing.

Taking the threshold will help us separate the license plate information and background information, here I choose to take the dynamic threshold (Adaptive Threshold). Next, we use the Canny edge detection algorithm to extract the edge details of the number plate. In the process of computer processing that can confuse number plates with noisy details, the final filtering by the proportions of height/width or the area of the number plate will help determine the correct number plate. Finally, we will determine the location of the number plate in the photo by drawing a contour around it.

VI. RESULTS

Figure 7 Number Plate Detection & Classification

VII. ADVANTAGES

CNNs offer significant advantages for vehicle number plate recognition due to their powerful feature extraction capabilities, robustness to various challenges, and high accuracy, making them a leading approach in this field.

VIII. LIMITATIONS

The limitations of the current system will be outlined, with suggestions for improvements. These might include refining tamper detection, increasing the dataset size, integrating other technologies (e.g., AI-powered cameras), or scaling the system for use in large cities.

IX. CONCLUSION

In this research, a system is proposed for detecting and recognizing vehicle numberplates in Bangladesh, which are written in the Bengali language. In this system, the imagesof the vehicles are captured and then the number plate regions are extracted using the templatematching method. Then, the segmentation of each character is performed. Finally,a convolutional neural networks (CNN) is used for extracting features of each characterthat classifies the vehicle city, type, and number, to recognize the characters of the numberplate. The CNN provides a large number of features to help with accurate recognitionof characters from the number plate. This research used super resolution techniques torecognize characters with high resolution. In order to evaluate the experiment results,700 vehicle images were appointed. After training,the CNN acquired 98.2% accuracy based on the validation set, and attained 98.1% accuracybased on the testing set. This system can also be used for the number plates writtenin other languages in the same way.

X. FUTURE SCOPE

the future of CNN-based vehicle number plate recognition systems lies in achieving higher accuracy and robustness under increasingly challenging real-world scenarios, seamless integration with smart city infrastructure, greater adaptability to global number plate variations, and the incorporation of complementary technologies for enhanced performance and reliability.

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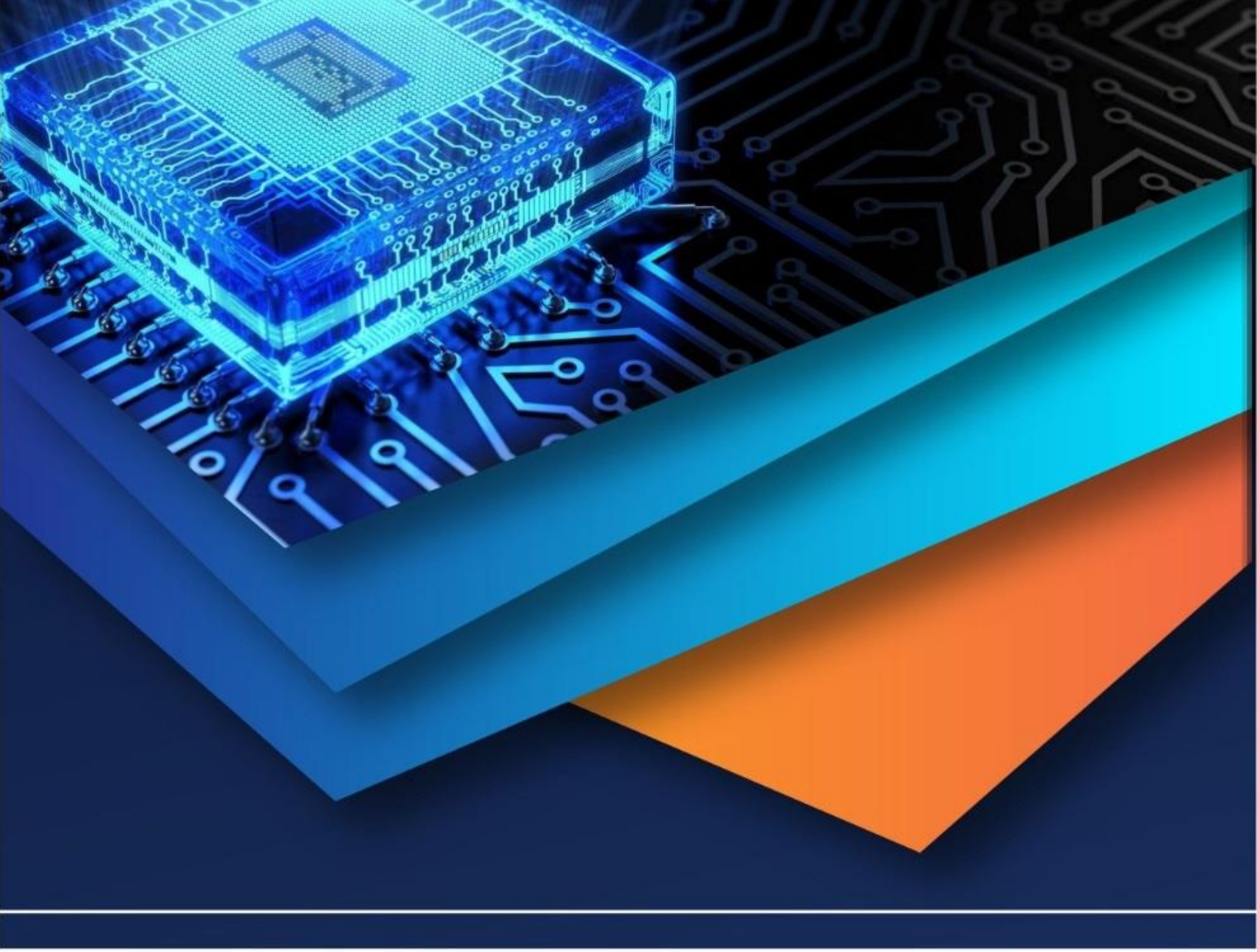

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