

Automatic HSRP Licence Plate Detection System Using Image Processing

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Abstract

Automatic High Security Registration Plate (HSRP) detection has become an important research area in intelligent transportation systems due to the increasing demand for automated vehicle identification and monitoring. This paper presents an Automatic HSRP Licence Plate Detection System using Image Processing techniques for accurate detection, recognition, and verification of vehicle number plates. The proposed system follows a systematic image processing pipeline including image acquisition, grayscale conversion, noise reduction, edge detection, image binarization, morphological operations, and licence plate localization. EasyOCR is integrated for character recognition and extraction of alphanumeric information from detected HSRP plates. The system is implemented using Python with OpenCV, Imutils, Pillow, NumPy, and EasyOCR libraries to ensure modularity, efficiency, and real-time processing capability. Experimental results demonstrate high detection accuracy and effective recognition performance under normal operating conditions. The proposed approach offers a reliable, software-based, and cost-effective solution suitable for intelligent transportation systems, traffic surveillance, toll management, parking systems, and vehicle verification applications.

Index Terms—Automatic HSRP, Licence Plate Detection, Image Processing, OpenCV, OCR, EasyOCR, Vehicle Verification, Intelligent Transportation Systems

1. Introduction

Automatic Licence Plate Recognition (ALPR) systems play a significant role in modern intelligent transportation and traffic management systems. Due to the rapid growth in the number of vehicles, manual monitoring and verification of vehicle registration numbers has become difficult, time-consuming, and highly prone to human error. Automated systems capable of detecting and recognizing vehicle licence plates are therefore essential for efficient transportation management.

In India, the implementation of High Security Registration Plates (HSRP) has introduced a standardized format for vehicle identification. HSRP plates contain features such as fixed dimensions, reflective sheeting, chromium holograms, laser-etched serial numbers, and standardized fonts. These security

features help prevent vehicle theft, cloning, forgery, and illegal vehicle operations.

Although HSRP plates improve standardization, automatic detection and recognition remain challenging due to varying illumination conditions, shadows, low image quality, motion blur, complex backgrounds, tilted plates, and environmental disturbances. Therefore, robust image processing techniques are required to accurately detect and extract the licence plate region from vehicle images. The proposed system uses image preprocessing, edge detection, contour analysis, segmentation, and OCR-based character recognition to automatically detect and verify HSRP licence plates. The system aims to provide an efficient, low-cost, and scalable solution for traffic monitoring and intelligent transportation applications.

2. Related Work

Several researchers have proposed Automatic Licence Plate Recognition systems based on image processing and OCR techniques.

Anagnostopoulos et al. [1] presented a comprehensive survey on licence plate recognition methods using still images and video sequences. Their work highlighted challenges related to illumination, segmentation, and character recognition.

Du et al. [2] discussed state-of-the-art ALPR systems focusing on segmentation, feature extraction, and OCR approaches. Their work emphasized the importance of preprocessing for improving detection accuracy.

Kaur and Aggarwal [4] proposed a licence plate detection system using grayscale conversion, edge detection, and contour analysis. The system demonstrated improved localization accuracy for standard vehicle number plates.

Patel et al. [7] specifically focused on High Security Registration Plate detection using image processing techniques. Their work validated the effectiveness of standardized HSRP features such as reflective backgrounds and fixed dimensions. Recent studies also explored fake plate detection and HSRP verification using geometric analysis, font consistency, and OCR-based validation methods. However, existing systems still face challenges under poor illumination, complex traffic environments, tilted images, and motion blur conditions. Therefore, an efficient and reliable automated HSRP verification system remains necessary for intelligent transportation applications.

3. Methodology

A. Software Requirements

The proposed system was developed using the following software tools:

- Python 3.x
- OpenCV Library
- EasyOCR
- NumPy
- Imutils
- Pillow Library
- Matplotlib

B. Hardware Requirements

- Intel i5 Processor or above
- Minimum 8 GB RAM
- Webcam / Digital Camera
- Windows/Linux Operating System

C. Dataset Collection

Vehicle images containing HSRP number plates were collected under different environmental conditions including day-light, shadows, and varying distances. The dataset contains multiple vehicle categories such as cars, bikes, and commercial vehicles.

D. Libraries Used

OpenCV was used for image preprocessing and contour extraction. EasyOCR was used for character recognition. NumPy handled matrix operations, while Imutils simplified contour manipulation and image resizing operations.

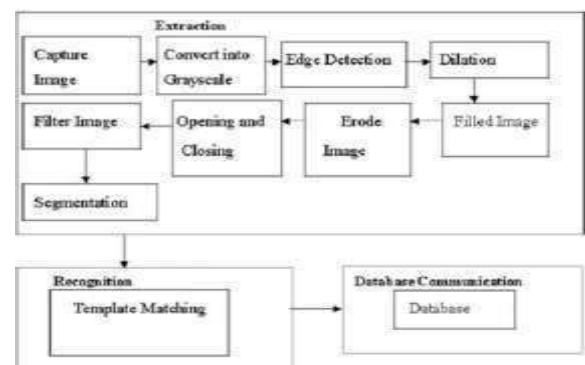


Fig. 1. Block Diagram of HSRP Detection System

A. Camera Initialization

The process begins with camera initialization. The camera captures the front view of the vehicle which acts as the primary input for the HSRP detection system.

C. Image Acquisition

The captured image is converted into digital format for further image processing operations.

D. RGB to Grayscale Conversion

The RGB image is converted into grayscale to reduce computational complexity while preserving edge and intensity information.

E. Image Binarization

Thresholding techniques are applied to convert grayscale images into binary images for better foreground-background separation.

E.Noise Reduction

Gaussian filtering and smoothing operations are performed to reduce image noise and improve edge continuity.

F. Edge Detection

Canny edge detection is applied to identify object boundaries and locate rectangular licence plate structures.

G. Morphological Operations

Dilation and erosion operations improve contour connectivity and remove small unwanted regions from the image.

H.Licence Plate Localization

Contour detection techniques identify the Region of Interest (ROI) containing the licence plate.

I.Character Segmentation

The extracted plate region is segmented into individual characters using contour analysis methods.

J. Character Recognition

EasyOCR extracts alphanumeric characters from the segmented HSRP plate image.

K. Plate Verification

The recognized plate number is validated against HSRP formatting standards and verification databases.

4. Results and Discussion



The proposed system was implemented using Python 3.x and tested on multiple HSRP vehicle images under different environmental conditions.

Fig. 3. Original Vehicle Image

Figure 3 shows the original vehicle image captured from the input camera module before preprocessing operations.

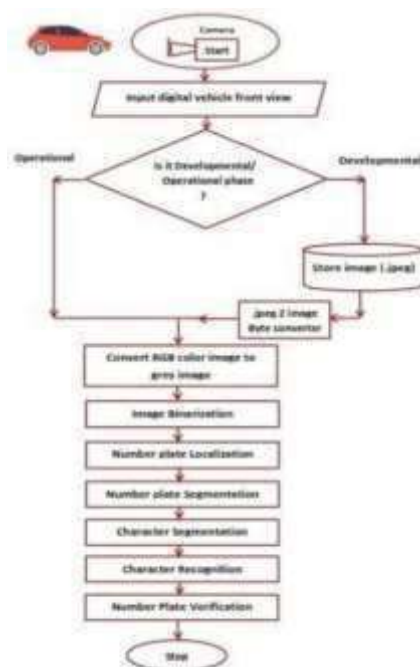


Fig. 2. Flow Chart of Proposed Methodology

Fig. 4. Gray Scale Conversion

Figure 4 illustrates the grayscale converted image which reduces computational complexity while preserving essential edge information.

Figure 5 represents the output of edge detection where the boundaries of the licence plate are highlighted.

Figure 6 shows the morphological processing stage which improves contour continuity and removes unwanted noise regions.



Fig. 5. Edge Detection



Fig. 6. Morphological Processing

Figure 7 shows the final cropped licence plate extracted from the vehicle image for OCR-based recognition.

A.Key Learnings

- Grayscale conversion reduced computational complexity.
- Noise removal improved edge continuity.
- Morphological operations enhanced contour extraction.
- EasyOCR improved recognition accuracy for Indian HSRP plates. Detection accuracy reduced slightly under poor lighting conditions.

B. Performance Evaluation

TABLE I



Performance Evaluation

Performance Parameter	Observed Result
Licence Plate Detection Accuracy	92-95%
OCR Recognition Accuracy	85-90%
HSRP Verification Accuracy	95%
Average Processing Time	< 1 second/image
False Detection Rate	Low
Licence Plate Detection Accuracy	92-95%
OCR Recognition Accuracy	85-90%
HSRP Verification Accuracy	95%
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False Detection Rate	Low
Licence Plate Detection Accuracy	92-95%
OCR Recognition Accuracy	85-90%
HSRP Verification Accuracy	95%
Average Processing Time	< 1 second/image
False Detection Rate	Low



Fig. 7. Detected Plate Crop

TABLE II

Comparison with Existing Systems

Feature Existing Systems	Proposed System	Plate Detection Accuracy
EasyOCR	92-95%	85-90%
EasyOCR	95%	95%
EasyOCR	< 1 second/image	< 1 second/image
EasyOCR	Low	Low

sed SystemPlate DetectionGen ericHSRP- focusedVerifica tionLimitedF ormat- basedAutoma tionPartialFul ly AutomatedCo stHighLowFle xibilityModer ateHigh Existing SystemsPropo sed SystemPlate DetectionGen ericHSRP- focusedVerifica tionLimitedF ormat- basedAutoma tionPartialFul ly AutomatedCo stHighLowFle xibilityModer ateHigh	icHSRP- focusedVerifica tionLimitedFor mat- basedAutomati onPartialFully AutomatedCost	focusedVerifica tionLimitedFor mat- basedAutomati onPartialFully AutomatedCost Plate DetectionGener icHSRP- focusedVerifica tionLimitedFor mat- basedAutomati onPartialFully AutomatedCost
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FlexibilityModerateHigh	ModerateHigh	High

D. Comparative Analysis

5. Conclusion

This paper presented the design and implementation of an Automatic HSRP Licence Plate Detection System using Image Processing for intelligent transportation applications. The proposed system successfully integrates image preprocessing, edge detection, morphological operations, contour extraction, and OCR-based recognition techniques to automatically detect and verify HSRP licence plates. Experimental evaluation demonstrated high detection accuracy and effective OCR recognition under standard operating conditions. The system reduces manual effort, minimizes human error, and provides a reliable and cost-effective automated solution for vehicle verification and traffic surveillance. Future improvements may include deep learning-based object detection models, cloud database integration, real-time deployment on embedded systems, and improved performance under adverse environmental conditions.

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