License Plate Recognition Using Image Processing Techniques

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Abstract

This study examines different image processing techniques to improve the accuracy of License Plate Recognition (LPR). Our goal was to find the best method for making license plates clearer and easier to detect. We applied techniques like smoothing (using Averaging and Gaussian Filters), sharpening, edge detection (Sobel and Canny Operators), and contrast enhancement (histogram equalization) to see which gave the best results. For license plate detection, we used a pre-trained model from Roboflow's *License Plate Recognition Computer Vision Project*, and for reading the characters, we used easyOCR. To measure the effectiveness of each method, we compared the confidence levels of the recognized characters. The histogram equalized images stood out, achieving the highest confidence level of 81%, surpassing all other methods in performance.

1. Introduction

License Plate Recognition (LPR) is widely used in applications like traffic management and security, where accurately detecting and reading license plates is crucial. However, recognizing plates clearly can be challenging, especially when dealing with blurry images, poor lighting, or other distortions. In this study, we explore different image processing techniques to improve the clarity of license plates and boost recognition accuracy. We tested methods like smoothing, sharpening, edge detection, and contrast enhancement to see which works best. Using a pre-trained model from Roboflow's License Plate Recognition Project for detection and easyOCR for reading the characters, we compared the results based on the confidence levels of the recognized characters. Our goal is to find the most effective approach for making license plates easier to detect and read accurately.

2. Methodology

2.1 Dataset

The images or dataset used for testing the License Plate Recognition (LPR) with different image processing techniques was collected using a smartphone camera. It captures vehicles with a plate number attached and visible. These images were processed with different image processing techniques with a goal to enhance

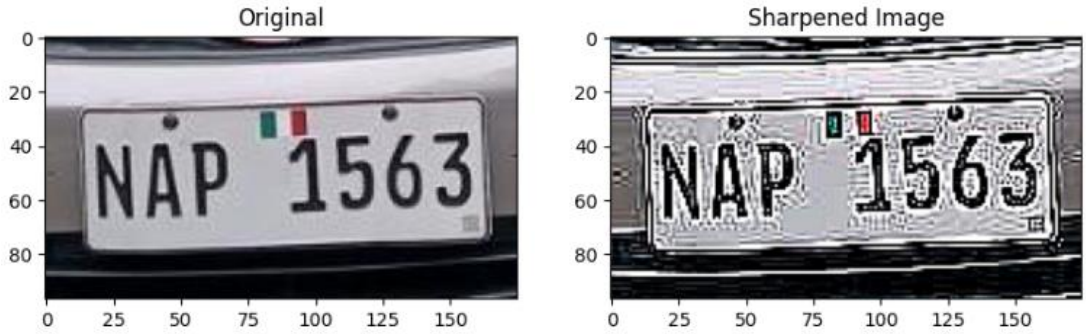
the visibility of the characters to improve the License Plate Recognition (LPR) systems. Vehicle used in the image was a personal vehicle.

2. 2 Smoothing Filters

The first image processing technique used for the study is smoothing filters. This includes two different techniques: Averaging Blur and Gaussian Blur. Averaging Blur is a simple way of A simple way of blurring an image by taking the average of neighboring pixel values. On other hand, Gaussian Blur applies a weighted average that gives more importance to central pixels, reducing the effect of distant neighbors.

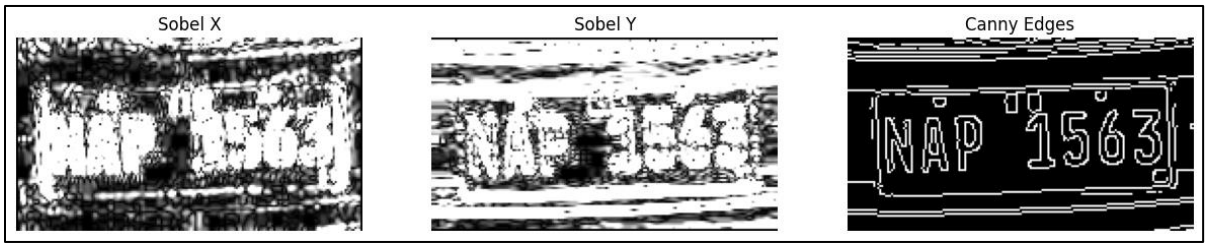
2. 2 Sharpening

Another image processing techniques used for the study is sharpening. It enhances the edges by amplifying the differences between pixel values in the vicinity.



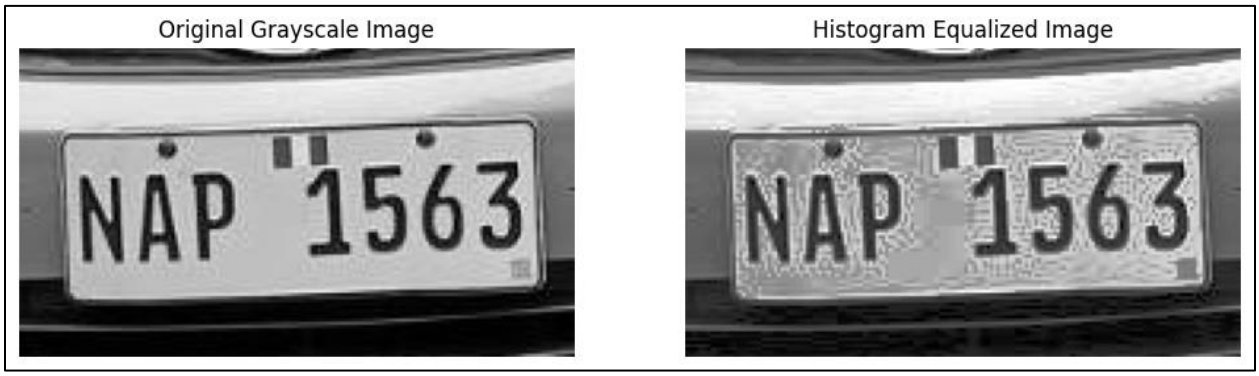
2.3 Edge Detection

Edge detection techniques were used to emphasize the boundaries of the imprints more clearly. The Sobel and Canny methods were applied to make the edges stand out, which helped define the text on the license plate more sharply.



2.4 Histogram Equalization

Histogram equalization enhances an image's contrast by redistributing its intensity values, spreading them more evenly across the entire range of pixel brightness. This technique is especially useful for images that appear overly dark or overly bright, helping to reveal more detail.



2.5 License Plate Detection

To identify the license plates in the images, we used a pre-trained model from the Roboflow Universe that is publicly available. It was developed by Roboflow itself. To access the model, we need to run the follow block of code to our project:

```
from inference_sdk import InferenceHTTPClient


CLIENT = InferenceHTTPClient(
    api_url="https://detect.roboflow.com",
    api_key="IJgd8jCLHIdJE3mNjMvJ"
)
result = CLIENT.infer(your_image.jpg, model_id="license-plate-recognition-rxg4e/4")
```

To further enhance the license plate number reading, once the license plate is detected, it will be automatically cropped. See the image below.

Original Image

Cropped Image

2.6 easyOCR

To detect the text within the cropped license plate image, we utilized a publicly available Optical Character Recognition (OCR) the easyOCR. It is a ready-to-use OCT Ready-to-use OCR with 80+ supported languages and all popular writing scripts including Latin, Chinese, Arabic, Devanagari, Cyrillic, etc.

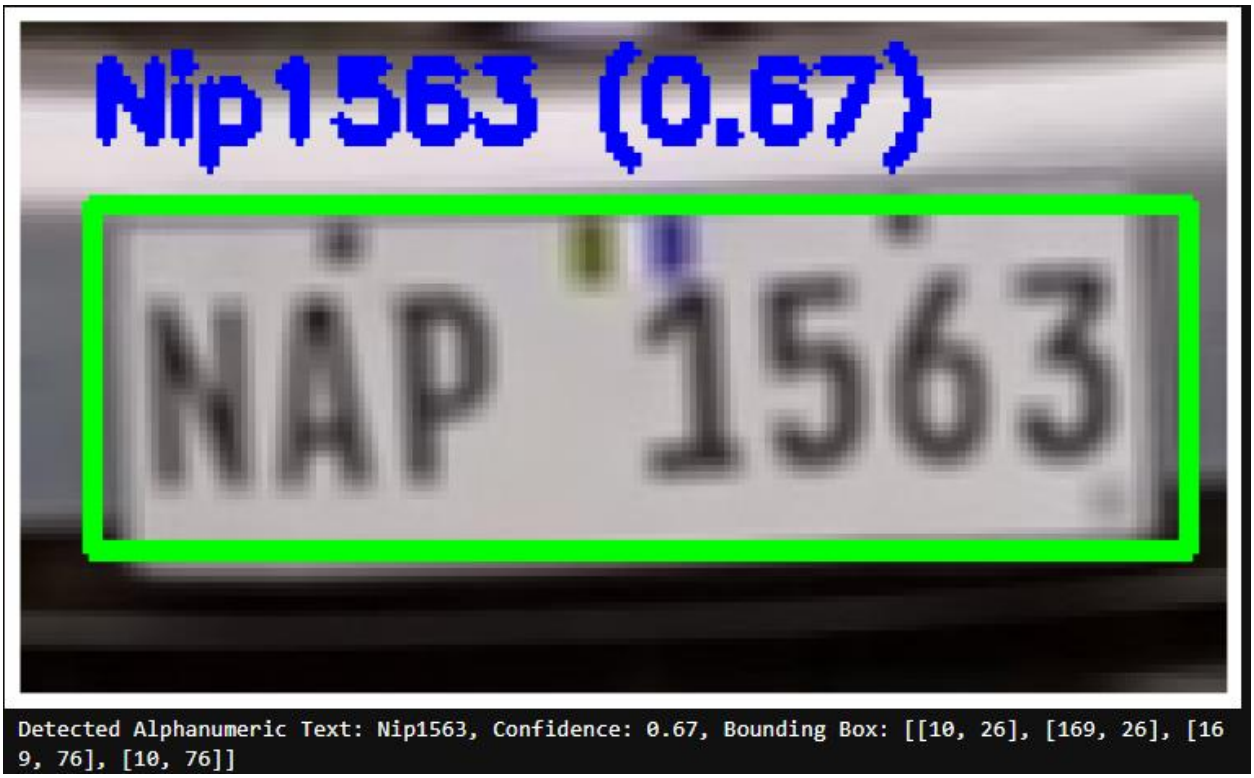
3. Results and Discussion

This section discussed the detailed analyzation of each image processed in different image processing methods. The objective of this discussion is to find the effectiveness of these image processing techniques in the improvement of License Plate Recognition Systems. We will compare the different processed images based on the output text and confidence level of the recognition.

Images below are the processing image and the results of the OCR detected:

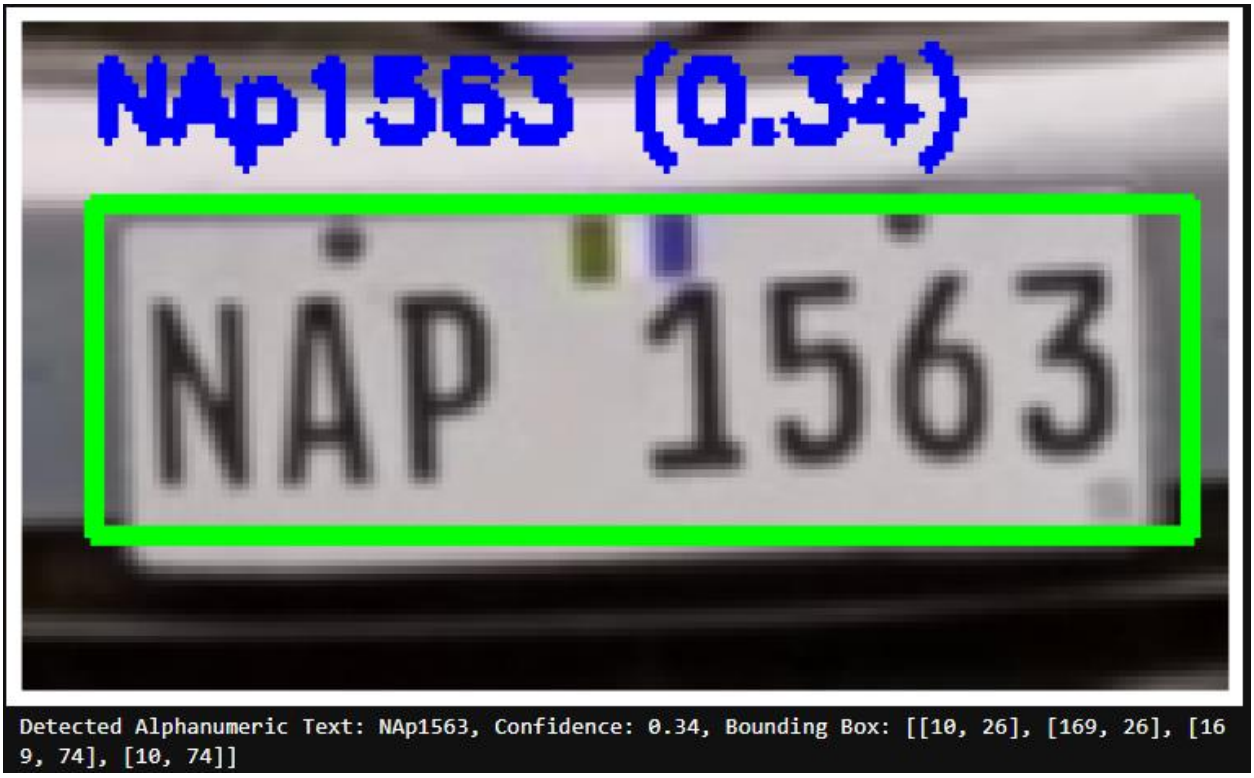
Original Image

Averaging Blur



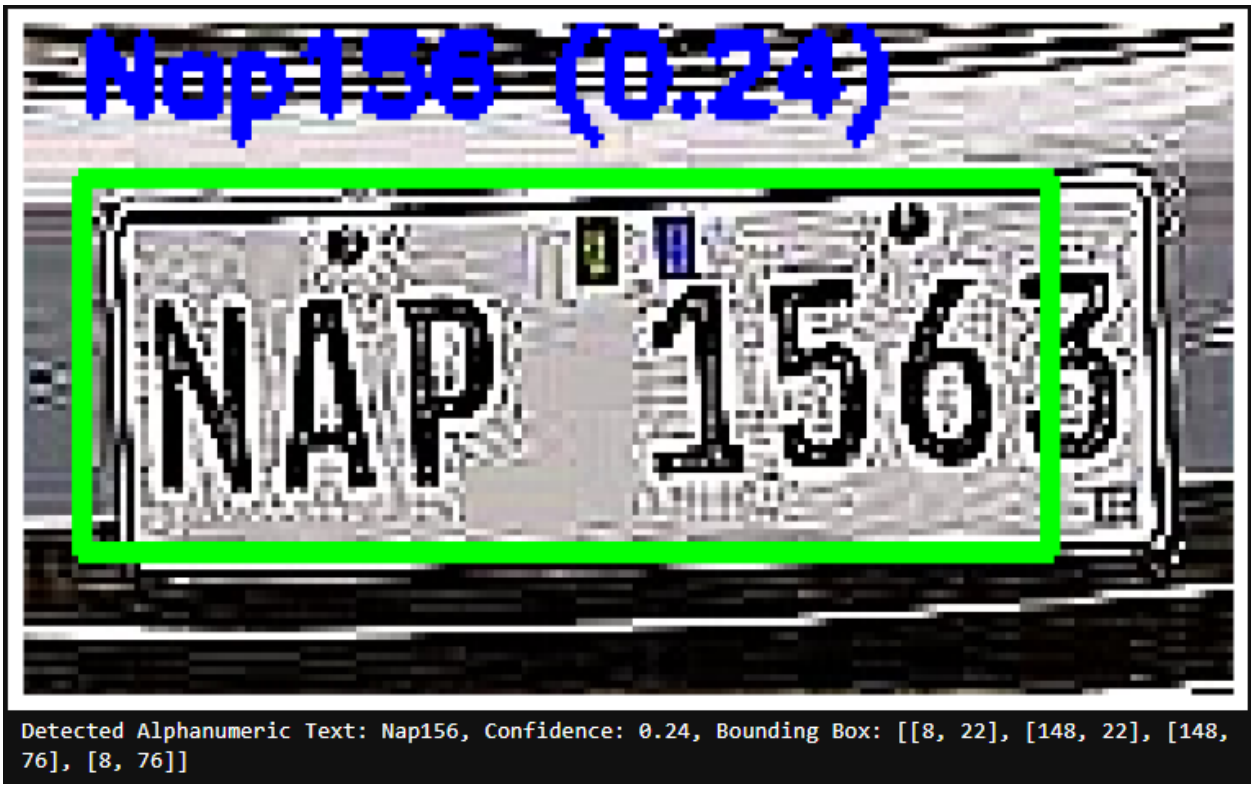

```
Detected Alphanumeric Text: Nip1563, Confidence: 0.67, Bounding Box: [[10, 26], [169, 26], [16
9, 76], [10, 76]]
```

Gaussan Blur



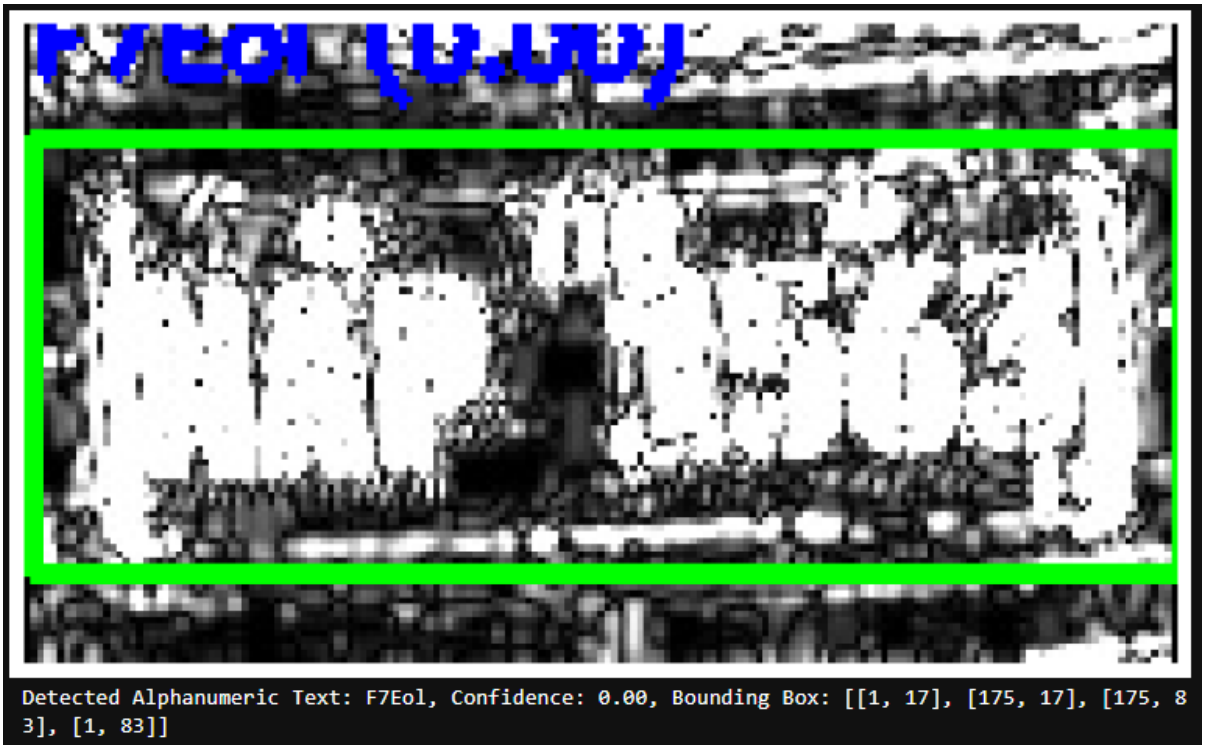

```
Detected Alphanumeric Text: NAp1563, Confidence: 0.34, Bounding Box: [[10, 26], [169, 26], [16
9, 74], [10, 74]]
```

Sharpened Image



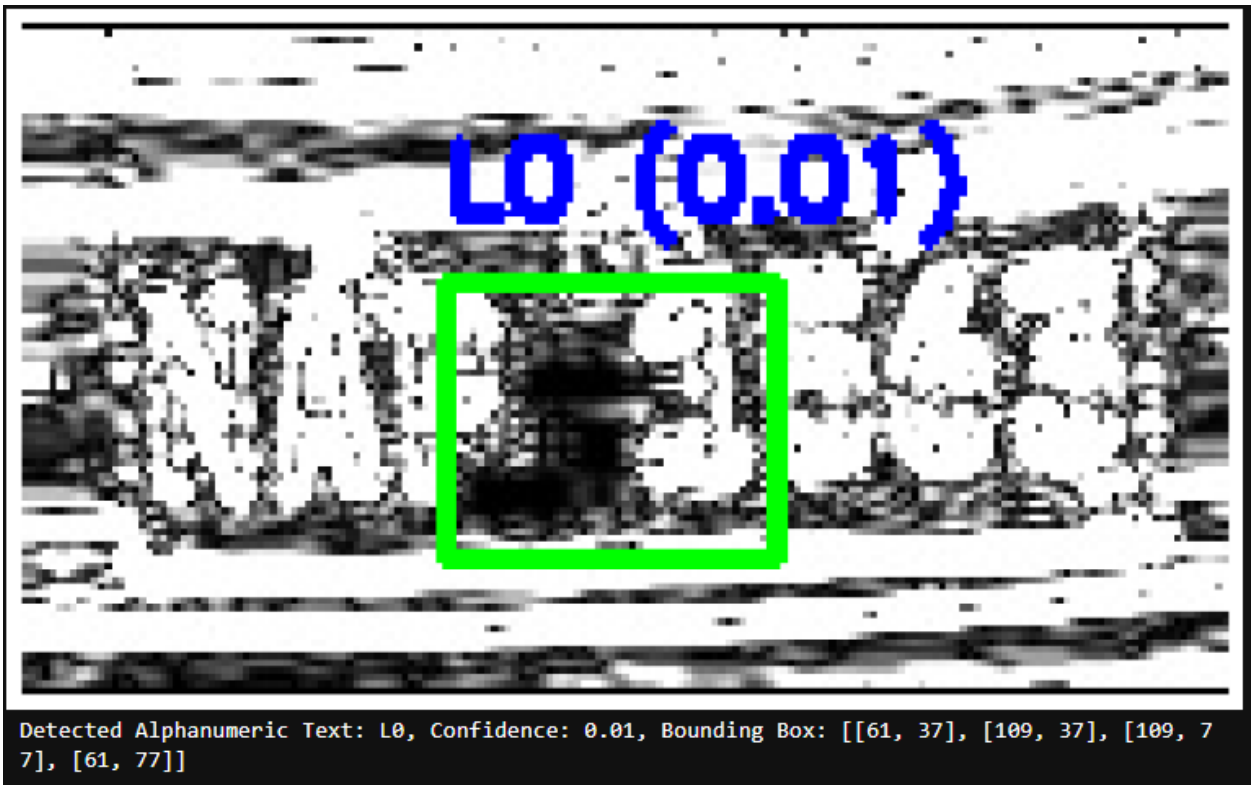

```
Detected Alphanumeric Text: Nap156, Confidence: 0.24, Bounding Box: [[8, 22], [148, 22], [148, 76], [8, 76]]
```

Sobel X




```
Detected Alphanumeric Text: F7Eol, Confidence: 0.00, Bounding Box: [[1, 17], [175, 17], [175, 83], [1, 83]]
```

Sobel Y



Canny Edges

Gray Image


```
Detected Alphanumeric Text: NAp1563, Confidence: 0.70, Bounding Box: [[13, 29], [165, 29], [16
5, 73], [13, 73]]
```

Histogram Equalize Image


```
Detected Alphanumeric Text: NAp1563, Confidence: 0.81, Bounding Box: [[10, 26], [169, 26], [16
9, 76], [10, 76]]
```

Results

Image	Detected Text	Confidence Level
Original	**NAP 1563**	**0.68**
Averaging Blur	**NIP 1563**	**0.67**
Gaussian Blur	**NAP 1563**	**0.34**
Sharpened	**NAP 153**	**0.24**
Sobel X	**F7Eol**	**0.00**
Sobel Y	**L0**	**0.01**
Canny Edges	**Blank, 15631**	**0.40, 0.39**
Gray	**NAP 1563**	**0.70**
Historgram Equalized	**NAP 1563**	**0.81**

The table presents the results of various image processing techniques applied to detect text in a license plate and their corresponding confidence levels. The original image had a confidence level of 0.68 with the detected text as "NAP 1563." Averaging and Gaussian blur methods yielded slightly lower confidence levels of 0.67 and 0.34, respectively, while sharpening reduced accuracy, detecting "NAP 153" with a lower confidence of 0.24. Sobel edge detection methods, particularly Sobel X and Y, produced poor results, with Sobel X showing no detected text and Sobel Y yielding an irrelevant string ("L0") and a confidence of 0.01. The Canny edge detection method produced two results: one blank with a lower confidence and "15631" with confidence levels of 0.40 and 0.39. The grayscale transformation improved detection with a confidence level of 0.70, while histogram equalization proved to be the most effective, achieving the highest confidence level of 0.81, maintaining accurate text detection as "NAP 1563."

4. Conclusion

In conclusion, the results demonstrate that histogram equalization is the most effective image processing technique for improving license plate recognition in this study. With a confidence level of 0.81, it outperformed all other methods, including blurring, sharpening, and edge detection, by significantly enhancing the clarity and contrast of the license plate text. The original and grayscale images also provided relatively good results, while Sobel edge detection and sharpening techniques resulted in poor performance. Therefore, contrast enhancement through histogram equalization is recommended for optimizing license plate recognition in challenging image conditions.