Journal of Positive School Psychology
2022, Vol. 6, No. 5, 5400–5405

Indian Vehicle Number Plate Detection and Recognition using Deep Learning

Lalitha Madanbhavi[1],Geeta R. Bharamagoudar[2],Nikita Parakh[3], Nikhil Pujari[4]
Praveen Kakhandaki, Meena S.M[6]

[1]KLE Technological University Hubballi, India,[2]KLE Institute of Technology Hubballi, India,
[3,4,5,6] KLE Technological University Hubballi, India
[1] lalita@kletech.ac.in,[2]geetatotad@yahoo.co.in,[3]30nikitajain@gmail.com
[4] ncpnikhil05@gmail.com,[5]shreepavkk@gmail.com [6]msm@kletech.ac.in

Abstract

The increase in the number of vehicles in the last few years has made it challenging to manually note the number plate text of the vehicle. Hence, in order to reduce the manual work, there is a need to propose a methodology that can detect the number plate region from the input image and recognize the characters of the number plate. Systems have been built for the same using Image Processing techniques, but this technique fails to provide accurate results occasionally in the case of real data. Modern technology such as Deep Learning overcomes this problem. Hence, a deep learning-based methodology is proposed to detect the number plate region from the input image and recognize its characters. Using the Region-based Convolutional Neural Networks (RCNN), the number plate region is detected and using Convolutional Neural Networks (CNN), the characters are recognized from the detected plate region. Once the characters of the number plate are obtained, the system derives the name of the state to which the vehicle belongs, and using the Vahan-info website, the complete details of the vehicle are obtained. The system also stores the number plate text with its state name into the database to maintain a record of number plates detected. The proposed system provides promising results, resulting in an accuracy of 98.46% for RCNN model and an accuracy of 95.98% for CNN model.

Keywords— Deep Learning, RCNN, CNN

I. INTRODUCTION

In recent years, the population of vehicles has been increased drastically which has made it difficult for the authorities to identify the vehicles in case of any violation. The manual approach to identify the vehicles would be arduous and exigent whereas modern technology can resolve it in a convenient manner. The Number Plate Recognition System has turned up to be one of the useful and convenient approaches for vehicle management and surveillance. The Number Plate Recognition System uses the number plate of the vehicle to identify the vehicle and can be used in various domains like traffic monitoring, challan management, detection of stolen vehicles, electronic payment of tolls on highways or bridges, parking lots access control. Addressing the above mentioned subject, a system is built that proposes a number plate detection and recognition system that identifies the vehicle by its number plate. The proposed system would facilitate the authorities to easily manage the vehicles. The proposed system is built using deep learning methodology that detects the number plate of the vehicle using RCNN and the characters of the number plate are recognized using a CNN model that is trained for all 36 characters. Once the number plate characters are obtained, the system derives the name of the state to which the vehicle belongs and provides complete

information about the vehicle. The system also stores the number plate text and its state into the database to maintain records of detected number plates.

II. PROPOSED METHODOLOGY

Number Plate Detection and Recognition is carried out with three main aspects; Number Plate Detection, Character Segmentation, and Character Recognition. Figure 1 depicts the flow of solution for the proposed methodology at the simplest level.

Figure 2 depicts the architectural framework for Number Plate Detection and Recognition. It consists of five phases -

Phase 1: Building RCNN Model to Detect Number Plate Phase 2: Number Plate Detection

Phase 3: Character Segmentation

Phase 4: Character Recognition Phase 5: Save to the database

Building RCNN Model to Detect Number Plate- During phase-1, a Regional based Convolutional Neural Network (RCNN) model is built by applying a Selective search algorithm on each image of the dataset. This algorithm divides the image into 2000 regions, and for each region based on IoU computed, the region is classified into plate or not plate and in this way, a new dataset called use data is generated. Using this newly generated data, the RCNN model is trained. Figure 3 shows the architecture of the RCNN Model.

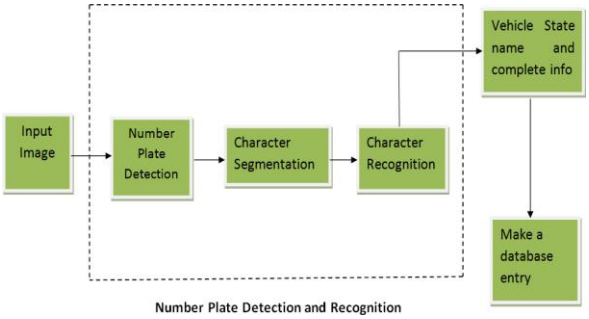


Figure 1: Block Diagram

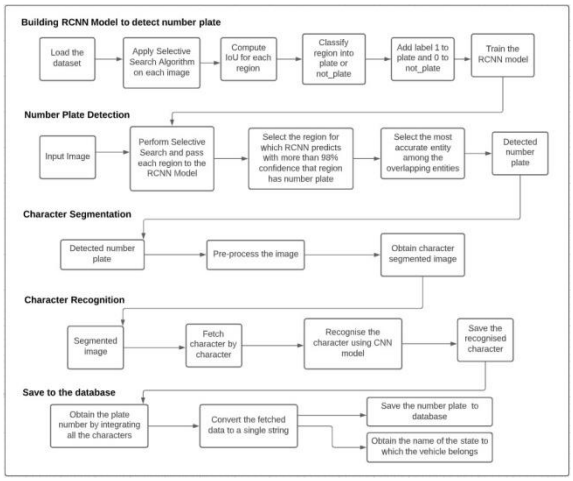


Figure 2: Architectural Framework

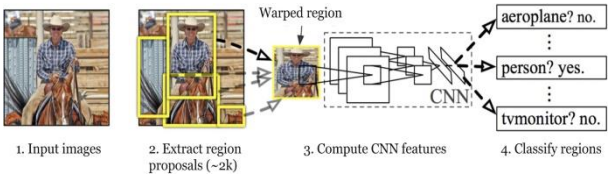


Figure 3: Architecture of the RCNN model to detect the number plate

Number Plate Detection- In phase 2, the number plate is detected for the given image. This is done by performing a Selective search algorithm on the image and pass each region to the RCNN model. The model gives a confidence value to each region and all the regions for which the model predicts with more than 98% confidence are selected. Among all the selected regions, the most accurate region is selected by using the non max suppression fast function. And that region is considered as the detected number plate region. Figure 4 gives pictorial representation of working of the non_max_suppression_function

Figure 4: Working of non_max_suppression_fast_function

Character Segmentation- Character segmentation is an operation that seeks to decompose an image of a sequence of characters into sub-images of individual

characters. In phase-3, from the number plate region detected, character segmentation is performed.

Character Recognition- In phase-4, each character from the segmented image is individually served as input to the CNN model. After all the characters are recognized, the number plate text is obtained. Figure 5 shows the architecture of the CNN Model.

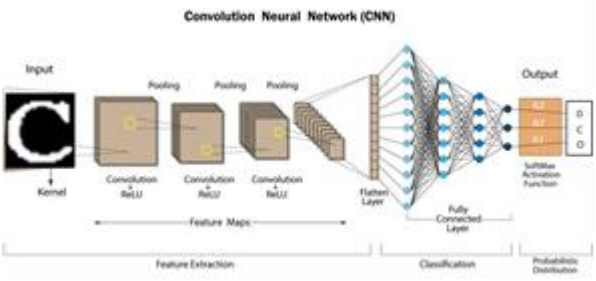


Figure 5: Architecture of the CNN model to recognize characters of number plate

Save to the database- In phase-5, the number plate text is converted to string format, and using the first 2 characters recognized by the CNN model, the state to which the vehicle belongs is obtained. Then the number plate text and the state of the vehicle are stored in the database. In addition, using the number plate text - the detailed information of the vehicle can be obtained via Vahan-Info site.

III. IMPLEMENTATION

The proposed methodology is implemented in a modularized manner, which means that each module is built separately and then combined together.

Building a RCNN model- To build the RCNN model, the newly generated data - use data (described in section II) is used. Every image from use data is labeled as 1 for plate and 0 for not plate. The data is split into two categories - train and test (7:3), using train test split, a function in the Sklearn model. Then a model is built with 6 Convolutional Layers followed by Max Pooling. This model is compiled with Adam optimizer and binary cross entropy loss function. Then, the model is trained on the training data for 12 epochs.

Number Plate Detection- For the given input image, the selective search algorithm is performed and 2000 region proposals are generated. The number plate is detected by passing each region to the RCNN model. The model predicts the class and gives a confidence value to each region and all the regions for which the model predict as plate region with more than 98% confidence are selected. Among all the selected regions, the most accurate region is selected by using the non max suppression fast function. And that region is considered as the detected number plate region.

Character Segmentation- In this module, on the detected number plate region, character segmentation is performed. To do so, several image processing techniques such as image grayscaling, thresholding, eroding the boundaries, increasing the white region is applied to the image. Then the contours are drawn on each character within the cropped region of the number plate using the findContour function of OpenCV.

Character Recognition- Taking each character of the number plate as an input, character recognition is performed. To do so, a CNN model is built with 4 convolutional layers followed by MaxPooling layers. The model is then compiled with loss function categorical crossentropy and adam optimizer. The model is trained on training data for 25 epochs. Each segmented character is passed to the model and the model predicts the character. All the characters are then combined and the final result is obtained.

Save to the database In this module, using the first two characters of number plate text, the state to which the vehicle belongs is obtained. For this, we have a dataset (the dataset is as per 2021) in CSV for- mat which includes names of all Indian states and union territories along with their abbreviation. Then the number plate text and the state, both are stored in the respective fields of table vehicle number plates created in SQLite3 database. To do so, firstly connect to the the

SQLite3 database using the command - sqlite3.connect('database.db') and the record is inserted using the insert command INSERT INTO vehicle plate numbers (plate number, vehicle state) VAL- UES (number plate text, state of the vehicle) . Further using the Vahan-Info website, giving the plate number as input - detailed information of the vehicle can be obtained. The website is free to use and available in the web.

IV. RESULTS AND ANALYSIS

This section discusses the outcomes of the proposed methodology.

Results obtained for RCNN Model- RCNN Model is built for Number Plate Detection. Following results were obtained by the model.

1) The model achieved an accuracy of 98.46% for 12 epochs.

2) The RCNN model performs well for most of the input images.

3) It also works better when an image has multiple vehicles in it. Figure 6 depicts the same scenario.

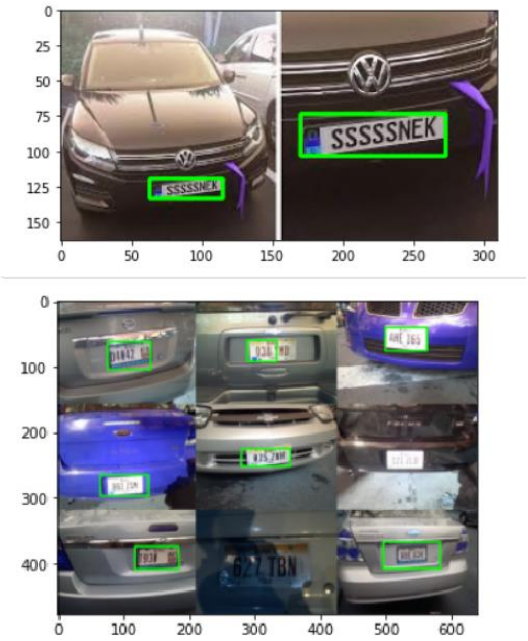


Figure 6: Number Plate Detection for multiple vehicles in same image

Results obtained for CNN Model- CNN Model is built for Recognizing characters of number plate. Following results were obtained by the model.

1) The model achieved an accuracy of 95.98% for 25 epochs.

2) The CNN model performs well for similar charac- ters like 'Z' and '2' and others. Figure 7 depicts the same scenario.

```
In [40]: img = cv2.imread('./dataset2/val/class_Z/class_Z_28.jpg')

         dic = {}
         characters = '0123456789ABCDEFGHIJKLMNOPQRSTUVWXYZ'
         for i,c in enumerate(characters):
             dic[i] = c

         img = img.reshape(1,28,28,3) #preparing image for the model
         y_ = our_model.predict_classes(img)[0] #predicting the class
         character = dic[y_]
         print('The character is : ' + character)

         The character is : Z
```

```
In [45]: img = cv2.imread('./dataset2/val/2/class_2_6.jpg')

         dic = {}
         characters = '0123456789ABCDEFGHIJKLMNOPQRSTUVWXYZ'
         for i,c in enumerate(characters):
             dic[i] = c

         img = img.reshape(1,28,28,3) #preparing image for the model
         y_ = our_model.predict_classes(img)[0] #predicting the class
         character = dic[y_]
         print('The character is : ' + character)

         The character is : 2
```

Figure 7: Model Performance for similar characters - 'Z' and '2'

Results obtained for a Sample Image The proposed methodology produces the following results for a sample image provided as input.

1) Input Image

Following figure is a sample input image.

Figure 8: Input image

2) Number Plate Detection

Applying a selective search algorithm to the input image generates 2000 region proposals for the image. Each region proposal is passed to the RCNN model built. The model classifies whether the region is number plate or not. For the input image provided, the following figure is the output of the RCNN model.

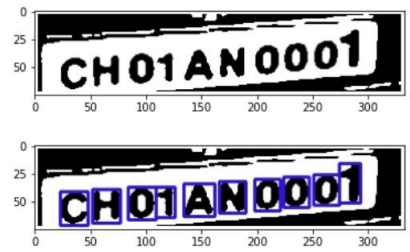
```
In [32]: name='./images/6.jpg'
number = 6
extract(name, number)
```

```
Number Plate Detected successfully
```

Figure 9: Number Plate Detection

3) Character Segmentation and Recognition

Once the region of interest is obtained, character segmentation is performed. The segmentation seeks to decompose the number plate characters into sub-images of individual characters. Then each character is passed to the CNN model built and the following figure is the output obtained.




```
Number Plate : CH01AN0001
```

	plate_number	vehicle_state
	Filter	Filter
1	0L8CAF5030	None
2	CH01AN0001	Chandigarh

Figure 10: Character Segmentation and Recognition

4) Obtaining the state of vehicle

Using the first 2 characters of number plate text, the state of vehicle is obtained.

```
a = find_state(text)
vehicle_state.append(a)
```

```
CH01AN0001
Chandigarh
```

Figure 11: Finding the state of the vehicle

5) Storing the number plate data and state of the vehicle in database

To keep a record of vehicles captured, we store the number plate text of the vehicle and its state into the database.

```
a = find_state(text)
vehicle_state.append(a)
```

```
CH01AN0001
Chandigarh
```

Figure 12: Store into the database

6) Obtaining detailed information of the vehicle from Vahan info website

Using the Vahan-info website, the complete details of the vehicle (owner name, fuel type, engine num- ber, and others) can be obtained. The following figure is the snapshot of the same.

Vehicle owner Details of Registration Number		
Registration Number	:	CH01AN0001
Registration Authority	:	
Registration Date	:	
Chassis Number	:	null
Engine Number	:	JF50E78127989
Fuel Type	:	PETROL
Engine Capacity	:	
Model/Model Name	:	
Color	:	
Owner Name	:	HARGOLD CONSULTANCY PVT LTD
Ownership Type	:	
Financer	:	null
Vehicle Class	:	class
Fitness/Regn Upto	:	null
Insurance expiry	:	Invalid date
Vehicle Age	:	null
RTO Code	:	CH01
Vehicle RTO	:	CHANDIGARH

Figure 13: Snapshot from Vahan-Info

V. CONCLUSION

A Novel Method for Indian Vehicle Registration Number Plate Detection and Recognition was carried out using Image Processing Techniques'. In this article, there was a gap that Deep Learning-based approaches provide reliable results on actual data when compared to Image Processing techniques. Upcoming this gap, we proposed a Deep-Learning-based methodology for Number Plate Detection and Recognition. We used Region-based Convolutional Neural Networks for Number Plate Detection and Convolutional Neural Networks for Character Recognition. After recognizing the number plate text, the state and the detailed information of the vehicle are obtained. The record of vehicles detected is also maintained by storing the number plate text of the vehicle and its respective state name into the database. The proposed methodology for Number Plate Detection and Recognition using deep-learning, landed up with an accuracy of 98.46% for the RCNN model and an accuracy of 95.98% for the CNN model, resulting in trustworthy findings. As a result, the proposed methodology finds a solution to the identified gap.

Our methodology includes the dataset having only Indian vehicle images with white background number plates and simplest font style; as a part of our future scope, we can carry out the same methodology/approach for the dataset including the different varieties of the number plate in terms of their font style, background color, and number plate text split into 2 lines (usually seen in two-wheelers).

REFERENCES

1. H Krishna B, R Kiran Varma P, S Ganta and Praveen S. ”A Novel Method for Indian Vehicle Registration Number Plate Detection and Recognition using Image Processing Techniques”. Procedia Computer Science, vol. 167, pp. 2623-2633, 2020.
2. S Hashmi, K Kumar and S Mittal. ”Real Time License Plate Recognition from Video Streams using Deep Learning”International Journal of Information Retrieval Research, vol.9, pp. 65-87, 2019.
3. S Ghadage and S Khedkar. ”A Review Paper on Automatic Number Plate Recognition System using Machine Learning Algorithms”. International Journal of Engineering Research and Technology, vol. 8, 2019.
4. From Vahan Info. Vehicle details by number plate. https://vahaninfos.com/vehicle-details-by-number-plate.
5. From Kaggle. Car license plate detection.https: //www.kaggle.com/andrewmvd/car-plate-detection.
6. From Kaggle. Character recognition from number plate. https://www.kaggle.com/kdnishanth/ characterrecognitionfromnumberplate.
7. List of state abbreviation codes of Indian states. https://www.downloadexcelfiles.com/inen/ download-list-state-abbreviation-codes-indian-states.