Number Plate Recognition From a Vehicle Image

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Approach:

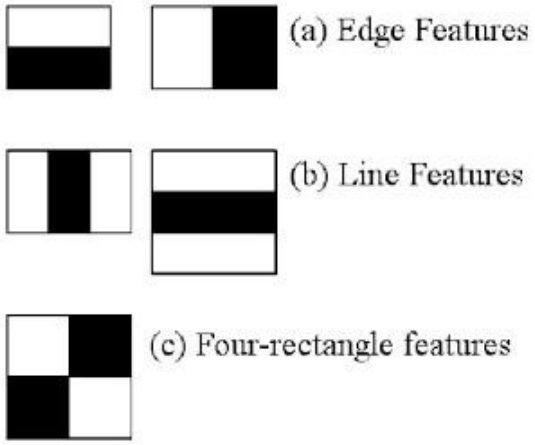
- Detect Number plate (Using Haar Cascade Classifier)
- Preprocessing on Detected Plate(Binarization, Opening)
- Character level segmentation(Contours Detection)
- Recognition using CNN model.

Cascade Classifier

- It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images.

Haar Features:

- The algorithm needs a lot of positive images and negative images to train the classifier. Then we need to extract features from it. Example Haar features shown in the below image. They are just like our convolutional kernel. Each feature is a single value obtained by subtracting sum of pixels under the white rectangle from sum of pixels under the black rectangle.

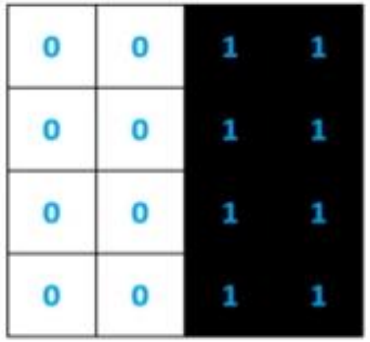


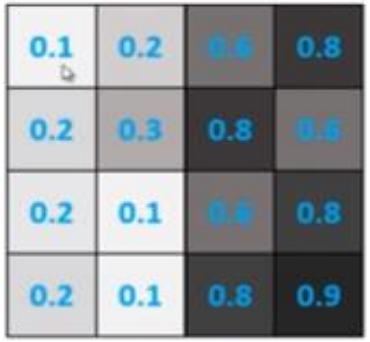
Rapid Object Detection using a Boosted Cascade of Simple Features Paul Viola, Michael jeffery Jones CVPR 2001.

Cascade Classifier

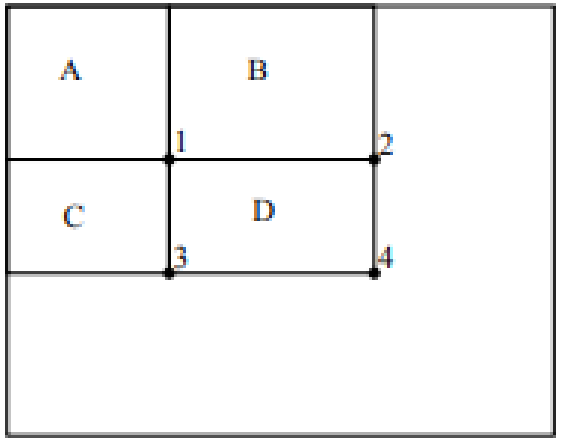
How it works:

- Real Time Images in Gray scale not in Binary
- Viola-jones algorithm compares real scenario with ideal case
- (Sum of all black pixel intensity) – (sum of all white pixel intensity)
- If near to one then edge





Cascade Classifier



Integral Images:

- Also for Feature Extraction
- The sum of the pixels within rectangle can be computed with four array reference
- The value of the integral image at location 1 is the sum of the pixels in rectangle A. The value at location 2 is A+B, at location 3 is A+C, and at location 4 is A+B+C+D. The sum within D can be computed as 4+1-(2+3).

Cascade Classifier

Adaboost:

- After applying each and every feature on all the training images, for each feature, it finds the best threshold which will classify the images to positive and negative. But obviously, there will be errors or misclassifications.
- It select the features with minimum error rate.
- Each image is given an equal weight in the beginning. After each classification, weights of misclassified images are increased.

Cascade Classifier

- Then again same process is done. New error rates are calculated. Also new weights. The process is continued until required accuracy or error rate is achieved or required number of features are found.
- Final classifier is a weighted sum of these weak classifiers. It is called weak because it alone can’t classify the image, but together with others forms a strong classifier.

Haar Cascade:

- Cv2:Cascade classifier
  - Load pre trained classifier
    - haarcascade_licence_plate_rus_16stages.xml
    - indian_license_plate.xml

- Detect Location and size
-

Pratiksha Jain, Neha Chopra, Vaishali Gupta - Automatic License Plate Recognition using OpenCV, International Journal of Computer Applications Technology and Research Volume 3– Issue 12, 756 - 761, 2014, ISSN:- 2319–8656

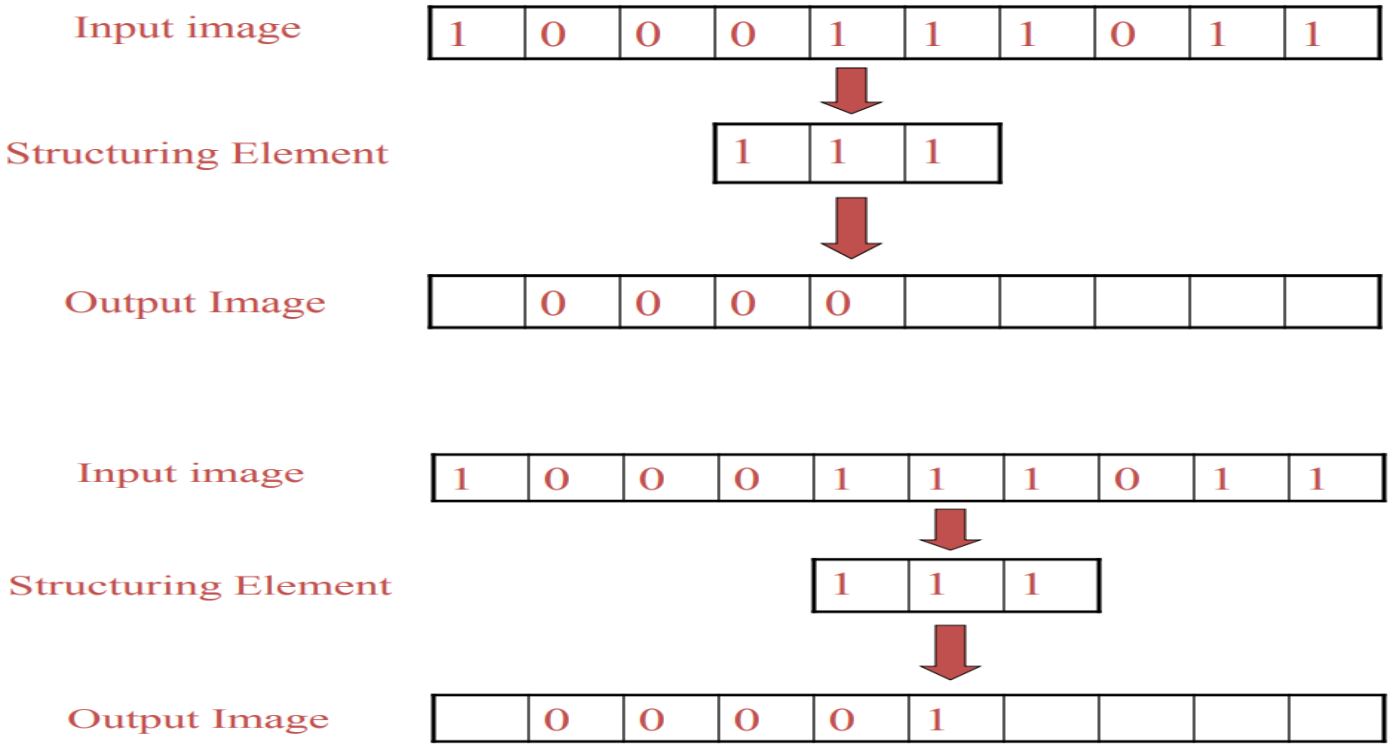
Preprocessing:

- Gray Scale Conversion
- Otsu's binarization
- Opening
  - Erosion(3x3 structural element): used to reduces extra width of edges.
  - Dilation(3x3 structural element): increase the thickness

Paper ref: V.Karthikeyan and V.J.Vijayalakshmi - **Localization of License Plate Using Morphological Operations, cvpr-2014**

Erosion

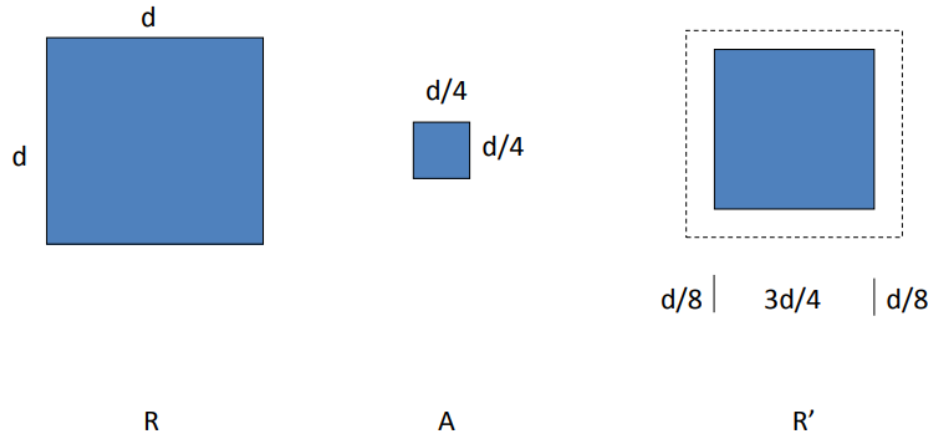
- $X \ominus B = \{ p \in Z^2 \mid p + b \in X \text{ for every } b \in B \}$

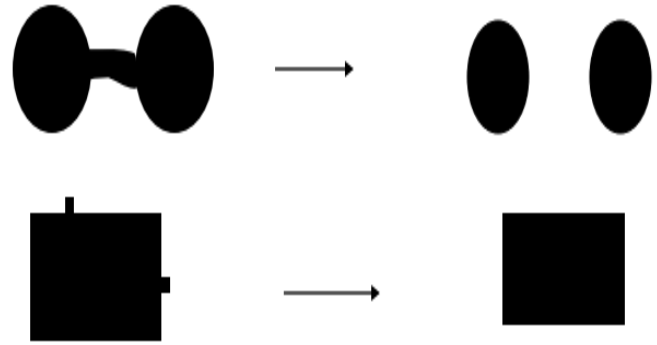


Digital Image Processing, R. C. Gonzalez & R. E. Woods

Erosion

- $R' = R \ominus A$





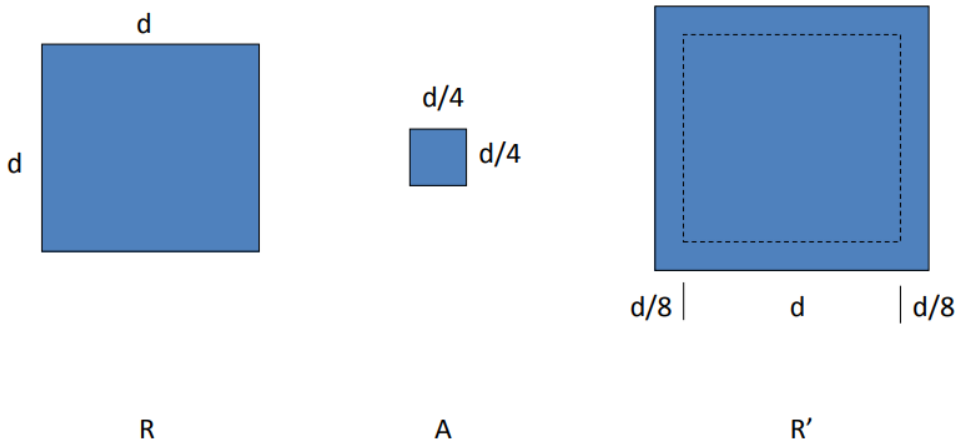
Binary Image

Erosion Applied

Dilation

- $X \oplus B$, is defined as = $\{ p \in Z^2 \mid p = x + b , x \in X , b \}$

- $R' = R \oplus A$

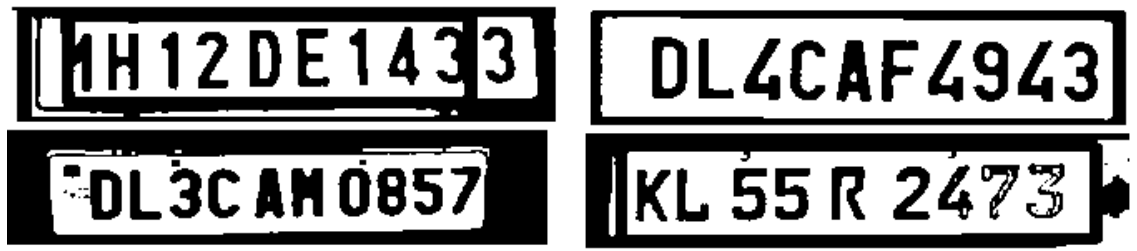


Before Dilation

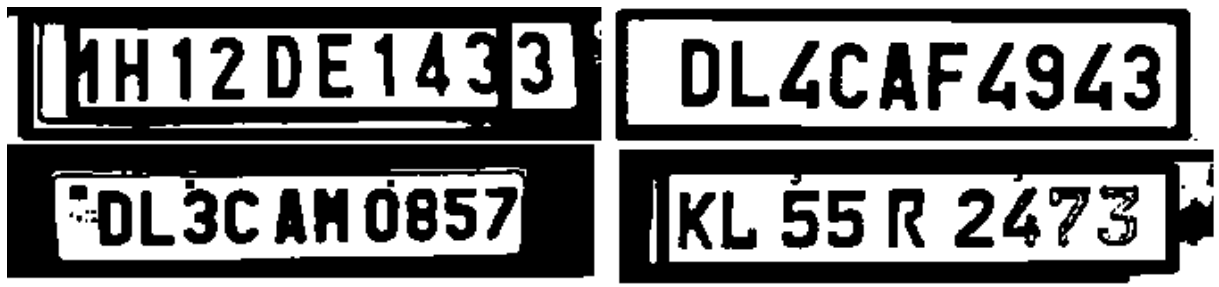
After Dilation

Preprocessing

- **Erosion:**



- **Dilation:**



Character Segmentation

- Contours Detection
- Sort according to area and keep first 10
- Discard Irrelevant
- range:[width/10,width/6] [height/2,height]
- Inverse Black and White

License Plate Detection and Character Recognition Using Contour Analysis, Volume 3, No.1, January – February 2014-International Journal of Advanced Trends in Computer Science and Engineering ,Kumary R Soumya, Angel Babu, Laya Therattil, ISSN 2278-3091

Character Segmentation

- Fix the same size
- sort according to Y-coordinates i.e. column wise

License Plate Detection and Character Recognition Using Contour Analysis, Volume 3, No.1, January – February 2014-International Journal of Advanced Trends in Computer Science and Engineering, Kumary R Soumya, Angel Babu, Laya Therattil, ISSN 2278-3091

Another Approach

- **Ref. Paper:** Automatic Number Plate Recognition (ANPR) System for Indian conditions
- **Authors:** Prathamesh Kulkarni et al.

- **Institute:** University of Pune

- **Published Year:** 2009

Number Plate Detection

- This paper follows the approach of number plate detection using inverse “L” filter which is to mainly to detect the horizontal upper line and vertical front line of number plate.

- We have used 20x20 filter size for detection of number plate. The process takes 20x20 part of an image and element wise matrix multiplication is done to check below condition.

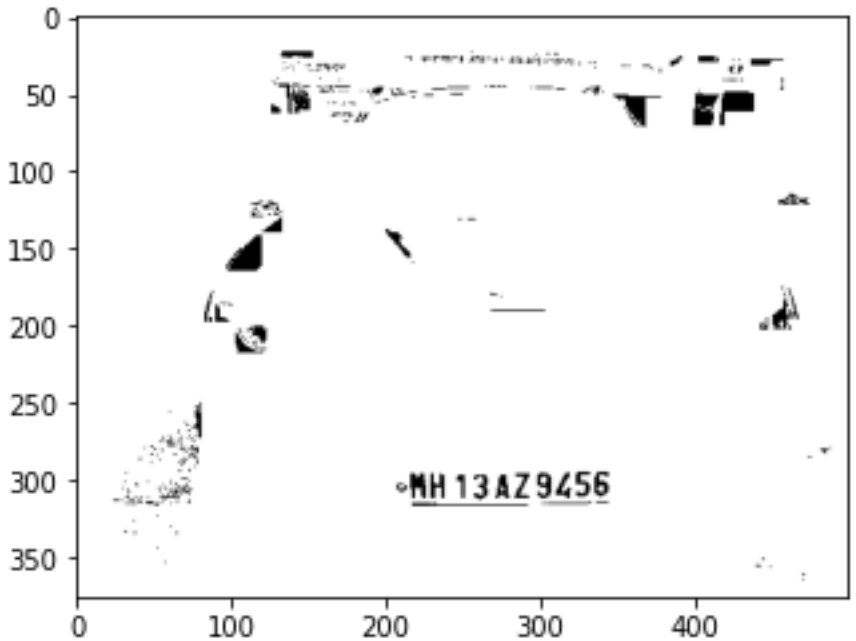
- Condition : first row and column with each pixel intensity 255 and at least one pixel from second row and column must be 0.

- If the condition satisfies then that part is taken.

- Iterate filter over image with stride size 1.

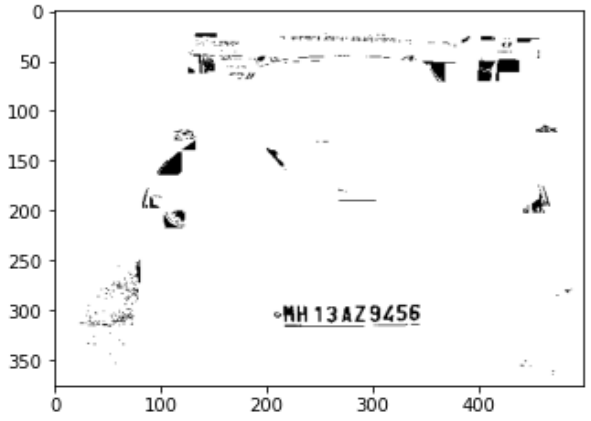
Number Plate Detection

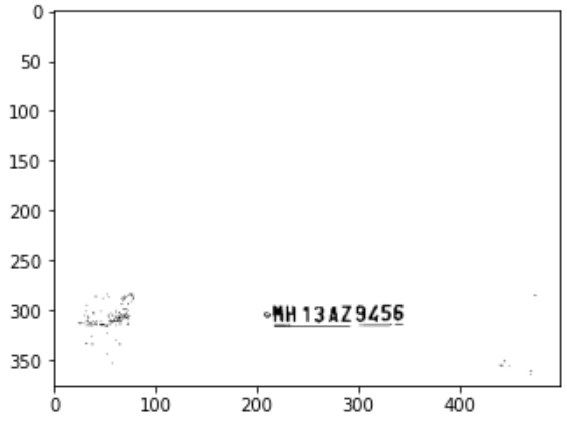
- Detected number plate is shown below. It detects the number plate with some other cluster points.



Processing

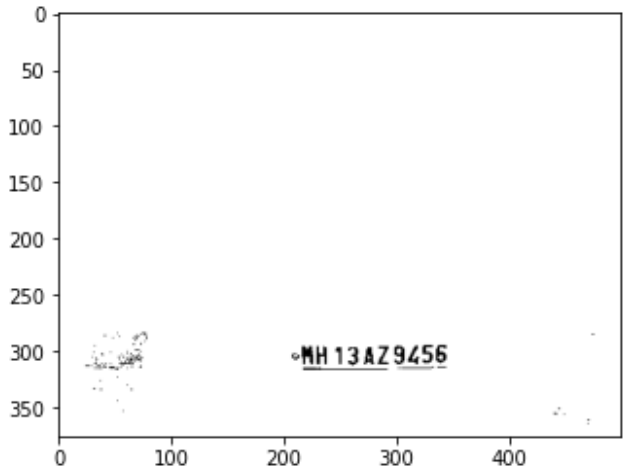
- Detected number plate contains irrelevant noise. To remove this we are considering 142 pixels in each row(approximated) in image and removing all the chunks that are larger than that size. And we are discarding pixels if density is lower than 0.2. Then Iterated it using 142 stride size.





Processing

- Further we have applied median filter to reduce noise then row-wise and column wise filter applied and we remove all the pixel of particular column or row that has density lower than 0.098 and then we invert the image to find contours.



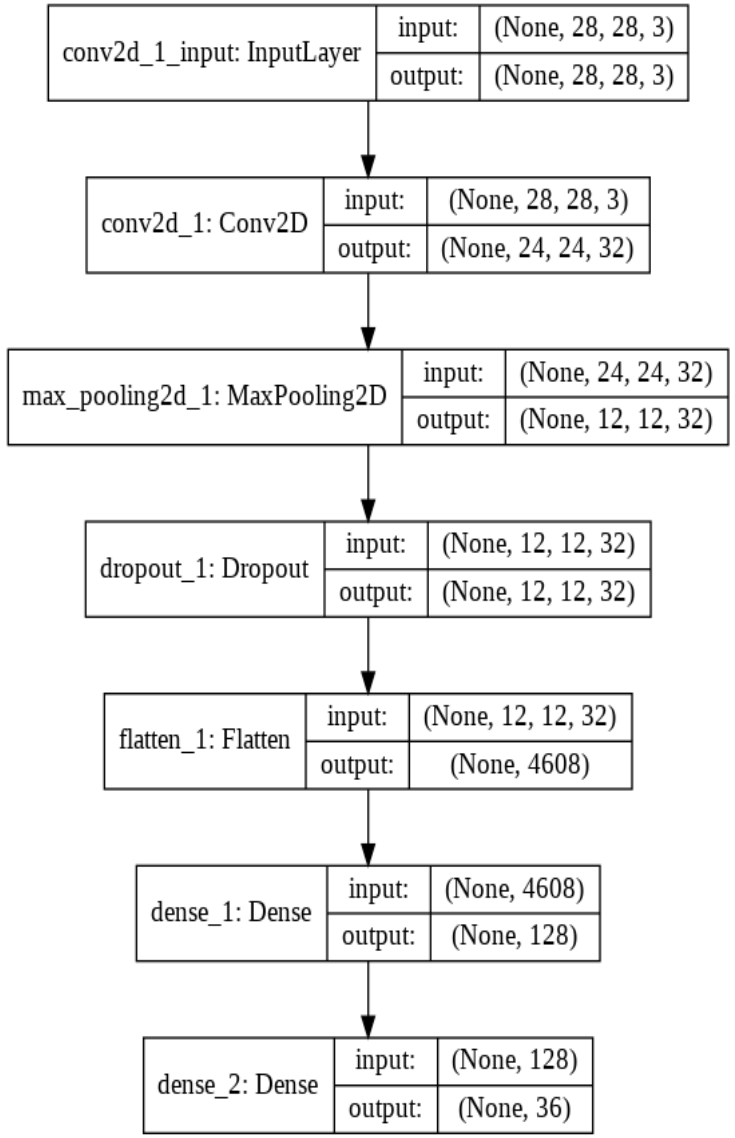
Contours Detection

- Contours are nothing but connected components in image. We have detected those contours using connected component algorithm. These are separate images combined to show.

Character Recognition

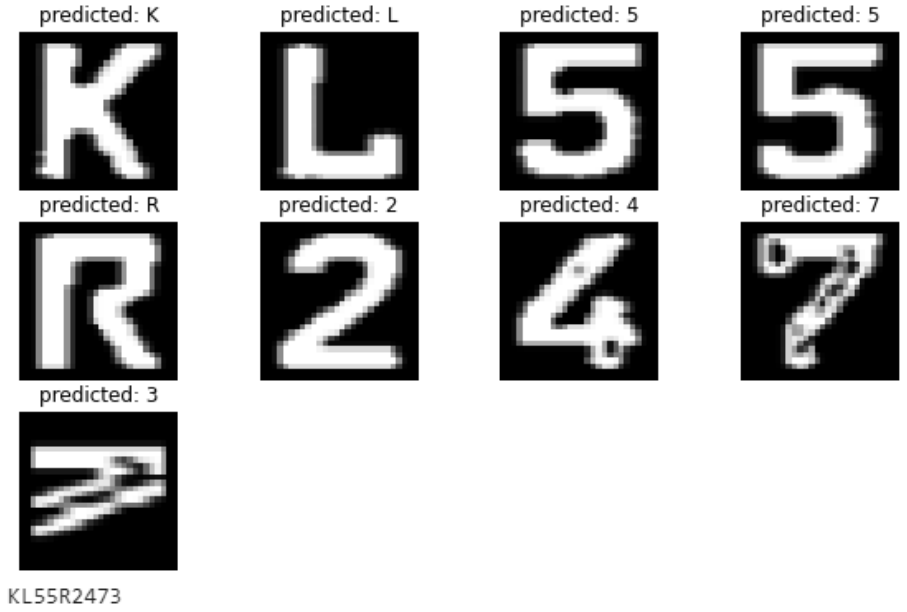
- After characters segmentation we have applied CNN to recognize the characters.
- We have taken dataset which contains 36 class [0-9,A-Z] and 30 images of each class.
- We have trained model with given parameters: Conv. Layer : 32 filters of kernel size 5X5 with activation relu, Max Pooling 2D : pool size 2X2, Dropout : 40% rate, Flatten, Two Dense Layers: relu, softmax.

CNN Model:


conv2d_1_input: InputLayer
input: (None, 28, 28, 3)
output: (None, 28, 28, 3)
conv2d_1: Conv2D
input: (None, 28, 28, 3)
output: (None, 24, 24, 32)
max_pooling2d_1: MaxPooling2D
input: (None, 24, 24, 32)
output: (None, 12, 12, 32)
dropout_1: Dropout
input: (None, 12, 12, 32)
output: (None, 12, 12, 32)
flatten_1: Flatten
input: (None, 12, 12, 32)
output: (None, 4608)
dense_1: Dense
input: (None, 4608)
output: (None, 128)
dense_2: Dense
input: (None, 128)
output: (None, 36)

Character Recognition

- CNN output gives indexes of characters in the dictionary we created.



Limitations

- First approach gives good result on most of the images whereas second approach is to be modeled manually for filter sizes.
- Our code does not work on frames which contains more than one number plates in a frame.
- Cascade Haar training requires powerful machines so using Pretrained Classifier

Thank you