INDIRA GANDHI
DELHI TECHNICAL UNIVERSITY FOR WOMEN

Apartment Security using Automatic License Plate Recognition module

(Minor Project Report)

Submitted By
Riya Agarwal
Shaifali Jindal
Shradha Narain

Under the supervision of
Rishabh Kaushal
Assistant Professor
Department Of Information Technology

STUDENT UNDERTAKING

Dated: 25.05.2020

This is to undertake that the work titled **Apartment Security using Automatic License Plate Recognition module** in this Minor Project Report as part of 6th Semester in B.Tech. with specialization in Information Technology during January – May, 2020 under the guidance of professor Rishabh Kaushal is my original work.

Anything that appears in this report which is not my original has been duly and appropriately referred / cited / acknowledged. Any academic misconduct and dishonesty found now or in future in regard to above or any other matter pertaining to this report shall be solely and entirely my responsibility. In such a situation, I understand that a strict disciplinary action can be undertaken against me by the concerned authorities of the University now or in future and I shall abide by it.

Date-of-Submission, New Delhi
25.05.2020

DEPARTMENT OF INFORMATION TECHNOLOGY
INDIRA GANDHI DELHI TECHNICAL UNIVERSITY FOR WOMEN
KASHMERE GATE, DELHI - 110006

Dated: 25.05.2020

CERTIFICATE

This is to certify that the work titled **Apartment Security using Automatic License Plate Recognition module** submitted by Riya Agarwal, Shaifali Jindal and Shradha Narain (Team 13) in this project report as part of 6th Semester in B.Tech. with specialization in Information Technology during January – May, 2020 was done under my guidance and supervision.

This work is her original work to the best of my knowledge and has not been submitted anywhere else for the award of any credits / degree whatsoever. The work is satisfactory for the award of Minor Project credits.

Rishabh Kaushal
Assistant Professor
Department of Information Technology
Indira Gandhi Delhi Technical University for Women

ACKNOWLEDGEMENT

First of all we would like to thank our professor Rishabh Kaushal for helping us throughout the process.
We three students of 3rd years,Information Technology department have completed this project titled Apartment Security using Automatic License Plate Recognition module as our mini project as part of 6th Semester in B.Tech with specialization in Information Technology during January – May, 2020.
We are very thankful to our professor whose guidance have helped us through all the difficulties.His advice and tips were very insightful.
Thank you sir, we thoroughly enjoyed working on this project. We believe it helped us enhance our skill set and add to our stack of existing technologies.

Riya Agarwal
Shaifali Jindal
Shradha Narain

Apartment Security using Automatic License Plate Recognition Module

Riya Agarwal Shaifali Jindal Shradha Narain

May 2020

Abstract

Character Recognition in license plates plays a crucial role in Road Safety. It helps in tracing stolen cars, finding parking slots, etc. Here we present a solution for apartment security using automatic recognition of license plates of vehicles from video feed. We used a simple approach of licence plate detection from multiple frames and applying deep learning algorithm (KNN) on it to improve the efficiency. Real time video stream is fed to the model and the license plate is recognized.This helps in monitoring the movement of vehicles moving in and out of the apartment areas. Automatic License Plate Recognition(ALPR), Optical Character Recognition (OCR), deep learning, bounding box(ground truth)

Contents

1 Introduction

The massive integration of information technologies, under different aspects of the modern world, has resulted in increased focus on vehicles to be used as resources in information technology too. Technology is constantly being used to make our lives better. In this project, technology would be used to provide safety in the societies by monitoring all the vehicles entering and exiting the society and alerting in case of any malicious activities.Entry to only known vehicles is provided. This would help reduce theft and make the area a better and safer place. Automatic License plate Recognition(ALPR) in real-time from video feed generated from the CCTV footage of the society using deep learning would be used to achieve this target.

1.1 License Plate Recognition

ALPR Systems uses OCR(optical character recognition) to extract the characters from a license plate. In other words, it takes the image of a vehicle and provides us with the characters of the number plate as text.
We use deep learning techniques like KNN (K- nearest neighbors) or CNN (Convolution neural networks) to improve the efficiency of LPR. An ALPR system generally consists of three major parts:

- **Detecting** the license plate
- **Segmentation** of characters
- **Recognition** of characters

The proposed system is desired to give correct results even with undesirable and noisy conditions like
1)blurred/low contrasts images 2)unsuitable weather conditions

1.2 Application

ALPR systems have various applications as mentioned below:

- Tracking System for Stolen Cars
- Vehicle Surveillance System
- Controlling thefts
- Illegal vehicles classification
- Efficient toll collection(for electronic toll)
- Catching speed limit violators
  and many more.

The application which is our main focus is: **Apartment/ Society Security** where this license plate recognition would help providing security to the society by supervising the entry and exit of all vehicles and generating alerts in the case of malicious entry. Entry to only known vehicles is provided. This would help reduce theft and make the area a better and safer place.

1.2.1 End User - Use case

End-users are the people who can enjoy the benefits of ensuring traffic discipline and automatic supervision of societies. Using ALPR in apartments provides security by preventing car thefts for residential vehicles. This solution is capable of easily notifying the security personnel in case of malicious entry or exit of vehicles without any physical inspection by human beings.

Moreover, it helps the them to effectively manage the residential vehicle database without the traditional registers and cards for entry and exit.All the entries and exits are saved with time. The system would act as helpers for the security guards by providing alert in case of suspicious activities.

ALPR can also be used for many other applications as mentioned above and the end users would thus change according to the problem statement. For eg. Illegal crossing or violation of road rules can be mapped and tracked down by the traffic police.

Problem Statement. ***Apartment and society security by using Automatic Detection and Recognition of License Plate in real time embracing technologies like deep learning.***

2 Related Work

Ensuring discipline with traffic surveillance has been a significant step in road safety. Several solutions are proposed to achieve this, one of them is detecting the license plate number of a car for tracing purposes.

Vahid Abolghasemi [1] proposed a solution for detection of the license plate starting with intensifying the regions of car plate and then gauging the local density of the vertical edges. They used this as a criteria for local enhancements like canny edge detection. The final step was to connecting these vertical edges to obtain closed components that are like license plate. Some properties of license plates like shape, size, contrast, etc. are used to obtain a smaller candidate list of potential plate regions.

Harpreet Kaur and Manvi [3] mentioned video processing to be better than analysing a static image for getting better accuracy in license plate extraction in real-time.

Joseph Redmon [4] presented faster and better way of inserting bounding box in the instance of an image in faster and better way. Identifying the region of interest is the important part of the algorithm. They came up with an efficient solution to this using YOLO.

Saquib Nadeem Hashmi and Kaushtub Kumar [5] focused on improving the results of obtaining the number plate by applying the complete process of plate recognition and character classification on number of frames of video rather than on a single static image captured from the feed.

We apply a simple approach to obtain the ground truth by inserting bounding box to extract the region of interest (ROI) using **canny edge detection and contouring**. We obtain the plate regions and then apply **OCR with deep learning algorithms** for character information on every frame of the video feed to getter better results.

3 Methodology

For the given project, we first explain the data sets available and the dataset used, followed by the pre-processing required by them. Also, the report enlists possible approaches to the problem and explains the approach used in details.

3.1 Dataset Description

The data-set used here is the images of number plates. In a real time scenario these images would be extracted from a video stream after the video stream has been broken into multiple frames. Our algorithm is capable of achieving this task, however the data-set being used here are images of vehicles with there number plates.

The various data sets available are listed below with there description:
1. Indian number plates data-set[1]. The dataset has 353 items of which 229 items have been already labeled.Bounding boxes marked on license plates of vehicles.
2. Second Indian License plates dataset[2]. This dataset contains 10,000 images of Indian vehicle license plates. The instances here are just the number plates and the the whole vehicle.
3. UK License plates dataset[3]. This dataset contains 700 instances of UK vehicle license plates.

[1]https://www.kaggle.com/dataturks/vehicle-number-plate-detection
[2]https://www.kaggle.com/thamizhsterio/indian-license-plates
[3]https://medusa.fit.vutbr.cz/traffic/datasets/

Table 1: Details of different datasets.

Dataset Number	Instances
Dataset 1	353
Dataset 2	10,000
Dataset 3	700

Table 2: Details of Data Attribute.

Data Attributes	Brief Explanation
Image ID	Unique identifier of images

The dataset comprises of data attribute ie. Image id. Table 2 describes attribute of data.

3.2 Data Pre-processing

The ground truth here in the data-sets is the **license plate of vehicles**, these license plates are marked by a bounding box and this is done as a pre-processing step.
After splitting the video into frames, the pre-processing process of contouring the region of interest(ROI) and cropping the bounding box is performed on all the frames. These pre-processed cropped images are then fed to the algorithm for licence plate recognition.

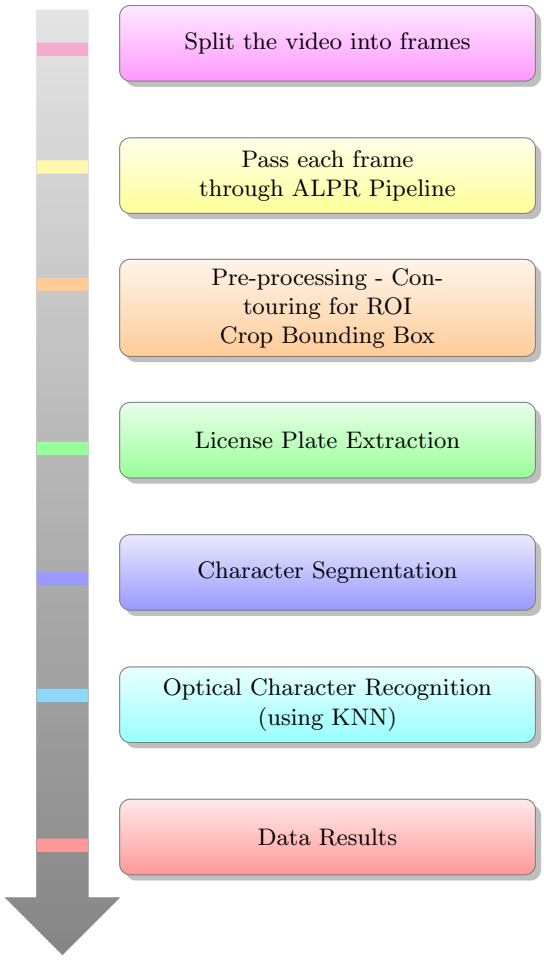
Some datsets have bounding box in there images, some don't and so for the algorithms to run properly we create the bounding box for those images where it is not present.

3.3 Proposed Approach

In this section, all phases of automatic detection and recognition of vehicle license plates from videos has been discussed. The process has been designed to perform targeted actions. First step is to load the python file which will recognize as well as classify all the characters. Then the video is processed into frames,detecting potential plate regions in each frame via a bounding box. We find the predicted plate number for each possible frame and return the longest character sequence as our output. Detailed process can be found in [5]

3.3.1 Split Input Video Into Frames

- Load the input **video**.
- From the video, if the **speed of the vehicle** is more than 70 kmph, split the video into approximately 25 frames for accurate results. However, if the speed of the vehicle is slower (for example, on a speed breaker) then 10-12 frames will suffice.
- The aforementioned steps are **applied on each extracted frame**.



3.3.2 Pre-processing and Bounding Box

- **Pre - processing of frame** in the form of grey-scaling and detecting the canny edges to enhance the quality and contrast of our detected plate
- **Contours are detected** from the pre-processed frame and pose as an imperative tool for bounding boxes of our plates.
- Identifying **Region of Interest from images**, inserting a bounding box, cropping of bounding box, are the processes to **extract the plate from each frame**.
- Return output in the form of a list of image objects with **highest probability of the real license plate.**

Python script : Read the image and extract Region of Interest using OpenCV

Steps to identify contour of number plate -

1. Loop over our contours to find the best possible approximate contour
2. Select the contour with 4 corners and Crop those contours
3. Store it in Cropped Images folder.

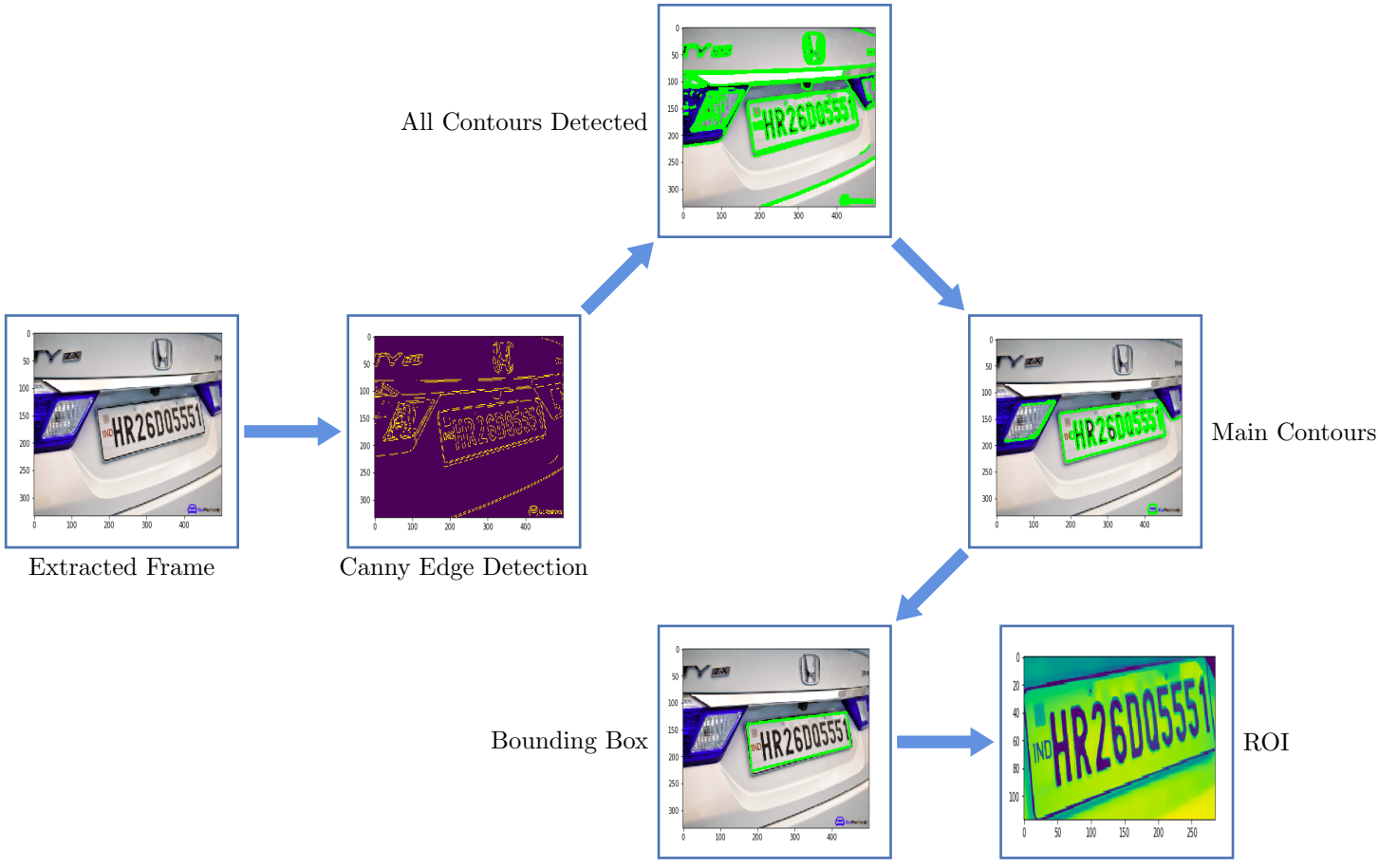
```
# loop over each of thr top 30 contours
#find the best possible approximate contour of number plate
idx = 1;

for c in cnts:
        peri = cv2.arcLength(c, True) #find perimeter
        approx = cv2.approxPolyDP(c, 0.02 * peri, True) #no. of edges for each contour
        if len(approx) == 4:  # Select the contour with 4 corners
            NumberPlateCnt = approx #This is our approx Number Plate Contour

            #crop according to coordinates - our ROI
            x, y, w, h = cv2.boundingRect(c) #This will find out co-ord for plate
            new_img = gray[y:y + h, x:x + w] #crop the grayscale image
            #cv2.imwrite('BoundedBox/' + str(idx) + '.jpg', new_img) #Store new image
            #idx+=1

            break
```

Output obtained in form of series of images - The process of obtaining a the license plate goes thorugh the series of image processing steps shown below:



3.3.3 Character Segmentation

- Cropped Region of Interest(ROI) are now set up for **optical character recognition**
- Crop the **individual character images** from license plates.
- The next step is to **increase the contrast and hue for better recognition**. Apply adaptive threshold to turn the image monochrome.
- Individual character images are cropped before processing them with our OCR Model.
- **Append** each detected character to our final result,

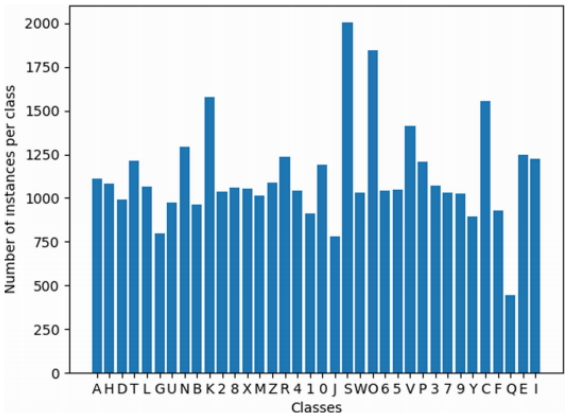
3.3.4 Optical Character Recognition

- The next step requires passing the image-frames through the OCR pipeline
- **K Nearest Neighbours:**
  A popular yet highly simple algorithm for **classification** problems that stores the **additional space-information** of all given inputs classifies them its similarity. For Eg. Euclidean distance is used as a parameter to judge the nearest neighbours.
  KNN has been implemented in our python code with K = 1. We experimented with the many values of K to enhance the result. This module takes a the input for OCR as the image of a character.
  For predicting the result for a new input, it finds K most similar examples to the test cases and outputs most dominant ones.
- **Frequency based approach** is used, where the recognized character with the highest frequency for the current video is chosen as detected number. It can be checked against the actual license number for more accurate results.

3.3.5 Improving Accuracy

- Each split video-frame is sent to the **ALPR model** and the count of each unique predicted character updated.
- The plate number with the **highest frequency for processed characters** is chosen as predicted number and returned as result.

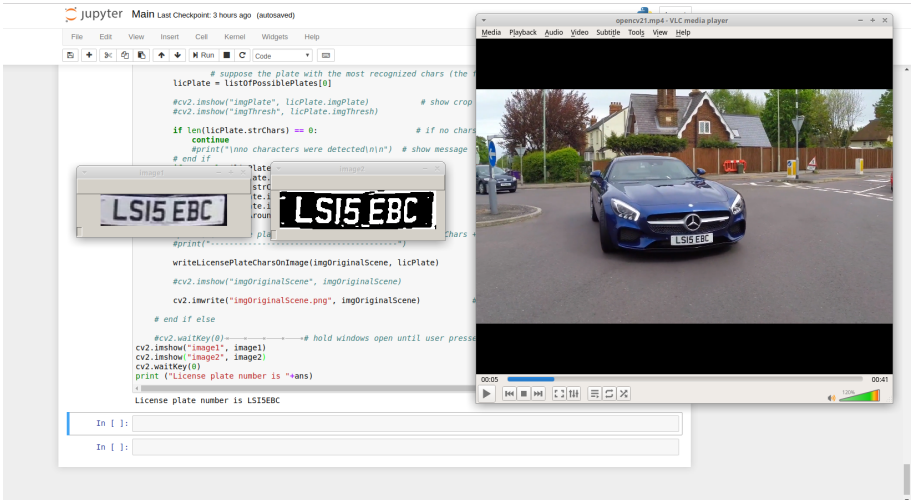
Figure 1: Instances per class



4 Results

- **Input** - video stream **Output** - License plate number
- So, The model we developed is used to provide security in the apartments and societies, the video feed from the CCTV footage provided to this model, all the incoming and outgoing vehicles will be monitored. The license plates from the vehicles would be detected and recognized by our model.
- The model would be used to notify in case of malicious activities like entry of unknown vehicles or in case of car thefts.
- The image below is an output image produced by our code when the shown video feed was given to the model as input.

Figure 2: License plate recognition from a video stream



4.1 Failed Test Cases

Accuracy of model depends on number of images the model fails to recognise the number plate.

- ALPR systems may fail to correctly recognize characters in case of **low image quality**.(blurred/Low-contrast image)
- ALPR systems may fail in case of **wrong contour detection.**

Figure 3: Unable to identify license plate contour

Figure 4: Wrong contour due to image defect

4.1.1 Dark Images

- License plate is not visible due to darkness, the model may fail

Figure 5: Plate is not visible

Figure 6: Model fails

- Even in dark images, if plate is visible the model successfully identifies the bounding box

Figure 7: Dark image but plate is visible

Figure 8: Model works

5 Future Work and Conclusion

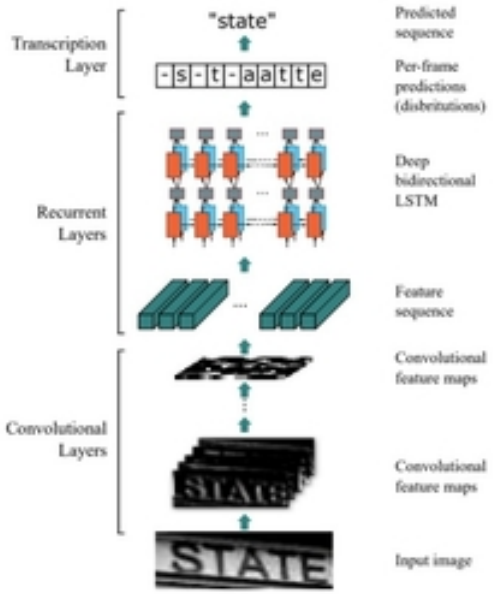
- We were able to obtain the license plate number from the video stream with an accuracy of **0.65 approximately.**
- In future, we would work on **efficient recognition of failed cases like blurry images, dark images and on improving the overall efficiency**.
- **Deep learning algorithms like RNN**(Recurrent Neural Network) would help us achieve better efficiency compared to KNN algorithm being used right now.
- Moreover, streaming of videos and splitting it into frames requires immense memory storage and time. Our aim would be to improve the time complexity by **analyzing a few potential frames and discarding the rest.**
- **CRNN** - Convolutional Recurrent Neural Network is a process which combines CNN, RNN(Recurrent Neural Network) and CTC(Connectionist Temporal Classification) layers which can be used for recognizing our character. This model **eliminates the need for character segmentation**, and is thus also a plausible approach to improve efficiency.

  CNN- Convolutional Neural Network is used for **feature extraction** from the ground truth image.

  RNN is used for label predictions.

  The **transcript layer** outputs the label sequence per-frame generated by Recurrent Neural Network.

  The architecture attached below in Fig. 10 is from a paper dated from 2015.

Figure 9: Lic 

video stream

References

[1] Abolghasmi, V., Ahmadyfard, A.: Local enhancement of car image for license plate detection (2007)

[2] Agarwal, R.: Deep Learning based ocr for text in the wild, `https://nanonets.com/blog/deep-learning-ocr/`

[3] Harpreet Kaur, Manvi, B.S.: Vehicle license plate detection from video using edge detection and morphological operators (2012)

[4] Joseph Redmon†, A.F.: Yolo9000: Better, faster, stronger (2012)

[5] Saquib Nadeem Hashmi, Kaushtubh Kumar, S.K.D.L.S.M.: Real time license plate recognition from video streams using deep learning (2019)