Cameroon's License Plate Recognition System

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1 Introduction

Automated license plate recognition is a technology used to identify vehicle license plates through the use of detection techniques and characters/strings recognition's techniques.
ALPR (Automatic License Plate Recognition) systems are used in several countries such as Morocco, Egypt, South Africa, countries of the European Union ...
They are used in these countries for several applications including:

- Border crossings ;
- Petrol stations (registration when a customer leaves without paying);
- Access control for car parks or private roads: automatic opening, or entry registration
- A marketing tool to record consumption patterns;
- Traffic management systems, which calculate the speed of traffic by measuring the time between passages in front of two reading points;
- Compare license plates to the Stolen Vehicle Register

They thus make it possible to automate and facilitate several police tasks. But the specificity of these systems is that they are local to the countries because they strongly depend on the principle of registration used in the country (plate color, number of characters for certain systems ...). Our work for this project was to develop a system for recognizing license plates specific to Cameroon in order to respond to a local problem that we will present later.In the rest of our work, we will present:

- The presentation of the problem
- The proposed solution
- The followed methodology
- The conclusion

2 Problem Statement

According to the World Health Organization (WHO), each year, more than 16,000 road accidents take place in Cameroon (in interurban or urban areas), accidents causing approximately 6,000 deaths according to WHO (1). These numbers show how alarming the situation is and it becomes even more critical if we must consider the indirect effects (number of seriously injured, disabled, families affected, orphans created ...). From this situation, it is natural to wonder what can be the cause? The direct reasons that emerge are generally:

- drunk driving
- speeding
- distraction
- somnolence

In order to limit these offences, a number of laws have been created, laws that are quite severe and are supposed to have the effect of seriously limiting accidents. However, we see that the number of accidents each year is not decreasing or is decreasing very slowly. This weak evolution is mainly due to the high rate of corruption within the police and gendarmerie (according to the 2004 barometer, (2), the police and gendarmerie are the 2nd most corrupt sector in the country after customs). The influence of corruption in this weak evolution resides in the fact that the number of fines to be given is reduced because of the different bribes offered, giving everyone the freedom to behave as

he or she wishes provided that they just keep their bribe. Thus the real problem comes down to the question: How can we ensure that all or almost all those who break the law are punished?

3 The proposed solution

The problem being to ensure the correct identification of offences and the effective application of the laws, one solution could be to seek to drastically reduce the rate of corruption within the police force, but this solution is very difficult to implement because it would require raising the awareness of the entire police force, monitoring, increased control during services, an increase in salary (because low income is one of the causes of corruption), but this solution is very costly and would take far too long to take effect without guaranteeing its success.

The solution we propose is the automation of the processes of infringement and control censuses. We therefore propose the implementation of a network of intelligent video surveillance cameras, capable of reading vehicle license plates, detecting their speed and sending their coordinates to a computer centre or to a police officer who must make the fine pay (or justify the cause of non-payment in the opposite case), in different corners of our cities on the one hand and in the interurban area on the other hand.

This is already going in the direction of the government's vision, which has begun to implement such a solution by installing video surveillance cameras (not intelligent for the moment) at various corners of the cities of Yaounde and Douala and monitoring everything from the General Delegation of National Security (GDNS). This solution, although very useful, is still incomplete because it requires a lot of work to control due to the absence of automation.

Our present work consists in proposing the prototype of a Cameroonian license plate recognition system. This system can be integrated in the different cameras to allow automatic control of offences (speeding).

4 Followed Method to develop the solution

The approach followed to implement the solution is as follows:

- The understanding of the problem
- Data collection, cleaning and annotation
- The construction of the model
- The test of the model

4.1 The understanding of the problem

During this phase it was a question of determining which category our problem fell into. It was found that the given problem fell into a two-phase AI problem:

- Firstly the detection of the license plate (since when the camera captures a car the location of the license plate would have to be located).
- Secondly the recognition of the text written on the plate (just the registration number)

4.2 Data collection, cleaning and annotation

4.2.1 Data collection

Since the problem of license plate recognition is a rather local problem (depending on the background colour and handwriting of the plate as well as the police), we had to collect different pictures of vehicles with Cameroonian license plates on them. These photos were taken in car day-care centres, on the way, in petrol stations... for a total of nearly 240 photos (this low number was partly due to privacy issues and various interventions by passers-by asking to stop filming). An overview of the photos taken is presented below:

Figure 1: Some photos

4.2.2 Data cleaning

After the collection of the various photos, it was necessary to identify and remove all those that could cause problems (duplicates, photos of cars without license plates on them, very blurred photos ...). At the end of this cleaning, 218 photos were selected as usable.

4.2.3 Data annotation

The last phase concerning the data is the annotation. In order to be able to apply various plate location algorithms, it was necessary to annotate the different photos collected. For this we used the LabelImg software which allows us to annotate the boxes of interest and to keep them in xml files in Pascal VOC format.

Figure 2: Annotated car

4.3 The construction of the model

The model had two phases:

- The detection of the plate
- The recognition of text on plates

4.3.1 The detection of the plate

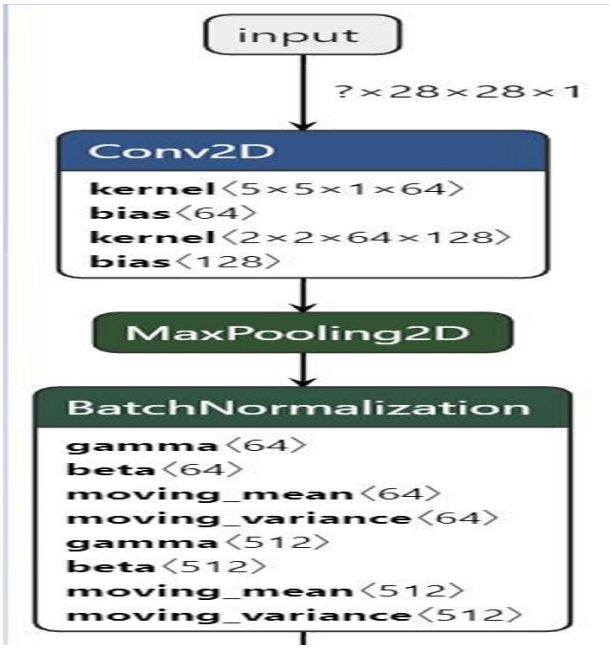
With the small number of plates acquired, directly applying a plate detection algorithm would result in too low an accuracy and therefore unusable. We therefore opted for transfer learning using pre-trained models to detect the shapes. We preferred to use the RCNN models present in Detectron2 (3) and then re-trained these models from our plates (which we converted to COCO format) so that they could detect them. The working environment was Google Colab and we performed 3000 iterations. The precision obtained by evaluating the algorithm with the test data (20 percent of the total amount of data) was 80.25 percent (due to the low quantity of data). After detecting the plate, we can proceed to the second step by inputting the selected image of the plate.
An example of result obtained from the image of a car is :

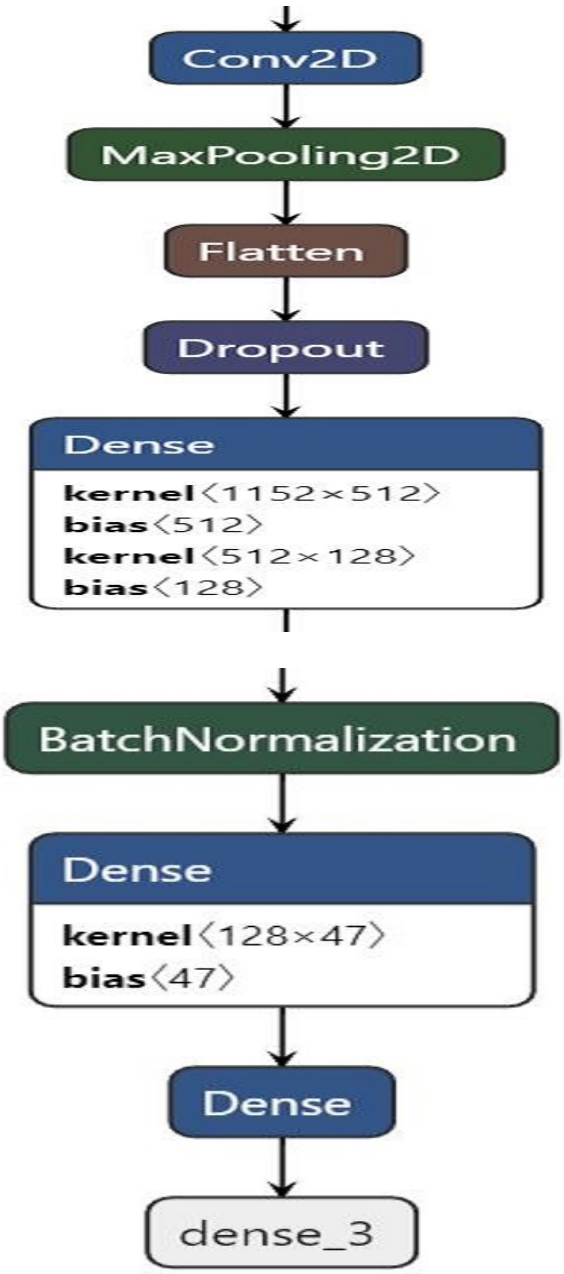
Figure 3: Photo resulting from the first model

4.3.2 The recognition of text plates

This has been the hardest part of the job. The goal being to recognize the text on the license plates, we thought first of all to use character segmentation and then character recognition on each of the segmented characters. The results were interesting for a few rare cases but in most cases there were problems due to bad segmentation (segmentation done by image processing): thresholding by the OTSU method and then edge discovery by the Canny Edge method) or bad character recognition (Indeed the algorithm we trained was on a dataset of numbers and letters but the results were not good, although being good on this dataset there at 96 percent, because our numbers and letters were not from the same data distribution and therefore were different. Moreover this method in real life is reduced to failure because the photos taken can have a lot of contrast, can be distorted, oblique ... thus biasing the segmentation and / or character recognition.

Figure 4: Character recognition model



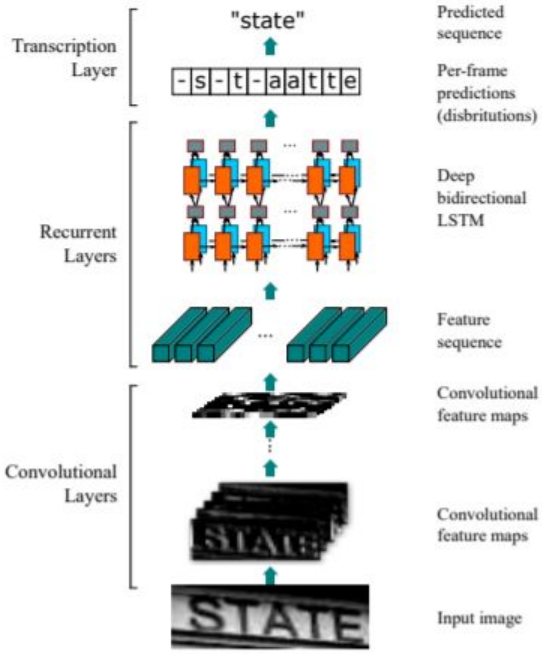


Finally in order to recognize the texts on the plate, we proceeded to implement a kind of OCR allowing to read texts on images. Our architecture was inspired from the article (4).

We opted for a CRNN (Convolutional Recurrent Neural Network) model which is known to have very good results in this task. CRNN is an architecture created to solve the problem of reading text on a wilderness background. It has been trained with more than 9 million images of text written in English (https://www.robots.ox.ac.uk/ vgg/data/text/) and has a 93 percent rate on this dataset.

So since this architecture works well with texts on real backgrounds, we assumed that it could

Figure 5: CRNN model



also work well with ours. So we proceeded to implement this architecture but we couldn't use our dataset on this one because it was too small.

After implementation, the results were also not very good (because of the difference in distribution) but for most plates, at least 4 to 5 characters were predicted correctly but the algorithm inserted for almost every plate a first character which doesn't exist. Below are some examples :

Figure 6: The real answer is : YNA2303

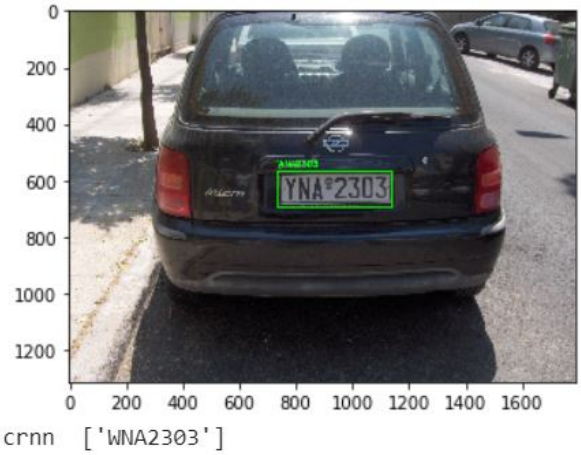
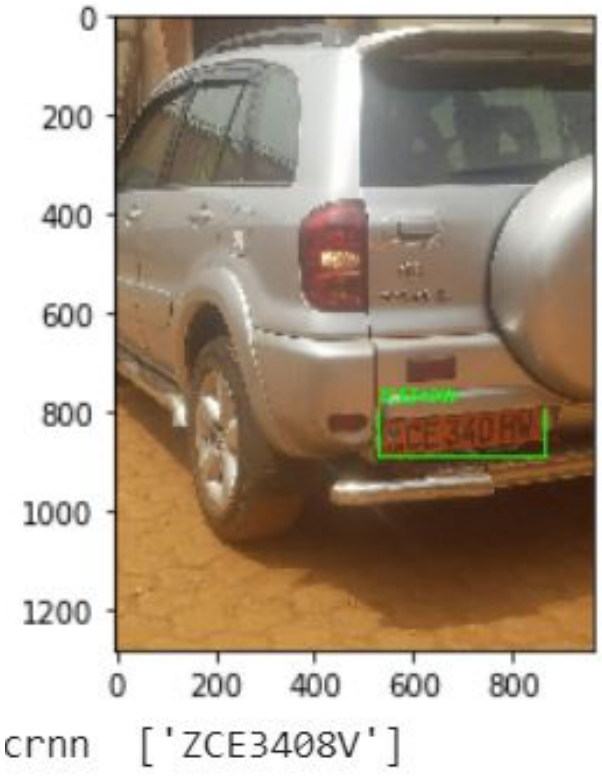


Figure 7: The real answer is : LT078FM (a character was inserted

Figure 8: The real answer is : CE340HW



5 Conclusion

At the end of our work, where we proposed a project that could improve the management of our systems in Africa, it emerged that the license plate recognition system is a system that integrated with various adapted cameras can reduce the number of accidents per year, reduce corruption and thus improve security, an objective pursued by the State, which has already installed a thousand surveillance cameras throughout the country. Nevertheless, this model still requires a lot of improvements in terms of precision and adaptability to difficult conditions (low resolution, low lighting, variety of plates, etc.) as well as in terms of speed. Indeed, this model does not allow for the moment to read correctly all the texts of the plates. To solve these problems, the solution is to increase considerably (5000 photos) the whole of our data by making them more representative of the different types of Cameroonian plates, by blurring and modifying some images in order to make the system coherent in the face of difficult conditions. We would also need about 10000 license plate photos annotated with their text in order to increase the accuracy of the text recognition model. Another challenge is to be able to alert the authorities when cars with missing or non-legal license plates or partially destroyed license plates pass in front of the camera. At the end of the realisation of this system, its practical use is just a matter of inserting it into a software program that will be inserted into a good camera (with infrared vision that can see vehicles travelling at high speed in slow motion).

References

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