Recognition of automotive license plates for automating the inspection of exclusive lanes for autonomous vehicles

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***Abstract*—This project refers to the final project of the discipline Special Topics in Software Engineering. The objective of this work was to use convolutional neural networks to build a Deep Learning model capable of detecting license plates in order to automate the inspection of exclusive lanes for autonomous vehicles. The results obtained were promising, enabling scalability for future research.**

I. Introdução

Computer vision is the scientific field that studies ways and techniques to make computers understand or extract information from digital images and videos. The implementation of systems that use Computer Vision is an efficient alternative for applications that involve data analysis. From a given image, it is possible to extract a range of data, thus, it is possible to score its applicability in the monitoring of vehicle identification plates, which mainly aims at safety.

According to (Rodrigues, 2017), the autonomous vehicle is that vehicle capable of moving and driving autonomously, thus reading and interpreting the world in real time and interacting with the elements around it. Autonomous vehicles are efficient in terms of deciding the best routes and moving safely from one point to another. However, it does not predict irrational attitudes of human beings, such as passing a red light or disrespecting other traffic laws.

In this perspective, in order to reduce the statistics of accidents involving autonomous vehicles, there is an alternative to creating exclusive lanes in order to separate autonomous vehicles from conventional vehicles and, consequently, the human factor.

To ensure its operation, it is necessary to monitor this range, an easy and efficient way to do this inspection is monitoring through computer vision. This system works by detecting and reading license plates using artificial intelligence. With the reading of the license plate performed, it is possible to search the databases of the traffic inspection agencies in order to identify whether a particular vehicle that is traveling in the exclusive lane is an autonomous or traditional car, making it possible to apply administrative measures. if an error is detected.

A. objectives

Develop a Deep Learning model specialized in the detection as well as the reading of vehicle license plates through OCR in order to automate the inspection of exclusive traffic lanes for autonomous vehicles.

B. Specific objectives

- Create the system architecture;
- Acquire training images;
- Train a Deep Learning architecture through a framework;
- Read characters from plate images using an OCR tool;
- Search for records related to the read plate in a database.

For the functioning of the system, the main concepts to be approached are the following: computer vision and the libraries that are used for the development of the work.

II. Methodology

For the construction of the license plate detection and reading system, 8 steps illustrated in the figure are necessary. 1 and will be described below.

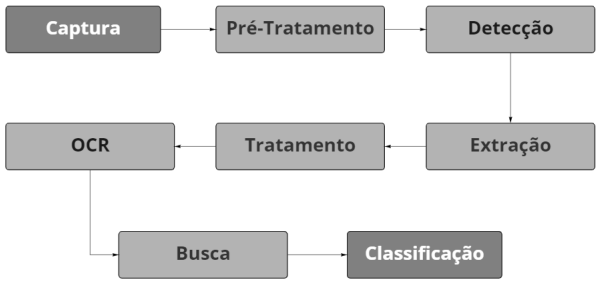


Fig. 1: Block diagram for license plate recognition.

A. *Captura*

The first step consists of capturing the images and refers to the acquisition of images of vehicles traveling through the exclusive use lane for autonomous cars. The capture is performed using conventional traffic cameras, illustrated in the figure 2. However, some requirements must be respected. For image acquisition, the camera must be positioned at a specific angle in order to frame the vehicle's license plate as much as possible and reduce image noise. Noise in the context of image processing with artificial intelligence is anything that can confuse the intelligent agent such as lighting, vehicle overlapping, other traffic lanes, obstacles such as poles, advertising boards, vegetation, among others. The figure 3 presents an example of capture in a real environment.

Fig. 2: Conventional traffic camera.

Fig. 3: Capture in an uncontrolled environment.

B. *Pré-tratamento*

The second step consists of a pre-treatment on the image acquired in the previous step. Even taking care with the capture device's positioning angle, it is still necessary to pre-treat the image in order to eliminate the remaining noise. The most relevant noise that must be ruled out is the interference of cars in the adjacent lanes. One way to do this is by delimiting, via software, specific areas in the captured image. The figure 4 represents the result obtained at the end of this step.

Fig. 4: Result obtained at the end of the pre-treatment stage.

C. *Detecção*

With the detection area established by the pre-treatment step, it is possible to start the detection step. Plaque detection can be performed by several image processing techniques. One of them is known as the contour technique and consists of recognizing geometry patterns followed by a filter. This technique has good results in controlled environments. However, in uncontrolled environments, the model has a low accuracy. For uncontrolled environments, the technique of detection through artificial intelligence stands out.

This technique consists of training a deep learning architecture specialized in the detection of automotive license plates. To do this training, it is necessary to supply a large volume of car images to a neural network architecture, which will seek to recognize patterns and intensify the most relevant features by iteratively adjusting the synaptic weights.

As seen, training data plays a key role. However, they need to meet certain criteria. To have a satisfactory performance in an uncontrolled environment, the training images need to have a similar angle to the images that will be processed and some noise interference. With the images collected, it is necessary to identify the coordinates of the objects of interest in each image and develop the files called Label Map.

For this project, we used the database These images were chosen because they meet the requirements of angulation, resolution quality and certain noise interference.

With the model built, it is applied to the image acquired in the step II-B, obtaining the result shown in Fig. 5

Fig. 5: Image of the license plate detected through artificial intelligence.

D. *extração*

With the location of the card, it is possible to extract it from the raw image and temporarily save it in a separate ".png" file. This is the third step of the process, made possible by the use of the OpenCV module. The figure 6 brings the image 'Placa.png' resulting from this step of the process.

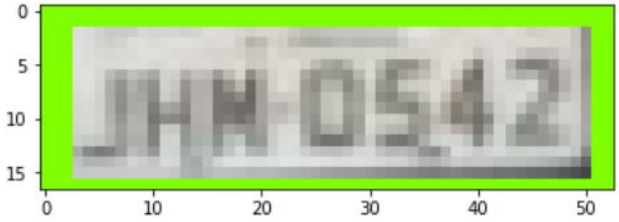


Fig. 6: image "Placa.png"

E. *Tratamento*

Characters cannot always be extracted directly from the "Placa.png" image, thus requiring a treatment step to again reduce noise and intensify the contrast of the letters in relation to the surrounding environment. This is accomplished in step 5.

The first treatment of step 5 is the transformation of the image to grayscale. The treatment is necessary because several OpenCV functions expect to receive a grayscale image. The second treatment is image smoothing, which aims to eliminate noisy features that can later be confused with characters.

The third and final treatment is Image Threshold. The latter consists of leaving the image black and white in order to enhance the characters. There are several thresholding techniques whose results can be seen in the figure 7. The thresholding that best adapted to this application, by effectively differentiating the letter "A" from the number "4", was using the Thresh Binary technique with a threshold parameter of 158.

F. *OCR*

Now, with the image of the plate already treated, it was possible to read the characters, this being the sixth step of the process. For this task, the Tesseract module was used, a tool that transforms text from images into strings. Even after

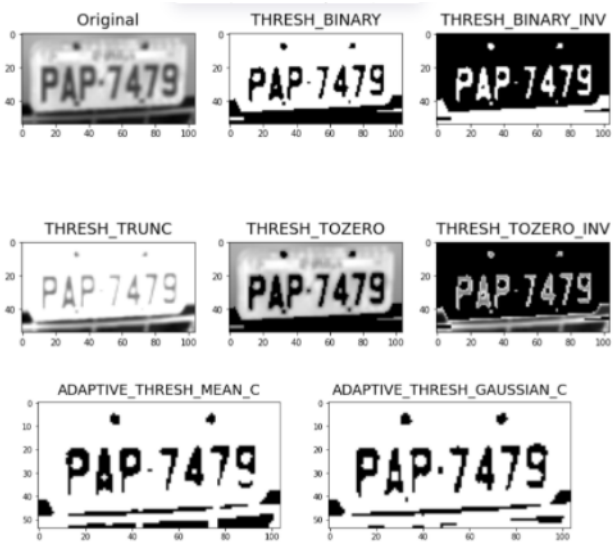


Fig. 7: Various thresholding techniques.

the treatment of the step II-E, it is still possible to get some unwanted characters such as symbols and lowercase letters. These characters are not part of the text of Brazilian plates. Therefore, still at the stap II-F, in order to minimize these inaccuracies, a filtering takes place on the obtained string. The figure 8 illustrates how an OCR like Tesseract works.

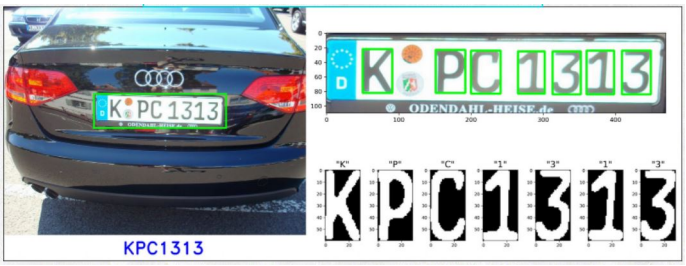


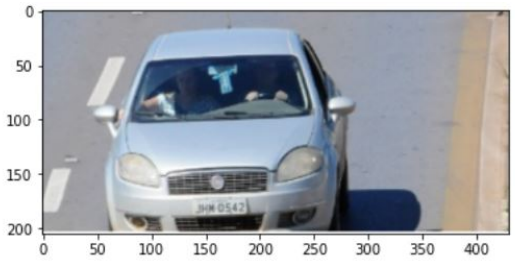
Fig. 8: OCR works

G. *Busca*

This step consists of searching the string obtained in the previous step in a database of the agency responsible for inspection, in order to obtain vehicle information, identifying whether the vehicle is conventional or autonomous. As this project was a prototype, the search was performed in a fictitious SQLite database called "Garagem.db". In a real implementation scenario, this step can be performed by connecting to the supervisory body's database through an API.

H. *Classificaçao*

The classification step consists of receiving the return of the step function II-G. If the license plate consulted is a conventional vehicle, an administrative measure in force in the traffic law will be applied to the driver.



```
     Proprietario
35  Amanda Pereira

Out[97]: 35    Autonomo
         Name: Classificacao, dtype: object
```

Fig. 9: Result obtained in the classification stage.

III. Conclusion

The objective of this work was to use convolutional neural networks to build a Deep Learning model capable of detecting license plates in order to automate the inspection of exclusive lanes for autonomous vehicles. The architecture created proved to be efficient in detecting vehicle license plates even in uncontrolled environments such as highways. On the other hand, the OCR system for reading the characters on the plate presented inconsistencies in some cases. The results obtained proved to be promising, enabling scalability for future research.

A. *repository*

All code developed for the project can be found in the following repository:

https://github.com/marcelostosjr/TEES_OCR$_{P}laca_{d}e_{V}eiculos$

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