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Algorithm and Computer Application for the Recognition of the Number Plates of Moving Vehicles

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Abstract

The paper presents an algorithm and an application for the automatic recognition of the number plates of moving vehicles. The approach uses a number of techniques for image pre-processing and enhancement, region of interest extraction, and an optical character recognition module. The implementation of the algorithm was done using Matlab.

The application processes pictures taken from a fixed standard camera, of vehicles moving with reasonable speed.

Key words: *number plate detection, number plates recognition*

Introduction - State of the Problem

The problem of number plates' recognition is, nowadays, of great interest and has a large number of applications.

Be it done starting from moving or fixed cameras, in different illumination environments, with different angles between camera and the plate, the number plates' recognition is a complex process depending especially on the level of robustness of the methods used.

The number plates' recognition if often combined with validation schemes designed to verify if the recognized number plate fits a certain pattern (number of characters, succession of letters and figures etc.).

Some of the detection methods use template matching [1], Hough transform [2], neural networks [3], or genetic algorithms, but for almost all approaches, a very important step in the recognition process is to isolate the plate itself within the taken picture. This stage raises problems like the skewness of the plate region (due to the angle between the camera and the vehicle), or the disturbing effect that a dirty plate can have on the quality of the image (this is generally combined with the illumination conditions).

Many methods also use morphological transformations [4].

Another technique used in many number plates' recognition is the search of the signature of the number plate [5]

The scope of our paper is to present the algorithm and a computer application able to recognize, with fair results the number plates of moving cars.

Application Structure

The general structure of a number plate recognition system includes four modules, as presented in figure 1.

The images we are talking about are extracted from video sequences previously recorded.

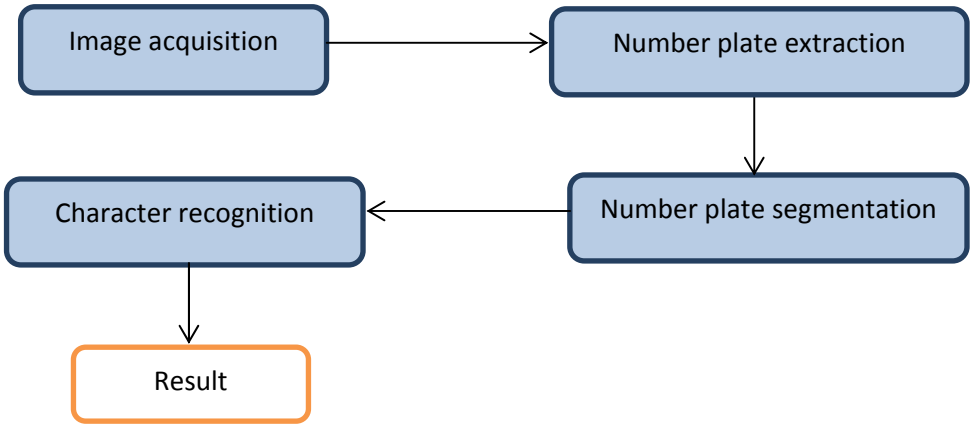


Fig. 1. Application structure

Application Modules

Number plate extraction

The number plate extraction implies the steps detailed in figure 2.

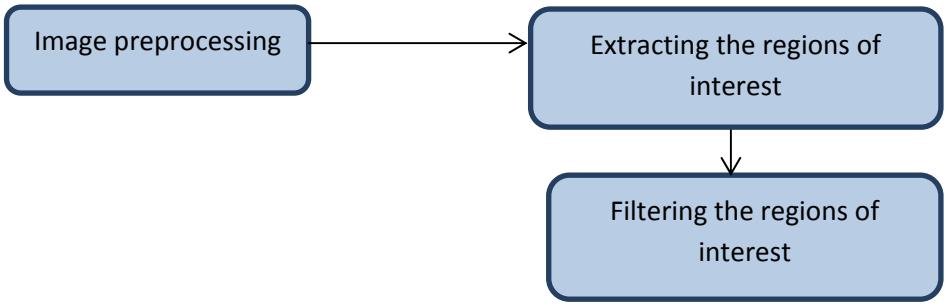


Fig. 2. Number plate extraction

Image preprocessing

The image preprocessing phase is necessary in order to increase the image quality, a very important factor for the next steps.

The process consists in applying successively four filters on the image:

- An adaptive smoothing filter;
- A sharpening filter to enhance the quick changes in grey levels;
- A step filter;
- A morphological closing filter.

The **adaptive filter** is applied in order to fade off the image the areas that do not contain important or significant information (from our point of view, "important information" means information related with the number plate). We have chosen to use an adaptive filter, because a normal one would have blurred also the plate number region of the image.
Figure 3, presents the result of applying the adaptive filter.

a) Initial image

b) Filtered image

Fig. 3. Applying of the adaptive filter

The **sharpening filter**'s scope is to identify edges on the image, starting from the fact that the number plate includes edges, or regions with important changes in gray levels.

The results of applying the sharpening filter is presented in figure 4.

Fig. 4. Sharpening filter

The mechanism we have used is to enhance the image clarity by subtracting the filtered image depicted in figure 4, from the initial image.

The step filter is applied in order to even better focusing on the number plate region of the picture. This filter works in the following manner: for each pixel of the image, one calculates the sum for the values of the grey level of the four neighboring pixels (above, under, left and right). If the value is above a certain value, we conclude that the pixel it is not "important" and as a consequence, it will be eliminated from the image. This way, we will get rid of the stray pixels.

The **closing filter** will use a structured element with a rectangular shape, with a dimension of 20 by 4 pixels.

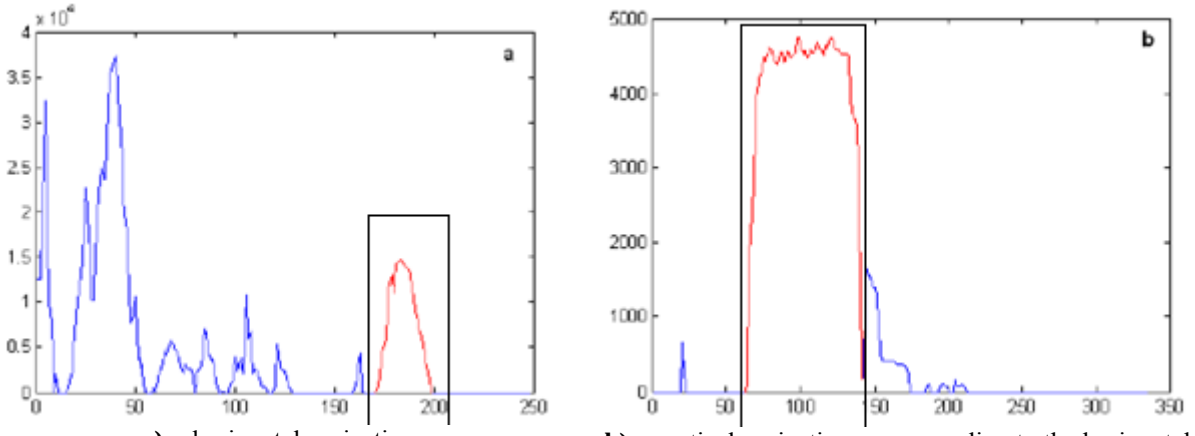
The results of applying the two filters are presented in figure 5.

a) - step filter **b) –** closing filter

Fig. 5. step and closing filters

Extracting the regions of interest (ROI)

This phase of the application starts from the image presented in figure 5.b. The essence of the method is to analyze the horizontal and vertical projections for the image (the sum of the grey levels for each row, respectively column). This action will produce plots like the ones presented in figure 6, where the rectangles mark the number plate area.



a) - horizontal projection **b) –** vertical projection corresponding to the horizontal projection

Fig. 6. Horizontal and vertical projections

The area where the number plate presumably is placed in the image, is duble checked by verifying if the following extra conditions:

- The ratio between the length and the height of the region ios between 1.9 and 5.9;
- The surface of the area should exceed 700 pixels;
- The length of the region should exceed 300 pixels.

Processing and identification of the area that includes the number plate

This stage will solve the problem generated by the fact that the camera do not points perpendicularly on the number plate, by detecting and adjusting the angle under which the number plate appears on the picture. Figure 7 presents this process.

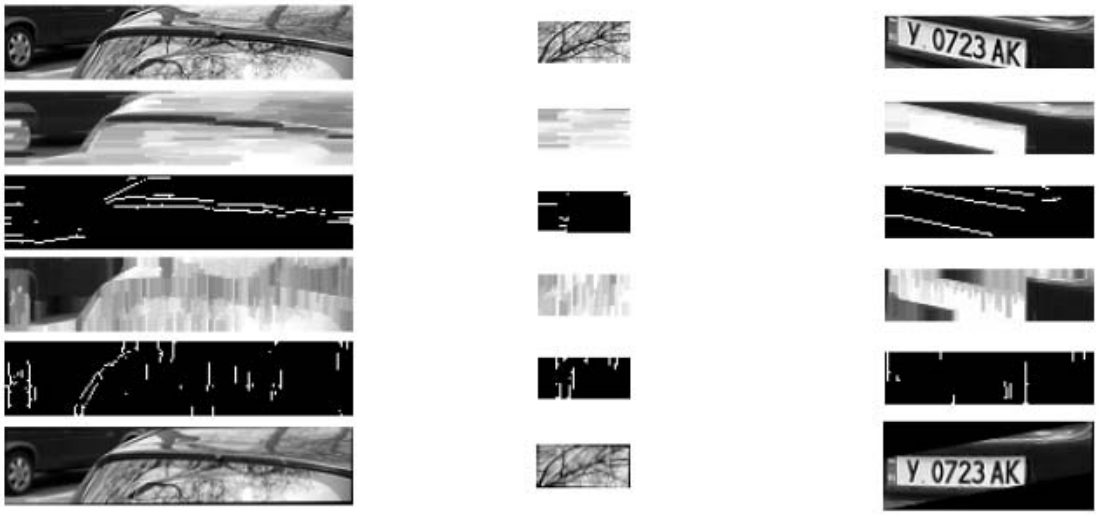
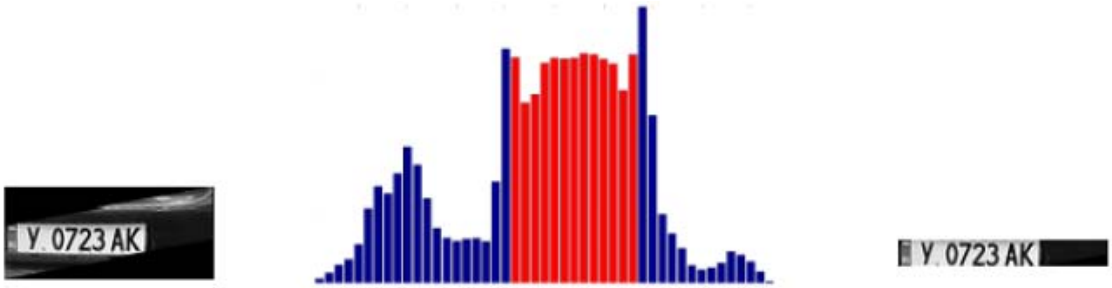


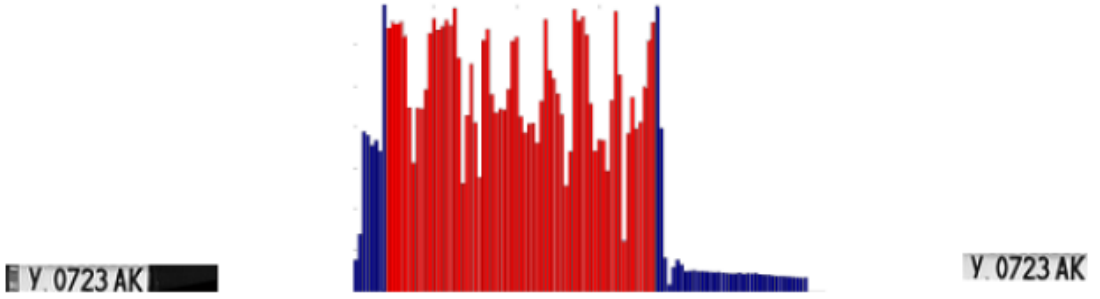
Fig. 7. Adjusting the tilting angle

The next step will be isolating the number plate, again by using horizontal and vertical projections, as depicted in figures 8 and 9.



Processed area Horizontal projection Vertical clipping

Fig. 8. Vertical clipping process

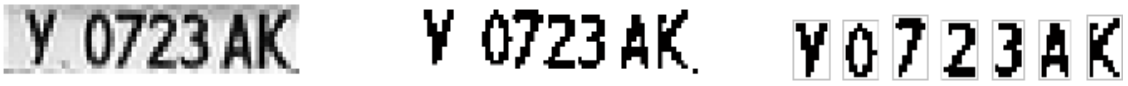


Processed area Vertical projection Horizontal clipping

Fig. 9. Horizontal clipping process

Character segmentation

The segmentation process is applied on the image resulted after extracting the number plate region from the picture. The process is illustrated in figure 10.



The number plate region | The binarized image | The segmented characters

Fig. 10. Character segmentation

Character recognition

The character recognition is done by matching the segmented regions of the number plate with a set of template characters used for the number plates (DIN 1451).
We are talking of 36 template characters (see figure 11).

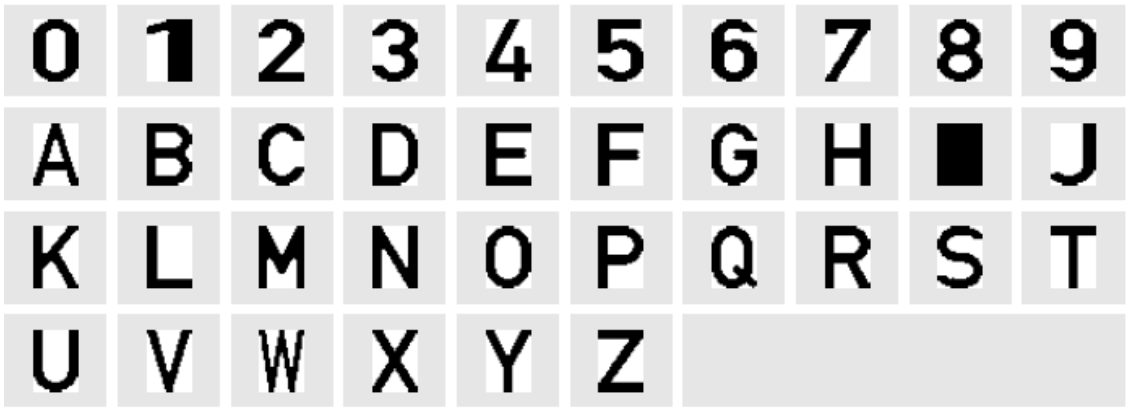


Fig. 11. Character recognition - templates

The templates are designed in a manner to avoid any white rectangle shaped region in the border regions of any character (see for example the case of letter I and number 1). This condition is imposed by the comparison between the segmented characters and the templates.

The comparison is done in sequence, for all the characters of the number plate. It is possible that certain characters be wrongly identified (for example 0 – O – D, 1 – I, or 5 – S). In this case the quality of the image is of paramount importance.

The process itself is described in figure 12.

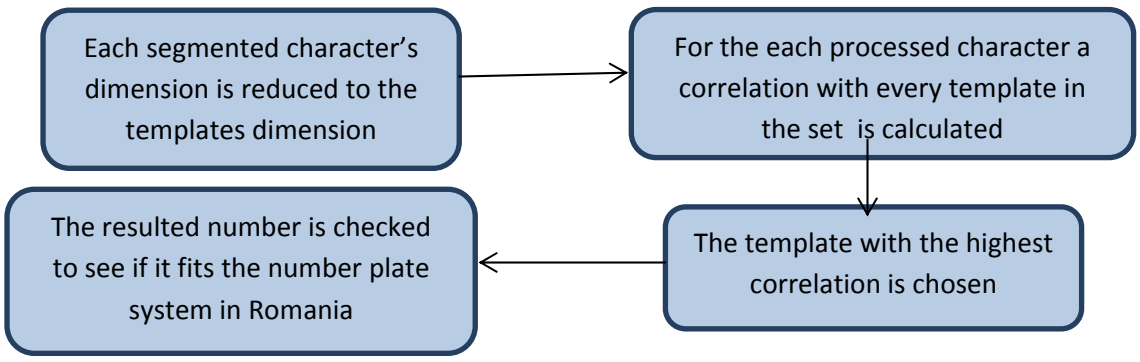
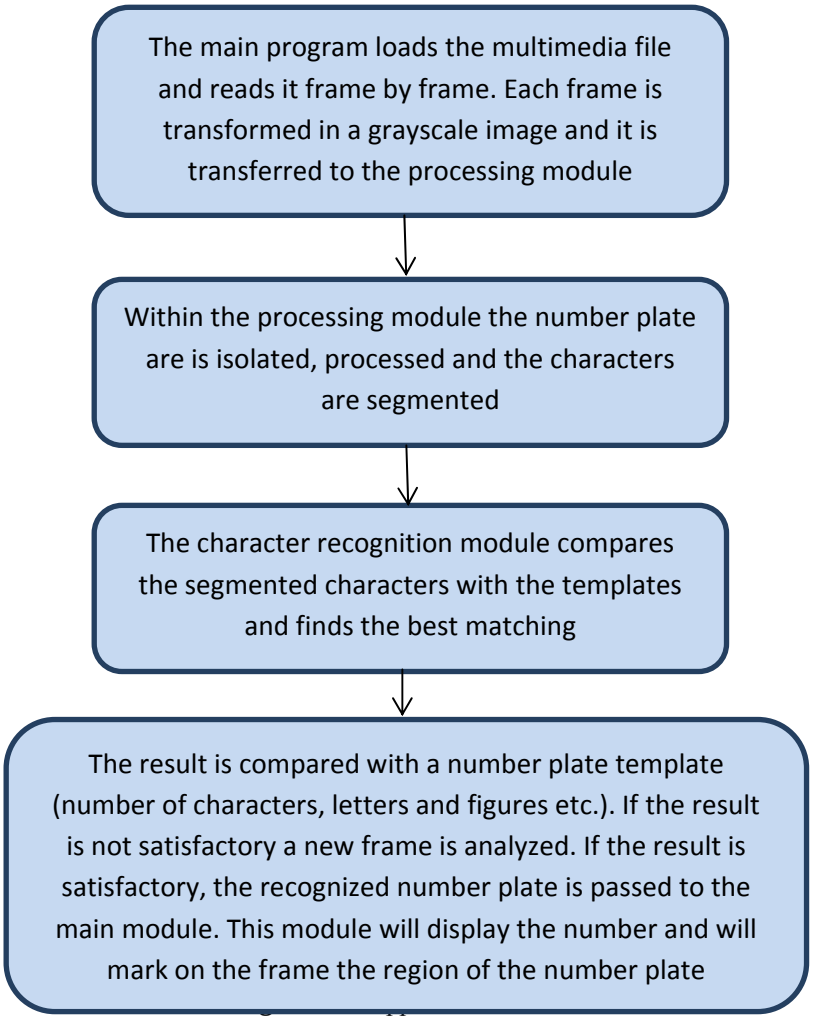


Fig. 12. Character recognition

The application

The application has been developed in Matlab, and its structure is presented in figure 13.



Conclusions

The application provides good results if the images are taken from a medium distance. This is a direction where the application could be ameliorated.

Another possible development would be the use of parallel processing. This will reduce the duration of the process.

The application works at the moment only wit Romanian number plates. It could be developed by adding new number plate templates (corresponding to different countries).

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Algoritm şi aplicaţie pentru recunoaşterea numerelor autovehiculelor în mişcare

Rezumat

Articolul prezintă un algoritm şi o aplicaţie informatică pentru recunoaşterea numerelor autovehiculelor în mişcare. Abordarea foloseşte un număr de tehnici pentru pre- procesarea , procesarea şi ameliorarea imaginilor, extragerea zonelor de interes, sau recunoaşterea caracterelor. Implementarea s-a făcut în mediul Matlab.

Aplicaţia procesează cadre ale unor imagini filmate cu o cameră video obişnuită, de la o distantă media, pentru vehicule care se deplasează cu viteză rezonabilă.