

# Automatic Identification for Automotives Vehicles Plates

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**Abstract:** - This article describes the adopted strategy for the conception and development of a system for automatic recognition of automotives vehicles plates. We used a modular solution to approach this problem that is divided in six phases. It covers from the way of taking the images to how to recognize each one of the characters in the plate. Process images and intelligence computational techniques were used as well as neural networks system.

**key Words:** - traffic controllers, stolen localization cars, access controls, fines application, plates recognition, characters segmentation, extraction of characteristics, neural networks.

## 1 Introduction

With the constant growth of the vehicles fleet in the world, more and more traffic problems are getting complicated to solve and therefore, they need more creative and automatic solutions. Today, There is a big need to obtain quick information from the traffic controller engineer and plates recognition of the cars. So that it is possible to increase the efficiency of controlling and monitoring of the traffic, as well as lower the costs of those operations.

Plate recognition is not only useful in controlling or in monitoring the traffic. Other application exists that can be benefited, such as: stolen located cars, fines application in bad drivers, control access of a parking areas, statistics flow data of entrance and exit of cars in a certain local areas or even generate subsidies for the tourism area.

In Brazilian metropolitan cities the vehicle identifications, using photographs that exists in an endless number of remote indicating equipments in the public roads, are still deed manually and not in real time. With an automated system one can earned timing of answer, but can also immediately earned informations from countless other applications, such as in the areas of security, planning and tourism.

Having in mind a big concentration of vehicles in the big centers and knowing that the majority of the big Brazilian cities are already utilizing cameras for theirs traffic controlling or for fines application, the use of an automatic system for plates recognition it

would be an excellent ally to the public traffic controllers, to the big parking areas and to the highways privatized concessionaires that needs fast information available .

## 2 Obtaining Data

For the achievement of this research was necessary to obtain a big quantity of digital photographs. It is through them that the study and the development of a computational model became possible. The Federal Road Department of the State of the Rio de Janeiro (DER-RJ) through the Perkons Electronic Equipment Ltda company, firm that lends services of data processing to the DER-RJ, supplied with a set of 9.079 (nine thousand and seventy-nine) digital vehicles images. The images supplied were obtained through several cameras located in the highways of the Rio de Janeiro State, utilized in the fines applications and controlling.

These pictures were obtained in real conditions which enriches the study. It presents real problems which are necessary to be evaluated and approached, such as: fog, rain, brightness, angles and unlike speeds obtained from the images.

## 3 Analysis of the Images

A first analysis was carried out with a the set of images to verify the ability of the human being to identify a large quantity of photographs. From 9.079

images, 42,4% could not be identified by several problems, such as: Images of vehicle without plate, images without vehicle or completely dark, excessive brightness in the plate, bad characters defined in the plate or with slow rank of resolution. In summary, the study is being carried out with 5.233 (five thousand and two hundred and thirty-three) remaining pictures.

## 4 Approach Utilized

The system is constituted of modulate forms, like the plan shown in the Fig. 1, each of these module have a specific functionality.

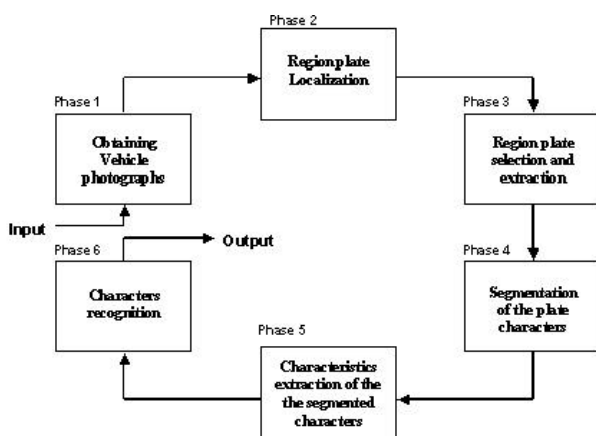


Fig. 1: Block Diagram of the system

### • Obtaining vehicle photographs

Responsible for the capture of the images. In this phase, the images are obtained by the cameras located in diverse points of public streets. This is the present procedure by the public controllers of the Brazilian traffic. The Fig. 2 shows how it is done.



Fig.2: detecting Camera

Three forms of images can be obtained: video, digital or analog (conventional) photographs. A good quality of image is fundamental to the

performance recognition of the system. The Fig. 3 shows the standard quality of an image captured by the system utilized by the DER-RJ. Despite the low definition, the image of this example is considered one of the best, regarding all data set.



Fig. 3: Image obtained by the detecting camera

### • Region plate Localization

Responsible of locating plates or candidates regions for it. The input is the entire picture and its objective is to supply as exit, a region where the plate is probably located.

### • Region plate selection and extraction

Responsible of selecting, amongst the candidates regions, the more probable one. Extract the region from the image and keep it in a file for execution in the following phase.

### • Segmentation of the plate characters

Responsible of separating the characters one from another and making seven each small news files. Each one of them containing the image of the character that composes the plate.

### • Characteristics extraction of the segmented characters

Responsible of extracting from each segmented character informations that allows it to be more easily classified by the recognition module.

### • Characters recognition

Responsible of recognizing each character that composes the plate, through out the available characteristics extracting module informations. This recognition is carried out through the neural networks technique.

## 5 Modules in Development

The modules of the plates automatic recognition system are being developed as following:

### 5.1 Region plate localization

Based on the government enforcement article 1º from the resolution nº 45/98 of the National Traffic Council - CONTRAN [9], the dimensions (in millimeters) accepted for the plates are the following:

- a) ideal: height=130 width=400;
- b) maximum: height=143 width=440;
- c) minimum: height=117 width=360.

The character dimension for the plates are 63 mm height. The width is to be defined for each one of the letters and numbers. The highest value is for the letter “W” (49 mm) and the lowest for the letter “I” (10 mm).

The study of this localization process involves algorithms processing application of images for the candidates of regions localization plate. After its localization, the regions from the plate are extracted and kept each one of them in a peculiar file, they will be used in the following phase.

### 5.2 Region plate selection e extraction

The algorithms utilized in the module for the region plate localization are not always capable of identifying the plate’s region. It happens because of the peculiar diversity conditions of the photographs. There are pictures in that the vehicles do not possess plate and there are pictures in that more then one region candidate is found.

An set of neural system is used to, amongst the regions of image found, select the better probability of then region’s plate. The final decision about accepting or not regions candidates, It is also been done by a neural network system. To support the study and the conception of both the modules, it was developed a program (Fig.4) that enables a manual extraction of regions with or without the plate included.

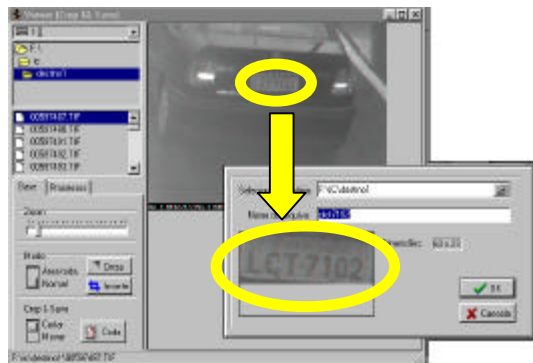


Fig. 4: Extraction of the region’s plate

### 5.3 Segmentation of the plates characters

After extracting the region from the plate, the next phase is the characters segmentation which is carried out the detachment of each character from another and creating seven files. Each one of them with the image of the character from the plate [1], showing in the Fig. 5. The segmentation is not always obtained all the characters in seven distinct files. Problems with low resolution and distortion image of some characters and close approximate among them, makes an union between two characters. The segmentation percentage of the seven distinct plate’s characters, in the present moment is 76.61%. This must be because of the set data of the DER-RJ, wich has in its big majority pictures of lowest quality. In good photos quality the rate of certainly from the segmentation has been of 100%.



Fig.5: Segmentation of the caracteres from the plate

It can be seen in the Fig. 6 and 7 down, an example of the initial image (input) and the image segmented (output) of a plate.



Fig.6: Initial image



Fig.7: Segmented image

#### 5.4 Extraction of the characteristics of the caracteres segmented

In this phase are extracted characteristics of each image segmented, in order to compose a signature for each caractere. The extraction is done by a technic developed by the group, that is derived from the algorithms of detention of contour [4] and [5]. The technic is based on the projection of the contour of the image from the sides of a regular polygon, positioned around each caractere. The surrounding polygon can be of any number of sides, from 3 (triangle) to many sides (circle). The vetor of characteristics is formed by the perpendicular distances taken from each side of the polygon to the contour from of image. The performance of the technic was evaluated through the study of peculiar polygons as shown in the Fig. 8 down:

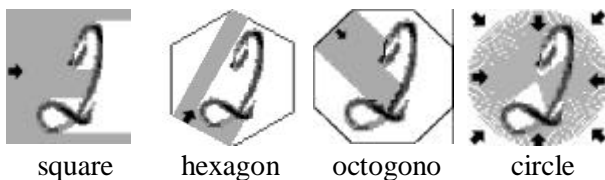


Fig. 8: Characteristics extraction approaches

In this work it, is being utilized the square's approach, aimed in [6] as the adequate one for this kind of application.

The size adopted for the square is of 32 pixels for each side, what totals up a vetor of characteristics with 128 measures of distance.

These vetores were generated through a program specially developed to read an image bitmap and produce the values for all kinds of polygons, as well as for the diverse sizes of the respective sides (Fig.9).

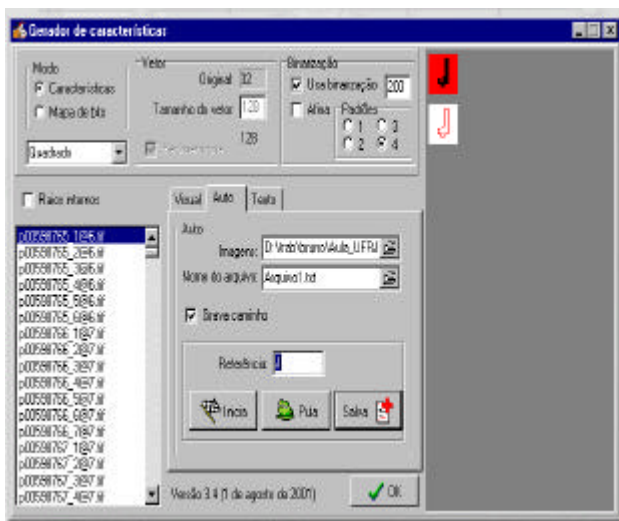


Fig. 9: Program extrator of characteristics

Of the available set of plates for to be studied, it was a base of data composee of letter and numerical digits, that presents to following distribution.

Table 1: Distribution of the letter in each class

Letter	Percentage	Letter	Percentage
A	5.38	N	3.48
B	6.32	O	3.36
C	10.24	P	2.56
D	1.83	Q	2.68
E	1.78	R	3.06
F	0.98	S	2.56
G	3.67	T	2.23
H	2.04	U	2.07
I	4.76	V	1.74
J	4.09	W	0.79
K	10.13	X	2.14
L	15.95	Y	1.59
M	3.13	Z	1.44
<b>Total</b>	<b>70.30</b>	<b>Total</b>	<b>29.70</b>

Table 2: Distribution of the numerical digit in each class

Digit	Percentage
0	9.80
1	9.35
2	10.40
3	9.80
4	10.30
5	9.65
6	10.90
7	10.80
8	7.80
9	11.20
<b>Total</b>	<b>100.00</b>

It can be verified that the frequency of distribution of the letter is not homogeneous, having a bigger incidence of the letter "C", "K" and "L" and a smaller one from the letters "F" and "W". On the other hand, among the set of digits, the distribution was more homogeneous.

#### 5.5 Caracteres Recognition

From the characteristics extracted from the set of caracteres of a plate, it is given the beginning of phase recognition. The input of the neural networks for each plate is composed of a matrix of 128x7. The three first caracteres for the neural networks letters and the four remainders for the neural networks of digits. The output to each caractere was configured

like a vector orthogonal of dimension 10 for the digits and 26 for the letters. [table 3 and 4]. Fig. 9 down illustrates the process of recognition of the characters through of a neural networks.

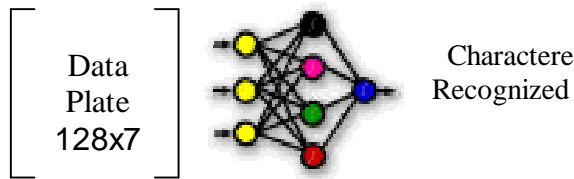


Fig. 9: Recognition neural

The kind of the two neural networks are Feedforward Multi-Layer Perceptron [2] and [8], trained with the algorithm backpropagation. The software utilized was the MatLab version 5.2. [7] The function of activation utilizes a simple sum of the entrances adjusted by its respective weights. As function of propagation the logistic function sigmoidal was used (“logsig” in the MATLAB) both in the hidden layer as well as in the output layer.

Various topologies and architectures were tested, where the “best” results obtained were through neural networks composed of two layers, one hidden and an output one. Both the neural networks operate with an input of 128 characteristics, obtained by the “method of the square”. The first layer, the hidden one, is composed of 47 neurons and the output one of 10 neurons, in case of specialized neural network in the recognition of numerical digits, and for 26 neurons in the one specialized in letters.

The output of the neural network was selected according the strategy “The Winner Takes All”, where the greatest value among all the output altered for one (1) and the remainder was altered for zero (0). Doing this an index zero (0) of rejection is obtained.

The output vector was chosen as being orthogonal to facilitate the training process. The tables 3 and 4 down, show the codification utilized in the output numerical neural network digits.

Table 3. Codification from the output of the numerical digits.

Digit	Output
0	0000000001
1	0000000010
...	...
9	1000000000

Table 4. Codification from the output of the letters.

Letter	Output
A	10000000000000000000000000

B	01000000000000000000000000
...	...
Z	00000000000000000000000001

### • Data pre-processing

The dataset was divided in two distinct subgroups: one for training with 80% of the samples and another for test with the 20% remainders [3]. All the information from the input (training and test) were normalized by a factor, where this factor represents the distance between the opposite sides of the used polygon. The purpose of the utilization of this factor is to put all the input values from the neural network inside the interval between 0 and 1. Fig. 10 presents how this factor is extracted in the case of the square.

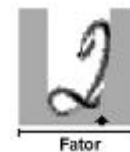


Fig.10: Representation of the factor of normalization

Another procedure adopted for the preparation of the was dataset was the elimination of all rows with variance zero. This simple procedure eliminates some variables of the input space, thus reducing its dimensionality. For example: the input of 128 size for the neural networks specialized in letter was reduced for 109; and in the neural networks specialized in numbers it was reduced from 128 to 99.

As written previously, the experiment was developed utilizing the toolbox of neural networks of the MATLAB version 5.2 and the training from the neural networks was carried out using the option “traingdx”, with moment and rate of learning adaptable.

### • Results

In the dataset test the following results weew obtained:

Neural networks: Numerical Digit

Nº epoch from training	6000
Nº epochs carried out	6000
% Correct Classifications	79.75
% Incorrect Classifications	20.25
% Rejects	0.00

Neural networks: Letters

Nº epochs from training	10000
Nº epochs carried out	10000



% Correct Classifications	72.26
% Incorrect Classifications	27.74
% Rejects	0.00

## 6 Conclusion

The results obtained were much lower than expected showed enough, specially the one responsible for the recognition of letters, however there are some determinant factors for these final results.

The most important was the low quality of the pictures in disposal. To low resolution, ally to difficulties as lighting, noises generated by the environment (rain, fog, etc) and problems with the cameras itself (absence of focus, localization inadequate, improper angle of vision, etc.), caused problems which certainty were the difficulties resources faced by the execution of the work.

In the module of segmentation the result was 76.61% of right, considering the seven caracteres of each plate. A performance, once more, lower than expected, consequence of low quality of the original photos.

In the module of recognition, were detected some more frequent confusion occurred among “B”, “D” and “O” for the neural networks of letters and between “0” and “8” in the neural networks of digits. That happens because the outside of those caracteres, following the utilized resourse in the making of the plates, has an very similar design.

Having in mind the short results obtained, mainly, in cases of distinction between “0” and “8”, many alternative solutions were tried. One of them involved the use of a neural networks specialized in the unbundling between “0” and “8”. However, even such attempt went wrong, having in mind the big influence from the bad quality of the data. This neural networks had as the best result barely 57% of right. For a neural networks of barely 2 output, this means to say that the training did not work out for the neural networks was giving randoms answers.

To sum up, it can be concluded that for an improvement in the recognition, it's necessary a better quality of images, that should be obtained through an equipment with a higher rate of resolution. The investment for the acquisition of such equipment is not so high, taking in to consideration, in case of application fines, the quantity of vehicles that can not be notified, due to the bad image quality. Remembering that 3.846 could not be used.

For the continuation of this work, images of better resolution are being obtained, and still, a new technique of characteristics extraction is being devepoed, which purpose is to reduce the confusion

that occurred in the recognition of the letter “B”, “D” and “O” and the algarismos “0” and “8”.

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