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Brazilian vehicle identification using a new embedded plate recognition system

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ABSTRACT

Expert systems for parking lot access control are developed in vehicle management through tracking and number recognition. These systems commonly use cameras to identify a vehicle through its license plates based on intelligent and optical character recognition techniques. This paper presents a new system to detect and recognize Brazilian vehicle license plates, in which the registered users have permission to enter the location. For this, techniques of Digital Image Processing were used, such as Hough Transform, Morphology, Threshold and Canny Edge Detector to extract characters, as well as Least Squares, Least Mean Squares, Extreme Learning Machine, and Neural Network Multilayer Perceptron to identify the numbers and letters. The system was tested with 700 videos with a resolution of 640 × 480 pixels and AVI format, granting access only when the plate was registered, getting a 98.5% success rate on the tested cases. The movement detection step is linked to the system, becoming faster and more accurate in real time. Thus, can be concluded that the proposed system is a promising tool with high potential which can be applied commercially.

1. Introduction

Developing countries have high rates of violence and insecurity in their societies, and Brazil is no different. However, access control to private locations is important, and in many cases is required.

In the past few years, intelligent traffic controls have been used for tool booths, real-time monitoring and parking systems [1]. These systems can use cameras to identify vehicles and license plates using Character Recognition [2].

Al-Ghaili et al. [3] presents a fast vertical edge detection algorithm (VEDA) based on adaptative threshold, which enhances the speed of the car-license-plate detection method. Al-Ghaili et al. [3] also compares the VEDA to the Sobel operator in terms of accuracy, algorithm complexity, and processing time. Mashuk et al. [4] locates the plate by applying an empirical crop, then it applies a median filter to reduce the noise and uses morphology to segment the characters. For the recognition, Mashuk et al. [4] uses a four layered Backpropagation neural network and uses 128 features, which are the pixels from the binarized image.

Qing-kun et al. [5] presents license plate recognition based on mathematical morphology that uses edge erosion, connected component analysis and geometry find

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the plate. To recognize the plate, Qing-kun et al. [5] use a RBF neural network.

Sulaiman et al. [6] presents on his article an automatic vehicle license plate detector using color conversion to gray scale, the image filters using Laplacian of Gaussian, then is applied to the bounding box technique to detect the characters on the image and to identify the characters. It is using the template matching technique.

In this context, this paper aims to develop an expert system able to recognize the standard license plates of Brazilian vehicles for control access in private parking lots, where only the registered users have permission to access the location. Hence, this paper seeks a way to make car access control more accurate and safe through the development of a Computer Vision System (CVS) using robust techniques of Digital Image Processing (DIP) such as threshold, Hough Transform, Canny Edge Detector and Pattern Recognition such as an Artificial Neural Network (ANN).

2. Materials and methods

A typical Computer Vision System is composed of, normally, six steps: (i) the image acquisition, (ii) pre-processing, (iii) segmentation, (iv) feature extraction, (v) identification and (vi) report. The image acquisition step consists of image capture while the pre-processing step consists of removing flaws and imperfections from the image [2]. The segmentation step is responsible for dividing the image into regions of interest [7]. Subsequently, the features are extracted by the segmented image, which is used to identify previously established standards. Finally, a report is generated with the analysis [2]. An illustration of the steps of a typical CVS can be seen in Fig. 1.

In this paper, Hough Transform, gradient operator, Canny Edge Detector, thresholding are applied in pre-processing, segmentation and feature extraction.

Afterward, the feature extraction techniques of Computational Intelligence are used to identify the characters from the plates based on multilayer perceptron.

2.1. Gradient operators

Among the techniques used to detect the objects edges in an images, we highlight the use of gradient operators which may be cited operators Roberts, Prewitt and Sobel [8]. One way to implement these operators is to apply a two-dimensional convolution in image using specific masks. In this paper, we used the Sobel operator, and the mask used in their convolution is given by Sonka et al. [9].

$$g(x,y) \cong \sqrt{(s_1^2 + s_2^2)} \tag{1}$$

in which

$$s_1 = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}; \quad s_2 = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \tag{2}$$

2.2. Canny edge detector

The Canny edge detector performs two effects: the filtering of noise and highlighting the pixels which set an object edge in a digital image [10]. To develop this algorithm, primary studies were focuses on optimal borders, whose representation can be made for functions in one dimension (1-D) [10]. He showed that the best filter to start their algorithm was a smoothing algorithm, Gaussian operator, followed by a Gaussian derivative, which in one dimension can be given by McAndrew [11]:

$$d = \left(-\frac{x}{\sigma^2}\right) e^{-\frac{x^2}{2\sigma^2}} \tag{3}$$

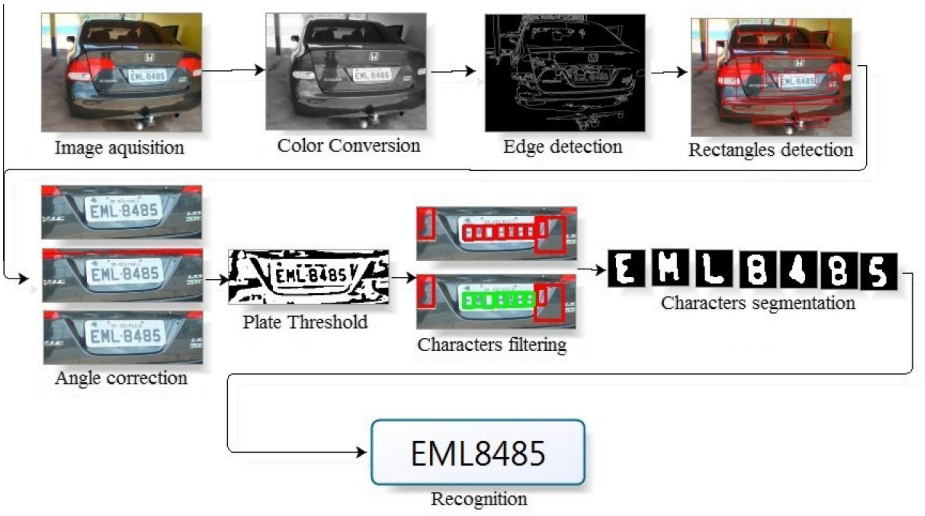

Fig. 1. CVS flowchart.