METHODOLOGY FOR CONSTRUCTING CAR NUMBER RECOGNITION SYSTEMS

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ABSTRACT

The technology of creating a system for searching and recognizing license plates is considered. Modified algorithms are proposed to improve the reliability and accuracy of such systems. These algorithms were used to create a software package consisting of a set of software modules that perform image preprocessing, license plate detection, character extraction, and character recognition.

INTRODUCTION

The problem of automated online recognition of textual information is an urgent task associated with a wide class of practical applications. One of these tasks is license plate recognition. The creation of an automatic system that registers license plates allows you to:

• to automate the control of entry and movement of vehicles at facilities with limited access and closed areas;

• track entry and exit in car parks, automatically calculate the cost of services provided, control free space;

• automate the control of the departure of paid or unpaid vehicles at service stations and car factories, control the loading of the service area; • track the entry, exit and time spent by vehicles on the territory of the warehouse and terminal, prevent possible theft;

• on motorways to ensure the control of traffic flows and carry out automatic tracing of stolen vehicles and those for which offenses are registered;

• automate the collection of statistics for municipal services. To date, there are already several automatic license plate recognition systems in the world. All of them are far from perfect and are constantly being modified. Nevertheless, the general structure and solutions to this problem have already been formed.

The image pickup device is a video camera. A number of restrictions are imposed on the installation of a video camera. The optical resolution of the camera is selected in such a way that the license plate occupies 25 to 33% horizontally in the frame. The maximum permissible vehicle speed at which recognition is possible depends on the angle of the camera to the roadbed. The work [1] declares: “The typical tilt angle of the camera should be 40° so that the car in front does not block the next one”, which also imposes a number of restrictions. The vertical size of the number plate decreases in proportion to the value of the cosine of the camera tilt angle. Therefore, it is necessary to increase the optical resolution, which leads to a reduction in the width of the field of view. Some number plates may be installed with a slope towards the roadway. With a large angle of inclination, the recognition of such numbers is very problematic. Horizontal installation of the video camera is considered optimal, i.e. at the level where the license plate is located. Such an installation is used in systems for automatically passing to a closed territory, parking, etc. Another important parameter is the minimum allowable contrast of the license plate image. In some systems, an additional module is installed, consisting of infrared illumination and the corresponding filter [2]. This approach allows you to increase the contrast of the license plate in relation to the rest of the image. This technology is based on the fact that the license plate has a special reflective coating, in which the reflected light propagates in the opposite direction to the propagation of the incident light (i.e. the angle between the incident and reflected beam is 0 °), due to which the camera will perceive mainly infrared light and

light reflected from the license plate. The picture in this case will be monochrome with no details except for the license plate.

Preprocessing of the received image includes the following steps.

1. Image correction - equalization, limitation of extreme brightness values, modification of the brightness distribution histogram.

2. Eliminate the effect of blurring the image that occurs due to the fact that the speed of the car is greater than the registration speed (shift compensation).

3. Elimination of redundant information - the use of infrared (IR) illumination, binarization, splitting the image into separate color regions.

4. Using a software motion detector to localize the car in the image.

The disadvantage of preprocessing with binarization is that the selected binarization threshold does not provide the required quality for any type of image. Factors such as lighting or even the color of the vehicle affect the quality of the image binarization. The use of adaptive binarization methods, however, makes it possible to solve this problem more qualitatively. One of the applied approaches for the localization of the license plate is the method of detecting the boundaries of the image using algorithms such as the algorithm of Sobel, Kenny, Robinson, etc. [3]. The edge detection algorithm must detect both horizontal and vertical edges. The resulting image, after selecting the edges, should contain a large number of lines in the license plate plate area, since it contains characters. This is the main property that is used to highlight the area of the license plate plate in the image. To localize the license plate area, a window is created that is approximately equal to the size of the license plate plate in the image. This window is used to evaluate the number of edges in all areas of the image that have the highest contrast. The window is superimposed on the resulting image in the most contrasting zones. If the number of faces is within the given range, then the given area is marked as an area possibly containing a license plate. The required number of faces is determined experimentally. The result of this window is a list of possible areas - candidates that can contain a license plate plate. The main disadvantage of this approach is that the candidate selection process is slow, since the values of all the pixels in the selected window do not need to be repeatedly summed. Another disadvantage is the recruitment of a large number of license plate candidates.

An alternative approach for license plate detection is the Ha-f transform, which is used to detect areas of various shapes in an image, such as a circle, an ellipse, a line, etc. [4] A binary image with vertical and horizontal selected edges is fed to the input of the Hough transform. At the output of the transformation, we get a set of straight lines that limit the proposed license plate, that is, a list of possible candidates for the location of the license plate plate. The Hough transform algorithm for detecting a straight line is as follows.

1. Selecting the initial pixel A(x,y). 2. Selection of the final pixel B(x, y). 3. Counting the points of a binary image along the line AB. 4. If the number of counted pixels is greater than the specified threshold value, then the AB line is present in the image and is marked. 5. Return to step 1 and select two more pixels until the last point of the image is reached. Horizontal and vertical pairs of lines are matched. Horizontal and vertical pairs of lines that make up a rectangle with an aspect ratio approximately equal to the aspect ratio of the license plate are marked as an area possibly containing a number.

One of the disadvantages of the Hough transform is the fact that the vertical lines on the license plate are much shorter than the horizontal ones and therefore can be noisier. After the license plate is localized, a character detection operation is performed. To eliminate redundant information, a binarization algorithm is used. The choice of the threshold in the algorithm is based on the brightness histogram of the image, which is a one-dimensional

array H[0.255], each cell of which contains the number of image points with intensity value I. According to observations, a license plate has the following property: the average area of all characters is about 23% of the area of the entire number, which has the shape of a rectangle. For different numbers, deviations from this value do not exceed 5%. In this case, the binarization threshold T can be defined as follows T −1 by the expression H[j] £ 0.23S, where S is the area j=0 a rectangle describing the car number.

The next step is to search for individual characters. For this purpose, we use a method based on the construction of the average intensity projection. The essence of this approach is as follows, the average intensity in each column is calculated, and in those places where there is no symbol, the average intensity will differ significantly. Further, performing the same operation on the lines, a set of individual characters is obtained, which can already be recognized. After performing this operation, we can get both symbols and various interferences that need to be eliminated. This is achieved by checking a number of conditions that a symbol must satisfy as a geometric object. First, the dimensions of the rectangle describing the candidate area are calculated. Checking- the condition 0.9 £ a £ 3.5 is met, where a and b are respectively the width and height of the object. Objects that do not satisfy this ratio are discarded from consideration. Secondly, the condition 0.4 £ b £ 0.9 is checked, where h is the height of the rectangle, describing the vehicle number. This ratio imposes a restriction on the minimum and maximum height of characters in relation to the height of the number. Finally, the third condition aims to remove small areas of no interest. Among the objects that satisfy the conditions described above, the object with the maximum area of the circumscribing rectangle S = a b is selected. Then, among the remaining regions, those are selected that satisfy the condition S ³ 0.1, where S is max is the area of the candidate object's rectangle.

Since the license plate contains a limited set of characters in a fixed font, in this case it is advisable to use a font recognition algorithm. The principle of operation is based on a direct comparison of the image of the symbol with the standard. The degree of dissimilarity is calculated as the number of mismatched pixels. To ensure acceptable accuracy of the template method, pre-processing of the image is required: normalization of the size, slope and thickness of the stroke. The standard for each class is usually obtained by averaging the images of the symbols of the training sample. This method is easy to implement, works fast, is resistant to random image defects, but has a relatively low accuracy. Widely used in modern character recognition systems.

The sequence of algorithms described above was used to create a program for searching and recognizing license plates. The program was developed in the Delphi 7 environment and tested on 200 images; the probability of recognizing a license plate was 85%.

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