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MODERN SYSTEMS FOR RECOGNIZING VEHICLE LICENSE PLATES

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Abstract
Recent decades are characterized by the large-scale introduction of Information Technology in various spheres of human life. Allows the implementation and use of intellectual transport systems to ensure road safety and solve the problem of improving road condition. Typically they are a set of interconnected functional systems, such as data collection systems from automotive detectors and television cameras. Due to the variety of external conditions under which these systems should work, the methods used in their creation can be very different from each other. However, most of the systems available today have two main blocks: the system of image acquisition and its subsequent analysis, the results of which are largely determined by the quality of the images obtained.

Keywords: Car, autorack, camera, image, intensity statistics, calculation, frequencies, filtering.

INTRODUCTION

Despite the simplicity of the application of the study, the recognition of the car number involves solving a number of insignificant issues, which is confirmed by many approaches and scientific publications. If the car number is located in a strictly horizontal position, is evenly illuminated, has a clean surface, has clearly distinguishable signs that “do not stick together” both with each other and with the frame, then it will not be difficult for the car vision system to recognize such a number. But in practice, such cases are rare: often the light is uneven, various noises appear in the image from the camera, and the car number itself is located at a significant angle to the horizon and can be covered with spots. This makes it difficult not only to directly recognize the car number characters, but also to determine the location of the number in the picture [1-4]. To solve these problems, the developers of automatic license plate recognition systems use various methods of image processing and analysis: calculating intensity statistics, filtering frequencies, various binarization methods, etc. Some systems are better at working with contaminated numbers, some are able to work in low light conditions, etc.

Due to the different external conditions under which auto-identification systems for license plates should work, the methods of their creation can differ significantly. However, all systems that exist today have a common structure, as shown in Figure 1.

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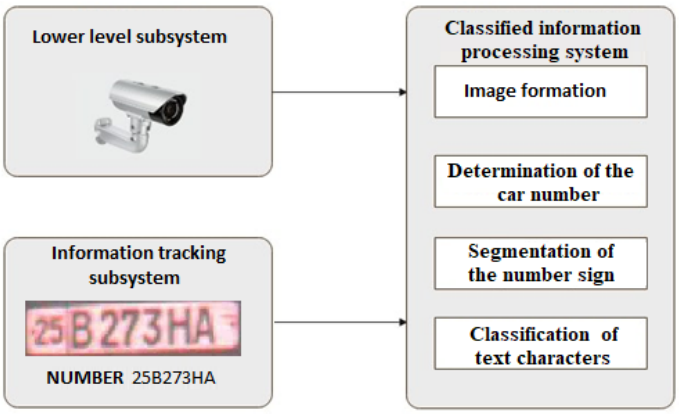

Figure 1. Scheme of the system of automatic recognition of car numbers.

A low - level subsystem serves to capture primary data, which can be used as video imaging devices or IP cameras. This is followed by a digital data processing subsystem consisting of the following blocks:

1. Image formation. The image from the camera is given to the input of the system for further processing and analysis. This operation is of paramount importance, and the operation of the entire system depends on the software and hardware used in it.

2. Determination of the car number. It is used for recording and subsequent analysis of the corresponding objects – car numbers.

3. Segmentation of the number sign. The car number identified at this stage, the dividing lines between them are divided into separate characters based on the most important pixels and for their subsequent recognition.

4. Classification of text characters. At the previous stage, the divided characters were divided into 21 classes, samples of which are the numbers and letters of the Russian alphabet, which are optimal for use in the registration of State cars in the Russian Federation. In the future, the classification of foreign state numbers is also planned [3,7,9]. Decision making on the results of data processing and the type of sequence of text characters in the car's license plate is provided to the end user through the information display subsystem.

1. Formation of images

To capture images, cameras are used that can be turned on when the vehicle appears in a certain area or work in continuous mode. In the first case, most often used in practical systems, the camera is turned on with a special signal from a trig device controlled by an inductive ring sensor. This method has a number of serious disadvantages. Firstly, it is not always possible to determine the exact location of the vehicle; secondly, the cost of the entire

system increases, finally, in the resulting images, the car number can be seen only partially. A system with a single continuously running camera is more compact and cheaper, but algorithmically more complex, since it needs to select separate cars from the traffic flow and find the license plates on them .

No matter what approach is used to capture images, the type of camera used plays a decisive role. The narrowness of the dynamic range of widely used cameras is a serious problem in creating robust systems for automatic detection of vehicle registration numbers, as the observed scenes usually have much larger brightness variations than the camera image. There are two ways to solve this problem: using cameras with improved performance or developing special video image analysis algorithms. Naturally, this is an undesirable situation due to the fact that the first method significantly increases the cost of the entire system. In the latter case, images with a larger dynamic range than those of the camera can be obtained by combining images obtained in different confusing conditions. To eliminate the effect of dim images caused by the rapid movement of the vehicle, it is necessary to use special processing and analysis methods.

After the image is received, it is transferred to the image processing and analysis department. It usually involves several stages: determining the car number in the frame, segmenting individual letters and numbers in it, and recognizing them.

2. Determination of the number mark

The first stage of the system for automatic recognition of the number icon consists in determining the car number in the ROM. This stage is extremely important, since the results of all subsequent stages depend on how correctly the car number is selected in the picture. A number of methods are known for distinguishing car numbers (Figure 1), which can be grouped according to the characteristic markings of the image used. The main characters are marginal dots, textures, color and symmetry.

The image of successful detection is shown in Figure 2

Figure 2. Car number identification: a) original image; b) allocated number plate

There are a number of factors that negatively affect the correct identification of the car number: low image quality, changing lighting conditions, image distortion (which can cause an error), the presence of signs and records other than the number in the car, light reflection from the car surface, close similarity of the car number and car color, etc.

Color information can be used to highlight car numbers in the image. In many countries, car numbers have a distinctive combination of background colors and letters and numbers. As

characteristic signs of the number, a sequence of color codes obtained by transverse scanning of the image from left to right is used. Next, classification methods such as autonomous neural networks and genetic algorithms are used, which allow the localization of the number field. Although the use of color information provides a number of advantages, at the same time, problems with changing the lighting of the environment and the proximity of the car number and the colors of the car itself remain. In addition, the amount of necessary calculations and the cost of equipment will increase significantly.

In addition, in the process of determining the car number, Additional a priori information about the car number can be used: aspect ratio, number of pixels in the selected area, its orientation, density (ratio of front and background pixels).

The first stage of the car number automatic recognition system consists in determining the car number in the ROM. This stage is extremely important, since the results of all subsequent stages depend on how correctly the car number is selected in the picture. There are a number of factors that negatively affect the correct identification of the car number: low image quality, changing lighting conditions, impaired image quality, the presence of signs and inscriptions in the car other than the number, light reflection from the car surface, close similarity of the car number and car color, etc.

Morphological operators are a very effective nonlinear image processing tool based on maximum and minimum conception [5-7]. Morphology has a number of advantages, among which it is necessary to highlight the possibility of effective software implementation, the simplicity of the physical meaning of the operations performed, which makes it possible to accurately adjust (adjust) the parameters depending on the purpose.

When choosing a car number field using morphological operators, it is usually assumed that the markings on the car number consist of thin lines that are much darker (in some cases brighter) than the background. For the most common case of black characters on a white background, processing begins with a closure operation with a structure element whose size is larger than the size of the characters. Now subtracting the original image from the processing result, we get segmented car number signs and other objects, as shown in Figure 3.

Figure 3. The difference between the closure and the original image.

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