The Automated System for Identification of License Plates of Cars

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***Abstract*—The paper focuses on the automated traffic rule control system. It examines the basic scheme of the system, basic constituents, principles of constituent interactions, search methods of moving objects, localization, and identification of the license plate.**

***Index Terms*—image processing, pattern recognition, traffic rule control system**

I. INTRODUCTION

According to official statistics the traffic rate has increased over the last years therefore the number of traffic accidents and potentially dangerous situations has risen as a result. The question arises: how to control road traffic and to punish offenders?

The problem can be solved partially by using the automated traffic rule control system. The paper describes the system, which can give the possibility of recording violations, save the data of violations on servers, and validate fines. The advantages of such a system over usual methods that make use of traffic officers are as follows:

- Round-the-clock service;
- Fast information gathering and data processing;
- Objective recording of traffic violation.

A. The general scheme of the automated system of traffic observation.

The traffic observation system consists of three principal components. Since observation points can be stationed at different road sections the first constituent of the system includes the autonomous module for information gathering, which consists of an observation device (motion detector, velocimeter etc.), memory, video systems, and a microcontroller. The second module is aimed at processing the received video. The third module processes the information about the identified offenders. The work of the system can be illustrated by the following scheme:

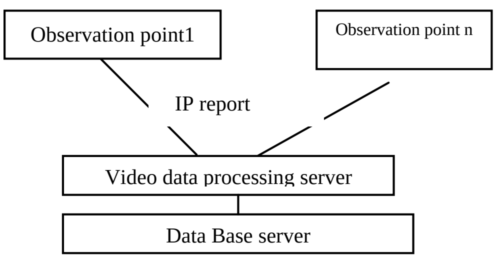

Figure 1. General scheme of the system.

The paper describes the interaction between modules of the observation system that records speeding. The work of the observation module can be illustrated by the following scheme:

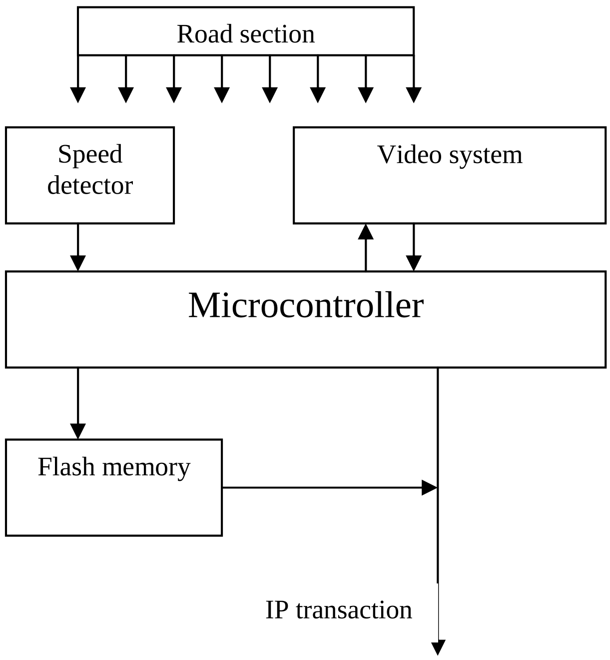

Figure 2. The scheme of the observation module.

Speed detector functions on a twenty-four-hour basis transmitting the information about the current motion to the microcontroller. In the case of speeding the microcontroller turns on a video camera, saves a series of control shots on flash memory, submits a query to the server requesting video information processing.

B. Image processing of the road section

To record traffic violation the following information must be processed:

- The address of the observation point;
- The time of the violation;
- Identification of the carrier.

Addresses and the time of the violation can be received from the observation point directly. The carrier is identified by the license plate. To identify the car's license plate the image must undergo the following actions: mark out the moving object, localize the license plate, and identify the symbols on the license plate.

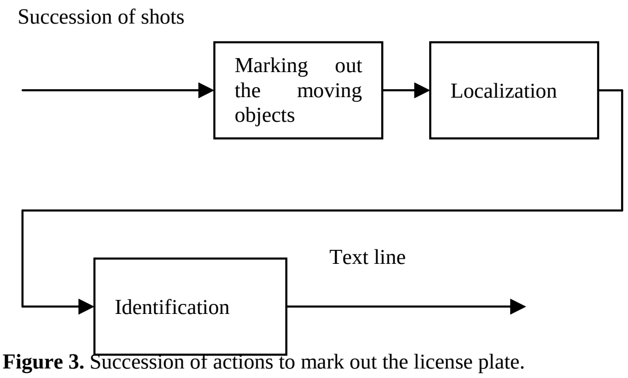

Figure 3. Succession of actions to mark out the license plate.

Localization of the moving carrier, localization of the license plate and identification of symbols is carried out according to the following algorithm[3].

The scene is constructed through normal division and every new shot renovates the model.

To begin with, the image must be transformed into half-tone format (tinges of grey colour). The corresponding transformation can be done with the help of the following formula that must be applied to every point:

$$X_i = 0.3 * R + 0.59 * G + 0.11 * B$$

For processing dynamic images a basic (background) image is made from n shots without moving objects. The mean and quadratic mean for the colour values are calculated for each pixel.

$$m = \frac{1}{n}\sum_{i=1}^{n} X_i \qquad d^2 = \frac{1}{n-1}\sum_{i=1}^{n}\left(X_i - m\right)^2$$

Where $X_1 ... X_i$ represent the values for each pixel on the first n shots.

Afterwards for every shot and for every pixel the following steps must be made. Let's regard c as pixel value with coordinates $[i, j]$ in a current shot. If $\frac{|m-c|}{d} \le e$ then the given pixel belongs to the background, if not, the given pixel belongs to a moving object.

Figure 4. The background.

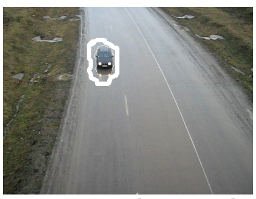

Figure 5. Marking out the object.

Good results are achieved by using normal division.

Let's make a model of the scene

$$S \approx \sum_{p=1}^{k} w_p * N(x, m_p, d_p^2)$$

where

$$N(x, m_p, d_p^2) = \frac{1}{\sqrt{2pd^2}} * e^{\frac{(x-m)^2}{2d^2}}$$

Every summand corresponds to the process of a pixel scene that is characterized by parameters of normal division and the coefficient *w*, which is called weight and is an index that shows how many times the given process in the given pixel scene was in camera coverage. Parameter *k* (the maximum quantity of processes) is chosen in accordance with computer resources, as a rule the value from 3 to 5 is taken.

Let's view the algorithm in more detail:

The first shot is an initialization of the model. In every pixel the process is formed with the parameters: $w = 0, m = C, d^2 = d_{std}^2$, where C is the value for the given pixel and d_{std}^2 is the dispersion.

For every next shot and pixel:

1. The search for the process that satisfies C. For every process in the model the following threshold is used:

   $$\frac{|m-c|}{d} \le e$$

   If it satisfies the threshold go to point 3, if not – to point 2.
2. The formation of the new process. The estimation of expectation is chosen in the following way $m = c, d^2 = d_{std}^2$. If the process equals k, then go to point 5. If the quantity of processes has not reached the maximum, the new process is added to the list of processes. Its weight equals 0. Go to point 4.
3. The renovation of the process. Mark m_{t-1} and d_{t-1}^2 as parameters of the process at the previous step. m_t i d_t^2 is the estimation of process at this step.

   $$m_t = (1-a_1) * m_{t-1} + a_1 * c$$

   $$d^2 = (1-a_2) * d_{t-1}^2 + a_2 (c - m_1)^2$$

   Where a_1, a_2 are the filter parameters, which help to regulate the speed of studying.

4. The renovation of the weight of the processes. Let's mark $w_{i,j-1}$ the weight of the i-process at the previous step. $w_{i,j}$ the weight of the i-process at this step. Then the weight of the i-process at this step is

   $$w_{i,j} = (1-a_3) * w_{i,j-1} + a_3 * M(i)$$

   Where a_3 is the parameter that is responsible for the speed of process change. The $M(i)$ function equals 1 when i equals the index of the given process; it equals 0 under any other value.

5. The classification of the pixel. Let's apply the threshold to the given process. If the value of the given process is bigger than the value of the threshold then the pixel belongs to the background, in any other case the pixel belongs to the previous object. The threshold must be chosen from the interval (0,1).

C. The localization of the license plate.

The camera must be installed at such a distance and under such angle so as to provide sufficient quality of the car image.

Figure 6.

For localization of the license plate, the image is transferred into half-tone format.

Figure 7.

To obtain the ‘grey’ image the horizontal (Figure 7 a) and vertical (Figure 7 b) diagrams of colour division are built:

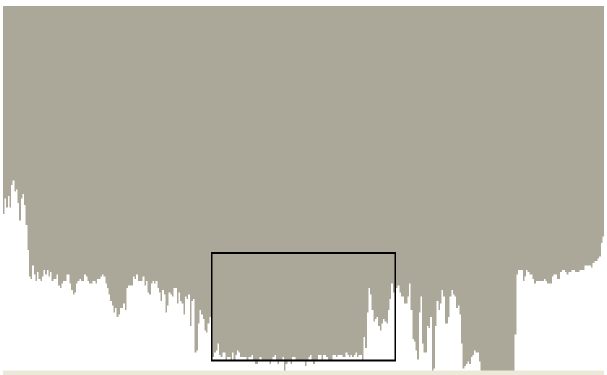

Figure 7(a).

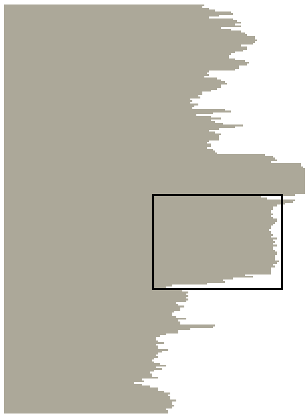

Figure 7(b).

In some cases the license plate must be leveled according to horizontal axis.

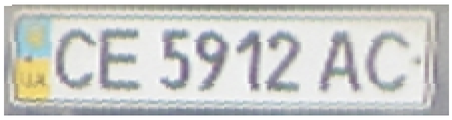

Figure 8.

Since the symbols on the license plate have a standard location and size, the localization and identification of separate symbols can be made with rather high reliability.

II. CONCLUSION

This article views the general scheme of an automated traffic rule control system, in particular, constituent parts and succession of steps when the violation occurs. Besides, it examines the method of identifying the moving object. This method is widely used in practice and gives a possibility to record the object motion under any weather conditions.

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