THE PROBLEMS OF URBAN ROAD TRAFFIC MONITORING

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Abstract *This article discusses the problems of urban road traffic monitoring and investigation. A brief description of a video system for the traffic observation is presented. As an illustration of it use, the density of a road traffic calculated from a video is given.*
Keywords : *traffic monitoring, traffic control, image processing, swarco*.

1. Introduction

Road transportation plays an important role for each country. Yearly, it completes approximately 80% of freights and 75% of passenger transportation. Until recently, the problems of coordination and controlling the transport flows on the street-road network (SRN) were not used with high actuality. In conditions of not-so-high loads, the SRN functioned efficiently enough and their activity did not lead to serious shutdowns and service denials. During the last few years, the increasing number of automobiles and the mobilization of the population has led to a saturation of urban streets, which became a reason to re-evaluate the principles for controlling transportation flows [4,11] and requires special attention towards reconstructing the SRNs in order to improve their functionality. The yearly increase in transportation load of the networks leads to a decrease in the speed of the flow and the appearance of traffic-jams.

The appearance of the latter, even when there is a surplus of free passages, is due to the unclear and uncoordinated processing of traffic lights, which increases the length of vehicles in service queue at crossroads. When the conditions are similar to a traffic jam, the vehicle queue may not be able to fit into the time interval needed to traverse two consequent crossroads. This situation is known as network congestion [2], and leads to disturbances in the work regime of the previous crossroad's traffic lights.The main priorities in the organization of road traffic are the issues of controlling them in the conditions of a traffic jam [4,10]. They require special attention when developing new principles and control norms in high levels of auto mobilization and dense traffic flows, which require the solution of new civil engineering and technical tasks.

2. BASIC FLOW MONITORING INDICATORS.

Traffic monitoring plays an important role for increasing the efficiency of traffic flows through the SRN. The information received by it is of significant importance for deciding the placement of road signs, traffic lights, information labels, when evaluating the driver's behaviour, which also introduces a certain influence in the functionality of the SRN, and other factors. In order to interpret the results correctly, the classification and exploitation characteristics of the vehicles play an important role. Usually, the vehicles are divided into several categories – cars, trucks, buses, trams, motorcycles and bike. A useful criteria, which generalizes the exploitation characteristics is the mass-power ratio. It determines the rate of acceleration and stopping, which are important factors to take into account when designing the traffic lights' signal schemes, fuel economy readings and evaluating the ability of the flow to resume its movement after stopping [2].

When buses and trams are present in traffic, the time required for serving their stops also has to be taken into account. The latter varies with regard to the loading/unloading zone, the number of passengers, the door configuration and the payment method.The presence of bicycles in traffic also requires special attention, as their drivers can execute various and often surprising mmaneuvers, unlike car drivers. The behaviour of pedestrians has a similar characteristic, and they are generally considered a factor in road traffic, due to the fact that the traffic light schemes have to be adjusted with regard to their mean velocity.

3. INDICATORS, DERIVED FROM THE TRAFIC FLOW MONITORING INFORMATION.

The flow load is an indicator which varies depending on the month, the day of the week and the hour. It depicts the social and economic activity in the area, served by the traffic. The variations in the load during the different days of the week depend on the type of the route on which the traffic is conducted. An important part in the process of analysing the passage ability is given to the maximum load in certain time intervals (rush hour). They are the most crucial interval of the route's function and require the greatest passage ability. The load during rush hour is not constant. It varies in different days and seasons and leads to the formation of long queues. The traffic distribution in directions and lanes in a given route is another important part in analysing the passage ability. During each hour, the traffic in a given direction can differ greatly from the traffic in another direction. A typical example is the urban radial streets, for which the level of balance of flows in directions can reach a ratio of 2:1. The directional distribution is not a statistical characteristic and varies with regard to years, hours of the day, days of the week and seasons.

As an example the one day trafic flow distribution captured amnong 8 till 14 o'clock from crossroad of Shipchenski prohod" blvd. and "Ivan Dimitrov" str. (in front of block 2 of IICT, BAS), is presented on figure1.

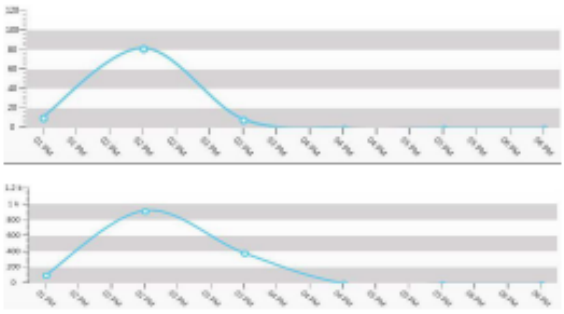

Fig.1. *Distribution of the number of cars that have traversed the monitored area.*

The distribtion of the first week of june trafic flow passed through the same crossroad is shown on figure 2.

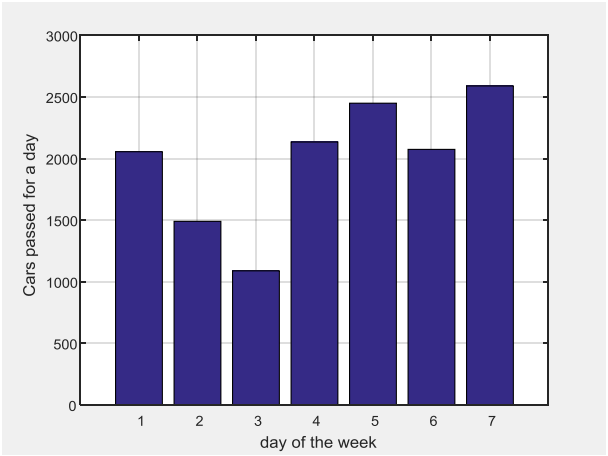

Fig. 2. *The first week of june trafic flow distribtion.*

When the movement in one direction is conducted in 2 or more lanes, the traffic distribution varies greatly. Generally, it is dependent on the movement rules, the flow's speed and intensity, the number and placement of conduits, transportation routes and others. The passage ability is given in terms characterizing the maximum intensity of the flow, which can be served by the given road part in dominant conditions. Its direct monitoring is difficult due to the fact that fixing the maximum intensity of the flow for the given part does not guarantee that a high intensity flow will not be present at another time.

4.TRAFFIC CONTROL

In urban conditions the flow of vehicles can be considered continuous only in the segments between crossroads. A main role in the successful serving of these areas is given to traffic lights. In more cases, this mode of crossroad regulation is based on the principle of time division. Its use does not provide the necessary bandwidth, as they operate as a closed system in terms of the external environment and do not adapt to the changes of the road conditions.

A more modern and effective way to regulate intersections through traffic lights is adaptive control [3,8]. Their strategy offers a configuration according to the current road situation, depending on many factors, and allows for the introduction of a local intelligence traffic light that determines the dynamics of switching on the signal groups according to queue length and flow velocity [1,5,7].A convenient approach to achieving optimization of a transport network according to the mode of transport traffic is the use of video information. It provides an opportunity to build an adaptive traffic control mechanism within a junction. Effective use of the obtained video information requires prior photogrammetric attachment of the observed stretch of the track with the observed image in the terms of the television broadcast standard. This ensures that correct performance of the operations intended to determine transport traffic parameters .A major drawback of video information systems is their dependence on light change and atmospheric conditions. When night or fog occurs, visibility and contrast in the image fall, which do not permits its reliable processing. The presence of rain or snowfall brings noise, which also reduces the contrast of the resulting image. Reduced illumination can be compensated by signal amplification or an artificial illumination use.To reduce the glare from the road and the vehicles themselves, cast shadows and merging objects, the use of polarization and anti-infrared filters is a good approach. The introduction of control sections in certain areas of the frame to be analyzed also contributes to the reliability of the information retrieved from the incoming video stream.

Generally, to improve contrast and visibility, the processing of the received video sequence is done digitally within two interrelated stages.

At the first stage, an adaptive background assessment and threshold detection of fragments that have made changes that are inherent to moving objects are performed. In the second stage, the video frame is framed with fragments that have overcome a certain threshold using morphological processing.The execution of such processing is a sufficiently complex task, which can be presented in the form of several successively executable relatively independent operations:

• background assessment by tracking its changes;

• background compensation;

• threshold detection of moving fragments;

• Morphological processing using operations erosion, growth and opening;

• Fixing the crossing times of the control sections from the linked areas;

As the result of this calculation of the basic parameters of the traffic flow can be determinate. Late, based on them, the length of the traffic light cycle can be calculated. In its entirety the traffic control is a process which requires previous information. In order to achieve satisfying results in the carrying of this process, a setup was developed, which allows the monitoring and registering the traffic. The general appearance of the setup is given in Fig. 3.

Fig. 3. *General appearance of the setup for traffic monitoring and registering.*

As a registering device the IP Camera DCS-2330L was used[6]. The camera features a 1/4 "megapixel progressive CMOS sensor, a 3.45mm focal length and a waterproof IP65 housing, and features a built-in, infrared-free filter, a full-blown LED, and a built-in PIR motion sensor. It is equipped with H.264 compression, Motion JPEG, and 10 times digital zoom. Exposure time ranges from 1/7.5 to 1/10,000 sec. Supports a wide range of video resolutions,

interfaces to external Devices, and network protocols. It can be used with Microsoft Windows 8/7 / Vista / XP operating systems (see Fig. 4.).

Fig. 4. *The IP Camera DCS-2330L*

The camera is placed firmly on a vibration safe stand and connected to a PC. It is used to observe the crossroad of "Shipchenski prohod" blvd. and "Ivan Dimitrov" str. (in front of block 2 of IICT, BAS), shown in Figures 5. and 6. The images received from the camera are stored in the computer. As a main tool for their processing, the Matlab envirounent is used. Based on its image prosseing tools, the information for a current momentary condition of the traffic flow is extracted from the pictures obtained from the camera. . Later, this information is used to carry out an adaptive traffic light control. In order to inprove the statistical robastity of theexpected estimations, the information is averaged over a given time period. The averaged information is used to conduct an adaptive control of the traffic light connected to the swarco controller, shown in Fig. 7.

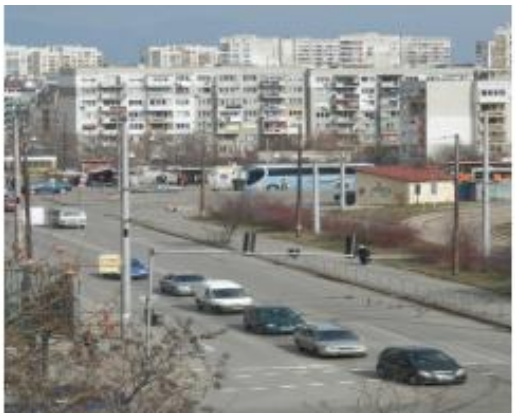

Fig. 5 *Ivan Dimitrov str.*

Fig. 6 Shipchenski prohod bul.

Fig. 7. *ITC-2 Mini controller*

5.CONCLUSIONS

This article presents a tool to monitor the density of traffic. Management of traffic light to control the measured density of traffic:

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