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To cite this article: I S Damianov *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **618** 012061

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Determining the velocity and the duration of the travel by the method of recording the registration numbers with the help of an integrated system of mobile LPR cameras

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Abstract. This paper presents research a determining the velocity and the duration of the travel via developed intelligent system of License Plate Recognition cameras and by using the method of recording the State Control Number (DK number) with the aim of improving the traffic organization and safety, as well as reducing the harmful impact and improving the ecological indicators in the research area. The intelligent system for recording and recognition of registration numbers provides the opportunity for statistical analysis to determine traffic performance and to take specific measures so as to improve the organization and increase the traffic safety. It is based on MySQL database and PHP scripts to solve the analysis tasks.

1. Introduction

The research on transport flows is a complex task and requires significant resources [1-4]. This is due to the use of existing methods for the examination of traffic indicators [5,6]. Some of them require the installation of dedicated technical means to report traffic [7,8]. Others require multiple observers who need to be instructed in the specifics of the tasks they will be performing [9,10]. Some methods allow for the use of video capture, requiring the installation of multiple cameras for the relevant surveyed areas of the roadway [11].

For the insurance of safe, economic and ecologically friendly traffic flow it is important the basic traffic indicators to be defined and assessed. The analysis, the assessment and the optimization of the transport traffic are based on the results that are obtained, their common relation and the knowledge about the tolerable limits, characterizing the demeanour of the traffic flow.

Software for modeling the traffic movement is based on input data for its metrics obtained by some of the known methods [12].

The established system uses License Plate Recognition cameras to register the State Control Number (DK number) of each vehicle and allows continuous video surveillance of transport flows. Functional potential of the developed algorithm allows to determine traffic flow indicators and to analyze the results obtained [13, 14].

Technology includes:

1. Traffic streams capture with the License Plate Recognition Registrar.
2. Processing the Received Data from the License Plate Recognition Registrar to determine traffic flow indicators.
3. Analysis of processed results.
4. Generating database on the nature of traffic flows.



2. Prerequisites and ways to solve the problem

The aim of the present research paper is to determine the velocity and the time duration of travel of the traffic flows, which pass through a particular section of the road. An intelligent system of License Plate Recognition cameras [15] is used, with the help of which an automatized video monitoring is done and an opportunity for further statistical processing is ensured. This allows for the necessary indicators, characterizing the traffic flow in the researched area of the road, to be determined. The analysis of the obtained data is used for organization and management of the traffic flow, reducing the congestions, improving the traffic safety and reducing the harmful impact of the traffic on the environment. The necessary indicators for the assessment of the road traffic are:

- modification of the traffic in time;
- density of the traffic flows;
- intensity of the traffic flows;
- composition of traffic flows, etc.

Besides from the State Control Number (DK number), the used License Plate Recognition cameras also report other indicators like the country from which the vehicle comes, the direction in which it travels, date, hour, etc. The acquired data is saved in the form of an Excel file and photographic material.

The information from the video registrars (exact time at which the vehicle is captured on the camera, license plate of the vehicle, etc.) are imported in a specifically developed database, which allows the data to be statistically processed according to the set parameters for the specific research problem.

During the analysis of the acquired data can be determined the basic indicators like the time duration of the travel between the places where the cameras are located and the velocities of the vehicles. Histograms can also be made.

The generated database gives the opportunity for collecting information, with which thorough analysis and research about the traffic flow's indicators can be conducted.

3. Results and discussion

The subject of the present research is to determine the velocity and the duration of the travel through a particular road section of the urban street network [16].

The aim of the research is to examine and analyse the traffic flows, as well as to assess the opportunity for optimization and increase of the traffic safety and the environmental impact [17, 18].

The study has been conducted on a road section on Kliment Ohridski Boulevard during the time of the morning rush hour from 8:00 to 9:30. The values of the examined indicators were determined with the help of two License Plate Recognition cameras to register DK - numbers. The cameras were positioned at predetermined locations (counting points) and spacing from one another shown in Figure 1.

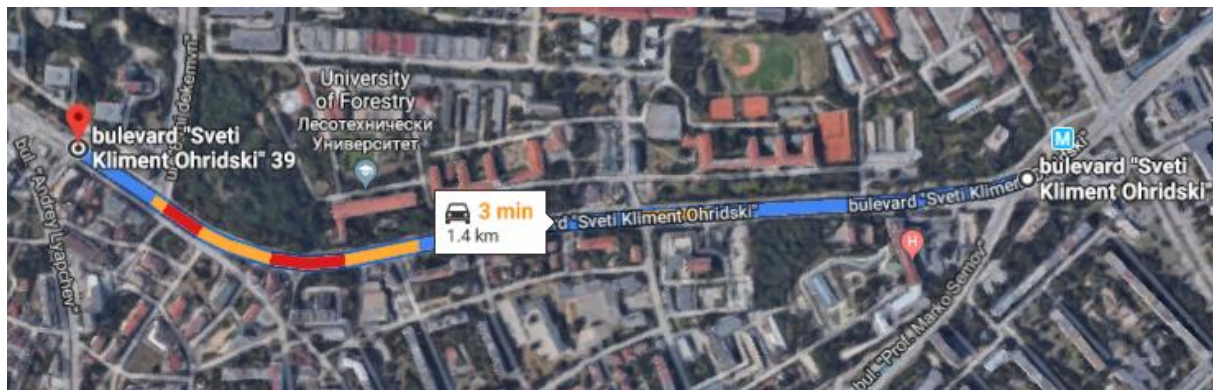


Figure. 1. Position of License Plate Recognition Mobile Cameras on the Research Area.

The tasks of the examination are defined as follows:

- intensity of the traffic flow at the counting points;
- number of vehicles which pass through the places where camera 1 and camera 2 are located and vice versa;
- time duration of the travel between the two cameras;
- velocity with which the vehicles pass through the section between the cameras.

In order for the traffic indicators to be defined, in both directions of the 1.4 km section that was examined the position of the cameras and the direction of shooting change. Thus, four data sets are obtained from each of the cameras, which are then merged in to two sets, one for each of the respective directions of the road:

- Direction I - from camera 1 to camera 2 - direction from G. M. Dimitrov Metro Station to Andrei Lyapchev Boulevard, for the time from 8:00 to 8:44;
- Direction II - from camera 2 to camera 1 - direction from Andrei Lyapchev Boulevard to G.M. Dimitrov Metro Station for the time from 8:45 to 9:30.

The time of the survey were determined by preliminary tests to determine the busy hourly periods in July 2018.

The extracted information in the Excel format is imported into the finishing database [19]. The information is presented in appropriate columns and tables.

The analysis of the data shows that the number of vehicles that have been captured via camera 1 is 251 and the number of vehicles that have been captured by camera 2 is 858 (Table 1). On the other hand, the total amount of vehicles that have passed through the lens of both of the License Plate Recognition cameras is 91. Therefore, only 36% of the vehicles pass subsequently through camera 1 and camera 2. Moreover, the intensity of the traffic flow in the place where camera 2 is positioned is approximately 3.5 times higher than the intensity of the traffic flow that has been captured by camera 1. The vehicles that have been captured by the lens of camera 1 make up a little more than 10% of the total amount of the vehicles that have been detected by both of the cameras.

Table 1. Traffic flow passing through direction I.

camera 1	camera 2	Vehicles that have been captured on both of the cameras
251	858	91

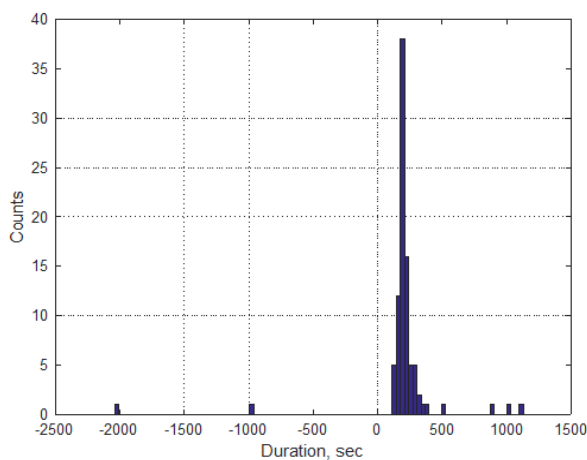


Figure 2. Histogram of the time duration of the travel in direction 1.

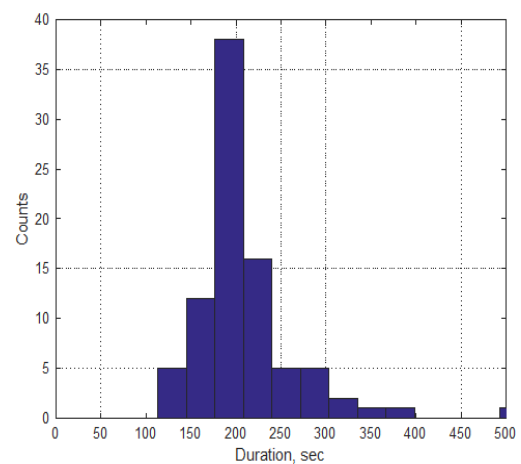


Figure 3. Histogram of the time duration of the travel (detailed).

The results from the analysis of the data about the time duration of the travel in direction 1 are shown on figure 2 and figure 3. Figure 2 and figure 3 show histograms of the time difference between the records of matched registration numbers from camera 1 and camera 2. Figure 3 presents the time distribution of the travel of all vehicles, while figure 4 shows the data distribution only in the range of 100 to 500 seconds.

However, in the records there are also exceptions. Two of the durations exceed 900 seconds (which is an indication of a stopover recorded time durations of the traveling vehicles are shorter (34 and 16 minutes), while other two of the recorded time).

The results from the analysis of the data show that the approximate time duration of the travel through that particular road section is around 3 minutes. The velocity of the vehicles is measured when the distance between the cameras (1.4km) is divided by the time duration of the travel. The distribution of the velocities of the vehicles is shown on figure 4. The approximate velocity that has been measured is around 24 km/h. It is to be taken into account that the shortest recorded time for passing through the section in between the cameras is 118 seconds. That travel time refers only to two of the recorded vehicles. It is estimated that these two vehicles have reached an average velocity of 42,71 km/h, which probably is due to the non-compliance with the speed limits. The traffic law offenders in the surveyed area are around 2-3% of the total number of vehicles that have passed between the cameras. That is an indication of a high rate of compliance with the restrictions and control of road transport.

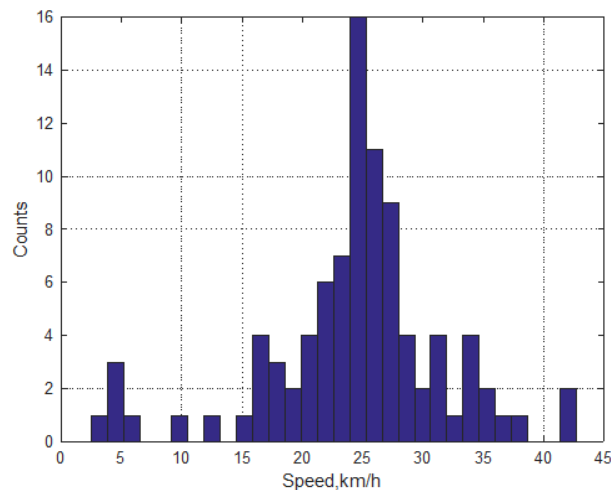


Figure 4. Histogram, showing the velocity of the vehicles in direction 1.

Analogically, the analysis of the data, acquired from the cameras in direction 2, shows that the number of vehicles that have been captured via camera 2 is 707, while the number of the vehicles that have been captured via camera 1 is 579 (table 2). The total number of the vehicles that have subsequently passed through camera 2 and camera 1 is 158. On the basis of that information it can be concluded that only 22% of the vehicles which have been captured by camera 2 have also been captured by camera 1. Moreover, the intensity of the traffic flow in the place where camera 2 is located is 1,2 times higher than the intensity in the place of camera 1. The vehicles that have passed through camera 2 are around 27% from the total amount of vehicles which have been captured by camera 1.

Table 2. . Traffic flow in direction II – from camera 2 to camera 1.

camera 1	camera 2	Vehicles that have been captured on both of the cameras
707	579	158

The results from the analysis of the data about the time duration of the travel in direction 2 are shown on figure 5 and figure 6. Figure 5 and figure 6 present histograms of the time difference between the records of the recurrent registration numbers from camera 2 and camera 1. Figure 5 shows the distribution of the time duration of the travel for all vehicles, while figure 6 presents the data of the distribution only in the range from 100 to 500 seconds.

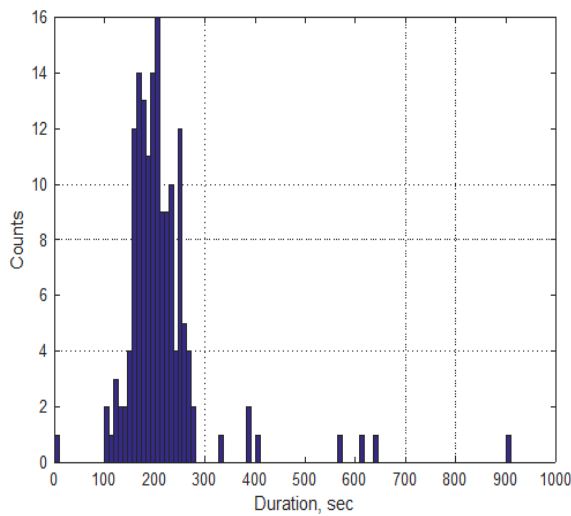


Figure 5. Histogram of the time duration of the travel in direction 2 (main).

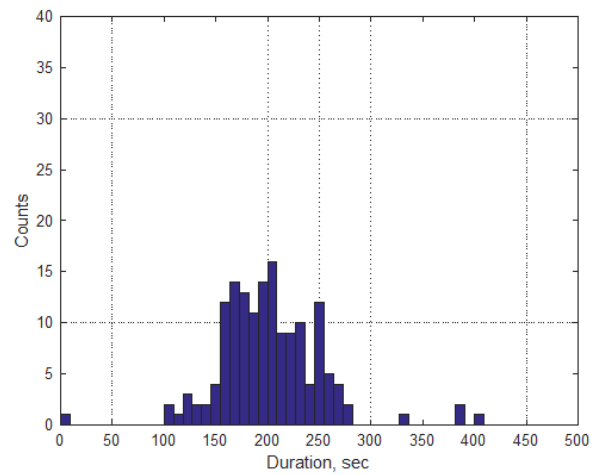


Figure 6. Histogram of the time duration of the travel in direction 2 (detailed).

The results from the analysis of the data show the average time duration of the travel in the studied section of the road is about 3 minutes. The velocity of the vehicles is analogically estimated as the velocity of the vehicles in direction 1. The distribution of the velocity of the vehicles in direction 2 is shown on figure 7. The average velocity of the traffic flow is around 25 km/h.

Unlike in direction 1, the minimal time duration of the travel in direction 2 is only 106 seconds, while the average velocity is 47,54 km/h. A total number of 6 vehicles during the conducted research have been traveling with a velocity above 40 km/h, which is probably due to non-compliance with the speed limits. The traffic law offenders in direction 2 are 3.79% from the total number of vehicles.

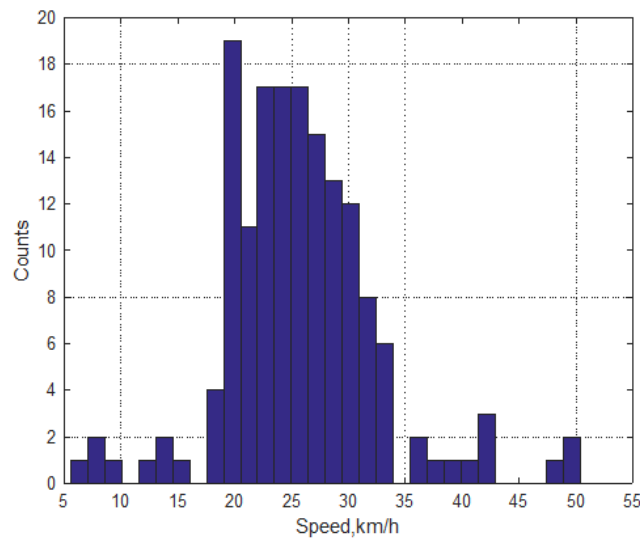


Figure 7. Histogram, showing the velocity of vehicles in direction 2.

4. Conclusion

The developed intelligent system for recording and recognition of registration numbers provides the opportunity for statistical analysis to determine traffic performance and to take specific measures so as to improve the organization and increase the traffic safety.

The research and analysis show the duration of the travel and the velocity of the vehicles, passing through a particular section of Kliment Ohridski Blvd in July 2018. The data acquired from the research will be used for the management and optimization of the transport flow, which will increase the safety and reduce the impact on the environment in the researched area.

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