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INVESTIGATION AND ANALYSIS OF TRANSIT ROAD TRAFFIC THROUGH SPECIFIC RESIDENTIAL AREA WITH THE USE OF AN INTEGRATED SYSTEM OF MOBILE LPR CAMERAS

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Key words: *intelligent transportation system, intelligent traffic lights, transit traffic, traffic organization and safety, LPR cameras, traffic measurement and analysis system*

Abstract: *The subject of the present research is the automobile transit traffic, passing through residential area Musagenitsa in city Sofia, Bulgaria. The investigation is done via integrated system of mobile cameras. The main aim is the gathered and analysed information to be used for the improvement of traffic organization and safety, as well as for reducing the harmful impact and improving the ecological indicators in the residential area that is an object of the conducted research. A system for measuring and analyzing traffic is developed, which allows a detailed analysis of the traffic at the city crossroads, optimize traffic and intelligent traffic management lights. The system will also be useful for recognizing the car, monitoring and security.*

1. INTRODUCTION

The increase in the volume of the transport in the European Union (EU) concerns the growth in European economy and the mobility requirements of citizens. This is the main reason for the increase in congestion and the depletion of the capacity of transport infrastructure. Meeting these challenges cannot be confined to taking conservative measures, including amplification of the existing transport infrastructure, but requires the implementation of innovative measures to provide appropriate solutions for overcoming the existing problems.

The organization and management of road traffic is based on research of its indicators with corresponding quantitative values and relations between them. The type of the examinations and the methods which are used are determined by the objectives set for the specific conditions of road traffic and the necessary measures for their achievement [1-4].

One way of solving the problems, related to road traffic organization and safety, is through the implementation of contemporary systems for monitoring, management and optimization of the traffic flow indicators [5, 6]. The constant increase in traffic volume requires a research of its main indicators and regularities, in order for the traffic safety and its proper organization and management to be improved [7, 8, 9].

The use of intelligent transport systems in road traffic research is an integral part of traffic data collection, vehicle tracking, velocity, intensity and density flow, as well as vehicle type [10-13].

Each decision, related to the organization of road traffic, must be based on in-depth preliminary studies and surveys based on extensive information about the state of the transport flows. The variation in transport flows in space and time depends on a number of factors, both on existing road conditions, and on the purpose, objectives and nature of transportation [14].

To ensure a safe, economical and environmentally friendly flow of traffic, it is necessary to define and assess key road traffic indicators. The analysis, assessment and optimization of the transport movement is based on the results obtained, their interconnection and the knowledge of the permissible limits characterizing the behaviour of transport and pedestrian flows.

2. SYSTEM DESCRIPTION

The aim of the present research paper is to investigate the traffic with the help of a developed smart integrated system of mobile LPR cameras, specifically designed to perform automated or partial monitoring, which enables the video capture to be processed so as the necessary for the study data to be obtained. The analysis of this information is used to optimize and manage road traffic and reduce congestion in order to increase traffic safety and environmental preservation.

The measurement of the road traffic and the plate recognition is accomplished by LPR (license plate recognition) camera, which is CMOS based and has FULL HD (1920x1080) capabilities with a resolution more than 2.0 MP. This requirement is evolved from the possibility to scan at least four road lanes. The recorded speed also has to be higher than 50 fps on the external FLASH memory such as SD card to guarantee the recognition process of the moving objects up to 70km/h. The LPR camera also must have IR filter at least 50 meters, vario-focus, IP67 certificate and temperature range from -30^0 C to 60^0 C. One of the low cost possible solution is recognized as a LPR camera DS-2CD4A26FWD-IZS, proposed by HIKVISION, which is shown at Figure 1.

Figure 1. LPR camera DS-2CD4A26FWD-IZS.

The movement of the traffic flows is a complex, scholastic and dynamic process, in the study of which it is necessary on the basis of system analysis to be applied statistical methods, probability theory, theory of transport flows, investigation of the operations and simulation. The method with the automatic recognition of the registration numbers of vehicles through video capture ensures the setting of transport traffic indicators and the making of adequate decisions when optimizing the organization and safety of road traffic transport. The load study, the process of determining the places with frequent congestions and traffic accidents, the identification of the basic automobile traffic flows and rush hours provide an opportunity for finding the causes and solving the existing transport problems.

For the assessment of the basic indicators of the transport traffic examinations for studying and modelling the demeanor of the automobile traffic in the city of Sofia have been done. For this purpose, specific experiments, based on the video capture method, have been carried out, so as for the particular task to be performed under the specified conditions. This method is realized through the use of a system of integrated mobile LPR [15] cameras and a software for recognizing the registration numbers of vehicles. The values of the following indicators are to be set:

- distribution of traffic flows between the entrances and exits of the examined junctions;
- intensity of the traffic;
- density of road traffic;
- intervals of movement of the vehicles;
- composition of the traffic flows;

Besides from the registration numbers of the vehicles, the system of LPR cameras can also memorise other indicators like the country from which the vehicle comes, the direction in which it moves and etc. The software of the camera enables XLSX files to be saved.

3. RESULTS

The subject of the present research is the transit traffic that goes through residential area Musagenitsa in city Sofia Bulgaria. A transit traffic is a traffic whose origin (source) and destination (aim) are outside the surveyed area, yet the traffic flow passes through the area (object of research).

The aim of the research is to examine and analyse the automobile traffic flow, as well as to assess the opportunity for optimization and improvement of the traffic safety and the environmental impact of transit traffic.

The automobile traffic flow, passing through residential area Musagenitsa has been researched during the morning rush hour (8:00-9:00). In order to be determined the place where the transit flow is formed, two specialized LPR cameras for recognizing the registration numbers of vehicles are positioned - camera 1 (exit 1) at the exit of residential area Musagenitsa (G.M. Dimitrov Blvd and Metodi Andonov Str.); camera 2 (entrance 1) entrance to the residential complex (junction Kliment Ohridski Blvd. and Traiko Stanoev Str.). Video capturing of traffic flows is carried out with standart cameras - camera 3 (entrance 2) - entrance to residential area Musagenitsa (junction Kliment Ohridski Blvd. and Dabnitsa Street); camera 4 (entrance 3) - entrance to the residential complex (junction Andrei Lyapchev Blvd and Plovdivsko shose Str.). fig.2.

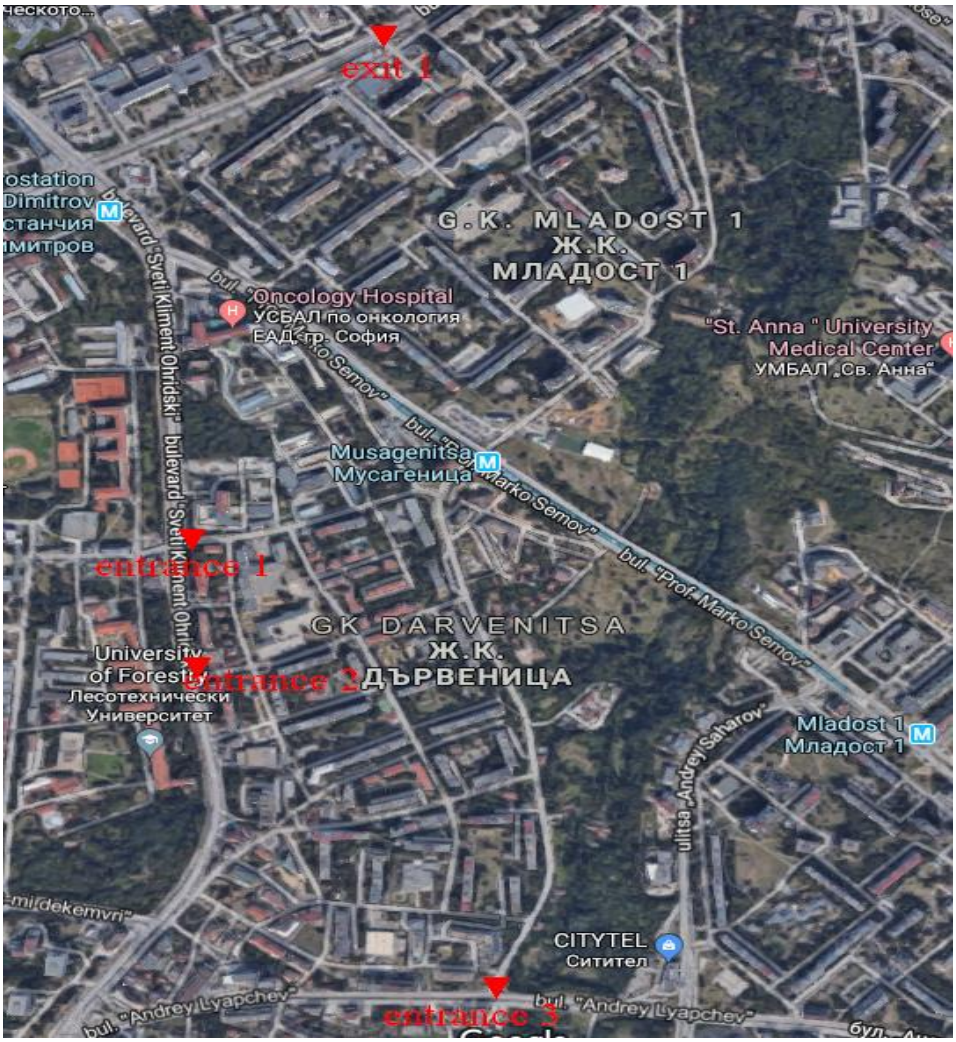

Figure 2. Positioning of the monitored sections.

For the processing of the data from the specialized LPR cameras, vehicle registration numbers are recorded in an XLSX file.

The processing of the video capture from camera 3 and 4 and the gathering of the necessary information have been carried out by an observer who records and reports the data about the traffic flow indicators. During the analysis of the processed data the number of the vehicles that have passed through the road section for a particular period of time, as well as the time intervals between the vehicles and the registration numbers of the vehicles are reported and then further imported into XLSX file.

The periods of video recording were determined by preliminary partial surveys in June and July 2018, which aimed to establish the rush hours.

After making the necessary measurements, the total number of vehicles entering the Musagenica area through the three entrances and passing through the single exit is determined.

The processed data about the total number of vehicles that have passed through the three incoming traffic flows and the outflow are shown in Table 1. During the observed time, the total number of incoming vehicles is 613 and outbound automobiles - 728.

Table 1. This is a table. Tables should be placed in the main text near to the first time they are cited

Incoming vehicles			Outbound vehicles
entrance 1	**entrance 2**	**entrance 3**	**exit 1**
280	65	268	728

The number of vehicles and formation of traffic flows that have passed through residential area Musagenitsa at the monitored sections - the three incoming flows and the outflow, are shown in Table 2.

Table 2. Automobiles that have passed through residential area Musagenitsa.

Incoming vehicles			Total
entrance 1	**entrance 2**	**entrance 3**	**exit 1**
36	6	22	64
56,25 %	9,375 %	34,375 %	100%

The average period of time for the vehicles to pass through the monitored entrances and the exit section is shown in Table 3.

Table 3. Average period of time over which vehicles pass through residential area Musagenitsa.

Incoming vehicles	Number	Average period of time in min.
entrance 1	36	7,55
entrance 2	6	12,04
entrance 3	22	8,11

In order to determine the average period of time during which the transit traffic passes through the surveyed area (on three main routes – fig.3), a route survey has been carried out using the mobile observer method under real conditions [17, 18, 19]. The results are shown in Table 4.

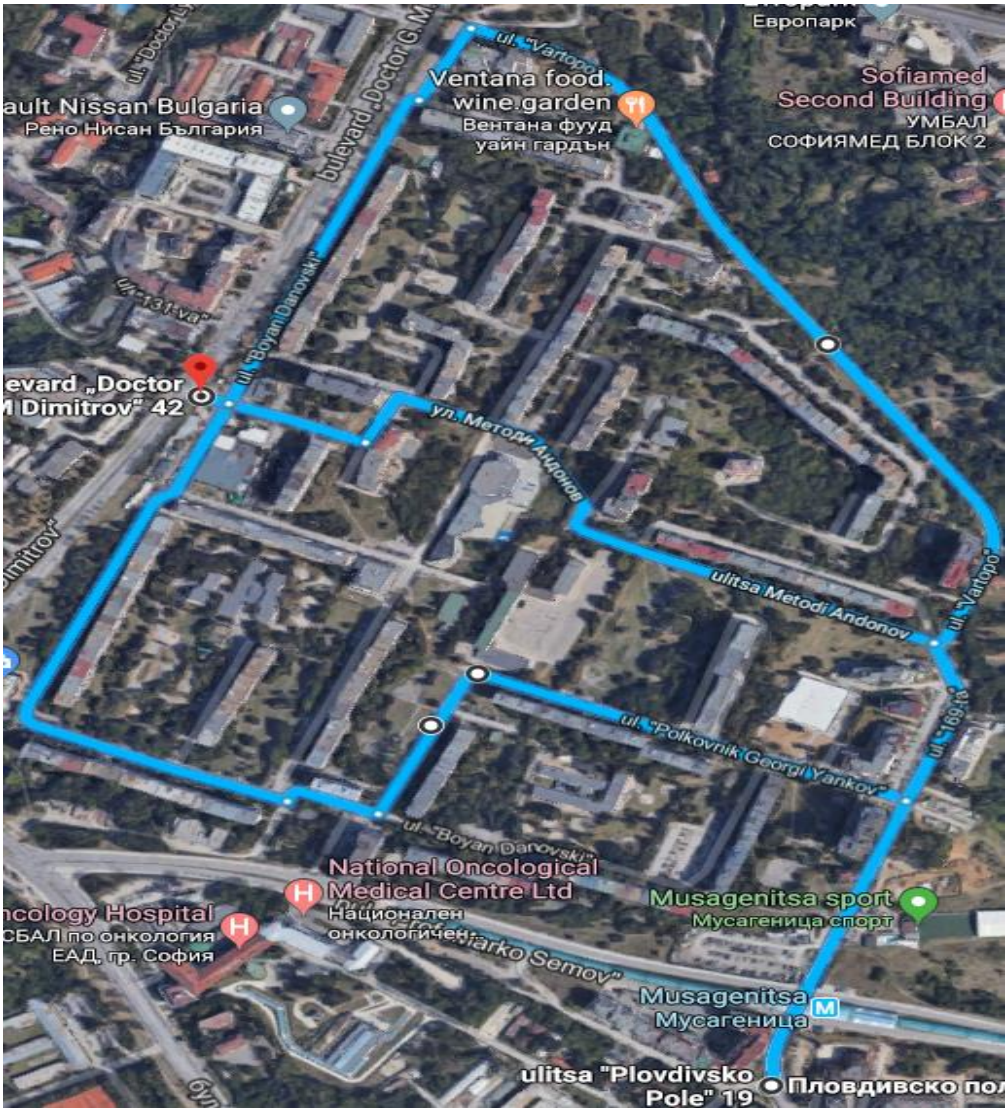

Figure. 3. Destination on three main routes.

Table 4. Average period of time during which the transit traffic passes through residential area Musagenitsa.

Incoming vehicles	Average period of time in min.
entrance 1	6,45
entrance 2	7,05
entrance 3	7,43

After determining the average period of time in which the transit traffic passes through residential area Musagenitsa, these vehicles that stayed longer than the period of time pointed in Table 4 are noted as not transit. In Table 5 are shown precised values of transit passing vehicles.

Table 5. Vehicles passing through residential area Musagenitsa.

Incoming vehicles	Number	Intentionally passed	Transit traffic
entrance 1	36	8	28
entrance 2	6	5	1
entrance 3	22	5	17
Total:	64	18	46

The formation of the transit traffic flows, which have passed through residential area Musagenitsa at the monitored entrances of the residential complex are shown in table 6, while table 7 represents the values of the total transit flow.

Table 6. Transit vehicles that passed through residential area Musagenitsa.

Incoming vehicles	Number	Transit traffic	%
entrance 1	36	28	77,7 %
entrance 2	6	1	16,6 %
entrance 3	22	17	77,2 %

Table 7. Transit vehicles that passed through residential area Musagenitsa.

Entrance	Number	%
entrance 1	36	60,89 %
entrance 2	6	2,17 %
entrance 3	22	36,94 %
Total::	46	100%

Table 8 summarizes the values of the transit traffic flow through residential area Musagenitsa. It is apparent that entrances 1 and 3 mainly form the transit flow across the area, while an in-car 2,17 % of the total transit flow of all entrances passes through inlet 2.

Table 8. Transit vehicles that passed through residential area Musagenitsa.

Incoming vehicles	Transit traffic	%
64	46	71,8 %

4. CONCLUSIONS

The use of highly developed integrated LPR camera system allows the road traffic indicators to be estimated and the necessary measures for the improvement of the traffic organization and safety to be taken. The main aim is the gathered and analysed information to be used for the improvement of traffic organization and safety, as well as for reducing the harmful impact and improving the ecological indicators in the residential area that is an object of the conducted research.

The acquired data from the conducted research about the transit road traffic in residential area Musagenitsa is expected to be used for further analysis.

The developed traffic measurement and analysis system, which allows a detailed analysis of traffic parameters in cities, will improve traffic optimization, reduce travel and fuel consumption, improve traffic and passengers safety, and can be used for intelligent traffic lights. The system will also be useful for recognizing the car, monitoring and security.

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REFERENCES

[1] W. McShane, R. Roess. Traffic engineering. Prentice-Hall. Englewood Cliffs, N.J, (1990)
[2] Highway Capacity Manual. TRB, National Research Council, Washington, 2010.
[3] Kerner B., Introduction to modern traffic flow theory and control, Berlin, Springer, 2009.
[4] A.D. May, Traffic Flow Fundamentals, Prentice Hall, Englewood Cliffs (1990).
[5] Antov A., „Transportation modelling 101“- practical guidelines, Sofia, 2017, ISBN: 978-619-188-109-3.
[6] O. Thabet, Modeling and Macroscopic Simulation Of Traffic Streams on Multi-Lane Highways (Master Thesis), Cairo University, Giza, 2010.
[7] R.P. Roess, E.S. Prassas, W.R. McShane, Traffic Engineering (third ed.), Pearson Prentice Hall (2004).
[8] J.C. Tai, S.T. Tseng, C.P. Lin, K.T. Song, Real-time image tracking for automatic traffic monitoring and enforcement applications, Image Vis. Comput., 22 (2004), p. 485
[9] L.A. Klein, M.K. Mills, D.P. Gibson, Traffic Detector Handbook, vol. I (third ed.), Turner-Fairbank Highway Research Center, McLean, VA (2006)
[10] N. E. Faouzi, L.A. Klein, Data Fusion for ITS: Techniques and Research Needs, Transportation Research Procedia, ISEHP 2016. International Symposium on Enhancing Highway Performance Vol. 15, Pages 495–512 (2016)
[11] Al Kherret, A. Al Sobky, R. Mousa, Video-based detection and tracking model for traffic surveillance. Paper No. 15-1465 Presented at the 94th TRB Annual Meeting, Washington, DC, January 2015.
[12] L. Mimbela, L. Klein, A Summary of Vehicle Detection and Surveillance Technologies Used in Intelligent Transportation Systems, FHWA Intelligent Transportation Systems Program Office, 2007.
[13] Al Kherret, Video-Based Detection and Tracking Model for Acquiring Traffic Data (Ph.D. Dissertation), Cairo University, 2015.
[14] G. Leduc, Road Traffic Data: Collection Methods and Applications, 2008.
[15] http://www.hikvision.com/UploadFile/image/20150120135448610 55.pdf
[16] Yordanov R., Miletiev R. Damyanov I., Iontchev E., Measurement and analysis of the road traffic - XXVII International Scientific Conference Electronics - ET2018, September, 2018, Sozopol, Bulgaria.
[17] F. Ryan, Olariu S., On a Variant of the Mobile Observer Method, IEEE Transactions on Intelligent Transportation Systems (Volume: 18 , Issue: 2 , Feb. 2017), pp 441 – 449.
[18] O. Czogalla, S. Naumann, "Travel time estimation using floating car observers", Proceedings 14th World Congress Intelligent Transportation Systems, Oct. 2007.
[19] R. P. Roess, E. S. Prassas, W. R. McShane, Traffic Engineering, Englewood Cliffs, NJ, USA:Prentice-Hall, 2011.

ИЗСЛЕДВАНЕ И АНАЛИЗ НА ТРАНЗИТНИЯ ТРАФИК ПО ПЪТИЩАТА В СПЕЦИФИЧНИ ЖИЛИЩНИ ЗОНИ С ИЗПОЛЗВАНЕ НА ИНТЕГРИРАНА СИСТЕМА МОБИЛНИ LPR КАМЕРИ

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Ключови думи: *интелигентна транспортна система, интелигентни светофари, транзитен трафик, организация на движението и безопасност, LPR камери, система за измерване и анализ на трафика*

Резюме: *Предмет на настоящото изследване е автомобилен транзитен трафик, преминаващ през жилищен район Мусагеница в град София, България. Изследването се извършва чрез интегрирана система от мобилни камери. Основната цел е събраната и анализирана информация да бъде използвана за подобряване на организацията и безопасността на движението, както и за намаляване на вредното въздействие и подобряване на екологичните показатели в жилищната зона, която е обект на проведеното изследване. Разработена е система за измерване и анализ на трафика, която позволява подробен анализ на трафика на кръстовищата на града, оптимизиране на трафика и интелигентни светлини системи за управление на трафика. Системата ще бъде полезна и за разпознаване на автомобила, мониторинг и сигурност.*