Measurement and analysis of the road traffic

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Abstract – **This paper represents a database system for measurement and analysis of the road traffic which allows detailed analysis of the car movement in the city crossroads, traffic optimization and smart management of the traffic lights. The system also will be useful for the car recognition, surveillance and security purposes. It is based on MySQL database and PHP scripts to solve the analysis tasks.**

Keywords – **Road traffic analysis, database**

I. INTRODUCTION

The urbanization process increases the number of the citizens and the number of the vehicles is also grown significantly in the last 10 years. This fact requires measurement and analysis of the road traffic to optimize it according to the following criteria: reliability (minimum disturbances), safety (minimum risks), effectiveness (minimum costs), environment friendly (minimum environment impact) and economical (maximum benefits) [1-5]. The road traffic systems are currently used in many surveillance installations such as speed limit enforcement and access control. The License plate capture cameras, also known as license plate recognition / LPR cameras, are a specialized type of video surveillance camera designed to capture numbers and letters of license plates on still or moving vehicles. Nowadays there is a choice of low cost multiple lane LPR with HD accuracy which allows to solve these tasks. The LPR cameras made a good images of the captured car plates during the daytimes therefore they are a good choice for the traffic monitoring of the crossroads as their load is highest during the start and the end of the working time.

The measurement and analysis of the road traffic are two stages of the traffic optimization process. The main challenges to the traffic monitoring systems are defined as follows: (i) Selection of the proper low cost LPR camera, which is capable to recognize the plate with the validity values higher than 70%, (ii) Selection of the appropriate file format or database to store the recorded data and (iii) Selection of the adequate tools or programs to analyze the recorded data according to the given criteria.

These steps are discussed in this paper to build smart and online based system for the road traffic monitoring and analysis.

II. SYSTEM DESCRIPTION

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

At least two of these cameras are situated at the selected crossroads to measure the road traffic and to store the car plates in the XLSX file, which is imported in the MySQL database. The selection of the MySQL database is based on the free license, significant flexibility and universality according to the further analysis by other tools especially by PHP scripts. The camera information is stored in the corresponding columns of the MySQL table as follows:

- Pid – unique measurement number, stored as int variable. The table is indexed according to this key
- Num – sequence number of the current measurement, stored as int variable
- Devnum – camera identification name, for example Camera 01, stored as char variable
- Plate – recognized car number, type char
- Timest – time of the recognition process, stored as timestamp variable
- Country – nationality of the recognized number, stored as char variable
- Lane – number of the road lane, stored as tinyint variable
- Direction – direction of car movement during recognition process (forward/reverse/unknown), stored as char variable
- Validity – coefficient of validity (median character recognition confidence) 0-100%, stored as tinyint variable
- Matching – matching the recognized number with the given name, stored as char variable

A part of the road traffic analysis includes the time duration of the car movement between the camera position

978-1-5386-6692-0/18/$31.00 ©2018 IEEE

points in the given direction, average speed, generation of the histograms for the time duration, etc. To solve the selected tasks the system uses PHP scripts to extract the data from the database according to the selected criteria and generation of graphics for the visualization analysis.

The time duration task is prepared by extracting the data from the cam tables for the equal car plates according to preliminary selected Camera1 and Camera2 objects and time period of the analysis. According to this data the PHP script generates a new table called "*compare*" as a result of the analysis, which contains the following columns:

- Pid – unique record number. This number is also a table key
- Plate – recognized car number
- Camnum1/Camnum2 – description of the selected cameras
- Timest1, Timest2 – time of the recorded plate for the two cameras respectively
- Duration = |Timest2 – Timest1| – time duration between the records of the selected cameras

The data from the *compare* table are analyzed by additional script to generate the histograms.

III. RESULTS

Two of the selected LPR cameras are situated on the crossroads of (Figure 2) and recorded the road traffic for 40 minutes in the time period from 8:07 to 8:47AM for the first camera and from 8:05 to 8:55 for the second camera when the traffic is very intensive. The tasks of this measurement are defined as follows:

- What is the traffic intensity in the selected crossroads
- What part of the cars passing by camera1 also passing by camera2
- How many time spend the cars to travel between two cameras
- What is the average speed of car movement
- How many toxic gases are evolved in the atmosphere during this travel

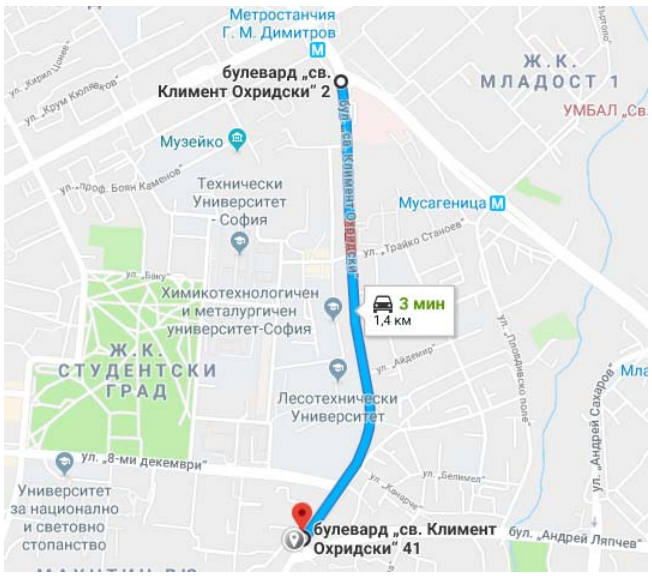

Figure 2. Position of two LPR cameras

To decide these tasks the data from the recorded XLSX file from the HD LPR camera is download and imported in the MySQL database. Each task is solved by specially written PHP script which compares the plates from the first camera to the second one and the result is written in the new "*compare"* table to prepare the data histograms.

The analysis of the data records shows that the number of the cars passing by the cameras are 448 and 1188 cars for the second camera. The number of the matched plates, which passing by camera 1 and camera 2 consecutively, is equal to 162. This shows that only 36% of the cars continue their travel from camera 1 to camera 2.

The results of the data analysis of the travel time duration is shown at Figure 3 and Figure 4, which represent the histograms of the time difference between records of the matched plates. Figure 3 shows the distribution of the time duration for all data when the Figure 4 represents the data distribution only in the range from 300 to 800 seconds, because the time travel higher than 1000s shows that there is a car stop in this period of time.

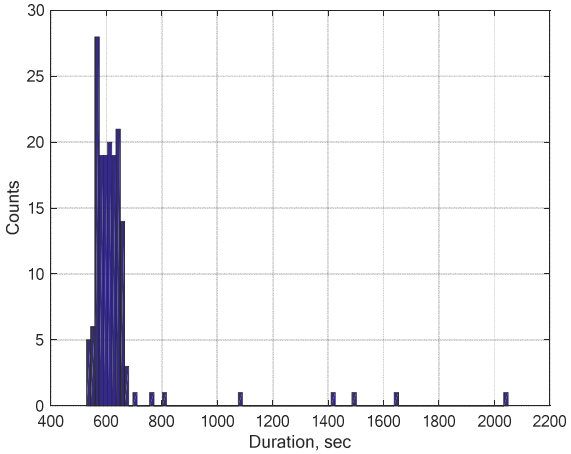

Figure 3. Time duration histogram (total)

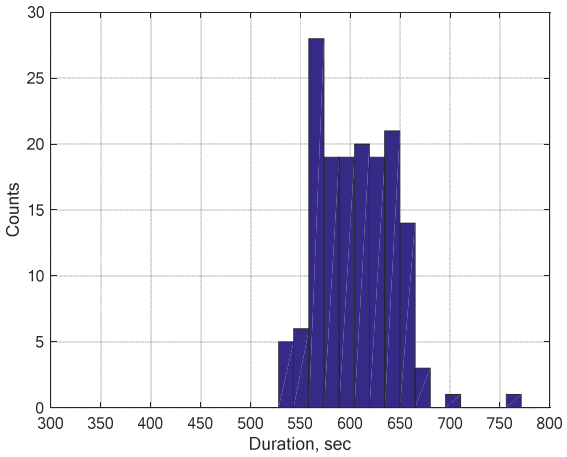

Figure 4. Time duration histogram (detailed)

This time is compared with the data from the Google map which shows only 3 minutes to pass between these points but if there is no traffic.

The average car speed may be calculated easily by division of the distance between cameras, which is equal to 1.4km, to the time duration and the results are shown at Figure 5. It is clearly visible that during this time period the

car average speed is lower than 10km/h which is a sign of the very intensive road traffic and there is a urgent need of the traffic lights optimization or dynamic configuration.

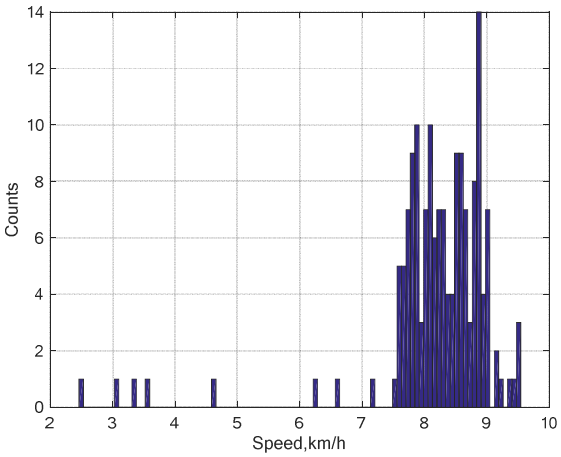

Figure 5. Speed histogram

One of the major question is the validity of the data. The Figure 6 and Figure 7 represents the histograms of the validity coefficients of the camera 1 and camera 2 respectively. It is clearly visible that the validity coefficient varies from 70 to 90% with a typical value of 75-80%.

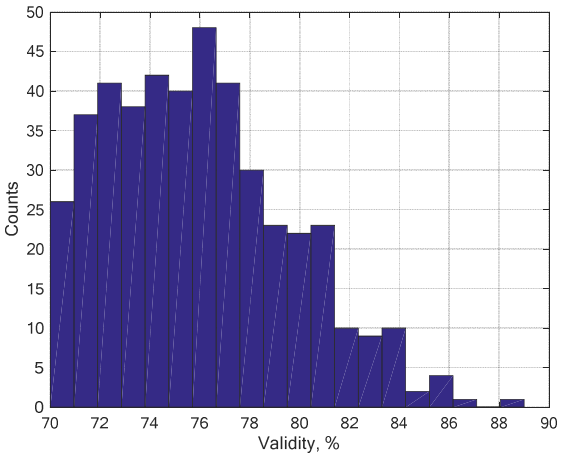

Figure 6. Validity coefficient of Camera 1

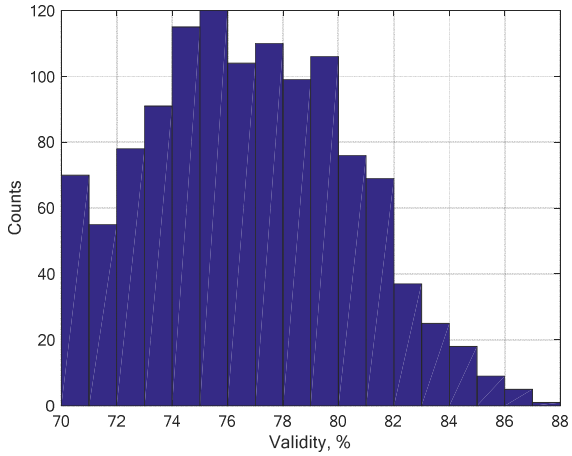

Figure 7. Validity coefficient of Camera 2

IV. Conclusion

The selected paper describes a database system for measurement and analysis of the road traffic which allows detailed analysis of the car movement. The selection of MySQL as a database and PHP scripts for the data analysis is a base of the further system development to the online based system. By selection of the LPR cameras, time period and the moving direction is it possible to compare and analyze the transportation flows on the roads and crossroads, traffic intensity for each hour of the day and optimization of the traffic lights.

The real-time analysis and traffic light optimization will allow a reduction of the air pollution as is well known that main part of the pollution is produced during the car stop intervals.

The further development of the system is directed to the (i) online analysis of the data, (ii) real-time analysis of the car plates, (iii) detailed analysis towards the car type recognition such as heavy trucks, buses, motors, cars, etc. and (iv) detailed traffic analysis of the transportation flows during the daylight time to build the smart light control for the traffic optimization and air pollution reduction.

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