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DATA PRODUCTION FOR ESTIMATION THE AVERAGE SPEED OF TRAFFIC FLOWS

Ionatan Popa[1], Daniela Florea[2], Dinu Covaciu [3], Janos Timar[4]
[1]Transilvania University, Brasov, ROMANIA
ionatanpopa@unitbv.ro; d.florea@unitbv.ro; dinu.covaciu@unitbv.ro; jancsika@unitbv.ro

Abstract: *This paper proposes a method of measuring the average speed in road traffic, using GPS technology. The GPS devices allow the collection of large amounts of information on vehicle dynamics monitored and processed in specific programs. Such data is used as input to the strategic noise maps. The proposed method was tested successfully by the authors in a project on achieving the strategic noise map of the city Tg. Mures.*
Keywords: *average speed, noise maps, GPS, traffic.*

1.INTRODUCTION

Under Directive 2002/49/EC of 25 June 2002 relating to noise management, countries should prepare and submit Strategic Noise Maps for urban areas. European recommendations on SNM provide for attainment of Europe-wide maps for each city in stages but also a common plan approach to allow analysis at the central level and action plans in Europe.
Strategic noise maps requires the analysis of 4 types of noise: Rail noise, Industrial noise, Airport noise and Road noise (under order of the Ministry Environment and Sustainable Development no. 1830 of 21. 11.2007 to approve Guidelines for implementation, analysis and evaluation of strategic noise maps). Road noise analysis of traffic data interpretation requires the calculation method recommended by the European Commission, NMPB-Routes 96 and 31-133 French standard XPS. This calculation method takes into account the following factors: types of vehicles, type of traffic flow, traffic speeds, type of road, longitudinal profile, type of road longitudinal profile, types of roadway surfaces.

2.THEORETICAL

Random movement of a vehicle can be best described statistically. To this end, measures should be taken to obtain the curves of variation depending on the cinematic time quantities and in particular speed. Since situations where traffic is congested are common and therefore it may influence the noise emission is strongly recommended calculation of accurate data determined from the statistical nature of the change in travel speeds. In this case the ideal would be to determine the value of V50 (median speeds) or V85 value (speed reached or exceeded 85% of vehicles for a given period of observation, ideally one hour). At this stage of preparation of input data to determine the actual speed of travel in many locations was adopted a method for determining optimal speeds, browsing the vehicle control as recommended in OM678/2006 routes, Chapter 3.2, item 3 using the tool 5.

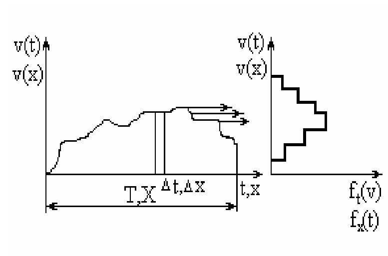


Figure 1: Absolute frequency distribution curve of a motor vehicle speeds

If speed is measured in *m* intervals of space and assigns the appropriate chart (Figure 1), in a coordinate system there is obtained absolute frequency distribution of vehicle speed or distance *X* investigated during *T*.
For it was established that in ($0, \Delta v$) speed can be m_1 times that of n_1 times, or generally in the range $[(i-1)\ \Delta v,\ i\Delta v]$ can be seen by m_i or n_i provided that some times, $\sum_{i=1}^{k} m_i = m$ respectively, $\sum_{i=1}^{k} n_i = n$.
Speed versus time graph is called the line speed and chart speed depending on the area is called the velocity profile.
Comparison of absolute frequencies at m_i or n_i at m respectively n, results relative frequencies:

$$m_i/m = f_t(v_i)$$

Where *v* is a function of time;

$$n_i/n = f_x(v_i)$$

Where *v* is a function of space, and is obtained by summing the relative frequencies.

To describe the frequency distributions of empirical values speed are used statistical methods. In general, it is sufficient if it is calculated arithmetic mean and dispersion respectively means square deviation or standard deviation.
Example of a statistical process of a vehicles speed while measured in time, in Table 1 results of the processing speed of a car produced by the recording function of time. In the table are given values of velocity for m = 229 intervals, which are summarized in 13 classes from 5 to 5 km / h.

Table 1: Processing speeds recorded against time

Speed class **[km/h]**	The average speed class	Absolute frequency ranges	Relative frequencies **$f_t(v_i)$**	Cumulative frequencies **$F_t(v<v_i)$**	Calculation of average speed $f_t(v_i)\cdot v_i$
1	2	3	4	5	
22,5 –27,5	25	3	0,0132	0,0132	0,330
27,5 – 32,5	30	5	0,0218	0,0350	0,654
32,5 – 37,5	35	10	0,0436	0,0786	1,526
37,5 – 42,5	40	22	0,0961	0,1747	3,844
42,5 –47,5	45	31	0,1354	0,3101	6,093
47,5 – 52,5	50	33	0,1440	0,4541	7,200
52,5 – 57,5	55	35	0,1528	0,6069	8,404
57,5 – 62,5	60	31	0,1354	0,7423	8,124
62,5 – 67,5	65	23	0,1006	0,8429	6,539
67,5 – 72,5	70	19	0,0830	0,9259	5,810
72,5 – 77,5	75	10	0,0436	0,9695	3,270
77,5 – 82,5	80	5	0,0218	0,9913	1,744
82,5 – 87,5	85	2	0,0087	1,000	0,7395
Σ	m = 229		1,000		54,3 km/h

Determination of the average speed

$$\bar{v}_t = \frac{1}{m}\sum_{i=1}^{k} m_i \cdot v_i = \frac{1}{229}\left(3\cdot 25 + 5\cdot 30 + 10\cdot 35 + \ldots + 2\cdot 85\right) = 54{,}3\ km/h$$

Speed was calculated using absolute frequencies, but the calculation can be simplified leading directly:

Dispersion rate is calculated:

$$\sigma^2(v_t) = \frac{1}{m-1}\sum_{i=1}^{k} m_i(v_i - \bar{v}_t)^2 = 151\ km^2 / h^2$$

Mean square deviation is:

$$\sigma(v_t) = \sqrt{\sigma^2(v_t)} = 12,3\ km / h$$

The statistical methods of processing experimental data - in this case the vehicle speed control integrated in road traffic. Thus one can identify the V50 as the median speed.

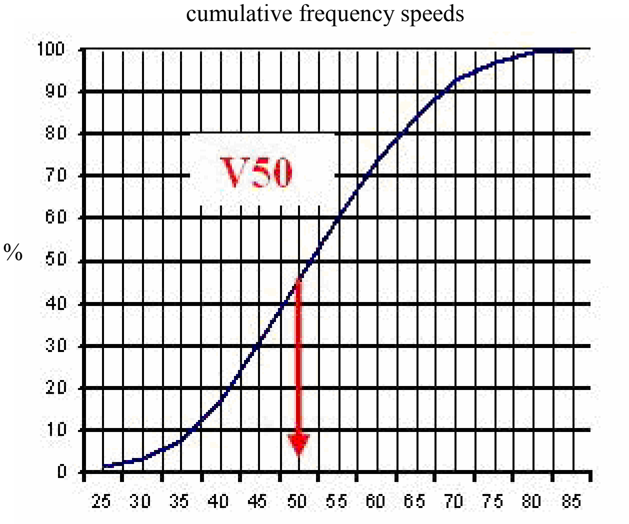


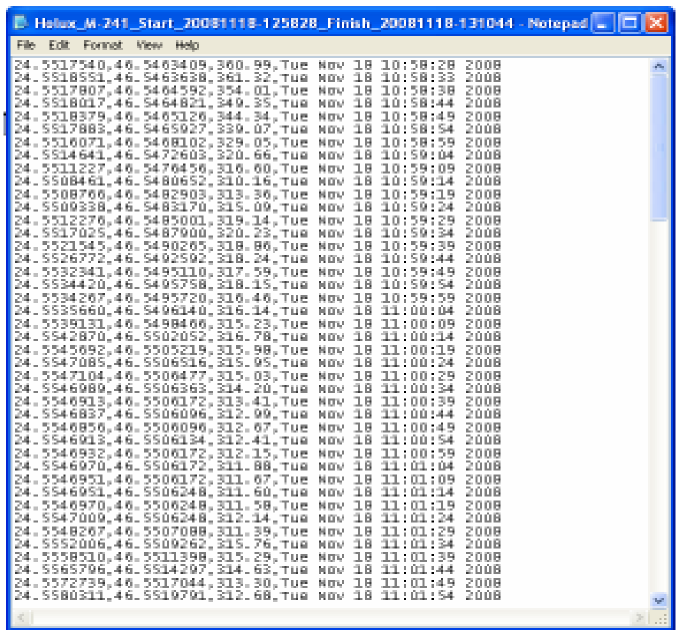
Figure 2: Determination of Median speed (V50)

If you prefer the adoption of V50σ ± value, then the value identified by graphical method or by interpolating the values in column 5 (Table 1) is determined V50 = 54,3 km/h, so the resulting the speed of 50± 12.3 km / h representing the limits may fall within average speed. In this case, the speed calculation error is 0.8 km / h.

3. EXPERIMENTAL DETERMINATION OF VEHICLE SPEED WITNESS

Records have been made with two types of GPS devices, Holux GPS Logger I-241 and Garmin GPS Map 60CSx), these devices record the speed at intervals of 5 seconds and one seconds respectively for Garmin GPS Map 60CSx device. GPS devices allow calculation of average speeds (Figure 3).
Vehicle control of the routes travelled repeatedly to determine a more accurate average speed on that route, default route on each segment.

Figure 3: GPS devices for recording data



Holux_M-241_Start_20081118-125828_Finish_20081118-131044 - Notepad

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24.5516071,46.5468102,329.05,Tue Nov 18 10:58:59 2008
24.5514641,46.5472603,320.66,Tue Nov 18 10:59:04 2008
24.5511227,46.5476456,316.60,Tue Nov 18 10:59:09 2008
24.5508461,46.5480652,310.16,Tue Nov 18 10:59:14 2008
24.5508766,46.5482903,313.36,Tue Nov 18 10:59:19 2008
24.5509338,46.5483170,315.09,Tue Nov 18 10:59:24 2008
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24.5532341,46.5495110,317.59,Tue Nov 18 10:59:49 2008
24.5534420,46.5495758,318.15,Tue Nov 18 10:59:54 2008
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24.5572739,46.5517044,313.30,Tue Nov 18 11:01:49 2008
24.5580311,46.5519791,312.68,Tue Nov 18 11:01:54 2008
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Figure 4: Example of table with data recorded by the device Holux GPS Logger I-241

The recorded data is imported into AutoCAD, can be seen in Figure 5. The overlap with the GPS device over the route already marked. These measurements can easily highlight issues of traffic, such as areas with slow traffic due to congestion, no traffic lights or intersections where traffic lights are with difficulty.

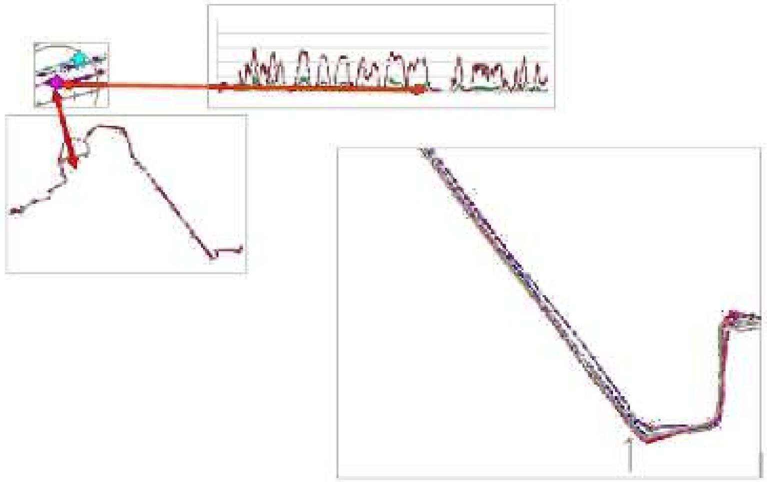

Figure 5: Issues during processing of data recorded with GPS devices

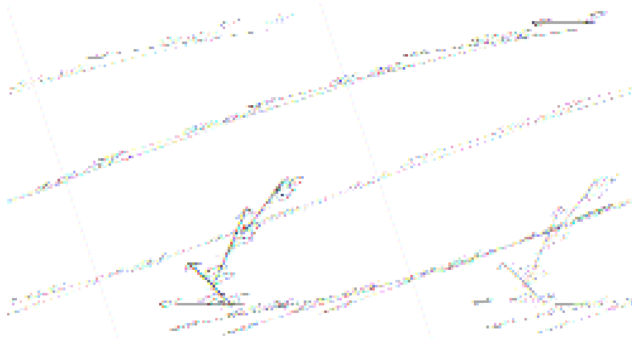

Figure 6: The trajectory and vehicle speed

Figure 7: The network of roads monitored in Tg. Mures

The distribution of average speeds was made for each segment in AutoCAD, and using an own application developed using the programming language "Alisip".

The controls are specially designed to achieve this (Figure 8).

Yellow Layer - Recording GPS:
Layer red - the main route street: Gheorghe Doja
Layer green - residential streets
White layer - roads connecting
Window commands and data about the route and speed combination.

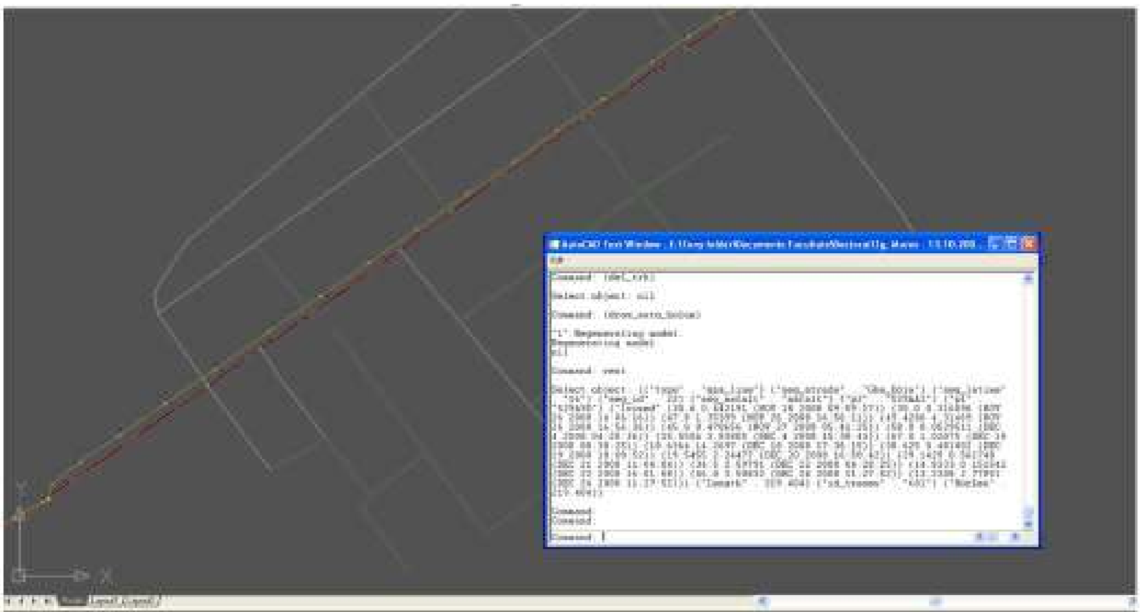

Figure 8: Association of achieved average speeds for each segment of a street

From AutoCAD with commands made by the same programming language "Alisp" there were exported and centralized as electronic data in an Excel table.

[illegible]

Figure 9: Table of traffic data collected for 1848 Blvd

This allows checking the route and easy measurements. This annex contains all the information about routes and traffic to these routes, according to the three central periods of the day, according OM678/2006, Chapter 1.

4. CONCLUSIONS

The specific rules for achieving noise maps, as recommended in OM678/2006, chapter 3.2 provide for the collection of data on average speed of vehicles. This is generally obtained using radars to monitor traffic. Collection of data by this method is expensive, requires substantial material resources and the machines are more expensive than the GPS devices. Personnel serving these devices are large and must devote more time to install the devices and monitoring them. Urban areas are locations where the setup of such devices is practically impossible. By using GPS technology presented in this paper saves significant time and material resources. The simplicity of the method and efficient methods are arguments for its use.

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