

# Research on Implementation of GIS Systems with Automatic Acquisition and Multi-criteria Analysis of Data

Sorin Borza, Carmen Simion

**Abstract**—In this paper, an automatic system of taking over the data of the environment and their automatic transformation in GIS Data, for some intelligent map's generation, is presented. Also, the system allows, by using the multi-criteria methods AHP and TOPSIS, an objective analysis of the factors that will be taken into account during the system. These factors will be taken over automatically by using the LabVIEW Software and with the help of the acquisition board that will be connected to the computer. By using the same LabVIEW software, the factors will be memorised in an ACCESS type database. The database will be connected to the Geomedia Professional Software, with the help of which an intelligent map will be generated automatically. The system allows, not only the automatic collection of data, but also their memorization and the generation of GIS elements and an objective analysis of the collecting points of data could provide a concrete answer regarding the most and least polluted points. As a novelty element, the paper allows the analysis of the polluted factors using the multi-criteria AHP method in such automatic taking-over storage and data generation system. The most polluted and the less polluted place was determined taking into consideration the determining pollutant factors. Also, in this paper is presented the possibility for combining AHP and TOPSIS multicriterial methods for evaluation of environmental quality through indicators that represent the environmental load. In conclusion, the paper offers new results regarding the use of the multi-criteria analysis for the interpretation of some factors of a different type to a common purpose, in this case air quality in a limited geographical area. For the first time, the use of software GIS for multi-criteria evaluation by means of AHP and TOPSIS methods was successful. In the first part of the paper, the general aspects of the paper will be presented. In the second part, the object oriented technics of the realization of the virtual apparatus and of the data transfer in the Access database. In the third part of the paper, the AHP method will be presented. In the fourth part of the paper, the TOPSIS method will be presented. The fifth part will present the physical realization of the module system of automatic taking over data, the analysis of the polluting factors taking account the AHP and TOPSIS methods, the automatic generation of the object-oriented classes needed for the elaboration of the intelligent maps.

**Keywords**— databases, virtual instrument, object oriented, GIS.

Sorin Borza *Faculty of Engineering, Sibiu University "Lucian Blaga", 10, Victoriei Bd, Sibiu, 550024, România* (e-mail: sorin.borza@ulbsibiu.ro).

Carmen Simion . *Faculty of Engineering, Sibiu University "Lucian Blaga", 10, Victoriei Bd, Sibiu, 550024, România* (e-mail: carmen.simion@ulbsibiu.ro).

## I. INTRODUCTION

Multi-attribute decision making problems which is an important part of decision making theory and method investigation, exists commonly in project design, economics, management and military activities. The essence of the problem is that to comprehensive evaluation from various attributes for each proposal of a given proposals group to found an optimal proposal, or comprehensive sorting of proposals of a given proposals group so that the sorting result can reflect intention of decision maker. During multi-attribute decision making process, the weightings of different attributes should be confirmed firstly regardless of which analysis method was used. Therefore, how to confirm weightings of different attributes will affect the reliability and correctness of decision consequences.

The development of human society has led to a negative anthropic and technogenic impact on the air quality, resulting in a significant series of adverse effects on human health, flora, fauna and ecosystems in general. In urban areas, the environmental dimension, the economic and the social one interfere the most [7].

Four out of five European citizens live in urban areas and their quality of life is directly influenced by the state of the urban environment. A high quality of the urban area also contributes to reaching the priority of the revised Lisbon strategy, which is „to make Europe a more attractive place to live and invest”. The attractiveness of the European cities will enhance growth potential and also job generation, and therefore cities will be key factors for the implementation of the Lisbon Agenda. In the case of urban habitats, transportation is “guilty” for more than 50% of NO<sub>x</sub>, particles (PM) and volatile organic compounds (VOCs), over 25% of CO<sub>2</sub> emissions and 80% of the noise level.

The U.S. Environmental Protection Agency's (EPA) Clean Power Plan, proposed in June 2014, would limit carbon pollution from existing power plants [8].

Vehicular air pollution has been recognized as a major anthropogenic activity responsible for deteriorating air quality in urban areas. One of the major traffic related air pollutants which have serious health effects is carbon monoxide (CO). One of the major components of traffic related air pollution is carbon monoxide (CO) that results from the incomplete combustion of fuel. CO does not participate in secondary

atmospheric reactions but has approximately 210 times more affinity for the hemoglobin (Hb) than oxygen (O<sub>2</sub>). Carbon monoxide enters the bloodstream through lungs and form Carboxy hemoglobin (COHb), a compound that inhibit blood capacity to carry oxygen to organs and tissues. Though studies have ruled out any possibility of detectable increase of genetic damage in blood cells due to moderate air pollution levels [9].

Data processing is realised by using software packages which may be grouped in different categories: data acquisition software, also comprising data processing toolboxes software such as: statistical analysis, spectral analysis, report generation (LabVIEW); database software (Access); GIS integrated systems – Geographical Information Systems (GeoMedia Intergraph). From an informational point of view, an integrated environmental monitoring system comprises the following: data sources, data servers and an application server, and the report generation / distribution activity to the decisional factors, figure 1[13].

Due to the uncertainty of decision making environment, the diversity of decision making index, and high complexity of multi-attribute decision making behaviors, the multi-attribute decision making information have huge uncertainty and most of which can be expressed as interval numbers. The combination assigning method which combines the advantages of both subjective assigning method and objective assigning method, presents system analysis with objective function of multi-attribute decision making nature and subjective experiences of decision maker, so that the reasonability of decision making evaluation can be increased. [10].

The data will be taken over, with the help of the sensors or with the help of the specific apparatus which will be connected to the computer. In the case in which the data will be taken over by the help of the sensors, the IEPE (Integrated Electronic Piezoelectric) sensors were used, the acquisition board NI 9234, NI Mseries. In the case in which the taken over data by the specialized apparatus, the Drager Pac III apparatus has been used for the measurement of the monoxide carbon and the sound level meter EXTECH 407780 for the sound measurement. The Drager Pac III apparatus is equipped with a sensor for the concentration measurement of the monoxide carbon. The values showed on the display apparatus are represented in parts on a million (ppm), these values must be multiplied with 1,16, and the resulted value represented in mg/m<sup>3</sup>. The virtual apparatus will be made using the compute, by the help of the LabVIEW software. The multi-criteria analysis will be realized by a virtual apparatus. Another part (branch) of the system will allow the data memorization in the ACCESS database for their following use in the class generation process (features classes) used for the elaboration of the intelligent maps.

In present AHP was used to determine the weights of seven criteria, chosen based on the human health effects, by pairwise comparisons. Subsequently, TOPSIS was applied to achieve final ranking preferences in descending order thus allowing relative performances to be compared[15].

## II. OBJECT ORIENTED PROGRAMMING IN LABVIEW

In object oriented programming with LabVIEW [5], a class consists merely of a user defined data type together with methods that can be applied to values of that data type. Once could say that object oriented programming in Labview allows the developer to create object oriented wires. Object orientation in Labview means the following:

1. Simple Inheritance. Neither multiple inheritance nor interfaces as in Java.
2. Strict encapsulation. Data of a class are always private. Public or protected data do not exist.

As in other object oriented languages, a derived class may overload an abstract method of its base class. However, the override method must have exactly the same input and output parameters as the respective method of the parent class.

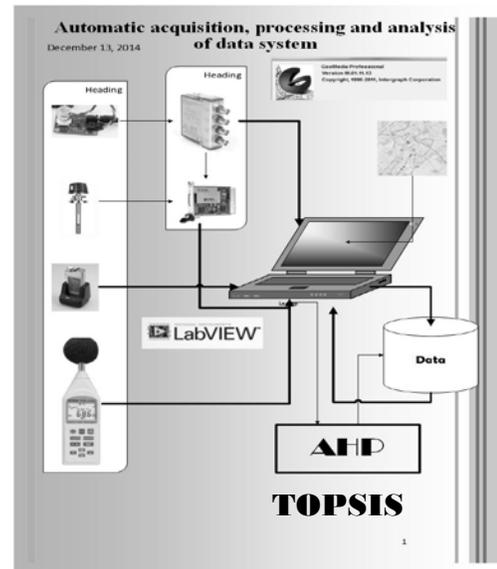


Fig. 1 The System presented in this paper

In object oriented programming for Labview [6] are three fundamental consequences.

1. Objects contain only data and no active code. Agents do not exist.
2. Labview does not have classical variables. For the same reason, in Labview has no equivalence to the concept of a *constructor* and a *destructor*. There are neither constructors nor destructors.
3. Objects can only be accessed "by value" and never "by reference".

The fundamental differences between object programming in Labview and conventional object oriented languages prevent a straightforward *implementation* of design patterns that are based on the idea of objects as entities. However, many of those design patterns are useful for designing control systems.

## III. ANALYTICAL HIERARCHY PROCESS (AHP) METHOD

Analytic Hierarchy Process (AHP) is used for decision making when a decision (choice of some of the available

alternatives, or their ranking) is based on several attributes that represent criteria [1]. Solving complex decision problems using AHP method is based on their decomposition in a hierarchical structure whose elements are goal (objective), criteria (sub-criteria) and alternatives. An important component of the AHP method is a mathematical model by which priorities of elements are calculated (weighted), for elements that are on the same level hierarchical structure. AHP was successfully used in environmental impact assessment for determining of weights for impact categories in paper [3]. In paper [4] AHP was used for verification of results gained by quantification of environmental aspects and impacts.

Summary of AHP method consists of converting subjective assessments to the relative importance of the criteria scores and weights. The method, developed by Saaty [1] proved to be the most common form of multi-criteria analysis. AHP input data are answers to questions such as "How important is criterion A relative to criterion B?". This results are compared in pairs, resulting are in scores and weights. For each pair of criteria required comparing the importance of the two, associating a score as follows (Table 1):

TABLE 1 PAIR OF CRITERIA

Definition	Intensity of importance
Equally important	1
Moderately more important	3
Strongly more important	5
Very strongly more important	7
Extremely more important	9
Intermediate values 2,4,6,8	

Numbered intermediate values can be used to define nuances among the five basic formulation. Of course, if it is considered that B is very strongly more important than A, when the opposite is true, so A is assigned the value of 1/7 compared to B. Therefore, since it is assumed that judgments are consistent with respect to all pairs and all the criteria are "equally important" to themselves, the total number of evaluations will be:

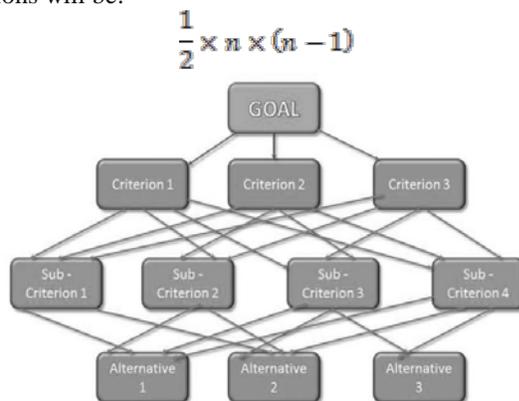


Fig. 2 General hierarchical model in AHP

Application of AHP method can be explained in four steps:

1. Setting a hierarchical model of decision problems in order with goal on the top criteria and subcriteria and alternatives at the bottom of the model (Fig. 1);

2. At each level of hierarchical structure each elements of the structure are compared in pairs, whereby the decision makers express their preferences with the help of appropriate scale which has 5 degrees and 4 sub-degrees of verbally described intensities and the corresponding numerical values for them in the range from 1 to 9 (Table 1);

3. Local priorities (weights) of criteria, sub-criteria and alternatives at same hierarchical structure level are calculated through appropriate mathematical model and afterwards they are synthesized in total priorities of alternatives;

4. Implementation of the sensitivity analysis for final decisions.

The matrix  $A$  has special features (all of it's rows are proportional to the first row, and they are all positive and  $a_{ij} = 1/a_{ji}$  is true) and because of that only one of it's eigenvalue differs from 0 and is equal to  $n$ .

If the matrix  $A$  contains inconsistent estimates (in practical examples almost always), weight vector  $w$  can be obtained by solving the equation  $(A - \lambda_{max} I)w = 0$  with prerequisite that  $\sum w_i = 1$ , where  $\lambda_{max}$  is the largest eigenvalue in matrix  $A$ . Because of matrix  $A$  properties  $\lambda_{max} \geq n$ , the difference  $\lambda_{max} - n$  is used in measuring consistency. With consistency index  $CI = (\lambda_{max} - n)/(n-1)$  measure of consistency can be calculated:

$$CR = CI/RI$$

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1j} \\ a_{21} & 1 & \dots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & \dots & a_{ij} \end{bmatrix}$$

Fig. 3 Matrix A

The next step is to determine the set of weights that are most consistent with the estimates of the relative importance of the criteria. This can be done in several ways. In the method developed by Saaty [2], the calculation of the weights is based on a relatively complex mathematical apparatus, using matrix algebra tools. The results are values associated to eigenvector of maximum eigenvalue matrix.

The calculations are quite complex, so it is necessary to use a dedicated program.

But in practice, we provide a simple method of calculation, which gives the same result with two decimal places:

- Calculate the geometric mean of each row of the matrix.
- It calculates the sum of the geometric mean.
- Normalized geometric mean.

#### IV. THE TECHNIQUE FOR ORDER OF PREFERENCE BY SIMILARITY TO IDEAL SOLUTION (TOPSIS) METHOD

The TOPSIS method, known as one of the classical MCDM methods, was first developed by Hwang and Yoon [12]. The basic concept of this method is that the chosen optimal alternative should be the one that has the shortest distance from the positive ideal solution and the farthest from the negative ideal solution. The positive ideal solution is a solution that maximizes the benefit criteria and minimizes the cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria [11]

The TOPSIS procedure is based on an intuitive and simple idea, which is that the optimal ideal solution, having the maximum benefit, is obtained by selecting the best alternative which is farthest away from the most unsuitable alternative that offers minimal benefits [14]. The ideal solution should have a rank of one, while the worst alternative should have a rank approaching 0. Ideal solutions are not probable and each alternative solution would have some intermediate ranking between the ideal solution and the worst solution (Shyjith,2008). Regardless of the absolute accuracy of rankings, the comparison of a number of different solutions under the same set of selection criteria allows an accurate weighting of relative solution suitability and hence an optimal solution selection. Mathematically, the application of the TOPSIS method involves following steps:

Step 1, establishing the decision matrix

The first step of the TOPSIS method involves the construction of a decision matrix  $m \times n$ , (DM), figure 4.

$$DM = \begin{matrix} & C_1 & C_2 & \dots & C_n \\ L_1 & \left( \begin{matrix} X_{11} & X_{12} & \dots & X_{1n} \\ X_{21} & X_{22} & \dots & X_{2n} \\ \dots & \dots & \dots & \dots \\ X_{m1} & X_{m2} & \dots & X_{mn} \end{matrix} \right) \end{matrix}$$

Fig. 4 The block schema of connection, sensor to microcontroller

where  $i$  is the criterion index ( $i = 1 \dots m$ );  $m$  is the number of potential solutions and  $j$  is the alternative index ( $j = 1 \dots n$ ).

The elements  $C_1, C_2, \dots, C_n$  refer to the criteria, while  $L_1, L_2, \dots, L_m$  refer to the alternative solutions. The elements of the matrix are related to the values of criteria  $i$  with respect to the alternative  $j$ , (Maliki, A, Owens, G., Bruce D., 2012)

Step 2, calculating a normalised decision matrix.

The normalised values  $r_{ij}$  denote the normalised decision matrix (NDM) which represents the relative performance of the generated design alternatives:

$$NDM = r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (1)$$

Step 3, determining the weighted decision matrix

Not all of the selection criteria may be of equal importance and hence weighting was introduced prior to quantifying the relative importance of the different selection criteria. The weighting decision matrix is easily constructed by multiplying each element of each column of the normalised decision matrix by the predefined weights:

$$V = v_{ij} = w_j r_{ij} \quad (2)$$

Step 4, identifying the positive and negative ideal solution

The positive ideal solution (PIS), ( $A^+$ ) and the negative ideal solution (NIS), ( $A^-$ ) are defined according to the weighted decision matrix via the equations given below:

$$PIS = A^+ = \{v_1^+, v_2^+, \dots, v_n^+\}, \text{ where: } V_j^+ = \{(\max(v_{ij}) \text{ if } j \in J), (\min(v_{ij}) \text{ if } j \in J')\} \quad (3)$$

$$NIS = A^- = \{v_1^-, v_2^-, \dots, v_n^-\}, \text{ where: } V_j^- = \{(\min(v_{ij}) \text{ if } j \in J), (\max(v_{ij}) \text{ if } j \in J')\} \quad (4)$$

where  $J$  is associated with the beneficial attributes and  $J'$  is associated with the non-beneficial attributes.

Step 5, calculating the separation distance of each competitive alternative from the ideal and non-ideal solution:

$$S^+ = \sqrt{\sum_{j=1}^n (V_j^+ - V_{ij})^2} \quad i = 1, \dots, m \quad (5)$$

$$S^- = \sqrt{\sum_{j=1}^n (V_j^- - V_{ij})^2} \quad i = 1, \dots, m \quad (6)$$

Step 6, measuring the relative closeness of each solution to the ideal solution. For each competitive alternative there has to be computed the relative closeness of the potential solution with respect to the ideal solution.

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}, 0 \leq C_i \leq 1 \quad (7)$$

Step 7, ranking the preference order. According to the value of  $C_i$ , the higher the value of the relative closeness, the higher the ranking order and hence the better the performance of the alternative. Ranking of the preference in descending order thus allows the comparing of relatively better performances.

## V. RESULTS AND DISCUSSION

Measurements were made in junctions with intense traffic such as Alba Iulia Road–Cibin Bridge, DN1 Km 306, Sibiu Union Square and in areas considered unpolluted (Sub Arini Park).

Monitoring points were established to evaluate the impact of road traffic on environment and implicitly on people.

Measurements were made on Sibiu Union Square, DN1 Km 306, Alba Iulia Road, Cibin Bridge and Sub Arini Park Sibiu, in the time frame 09.00-16.00. During the monitoring activity some moderated wind, mostly on north-east, was recorded.

The environment conditions during the measurements are presented in table 2

TABLE 2 THE ENVIRONMENT CONDITION

Location	Time frame	Humidity %	Temp °C	Solar radiation W/m2	Atmospheric pressure mBar
Union Square	10:00	57,63	9,8	82,83	952,4
	11:01	59,06	10,2	154,40	951,6
	12:01	56,28	10,9	666,40	951,0
DN1 Km 306	10:33	72,46	12,0	374,7	967,5
	11:33	63,41	15,1	404,33	966,9
	12:33	57,23	17,4	448,36	965,8
	13:33	52,13	19,2	399,13	964,9
	14:33	48,68	20,5	313,35	964,0
Alba Iulia Road	09:50	60,34	8,9	118,78	964,5
	10:51	58,9	9,5	145,18	963,1
	11:51	56,08	10,0	171,32	963,0
Sub Arini Park	09:30	65,23	11,7	314,25	965,5
	10:31	60,13	13,8	401,56	964,2
	11:01	51,48	16,4	395,98	962,8

The comparative situation of concentrations of pollutants recorded in the four locations as environments of the monitoring periods is presented below.

The concentration of nitrogen oxides are presented in table 3.

Table 3  
CONCENTRATION NITROGEN OXIDES  
NO [ $\mu\text{g}/\text{m}^3$ ]

Union Square	53.57
DN 1 Km 306	115.97
Alba Iulia Road	57.1
Sub Arini Park	35.1

The graph of measured values is shown in figure 5

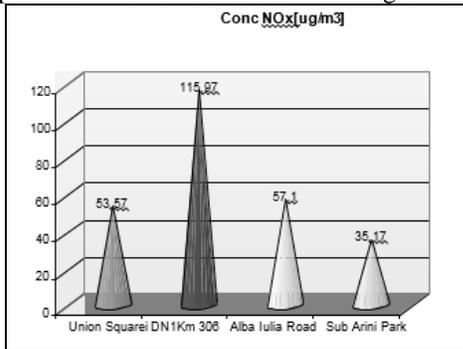


Fig. 5 The NO graph values

The concentration of nitrogen oxides  $\text{NO}_2$  are presented in table 4.

Table 4  
CONCENTRATION NITROGEN OXIDES  $\text{NO}_2$  [ $\mu\text{g}/\text{m}^3$ ]

Union Square	31,22
DN 1 Km 306	46,11
Alba Iulia Road	30,03
Sub Arini Park	24,87

The graph of measured values is shown in figure 6

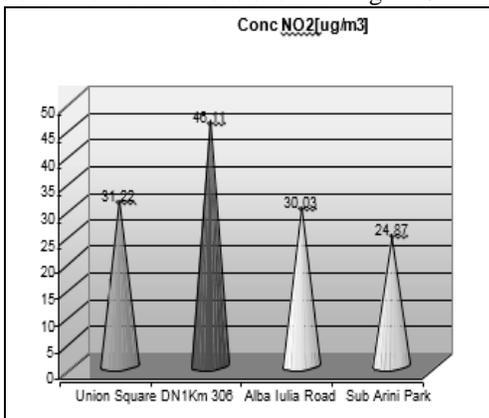


Fig. 6 The  $\text{NO}_2$  graph values

The  $\text{NO}_x$  variation is presented in figure 7.

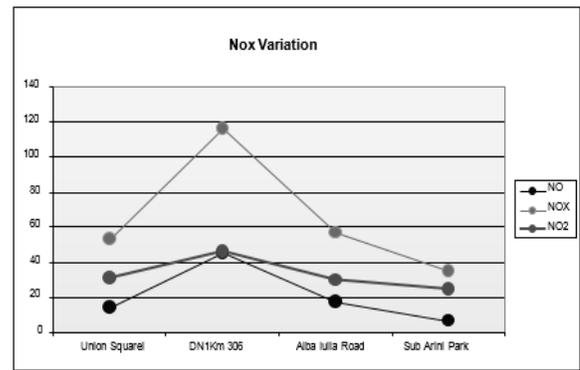


Fig. 7 The  $\text{NO}_x$  variation

By analysing the measured concentrations of nitrogen oxides one can notice that the highest values were recorded on DN1, and this phenomenon can be correlated with road traffic which is the most intense in this area. The least affected area is Sub Arini Park.

The graph of measured values for Ozone is shown in figure 8.

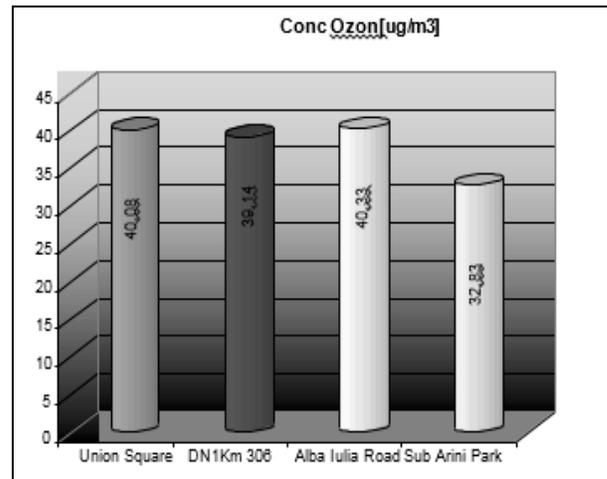


Fig. 8 The Ozone Graph

Although solar activity (which can contribute to the increase of ozone level in the ambient air) was intense during the monitoring activity, the maximum hour values recorded did not exceed information threshold and much less alert threshold.

The graph for measured values of Benzene is shown in figure 9.

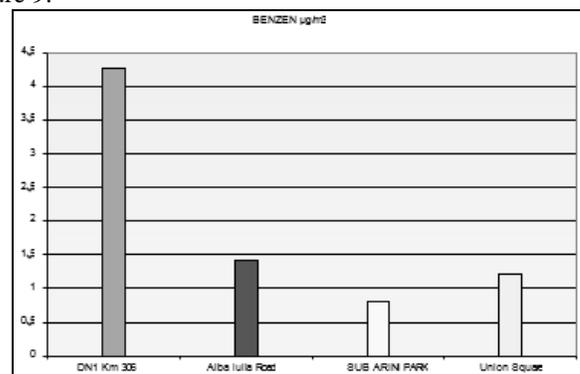


Figure 9 The Benzene Graph

From figure 9 one can notice that out of the three locations, the highest concentration was recorded on DN1 Km306, followed by Alba Iulia Road, Union Square and in Sub Arini Park the measured concentration is  $1\mu\text{g}/\text{m}^3$  air.

In the figure 10 is presented the graph of The Suspended Powders Fraction measured and the limit value of this cause pollution.

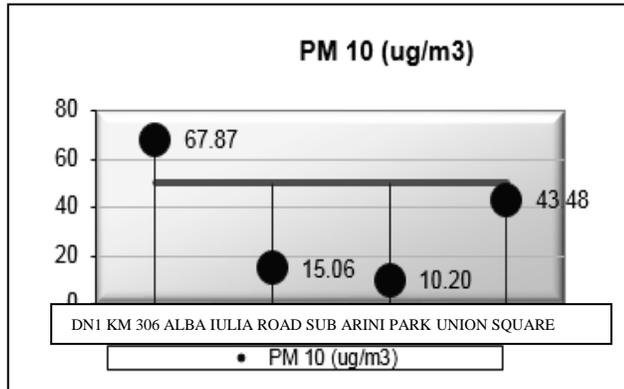


Fig. 10 The PM10 Graph

The system allows both measurements using dedicated equipment, and with the help of sensors and acquisition board. Measurements can be performed with the help of the mobile laboratory.

Monitoring points were established to evaluate the impact of road traffic on environment and implicitly on people.

By example, in the system, concentration measurements of carbon monoxide can be achieved using MG-811 sensor. Also this sensor is good for measurement CO concentration. This is an onboard signal conditioning circuit for amplifying output signal and an onboard heating circuit for heating the sensor. The MG-811 sensor is basically a cell which gives an output in the range of 100-600mV (400—10000ppm CO<sub>2</sub>). The LMC662 is used as the amplifier because of its ultra-high input impedance. According to the datasheet of MG-811, this sensor require an input impedance of 100-1000Gohm. This sensor need one analog input and one digital for connect the sensor to Arduino Mega Microcomputer. The Arduino Mega is a microcontroller board based on the ATmega1280. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The block schema is presented in figure 11.

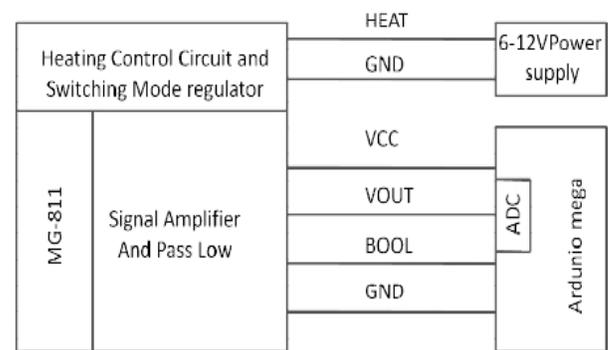


Fig. 11 The block schema of conection, sensor to microcontroller

The data obtained through hardware presented will be analyzed in Labview software. This permitted:

- Easy used Arduino digital input/output , analog input, I2C, and Serial Peripheral;
- Interface from LabVIEW;
- I/O engine sketch to load on Arduin;
- Communication wireless via XBee or Bluetooth;
- Loop rates: USB tethered (200 Hz) and wireless (25 Hz);
- IDE arduino sketch and LABVIEW toolkit VIs help to specification functionality.

The panel of this virtual instrument is shown in figure 12.

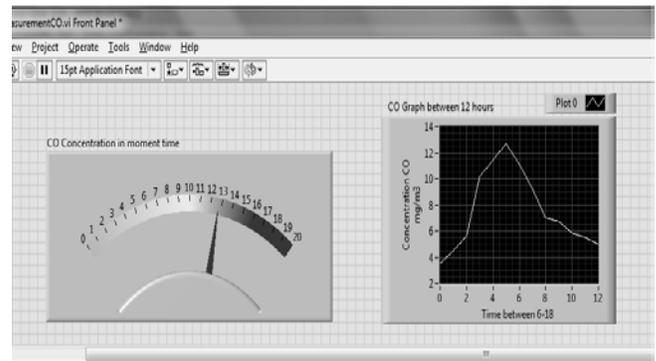


Fig. 12 The panel of CO concentration part of the system of automatic aquisition, processing and analyze data

Furthermore, we will present one of the most important parts of the automatic acquisition, processing and analysis of environment data system, which is the analysis of the AHP multi-criteria method implemented within the system. The virtual instrument created in this system is based on objected-oriented programming. The input data is processed by using the LabVIEW functions. With the help of these functions the data is memorised in a database, in order to be further used in the realization of the objected classes for the generation of the intelligent maps of the Geomedia Professional Software.

The system allows measurements for the diverse polluting chemical factors, like: NO<sub>x</sub>, PM10 dust and ozone.

The multi-criteria analysis that we will further present it is based on real measurements of the NO<sub>x</sub>, PM10 dust and ozone made in 4 different points from Sibiu: Union square, Alba-Iulia street, DN 1 306 km and the Sub Arini park.

The virtual apparatus projected for the realization of the AHP multi-criteria analysis works as follows:

- A subjective appreciation of the importance of each point stated above is made depending on the number of vehicles, number of people that are found in that concrete point at a certain time. The comparison matrix of pairs is realized, the weight of each observation point is calculated, the priority vector Lamda, CR and CI are being calculated. The block diagram are presented in figure 13.

- Depending on the measurements made for each of the polluting factors, the virtual apparatus will calculate the weight of each polluting factor from the observation points taken into account, figure 14.

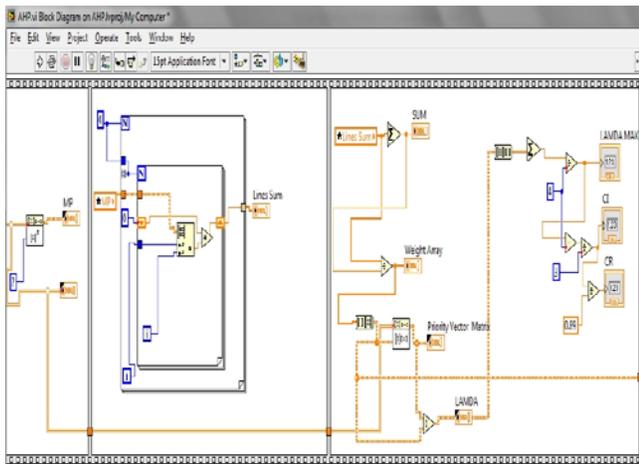


Fig. 13 The diagram of VI for measurement points in AHP analysis

- Finally, the matrix of polluting factors is obtained. This will be multiplied with the observation point's weights matrix. The virtual apparatus allows the determination of the most and least polluted observation point, depending on the subjective appreciation made upon them and also, depending on the weight that each polluting factor has in the observation points. The final results are presented in figure 15.

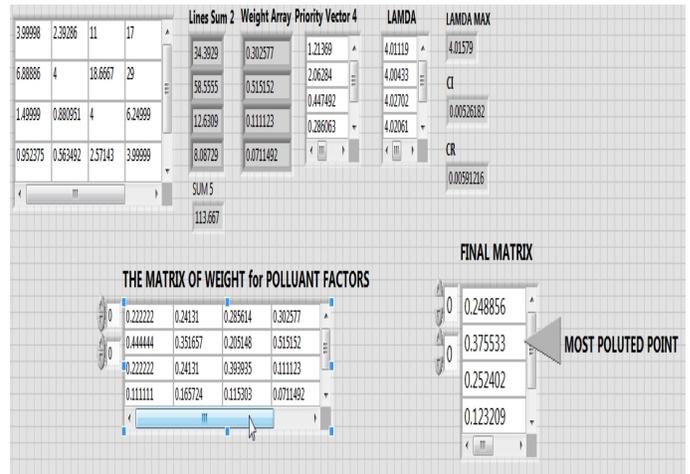


Fig. 15 The matrix of weight for pollutant factors and final matrix with results in AHP method

For the presented example we can observe that the most polluted point is DN 1 306 km, followed by Alba Iulia street, Unirii Square and, as expected, Sub Arini park.

In the same way it created a virtual machine for the method TOPSIS. The results are shown in Figure 16.

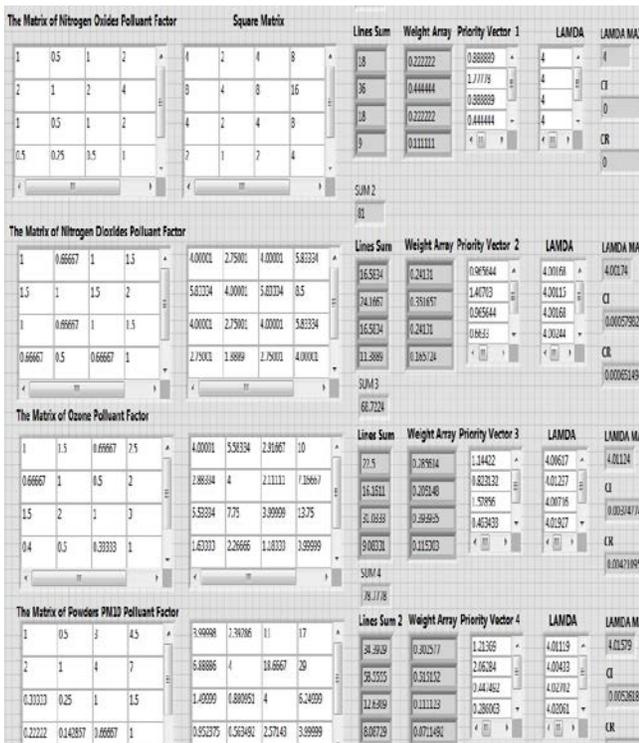


Fig. 14 The panel of VI for all pollutant factors

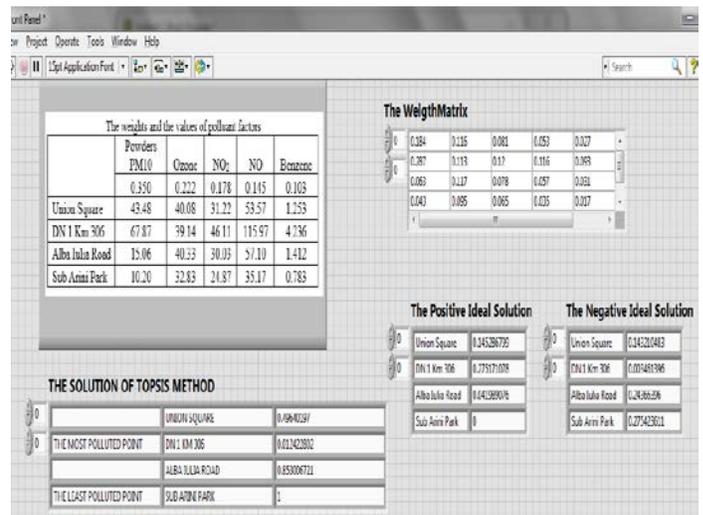


Fig. 16 The Final Results with Topsis Method

The presented system allows the automatic memorization of data measured and processed in ACCESS database. This is very important for the GIS Maps generation. The ACCESS table in which the data is saved is in this way projected, as for it to hold the specific object class attributes, which will be presented in the map that will be generated using the

Geomedia Professional Software, in figure 17.

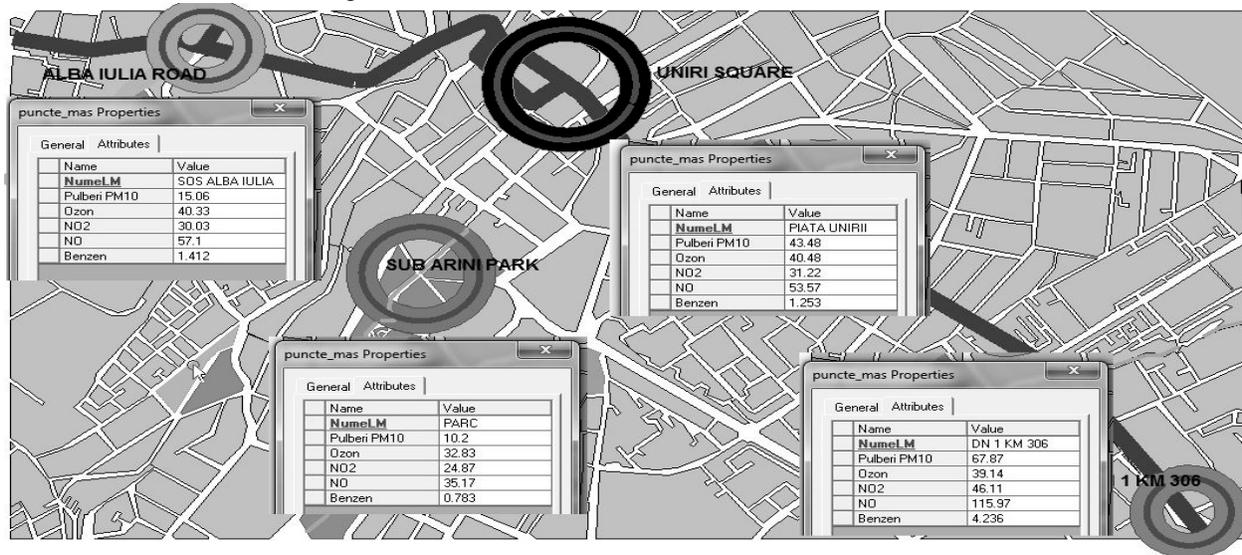


Fig. 17 The map with the observation points and database connection

The AHP and TOPSIS methods calculations performed data acquisition system, are transferred into the GIS system. In the map shown in Figure 18 are presented the results of the calculations in our system. In this figure point appears most

polluted and least polluting point depending on the pollutants considered. This is the result of using AHP and TOPSIS multi-criteria methods that allowed consideration of polluting factors of different nature.

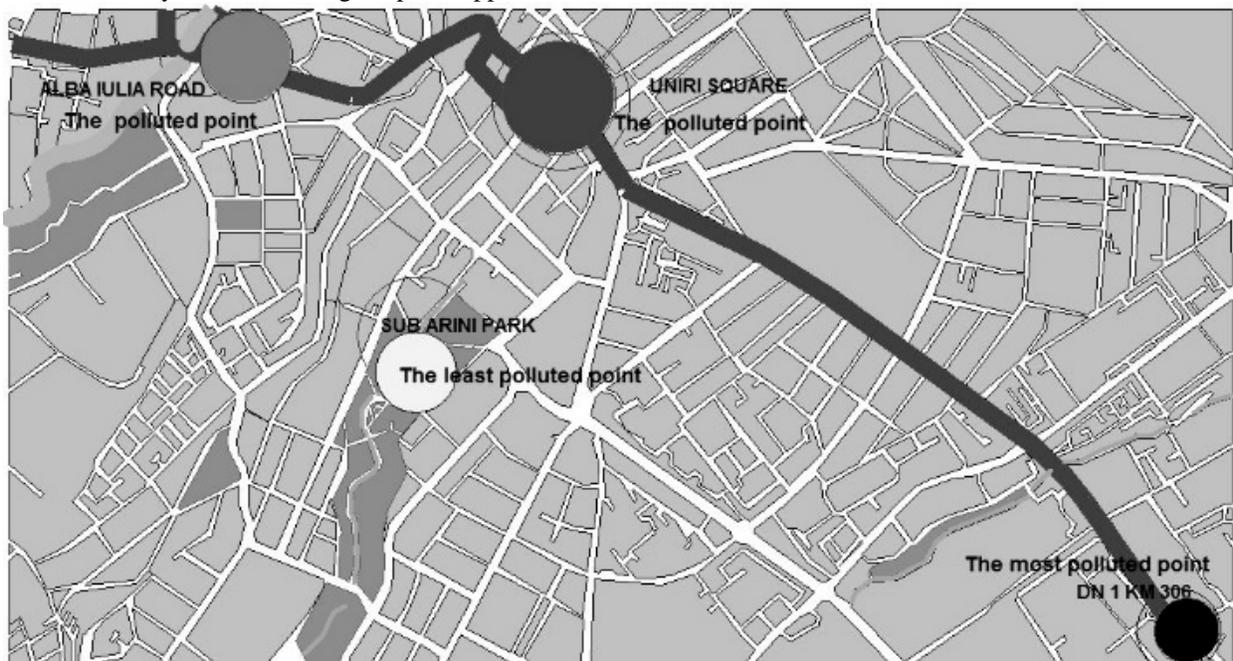


Fig. 18 The most polluted and the least polluted measured point

As it was expected the least polluted point from the measurement points is Sub Arini Park where is no road traffic and are not a large number of people. The most polluted point is the place where there are several malls in the city and big shops, where there is intense traffic and a large number of people.

## VI. CONCLUSIONS

The automatic system for the taking over, processing and data analysis allows obtaining the object class attributes used

for generating the intelligent maps.

The data are taken over and processed using the objectual technology and the implemented functions in LabVIEW. Plus, the system offers the possibility of the data analysis through sensors, microcontrollers, acquisition boards and specific apparatus, which is highly unused in the current literature. The multi-criteria analysis is made depending on the user's will. The elaborated system is very important because of the fact that it excludes the intervention of the human factor in the acquisition process, taking over and data memorisation.

In the future the system will be extended by using other analysis methods, or other optimization technics based on genetic algorithms. Also, it is very important the automatic generation of the pair comparison matrix, depending on the factor's values

Multi-criteria evaluation methods can be applied in various fields. In the case of air pollution, these methods allow the taking into consideration of some very different parameters which originate from various areas. Thus, the parameters taken into consideration were gas parameters, acoustic parameters, material parameters etc. The two multi-criteria methods allowed a very accurate overall evaluation.

Using multicriteria methods highlighted a known as Sub Arini Park is the least polluted area. Also the use of AHP and TOPSIS multicriteria methods allowed to determine the most polluted observation point of several points where measurements were made and the traffic of cars and the number of people was similar.

The values obtained allow assessment of the pollution in the observation points. AHP method allowed evaluation of the subjective point of view of the researcher, depending on traffic and the number of population. TOPSIS method allowed the determination of each point pollution according to the measured values and the importance (weight) of each observation point.

The software GIS which was used besides the calculation which it makes allows for the interpretation of the results both 2D and 3D.

The multi-criteria methods in this paper presented the expected results regarding air quality, in the park area they permitted the evaluation of the most polluted area from three observation points in which there is high traffic and a large number of persons. The intelligent map obtained allows the use of results in a complex spatial analysis.

Finally we got a intelligent map of Sibiu observation points and we have implemented algorithms of this two multicriteria methods presented in the paper, in GIS software, Geomedia Professional.

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