

ENVIRONMENTAL PARAMETERS LABORATORY MEASUREMENTS WITH VIRTUAL INSTRUMENTATION

Olga PLOPA¹, Cătălina SELIMAN¹,
C. DAMIAN¹

¹ The "Gheorghe Asachi" Technical University
of Iasi, Iași

e-mail: oplopa@ee.tuiasi.ro

This article presents a virtual instrument developed for relieving the laboratory analyzing of environmental parameters.

The laboratory has been developed and equipped with high performance equipment available on the market for the measurement of a series of pollutants found in water, air, soil and for measuring noise from various companies.

To reduce the work of studied laboratory personnel and to prevent some human errors we developed specialized software using the LabView programming environment.

The virtual instruments can turn the computer into a "command server" of a network of measuring devices able to communicate through a specific protocol.

Thus, connecting laboratory devices to a computer and implementing the specialized software we can command all this devices, namely we command taking, recording and processing results. In this way the laboratory is brought one step higher in performance.

Key words: laboratory, environment, virtual instrumentation

Environmental law defines the environment as a set of conditions and natural elements of earth: air, water, soil and subsoil, all layers of the atmosphere, all organic and inorganic materials and living beings, the natural interacting systems, including the items listed above, including material and spiritual values.

Also, by definition, pollution represents changing of natural components through the presence of foreign components, called pollutants, as a result of human activity, and causing by their nature, concentration and acting times, harmful effects on health, creates discomfort or prevent use of the environmental ingredients essential for life. The state of environment directly affects our health and life. That is why monitoring of pollution of the environment is absolutely vital.

The main purpose of an environmental laboratory is to perform tests and inspections of quality (water, air, soil), especially on environmental protection, pollutants, and some general services based on scientific and technical support provided by specialists which work in the laboratory.

The main tasks of this type of laboratories are: sampling, conservation, transport of samples, preparing samples for analysis, the analysis itself, transcription of data and other observations in working register, computer data saving, data interpretation and processing, storage of processed data in a database, verification, and filling in of such documents as sampling bulletin, sample reception bulletin, external order, internal order, first report results, final report, etc.

Most of the actual instruments and devices from a laboratory are limited to the following main functions: data measurement, analysis and displaying of results. These functions are implemented in hardware tool, so that they, once established, can not be changed. If anyone want additional features, it is necessary to modify the structure, with important consequences on the cost.

To expand any existing device functions, reduce the work of personnel from studied laboratory and to prevent some human error was developed a software using LabView programming environment.

MATERIAL AND METHOD

Our environmental laboratory has been developed and equipped with following high performance equipment available on the market:

- for measuring parameters of water and soil (soil samples are obtained after its mineralization):
 - DR 2800 VIS spectrophotometer, product company HACH Lange;
 - atomic absorption spectrometer ZEENIT700, Jena Analytics;
 - ORION multiparameter kit (pH, conductivity, dissolved oxygen);
 - ORION turbidimeter;
 - OXIDIRECT installation of BOD5.
- to measure at source the pollutants in the air we use:
 - FIRSTCHECK analyzer;
 - burnt gas analyzer MULTIRAE PLUS;
 - burnt gas analyzer OLDHAM;
 - burnt gas analyzer WOHLER.
- to measure the noise level:
 - sound level analyzer PULSAR 30.
- to measure the conditions in the laboratory:
 - temperature – humidity meter.
- for digestion of soil samples:
 - digestion device DIGESTAL, Hack Lange.

Most of devices are equipped with an interface for connection with a computer, thus being possible the connection of devices to the lab computer and implementation of developed software.

In short, the procedure for laboratory environmental parameters measuring is as follows:

- Step 1: sampling (water and soil, air samples are measured “in-situ”), filling the sampling report;
- Step 2: preservation of samples (with chemical solutions, if necessary, and/or storing in cold box), record these actions in sampling reports;
- Step 3: the transport and delivery of samples to the laboratory (completion of sample reception bulletin);

- Step 4: registration and coding of samples;
- Step 5: preparation of samples for analysis;
- Step 6: the analysis itself and storage of results in devices' memory;
- Step 7: carefully data transcription in working register and recording of all actions and laboratory conditions (temperature and humidity) in working register;
- Step 8: entering the data from working register to computer, data processing and interpretation, calculation of errors, the improper disposal, etc.;
- Step 9: storage of processed data in a database;
- Step 10: Verifying of data and its transfer accuracy, the data processing by the head of laboratory;
- Step 11: emitting of the final report by the head of laboratory;
- Step 12: recording and keeping of final report in the database.

Using the software developed in LabView programming environment, the procedure for environmental parameters measuring in the laboratory becomes simple, expedient and accurate.

Virtual instrumentation (VI) is the use of customizable software and modular measurement hardware to create user-defined measurement systems, called virtual instruments. It is specialized to simulate the characteristics and performance of an instrument or a system for measuring, testing or data recording [7].

The virtual instruments can turn the computer into a "command server" of a network of measuring devices able to communicate through a specific protocol [4]. Thus, connecting laboratory devices to a computer and implementing the specialized software we can command all this devices, namely we command taking, recording and processing results. In this way the laboratory is brought one step higher in performance.

Comparing to the classic measuring system, the difference is that all functions of data processing and analysis, the storage of this information and transmitting of this to the human user are made by computer and not by dedicated devices.

Thus, such software can replace roughly 80% of circuits of a classic measuring or testing specialized device. Software that performs these functions has in most cases a graphical interface with the same look as the front panel of a measuring device. That is why the applications are called Virtual Instruments.

The virtual instrumentation is not just a replacement for measuring devices used in laboratory research applications or teaching, but is complex and powerful tool for monitoring and control [9].

Unlike real instruments, the virtual ones are mainly based on computer programs, have a high degree of flexibility, any additional function is very easy to be implemented at minimal cost, through simple changes to the program. Basic functions that can be developed in a VI structure are:

- automatic acquisition of signals obtained in accordance with the structure and configuration set by the beneficiary;
- local, partial or total processing of information at the point of measurement, using dedicated microsystems;
- data storing on magnetic media like hard disk or optical media like CD-ROM or DVD-ROM;
- remote sending of processed or unprocessed data, to dispatcher, in the local computer networks, Internet connection or wireless (radio or mobile);
- displaying and presentation of data on the computer screen, on graphic user interface available in graphic or numeric format;

- automatic control of the process whose parameters are measured by numerical algorithms implemented on the computer (for slow processes) or digital signal processors (for fast processes);
- data organizing, local or at dispatcher, in the database or calculation tables, with their specific processing.

As you can see, the functions of a virtual instrument underlie a wider range of applications than those of a real instrument. The virtual instrument's functions should not be included in the same box, as for real instruments. The computer can retrieve a part or even all functions.

Virtual Instrumentation has developed in recent decades due to progress of digital technology and computer development. In consequence, the benefits of this technology turn up on measurement techniques too. Among these advantages we can mention:

- **expandability** - can purchase a large number of signals through the use of multiplexed analog inputs;
- **precision** - digital signal processing gives high accuracy because it is not affected by component tolerances, temperature, aging, noise, etc.. The only limitations are given by analog part of system (sensors and primary processing block). Thus, superior precision can be obtained, comparable to those of real digital instruments;
- **flexibility** – the possibility of adding new features with minimal cost, through simple changes to the program;
- **storage of measured information** in large amounts on computer memory, its organization in databases and statistical processing;
- **remote transmission** of data over computer networks, Internet, mobile phone or radio.

RESULTS AND DISCUSSIONS

Front panel of the developed program is shown in *figure 1*. This program can provide the following actions:

- record the laboratory conditions (temperature and humidity), step 7 of the environmental parameters measurement routine;
- provides information about the measuring device (date of last and next absolute calibration, date of last calibration), which are essential for reliability of obtained results and emitting of the final report;
- uploads to PC measured parameters values from each device, steps 7 and 8;
- calculate the errors of measurement, step 8;
- completes the archive and the final report, steps 9, 11 and 12.
- eliminates the need of step 10, which involves checking the correctness of data transfer from measuring devices to the computer and data processing.

Thus, we have automated steps 7 to 12, facilitating the work of environment laboratory personnel. Besides the advantage of speed, reliability and automation of activities in the laboratory, eliminating of human factor in taking the tests results, it's transmission to processing and calculation of errors is essential, all being performed by the developed program.

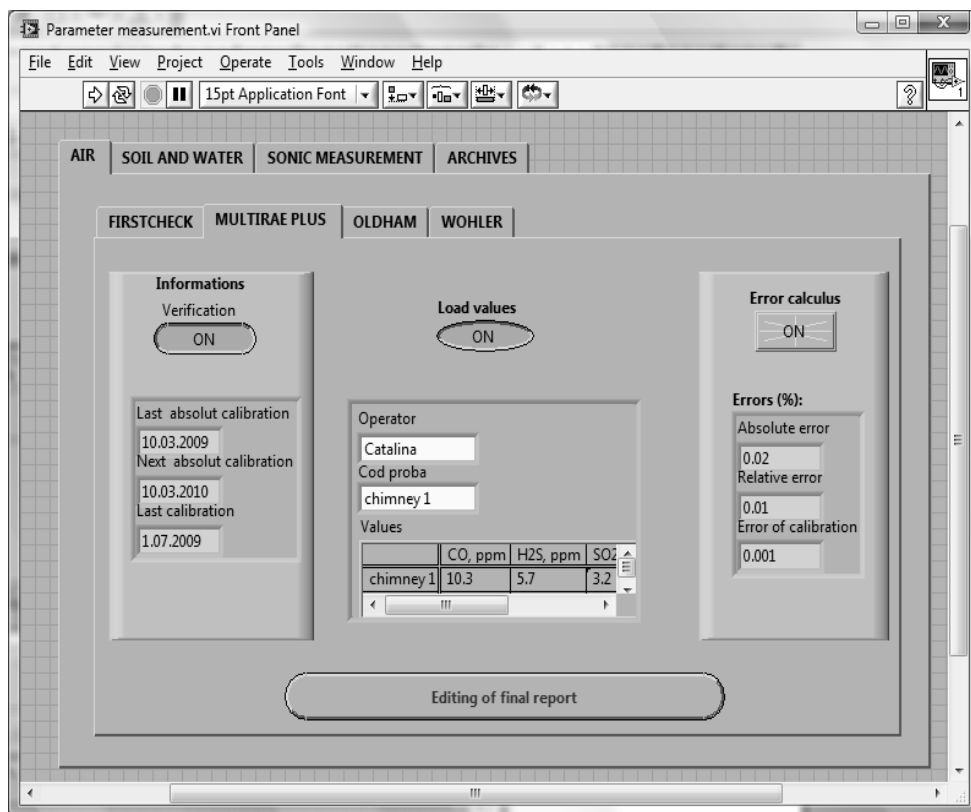


Figure 1 Front panel of “Parameter measurement” software

CONCLUSIONS

The implementation and use of developed software brings some benefits:

- automation of retrieval, processing and data recording;
- speed and expeditivity;
- expandability;
- accuracy and reliability;
- remote data transmission.

Implemented software eliminates the possibility of generation of errors due to human factor and the need for specialized personnel. Helps to store all data from measuring devices, warns staff one month before the next calibration date, record all service dates and keeps them in the archive, facilitates rapid finding of anterior data (analysis). Implemented software can be adapted to other measurement and analyzing laboratories.

In conclusion, implementing in a laboratory of such a virtual tool is very useful, facilitating the work of staff and providing time for other activities.

BIBLIOGRAPHY

1. Baraboi, B., Crețu, M., Foșalău, C., 2000 – *LabView în analiza gazelor*, Revista de instrumentație virtuală, pp. 101-105.
2. Damian, C., Foșalău, C., Zet, C., 2007 - *Wireless Communication System for Environmental Monitoring*, 1st IMEKO TC19 Symposium on Measurements and Instrumentation for Environmental Monitoring, Iași, România, pp. 108-112.
3. Donciu, C., Costea, O., Seliman, C., 2007 - *Environmental station for meteo measurements*, 1st IMEKO TC19 Symposium on Measurements and Instrumentation for Environmental Monitoring, Iași, România, pp. 103-107.
4. Donciu, C., Crețu, M., Foșalău, C., 2001 - *Communication in virtual instrumentation*, Int. Conf. on Management of technological changes, Oct. 25-26, Iași, România, pp. 69-74.
5. Foșalău, C., Postolache, O., 1999 - *Proiectarea asistată de calculator a sistemelor de măsură (Computer Aided Design of Measurement Systems)*, Editura "Gh. Asachi", Iași.
6. Foșalău, C., Postolache, O., Baraboi, B., 1999 – *Ion concentration and pH measurement by using a multisensor system*, Buletinul IPI XLV Fasc. 5A, pp. 342-347. National Instruments: "Labview User Guide".
7. Postolache, O.; Girão, P.M.; Dias Pereira, J. M., Crețu, M., Foșalău, C., October, 2001 - *"Air Contaminants Measurement Based on Neural Processing and PIC16F877 Hardware Support"*, Proc International Metrology Congress, Saint-Louis, France, Vol. 1, pp. 68 - 72,.
8. Toader, O. F., October 05, 2005 - *"Remote Data acquisition and Instrument Control Using Labview and Appletview"*, iJOE International Journal of Online Engineering.