# Virtual Meteorological Center

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*Abstract*—**A virtual meteorological center, computer based with Internet possibility transmission of the information is presented. Circumstance data is collected with logging field meteorological station. The station collects and automatically save data about the temperature in the air, relative humidity, pressure, wind speed and wind direction, rain gauge, solar radiation and air quality. Also can perform sensors test, analyze historical data and evaluate statistical information. The novelty of the system is that it can publish data over the Internet using LabVIEW Web Server capabilities and deliver a video signal to the School TV network. Also the system performs redundant measurement of temperature and humidity and was improved using new sensors and an original signal conditioning module.**

*Index Terms*—**RS232 data acquisition board, meteorological station, meteorological parameters, virtual instrumentation, redundant measurement, Internet and wireless transmission.**

## I. INTRODUCTION

The EU-funded conference on "Environment, Health, Safety: a challenge for measurements", held in Paris in June 2001, recognized the need to improve the performance of environmental measurement systems and their harmonization at EU level, to foster the dialogue between the providers of measurement methods and the users of measurement results, and to prepare the base - by establishing special communication tools – for the integration of research expertise and resources of environmental monitoring across Europe.

The concept presented herein aims to respond to this actual challenge by combining the latest software trends with the newest hardware concepts in environmental monitoring, towards providing reliable measurement results and representative environmental indicators, evaluating trends and quantifying the achieved results in order to manage the potential environmental risk in compliance with European legislation and local particularities.

The system presented below give the possibility of real measurements from a remote location, of an optimum access to sophisticated and/or expensive apparatus and instrumentation - even geographically distributed, or of repeating the same experience many times, at convenient hours, with minimum support from technical staff.

The climatically change in the last years impose the new modern meteorological stations. We have to develop new systems that perform high-speed frequency acquisition, transmission and data processing of the meteorological parameters. New methods, hardware and software, to increase the quality of measurement must be done.

In the same time the Web is changing the way we take measurements and distribute results. Many different options exist for publishing reports, sharing data, and remotely controlling applications. LabVIEW incorporates the latest Web technologies, and without many experience we can incorporate the Web technology into our application, for just sharing the data with colleagues to creating a unique, powerful distributed application combining different measurement nodes and multiple computers together into one measurement and control
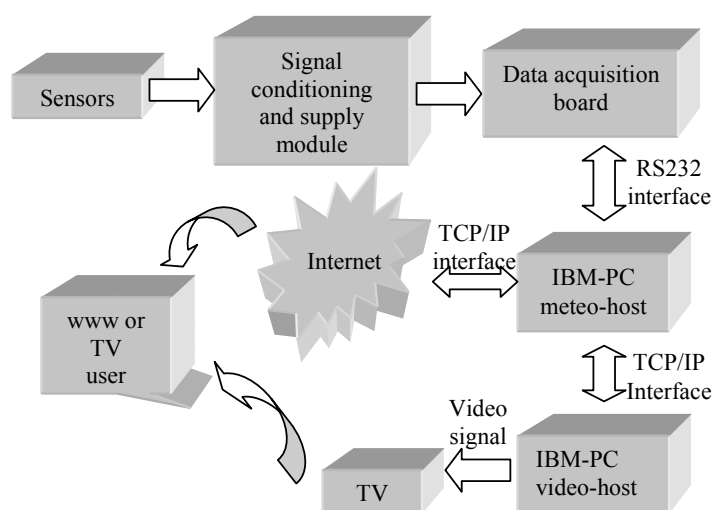


Fig. 1. Architecture of the virtual meteorological center with on-line measurement and data distribution by Internet and local television.

system. Just as advancements in PC technologies transformed the way we automate measurements, networks are revolutionizing the fundamental architecture of PC-based measurement solutions.

With networking technologies, we can distribute components such as I/O, processors, memory and storage, and displays, to the location most appropriate for our application.

Any LabVIEW application, without any additional development time, can be turned into a remote application accessed via a Web browser. High-level functions are available to generate Web reports through Microsoft Excel or Word so we do not have to design and develop the low-level interfaces.

## II. SYSTEM ARCHITECTURE

We propose an Internet Based Meteorological Center with an increasing data exchange speed of information between the small meteorological distributed centers and the other hand all the world can see the evolution of meteorological parameters using World Wide Web. In this case we can warn the people in utile time about bad weather. Electronic mail messages are automatically generated to notify researchers about any identified anomalies. The data are then stored in secure electronic databases and made available for retrieval and analysis via standard web browsers. Authorized users may select any portion of the data and conduct a variety of predefined, automated analysis procedures or import the data into local spreadsheets, databases, or other local analysis software.

The authors propose in the same time an educational measurement remote system. In this way, two parts compose the architecture of the system:

- client user that uses a client computer and
- measurement provider who disposes the server with the web site of the virtual laboratory.

Two cases are possible for remote teaching and education. In the first case, the professor from server room, after he set the students connected in this way, the students from their home study points can receive and follow the lessons.

The number of students connected in the same time is unlimited. All communication software is designed under LabVIEW graphical programming language.



Fig. 2.-.The main page of the Internet Based Meteorological Center and Virtual Laboratory for on-line measurements

In the figure 2 is presented the main web page of application. The main web page is located in server that allows the access to every station, using a connection link. In this machine a web server is running. The LabVIEW server represents the back up for the individual stations.

In the second case the server is set to all user masters. The students are able to perform the connection via modem and provider until server, in order to training and practice the programs. An adaptive Web server application tries to increase the performance of the Web server that hosts a Web site, as seen from the point of view of clients. The adaptiveness is based on the customization of the Web site in a manner that emphasizes the interests of the clients. Our server with dynamic allocation of client number is auto restarting.

The monitories parameters are the fallowing: air temperature (T1-T4), humidity (HR1-HR2), pressure (P), wind speed (WS) and wind direction (WD), rain gauge (RG), solar radiation (SR), and air quality (AQ). The sensor types and accuracies are listed below.

**Table 1**

| Parameter | Sensor | Accuracy |
|---|---|---|
| Temperature | precision integrated-circuit centigrade temperature. | 0.5°C accuracy guarantee able (at +25°C) |
| Humidity | the RH sensor is a laser trimmed thermoset polymer capacitive sensing element with on-chip integrated signal conditioning. | ±2% RH, 0-100% RH non-condensing, 25 °C, Vsupply = 5 Vdc |
| Wind speed | the sensor consists of a lightweight 3-cup anemometer, which is mechanically coupled to an AC generator. | ± 2.0 mph (0.90 m/s) over entire range m/s). operating range: 0-100 mph |
| Wind direction | the sensor consists of a vane and counterweight assembly, which is mechanically coupled to a potentiometer | ± 3.0° |
| Rain gauge | tipping bucket 0.01 inch resolution | ±1% at 1" per hour |
| Pressure | the sensor is made up of a bellows, which is directly coupled to the core of a linear variable differential transformer (LVDT) | ±0,02" Hg over any ±2,00" Hg span |
| Solar radiation (total sun and sky) | photovoltaic sensor | ±10% of the standard(48 junction thermopile black and white pyranometer) |

The system architecture is composed as follows:

- the specialized sensors,
- signal conditioning circuit,
- power supply - rechargible batteries
- a data acquisition board with data transfer by RS232 port,
- PC meteo-host, and the server provided with an Ethernet controller,
- PC video-host as shown in figure 1.

digital port on the ADR2010 labeled PORT A. The individual I/O lines are labeled PA0-PA7.

### III. SOFTWARE AND PROGRAMMING MODEL

The first step in accessing the ADR2010 via the serial port is configuring the serial port to the proper communication parameters which are 9600 baud, 8 bit words, no parity (Fig.3.a). To send commands to the ADR2010 the "serial write" command is used (Fig.2.b).

For example, the following command sends an RD0 (read analog port 0) command to the ADR2010. If a
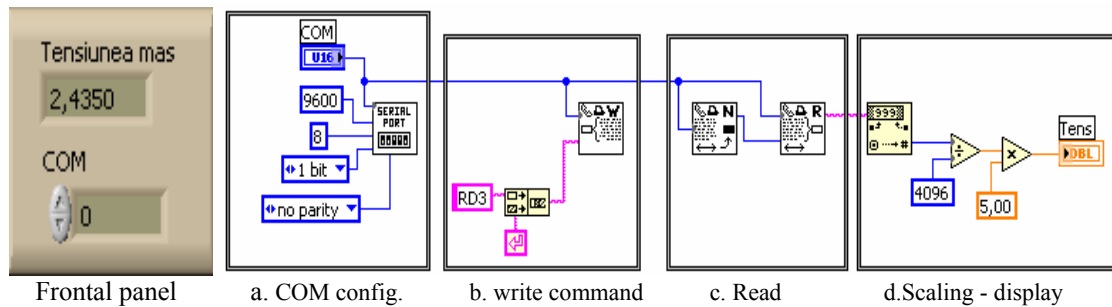


| Frontal panel | a. COM config. | b. write command | c. Read | d.Scaling - display |

Fig. 3.-.A simple program for reading one analog channel with LabVIEW software.

Using all this hardware we are able to perform a remote study for all type of the sensors, for the physical parameters and climate changes.

We use three interfaces to publish the data to the clients (users):

- RS232 for communication between the PC meteo-host and DAQB
- TCP/IP for communication between the PC meteo-host and the www user and for communication between the PC meteo-host and PC video-host. A LabVIEW VI that manages the TCP/IP data transfer is running on both PC.
- Video interface. The PC video-host take over the meteorological information's and provides the video signal to the school TV network using the output of the video card.

The signal conditioning module, made it by as, replace the old one. We use two humidity sensors and an LM741 amplifier for DAQB input impedance adaptation. We have four temperature sensors to improve the measurement accuracy. One of them can be selected by controlling the multiplexer using digital inputs/outputs from DAQB. The output of the multiplexer goes to one of the analog inputs of DAQB. We use LM741 to amplify the signal obtained from the photovoltaic cell and to make a precision full wave rectifier for wind speed and pressure measurement. The LVDT of the barometric pressure sensor is excited from the signal conditioner module NE5521.

The data acquisition board ADR2010 communicates via a standard RS232 port using a simple three-wire interface. The only signals used are received data (RC), transmitted data (TX) and ground (GND). We have 8 analog inputs, with 12-bits resolution, on the ADR2010 labeled AN0 to AN7. The analog input range is 0-5 VDC , 0-10VDC, +/- 5VDC, or +/- 10VDC. The input range is automatically selected by the command used to read a specific port. The PWM modules on the ADR2010 boards can operate at three fixed output frequencies. There is one, eight bit

command sent to the ADR2010 is a responsive command, that is, one that results in data being sent back to the host, the data is retrieved using the "serial read" command(Fig.3.c).

We use LabVIEW software for communicating with ADR2010 DAQB, processing the information provided by the sensors and to publish it to the Internet and school TV network. As program example we can find the Temperature VI.
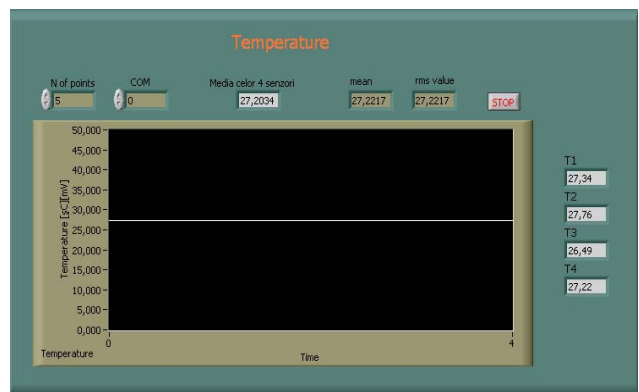


Fig. 3.-.Front panel and Diagram of Temperature VI.

The program of the Temperature Virtual Instrument communicates with the data acquisition system and picks samples from the sensors. The step by step program is:

1. Serial port configuration
2. Digital port configuration (ADR2010) "command CPA10000000"
3. Digital port write "command SPA0xxx0000"
4. Analog port read(AN0) "command RD0"
5. Convert read value(val_tensAN0) to grdC

$$grdC = \frac{val\_tensAN0}{4096} \cdot 5V \cdot 100 . \qquad (1)$$

6. The temperature mean value.

## IV. CONCLUSIONS

In this work a meteorological station using a data acquisition board with data transfer by serial port RS232 and the associated virtual instruments included into LabVIEW software was present it. The system performs good and fast measurement, processing and transmission of the basic meteorological parameters. This system is very useful in the new society information to create a Virtual Laboratory for a remote teaching. That means the students will be able to perform the lab work, controlling the applications and accessing the virtual library.

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