

The VSB-01 Portable System for Monitoring Environmental Conditions

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Abstract — Static devices for environmental parameters measurements are widely encountered in practice. Considering the advantages of mobile devices for environmental parameters measurements such as: low cost, possibility to perform measurements in different areas approximately in the same time, we focus our work on the design and the implementation of such mobile device. Further development of our device (VSB-01) is also discussed in this paper.

Index Terms — airpollution, amplifier, capacitor, microphone, sensors

I. INTRODUCTION

Portable system for monitoring environmental conditions is intended to achieve a distributed network of sensors to measure relative humidity, noise, vibrations, “air pollution” and temperature at the points where the measurements were made.

This paper contains software for data collection, processing measurements, training logs and database records (protected from modification by electronic signature), display graphics and printing data. The network of sensors allows the gathering and recording of data, with accuracy on an extensive monitoring.

The sensors and the modules for the connection to the K8055 bus are supplied through USB cable.

II. DESCRIPTION OF THE SYSTEM

The K8055 kit is an interface board that has 5 digital input channels and 8 digital output channels. In addition, there are two analog inputs, two analog outputs and two output voltage PWM (Pulse Width Modulation) with 8 bits. Number of inputs / outputs can be expanded by connecting more (up to a maximum of four) parts of the PC via USB. Each part is given an identification number via two jumpers.

The integrated circuit “amplifier” ULN2803A contains eight Darlington transistors with common emitters and suppression of diodes for inductive loads. Each Darlington has a current rating of 600mA (500mA continuous) and can withstand 50V least outside the state.

The PIC18F2550 microcontroller has 28 pins, it's a high performance CMOS and it belongs to the 8-bit family PIC18FXX.

The microcontroller is an eight-storey multiple with internal and external interruptions. Both instructions are executed in one clock cycle, excluding the root which requires two clock cycles.

This bit has a total of 35 of a set of instructions used to achieve high performance.

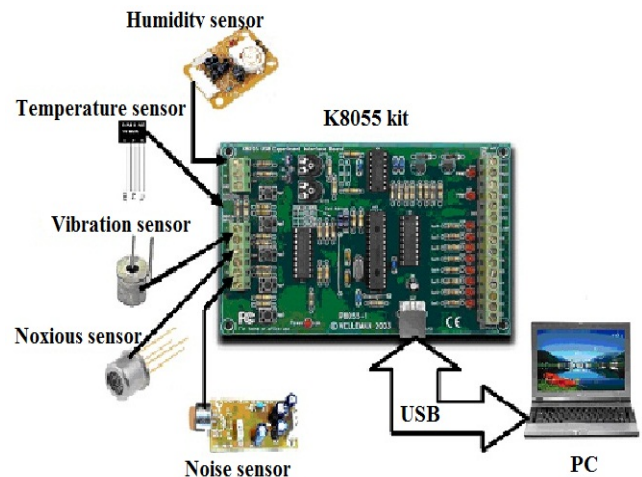


Figure 1. Overview of the data acquisition board.

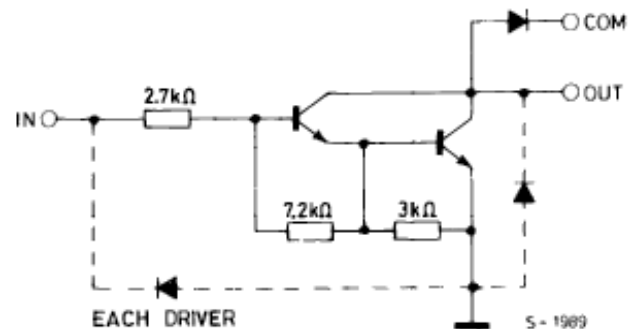


Figure 2. ULN2803A electrical diagram.

III. DEVICES FOR MEASURING ENVIRONMENTAL PARAMETERS

Sensors and transducers are typical elements of automation systems.

The choice of sensors and transducers should be done, by taking into account the property to monitor, the area in which it varies, the size or geometry to be observed, the working or environmental conditions, the type size output and not least by the cost.

A. Temperature sensor DS18B20

The DS18B20 temperature sensor operates from 9 to 12 bits. This sensor implements a communication protocol on a “1-Wire” bus, using a control signal. The control signal is kept in line by a pullup resistor that is connected to a port type 3-state or a open-collector, this being the DQ pin of the sensor. This signal is also maintained by an internal “capacitor” that is connected to the ground.

B. Humidity sensor

To monitor environmental conditions more efficiently, we used a humidity air sensor (HY-HS-220 fig. 3.2.1). Depending on the humidity in the air this sensor provides a certain voltage to output.

By reading the sensor output voltage we can determine the air humidity. The degree of humidity can be determined by analyzing a graph.



Figure 3. Humidity sensor.

C. Noise sensor

An electret "microphone" is a condenser type microphone, which eliminates the need for power supplies using a permanently charged material.

An electret is a stable dielectric material with a static electric charge permanently incorporated.

This type of microphone is made, by melting a suitable dielectric material such as plastic or wax material containing polarized molecules. Polar dielectric molecules align in the direction of the electrostatic field.

The sensor noise used in the VSB-01 portable system is presented in the following image:



Figure 4. Noise sensor.

D. Vibration sensor

Vibration "sensors" are used to detect acceleration, movement or vibration. The vibration detection sensor used is simple and effective. Everything vibrates at a frequency higher or lower. Thus, the sensor consists of a vertical and a horizontal slide.

At the production of vibration, the strip corresponding to the wave propagation direction of the vibration will resonate and make a contact with another fixed slide.



Figure 5. Vibration sensor.

E. Sensor of noxious

The semiconductor sensor contains a heating filament which brings to the operating temperature (100 ÷ 400 ° C)

the semiconductor material surrounding the ceramic tube filament.

In the presence of a reducing gas, the electrical resistance of semiconductor substance changes dramatically even for small concentrations of gas.

The gas-sensitive semiconductor material used, is tin dioxide. Other oxides are sensitive to gases such as: oxides of iron, zinc oxide, etc. and compounds oxide.



Figure 6. Noxious sensor.

IV. MPLAB PROGRAMMING ENVIRONMENT

MPLAB is a software program developed for embedded applications. It is called an integrated development environment (IDE), as it provides a single development environment for embedded codes .

The process of writing a program is often described as a development cycle. Very often the code is written, tested and then modified to obtain an application running correctly.

MPLAB IDE contains all functions needed to write software without requiring additional intervention.

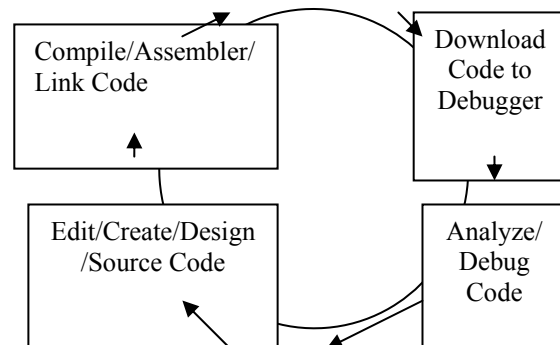


Figure 7. Write cycle.

V. DATABASE SOFTWARE SUPPORT

For storing the measured data, it has been developed a software application, in Visual Studio 2005.

Programming language used for software development is C # (C Sharp), a derivative of C++ programming language which simplifies writing programs for Windows.

Database software for recording environmental values is done in SQL Server 2005, a model relational database server product by Microsoft with these primary programming languages:

- T-SQL;
- ANSI SQL.

Protocol layer implements the external interface of SQL Server and all transactions that can be relied on Microsoft SQL Server are provided through a defined format, called Tabular Data Stream (TDS), an application used to transfer data between a server database and a client.

The software application is running in parallel with the

database server SQL Server 2005.

The database contains a single table with the following fields:

- Time;

When saving data in the database, in this field you enter the current date system.

- Locality;

It refers to the area, where the measurements are made.

- Temperature;

It is saved in the field taken from the temperature sensor.

- Noise;

The field where noise levels are saved by the sensor.

- Comfort;

The field where the noxious value taken from the sensor is saved.

- Humidity;

The value taken from the humidity sensor is saved in this field.

- Vibration;

The value taken from the vibration sensor is saved in this field.

The Strip control of status type, from the bottom of the application, will always show if the device is connected or not, and the area from which the data is saved.

The operating parameter with this device for measuring environmental parameters is simple:

- We open the database where we want to store the data, collected in the places where the measurements are taken;
- The device must be connected to the PC via USB cable, where we need to ensure that our device is connected by writing down the following message "Device connected";
- From the database it is selected the point where the measurements are made, and there we select an area to make measurements, but if we want another area, we access the "change status" button where we can introduce another area.

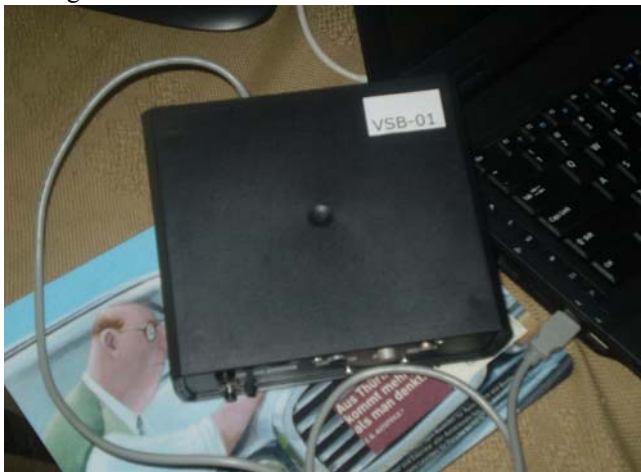


Figure 8. The VSB-01 system connected to a PC.

- After introducing the area where we want the measurements to be made, the Start button must be pressed for the measurements to start.
- After the measurements are finished, the STOP button must be pressed;
- Saving is done automatically in the database, where you can create and report the data collected at a time and in different areas.

The data collection was done in several days at different

times in several neighborhoods of the city of Suceava.

Results were collected in a database, and shown in a table for the completion of reports and charts. Such a table of reports collected in an area at different times is shown in figure 5.1.

Data report from the Burdujeni Orizont area

Date	Temp. [°C]	Noise [dB]	Noxious	Humidity[%]	Vibration[Hz]
7/7/2009 7:10:16 AM	16.60	49	30	76	0
7/7/2009 7:11:18 AM	16.18	49	420	76	0
7/7/2009 7:12:19 AM	16.00	48	385	75	0
7/7/2009 7:13:21 AM	16.18	48	361	75	0
7/7/2009 7:14:22 AM	16.25	48	340	75	0
7/8/2009 4:43:28 PM	27.25	33	124	35	0
7/8/2009 4:44:29 PM	27.18	114	533	31	0
7/8/2009 4:45:31 PM	27.18	46	499	31	12
7/8/2009 4:46:32 PM	27.12	37	476	31	0
7/8/2009 4:47:34 PM	27.56	39	461	31	0
7/9/2009 2:54:06 PM	26.75	29	22	35	16
7/9/2009 2:55:08 PM	24.75	49	323	30	0
7/9/2009 2:56:09 PM	24.62	29	317	30	0
7/9/2009 2:57:11 PM	25.81	45	313	32	0
7/9/2009 2:58:12 PM	25.25	75	311	33	22
Maximum	27.56	114.00	533.00	76.00	22.00
Media	22.98	49.20	327.67	46.40	3.33
Minimum	16.00	29.00	22.00	30.00	0.00

Figure 9. Example of a field data report.

VI. CONCLUSIONS

The VSB-01 is a system of great importance in everyday life, because it can provide comfort to anyone who wants to live a decent life.

This paper is designed using digital signal processing techniques, given that we used a DS18B20 temperature sensor which is a digital sensor, an air humidity sensor HY-HS-220, a AD-019 sound sensor, a CM4400-1 vibration sensor and a sensor of noxious CZGCO which are connected to a K8055 data acquisition board.

Also, it can be developed using analog signal processing techniques, for this purpose using a microcontroller which contains an analog-digital converter, such as the PIC16F87 and PIC16C71.

The data is measured in real time and transmitted via USB to a computer system and then stored in a database for processing.

The VSB-01 is a system with a very good appreciation from the Environmental Protection Agency Suceava, where the device was calibrated by standards and rules imposed by SR ISO 8756:1996 and ISO 9169:2007 for the determining of the environmental conditions, standards after which the appliances from the agency are calibrated. Measurements were made in all of Suceava neighborhoods, and we present some histograms of some of them in figure 6.1 and figure 6.2.

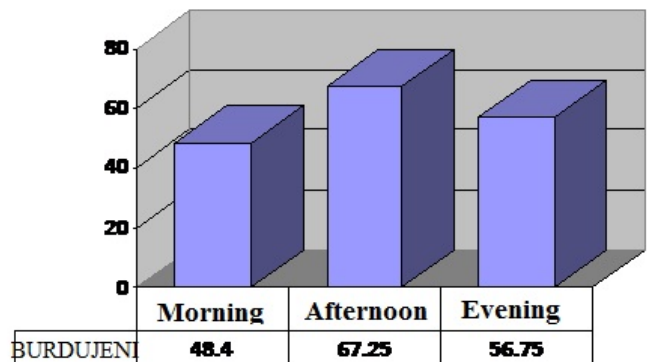


Figure 10. Noise measurements in Suceava.

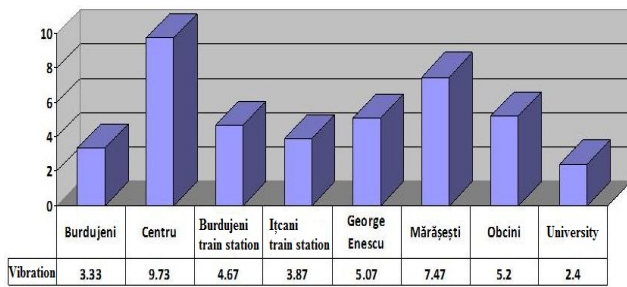


Figure 11. Vibration measurements in Suceava.

The VSB-01 system monitors environmental parameters after the standards set by the National Environmental Protection Agency where we had access to the S1 air quality monitoring station and the Quest 2800 sound level meter from the Environmental Protection Agency Suceava, and all the measurement date were the same as the measurements made by using the standard equipment of the Agency.

Following the verification and the sampling of the VSB-01 system, we obtained a certificate of compliance.

We believe the development directions of the system involving the environmental protection and a sustainable

development of Suceava, could be:

- adding a bluetooth module and implementing the system in bus stations, and when it comes in contact with the bluetooth module in the bus, it will transmit information about the environmental conditions, which will be shown on the display system in the bus.

- implementation of a GPS module, with which we record and monitor any geographical point, considering that the system is portable.

- it can be used as a fixed system of displaying the environmental conditions in public.

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