Hazardous Events Monitoring System in a Hospital

Radu ȚIGĂNESCUL-AMARIȚII
Stefan cel Mare University of Suceava
str.Universitatii nr.13, RO-720229 Suceava
rtiganescul@stud.usv.ro

Abstract — **The proposed assignment implies the building of an automated system to monitor a hospital (ASMH), the protection of its patients and its personnel against unwanted events, such as: flooding, gas leeks, breaking and entering, entering the hospital with forbidden objects.**

The system uses gas sensors, light sensors, smoke detectors, proximity sensors, flooding sensors and metal detection sensors installed in the points of interest. Sensors are connected to a monitoring system composed of a data acquisition board and a computer. In case of emergency a warning message will be displayed on the monitoring system and through the internet to the authorities. The message contains data about the type of sensor, its location and information about the sensor.

Index Terms — **monitoring system, automated system to monitor a hospital, ASMH, signal energy, electrical signals, sensor, transducer and transmitter**

I. INTRODUCTION

The sensor monitoring system in a hospital wants to be a cost effective system that can be implemented in a large number of hospitals, a necessary condition for the development and environmental ecology. The system contains eight types of sensors: capacitive, inductive, flooding, humidity, PIR, light, gas and smoke. These sensors will be mounted in locations of medical interest and in areas where a fire or explosion can occur. These sensors can be mounted on a mini robot capable of patrolling the corridors and measure several parameters, but the implementation cost would be too high and the reliability of the system is very low.

II. SENSORS USED IN HOME AUTOMATION

Sensors are key components for transducers which ensures the conversion of different kinds of signal energy (thermal, light, acoustic, mechanical, hydraulic, kinetic) into electrical signals. Their main applications are in robotics, measurements and automations.

In the technical literature, there is a distinction between sensor, transducer and transmitter. In this article it will be used the name sensor. A sensor with emitter has its output in current, not in voltage, standardized in the 4-20mA range. This solution applies in a industrial environment, the solution ensures immunity to noise and allows transmissions over large distances. Sensors parameters are:

- sensitivity;
- work range;
- precision;
- accuracy;
- resolution;
- offset;
- linearity error;
- response time;
- hysteresis.

Sensitivity is given by the lowest parameter of the input signal that generates a detectable output. Under the sensitivity threshold, which defines the resolution, we can not distinguish two neighboring values. Resolution is given by the smallest measurable input signal that can be detected at the output.

The work range is the difference between the minimum and maximum values of the input signal that can be measured.

The precision is given by the measurement error or the difference between the real value and the value indicated by the measurement device.

The accuracy is the maximum value of the measured error.

The offset is a different indication from zero of the sensor when its inputs are set to zero.

The linearity error indicates the measured characteristic's deviation from the theoretical one.

The hysteresis is the difference between the answer to increasing and decreasing values of the measured parameter.

The response time is the necessary time for the output signal to reach its final value, in the limits of a tolerance imposed.

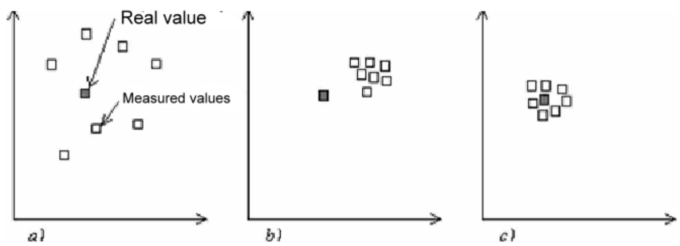

Figure 1. Illustration of precision and accuracy.

In figure 1 is illustrated the concept of precision and accuracy. In figure 1 a) is illustrated a measurement with low precision (scattered values) and low accuracy (large difference between the real value and the measured one). In figure 1 b) is illustrated a high precision measurement (grouped values) and low accuracy (large difference between the real value and the measured one). In figure 1 c) is illustrated a measurement with high precision (grouped values) and good accuracy (small difference between the real value and the measured one) [18].

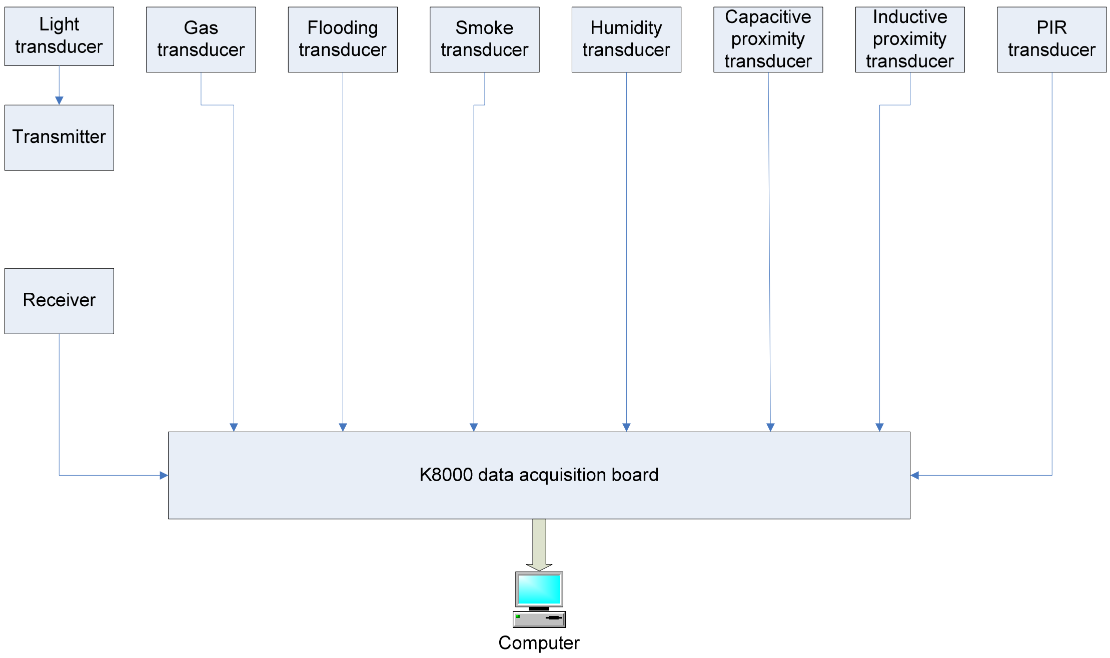

Figure 2. Hardware operation.

III. THE OPERATION OF ASMH

The sensors used in the ASMH were build to give a digital output. The sensors were connected to the digital port of a Velleman K8000 board. The interface consists of sixteen digital inputs/outputs optically isolated, eight analogical outputs, a high precision analogical output and four analogical outputs. The board includes an I^2C bus for communication with other interfaces. The board can be connected to a PC through the parallel port [9, 10]. The operation is illustrated below:

Each transducer is connected to the K8000 Velleman acquisition board. The light transducer is connected to a transmitter and the receiver is connected to K8000 acquisition board. This transducer is used to detect the presence of light in a specific room.

The gas transducer is used to detect gas leaks in the room in which it is mounted.

The flooding transducer detects water leakage in the hospital's basement.

The smoke transducer detects the presence of smoke in a saloon in which it is installed.

The humidity transducer detects whether the ambient humidity comfort is exceeded.

The capacitive proximity transducer detects the opening and closing of the door from the medicine storage room.

The inductive proximity sensor is used to detect persons with metal objects entering the hospital.

The PIR transducer notifies the presence of an unauthorized person in a room.

The Velleman board is connected to a computer through the parallel port.

The ASMH software is made in Visual Basic 6.0 [15]. Its operation is illustrated in the next diagram:

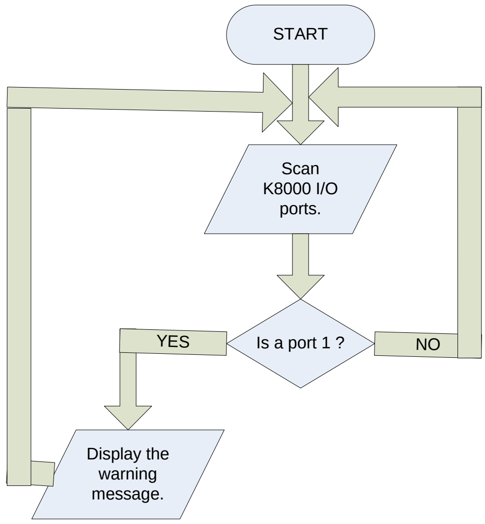

Figure 3. Software operation.

The software reads the K8000's ports and verifies whether there is a port on logical one. If there is, then it will be displayed a warning message, if there is not a logical one then the software will continue scanning the ports.

You have to copy an executable file "Server.exe" on the computer if you want to receive the warning messages and the computer must be connected to the internet in order to receive the messages. The computer's IP must be noted down because it needs to be inserted in the monitoring software in order to know to which computer to send the message. After the program is executed it waits for an event to appear. When an event appears the "Aplicatie Server" takes the info and displays the following:

- location;
- sensor type;
- sensor number.

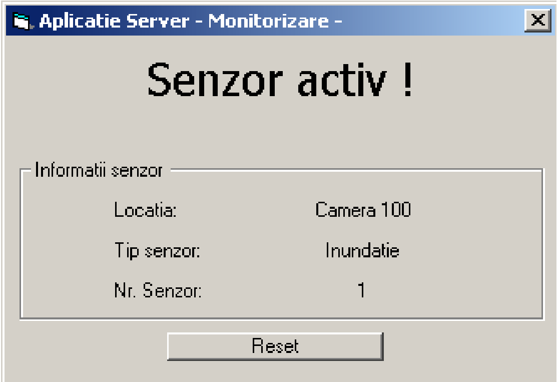

Figure 4. The interface in active mode.

On the computer where the data acquisition board K8000 is connected you must copy the directory with the monitoring software. This computer must be equipped with a parallel port and an internet connection. In order to start the application you must double click “spital.exe".

An authenticating window appears requiring a user and a password. The user is “admin" and the password is “admin".

Figure 5. Authenticating window.

After inputting the user name and the password, a new window will appear asking for the IP and port address of the computer to which the warning massage will be sent.

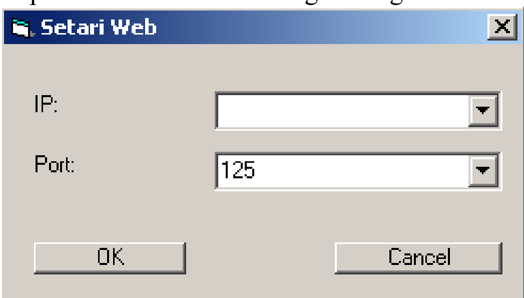

Figure 6. The window for entering the IP address and port.

After clicking OK the sensor monitoring application will start.

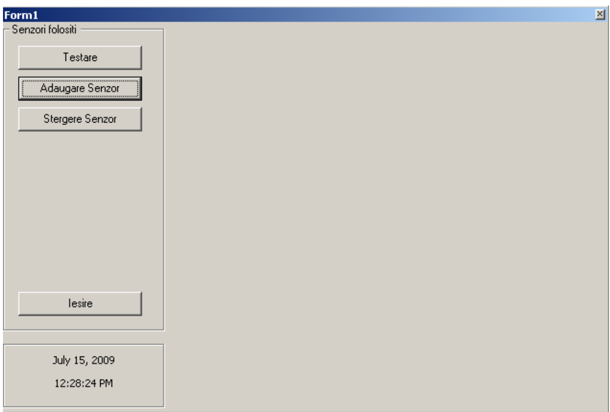

Figure 7. Menu window.

In this window can be chosen the testing mode, where the sensors are monitored. The information about the sensors is taken from a database created in Microsoft Office Access 2003. The database contains data about the sensor type, the port to which it is connected, special observations, the date and time when a sensor is triggered.

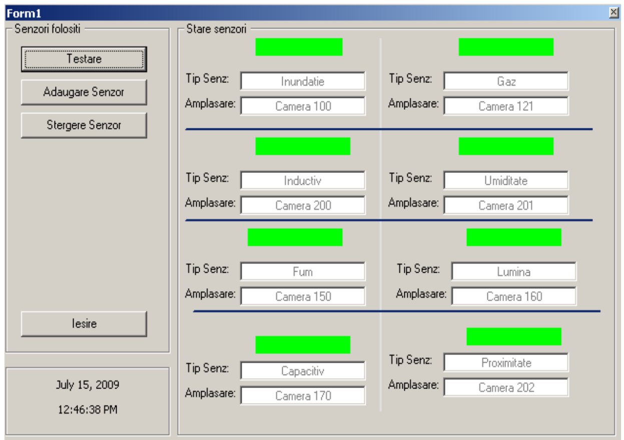

Figure 8. Sensor monitoring window.

To add sensors a click must be given on “Adaugare senzor" button. In the window are the following options:

- sensor type;
- port number;
- location;
- observations.

The sensor type and port number are read from the database.

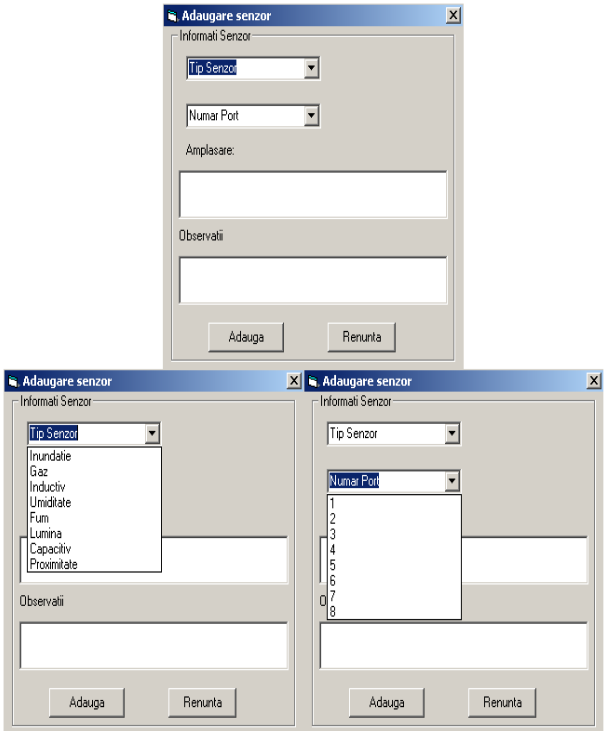

Figure 9. Sensor adding window.

In order to remove a sensor from the sensor monitoring window a click is necessary on “Stergere senzor" button. When the “Eliminare senzor" window appears you must click “Sterge" button.

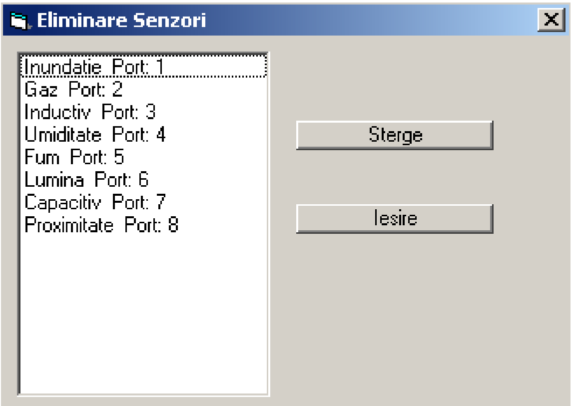

Figure 10. Sensor removing window.

When the “Sterge" button is pressed, the sensor is deleted from the database.

When an event appears a warning message is displayed.

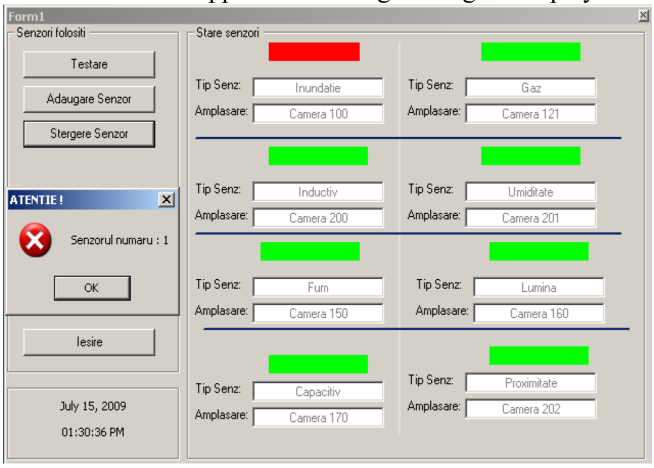

Figure 11. Warning window.

IV. CONCLUSIONS

The system is a cheaper alternative to commercial systems to hospital security. Its quality/cost ratio is very good and allows the Romanian hospital system to align itself to European standards.

ASMH system monitors eight sensors placed in medical important areas. The system can be upgraded by replacing the computer and the Velleman K8000 board with a PLC. This upgrade can increase the system’s reliability and energy costs can be cut down. Future research will focus on replacing the PC with a PLC in order to minimize the system’s costs and to enhance its reliability.

REFERENCES

[1] Alexandru, N.D, Graur, A., "Domotică", Mediamira, Cluj Napoca, 2005

[2] I.C. Paschalidis, W. Lai, X. Song/Optimized Scheduled Multiple Access for Wireless Sensor Network- IEEE Transactions on Automatic Control, Volume 54, Number 11, November 2009

[3] Aplicatii in Visual Basic / Bogdan Patrut. - Bucuresti : Teora, 2002, ISBN 973-601-981-0

[4] www.hwsensor.com/English/PDF/sensor /MC%20series%20specifications-ANWEI%20.pdf

[5] http://www.hwsensor.com/English/products/sensor/Catalytic.htm

[6] http://www.scientia.ro/tehnologie/39-cum-functioneaza-lucrurile/55-detectorul-de-fum.html

[7] http://pdb.turck.de/media/_ro/Anlagen/Datei_EDB/edb_2502126_ron_ro.pdf

[8] http://pdb.turck.de/media/_ro/Anlagen/Datei_EDB/edb_4618510_ron_ro.pdf

[9] Amplificatoare de radiofrecventa de putere / Mihai Albulet. - Bucuresti : Matrix Rom, 1996. - ISBN 973-97494-5-3

[10] www.velleman.be/downloads/0/illustrated /illustrated_assembly_manual k8059_rev1.pdf

[11] Efecte biologice ale radiatiilor electromagnetice de radiofrecventa si microunde / Mihail Zamfirescu, Ion Rusu, Gheorghe Sajin ... [et al.]. - Bucuresti : Editura Medicala, 2000.-ISBN 973-39-0426-0

[12] Senzori : Prezent si perspectiva / Dumitru Stanciu. - Bucuresti : Editura Tehnica, 1987.

[13] Senzori si traductoare / Petru Todos si Carmen Golovanov. - Chisinau : Editura "Tehnica" a U.T.M., 1998

[14] Totul despre Hardware / Winn L. Rosch ; trad. de Florin Moraru şi Cristian Mocanu. - Ed. a 2-a. - Bucuresti : Teora, 2001.

[15] Calculatoare numerice. Hardware : structura si proiectare / Fredrick J. Hill si Gerald Peterson. - Bucuresti : Editura Tehnica, 1980.

[16] Programarea aplicatiilor Windows in Visual Basic / Elena Cristina Turcu. - Suceava : Editura Universitatii din Suceava, 2002. ISBN 973-8293-43-X