Proceedings of the 17th International Conference on Manufacturing Systems – ICMaS
ISSN 1842-3183
University POLITEHNICA of Bucharest, Machine and Manufacturing Systems Department
Bucharest, Romania

WEB-BASED INFORMATION-CONTROLLING SYSTEM

Aldeniz RASHIDOV

Abstract: *This paper proposes Web-based information-controlling system, which make possible collecting, processing and analyze of data by the industrial end-devices located in the global Internet. It ensures monitoring, adjustment, configuration and control of the devices through the Internet. The system integrates the advantages of a Web, the information systems, as well a controlling of end-devices. It reports some unexpected and unwanted changes in a room, using different kind of sensors. As well as responds to some critical or failure situations, which occurred in the communication network, planning the necessary actions. The network structure, which allows a control on end-devices in a room from places located away, is suggested. The controlling of a part of them is in a direct dependence with the reported data. A database model of the system and simplified and protected from an illegal access user's interface, are proposed. It ensures the possibility the reported from the end-devices results to be analyzed from a remote station As well it sends requests for adjustment, configuration and control of the devices. The solution proposed can be used in the implementation of various industrial applications.*

Key words: *data acquisition, data fusion, web-based systems, information systems, control systems.*

1. INTRODUCTION

Collecting data from different end-devices, their further processing and analyzing in order to monitor and take decisions, has an important role in the systems for automated control with a net communication (SACNC). The link between the sub-systems of SACNC is realized via an industrial communication net. It is a fact that Ethernet specification has recently begun coming on a mass scale into the industrial nets.

A prerequisite for that is the large spreading of the Ethernet products, the decisions for technical and program security, the possibility for complete elimination of collisions and the simultaneous support of the 10/100/1000 Mb/s devices. As a result of this, there is increase in the use of such end-devices which are connected to the Ethernet. The end-devices in SACNC that support the communication interfaces RS-232 and RS-485 use converters and other specialized controllers for access to Ethernet. The variety of logical controllers (PLC) which can be programmed, sensors, executive mechanisms, modules for distant I/O, as well as communication interfaces and the necessity for the controlling and monitoring to be completed by distant junctions (operative, controlling computer stations and so on) connected with the industrial nets and systems are a prerequisite for projection and realization of Web-based information-controlling systems for collecting, processing and analyzing data. The more successful integration of the information systems into the Web gives the opportunity of the users to search and process data, as well as to store the data in these systems by remote work stations. These functions for collecting, processing and exchange of data, and also the procedures for controlling and monitoring of different production processes directly via a Web-browser make the Web-based information-controlling systems the most favorite among the services offered by Internet.

The present work aims to present a Web-based information-controlling system for collecting, processing and analyzing data from end-devices in global Internet. At the same time it presents the monitoring, adjustment, configuration and controlling the devices through the Internet.

2. ARCHITECTURE OF THE COMMUNICATION NET

The building of a suitable structure of the communication net (Fig. 1) is a base for the building of an automated control system. In view of the tasks, which the system should solve, the centralized processing of the data is very appropriate. That requires including a personal computer (DB Server), which would complete the role of a base station (BS). By a net connector (Router) and a Web-server access to the BS through the global Internet is ensured. In this way the remote and authorized stations can observe and control the devices through the Internet. The presented structure contains three kinds of specialized modules produced by TOPSCCC PRODUCTS CO, LTD. One of them (EX9188E2D) [2] has controlling functions and it is designed to control subordinate-slave modules (SM), by its own built-in mechanism and commands sent through the Ethernet. Each controlling module (CM) allows a connection with the 256 SM by the communication interface RS-485. Two types of SM are used – respectively with 8-analogous inputs (EX9017) [3] and 4-digital inputs / outputs (EX9065D) [4]. Each SM in the net has its identification number ID. Some temperature, humidity, sound and movement in room registration sensors are linked to the analogous inputs of EX9017.

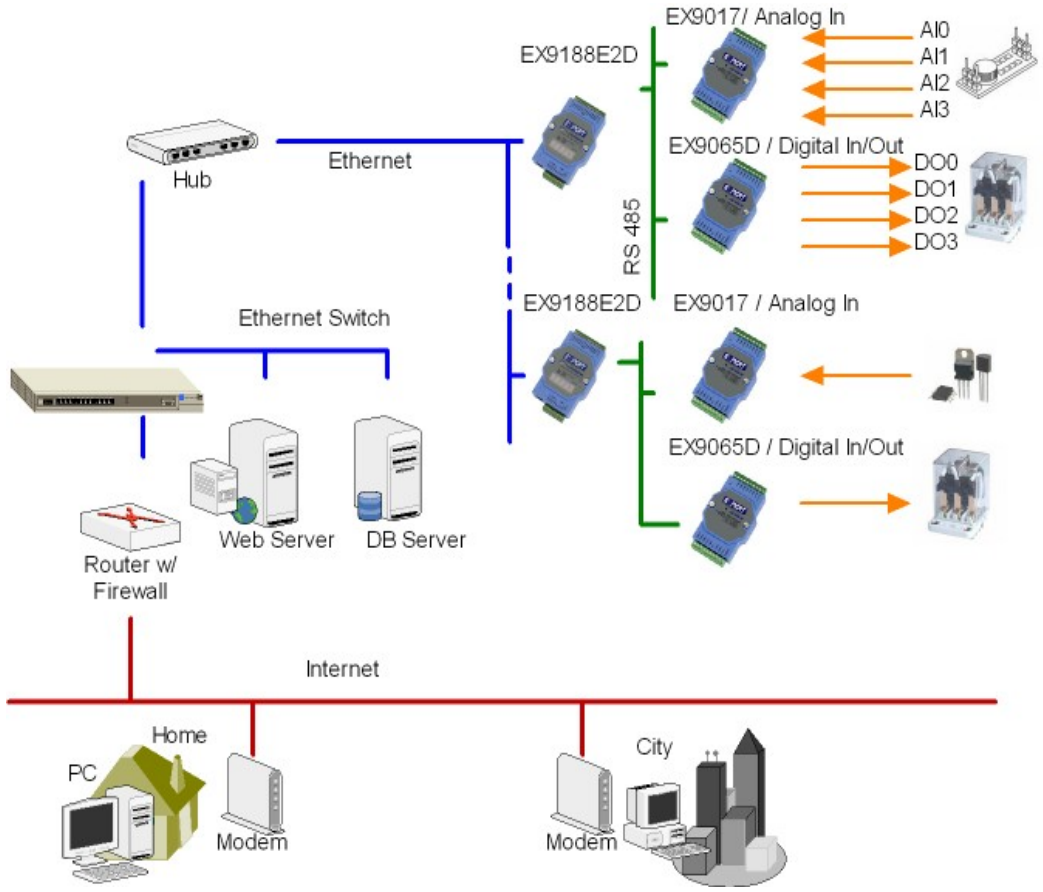

Fig. 1. Architecture of the communication network.

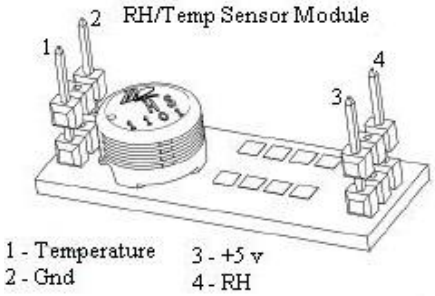

Fig. 2. Temperature and humidity sensor (HTM1735).

These various sensors make possible the registration of expected and unwanted changes in the room. Monitoring, analyzing and processing of the data measured by the sensors allow the devices linked to the digital outputs of EX9065D to be controlled. Relays, which turn on and off different devices in the room, are connected to them. The measuring of the temperature and the humidity in the offered structure are done at the analogous inputs A10 and A11 of EX9017 by HTM1735 (Fig. 2) of Humirel [5].

A device, which principle scheme [6] is shown on figure 3 does the reading of the sound level at input A12. The sensor Hygrosens PIR-STD-N4H [7] reads movements. It sends the signals by input A13. Some relays - type RAS5-10-A a production of Sun Hold Electric Inc [8] are connected to the digital outputs DO1-DO4 of EX9065D. Sending controlling and other kinds of signals between the controlling and slave modules is realized by the communication interface RS-485.

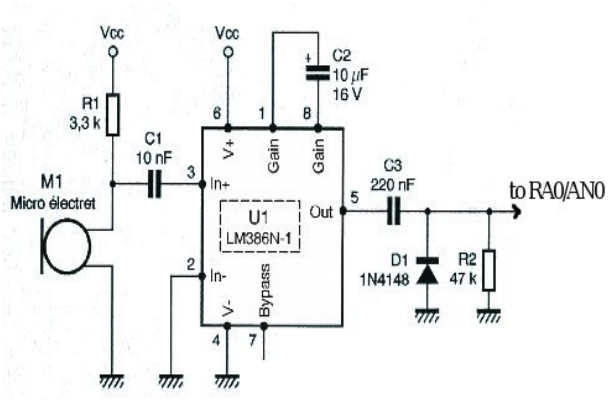

Fig. 3. Principle scheme on the sound detect sensor.

3. ARCHITECTURE OF THE SOFTWARE SUPPORT OF THE SYSTEM

The content of the software support depends directly on the tasks given to the system. The collection and processing of the data requires a database (DB) to be chosen. A relational DB of Microsoft SQL Server is appropriate for that purpose. The scheme of the data-flow and the block-scheme of the software support architecture of the system are shown respectively in Figs. 4 and 5.

The choice of a corporative DB is connected to the necessity for reliability, safety and the completing of time and event-planned tasks (Job Tasks), which relieve the rest of the software support at maximum.

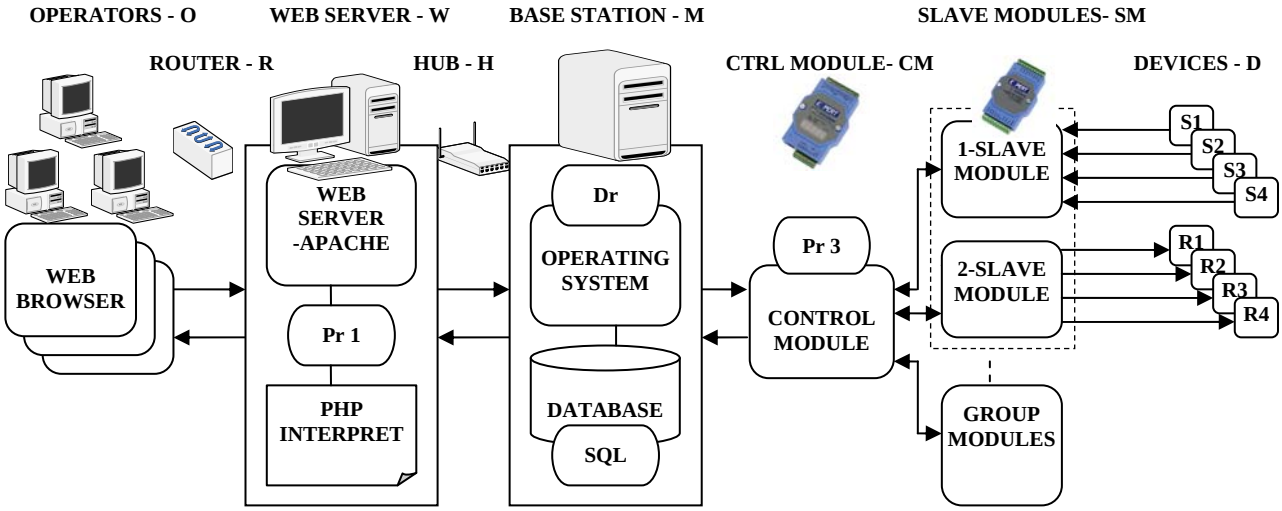

Fig. 4. Scheme of the data flow.

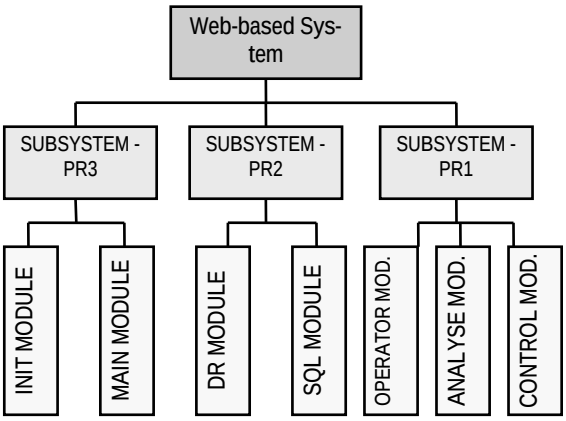

Fig. 5. Block scheme of the architecture of the software support.

The specialized software support (Pr3), which is in the EX9188E2D consists of three main program modules (PM). It has the task to complete some configurative (module Init), diagnostic, controlling and other functions (module Main), which are sent by the BS. Besides, it assures storing and resending of the converted data, coming from the SM. SM complete commands given by the CM, converting the analogous signals, which the sensors have measured by the inputs A10, A11, A12, A13, A14 in digital data and then send them via the communication environment (circle). Software-support (Pr2), included in the BS, is of special importance. A part of it (module Dr) sends commands and data exchange between EX9188E2D and it is synchronized with the control part and the software support of the CM. The DB of MS SQL Server gives the opportunity for Dr to be required by a request, written in SQL (module SQL). The request code is a function with I/O parameters and it is stored in DB and does the time and event-planning. The requests for remote monitoring and controlling by remote stations (O) through the global Internet include a choice of a Web–server (W). It allows the completion of dynamic Web-pages (Pr1) by authorized users that own some regulated access rights.

The dynamic Web-pages, written in Web-oriented program language – PHP make possible the completion of a large number of system and other kinds of functions, including ones which realize a DB access and meeting requests in the DB of MS SQL Server. Moreover, they allow monitoring the data measured by the sensors (module Operator), analyzing the data (module Analyze), diagnostics, configuration and control of end-devices (module Control).

The sequence of the activities in processing a request with commands to an end-device, sent by a remote station, consists of the following steps:

- A remote station sends a request for execution of a PM, to which the input parameters have been given. The request is given by a Web-browser.
- The Web-server finds out the code of the PM and sends it to the of PHP interpreter for processing and completing. The interpreter is a part of the Apache Web-server after it has been initialized as its module;
- The PM is processed by the interpreter. If the PM contains operations connected to the realization of a link to the DB, searching and processing data in it, the interpreter realizes a contact to the DB and sends SQL-requests, individually;
- The requests of SQL are received, stored and processed by the DB server in the BS. If in them there is an operation for a link to the CM, the BS calls a driver and at the same time it sends the input parameters to it. The driver sends commands to the CM, one by one. Meanwhile the BS identifies the SM to which each following command is connected. In case the CM is busy the request of SQL is defined as received and waiting to be completed.
- The CM receives commands from a BS. It recognizes the end-device to which each following command is connected. In case of a request to collect data from a temperature sensor, the PM "Main" in the CM sends commands to the SM. They are connected with a definite terminal (lead). When the commands are completed, the result and the states of execution are reported back to the CM.
- The driver, which completes a contact to the CM, accepts the result data and sends them to the DB Server. In this way the result data are stored, ready to answer the needs of the PM or for a following processing or analy-

sis. The SQL request sent to the DB is defined as a processed one;

- The interpreter finishes the completion of the PM, which usually includes a synthesizing and formatting the results in a code which would be easily interpreted by the Web-browser;
- The Web-server sends the code to the browser and the user receives the result or information about the condition of execution of the request by commands to an end-device. In case the sent request has been definite as a received and waiting for execution, the remote station is in a standby mode waiting for a result.

3.1. Projection of the system database

- One of the most complicated and important tasks concerning the building process of an information system [9-12] is the projection of the DB. The DB has the task to ensure the possibility for a speedy searching and processing the data stored in it. In addition it has the task to take up to the highest degree some of the functions and the procedures of the end-program applications completing DB access, which task is as important as the previous one. Because of that, the building of the model of a DB is a fundamental moment for the realization of the system. Figure 5 presents a model including the following main massives (tables):
- QUERIES – it stores the requests coming from the remote stations with commands to the end-devices. Depending on the content of a definite request, the results measured by the devices (did) are stored. These are data (userid) which identify the user by his unique net (IP) address, data (moment) about the registration of the current moment of accepting the request and about storing the request (zaiavka). The work conditions concerning the request are identified by a filed (izpylneno), giving information whether the request has been processed or has only been accepted, waiting to be processed. There are fields, which register the processing moment (zaiavka_data) and the moment when a station confirms the successful processing of the request (pregled_data).
- CONTROL – stores data during the realization of a request packet to the CM. They report the condition of completing and processing. The data (obrabotka), marking the last processing of a packet of requests, is written, as well as a field (krai), showing that the processing of requests has started.
- USERS – stores identifying data which are necessary for the system;
- DEV_TYPES –contains data about end-devices, type (dev_type, dev_type_name), which are used in the net (temperature, humidity, sound detection and movement sensors, a relay, a controlling and slave modules);
- ROOMS – contains data about the location (room_location) of the rooms (roomid), with switched on end-devices;

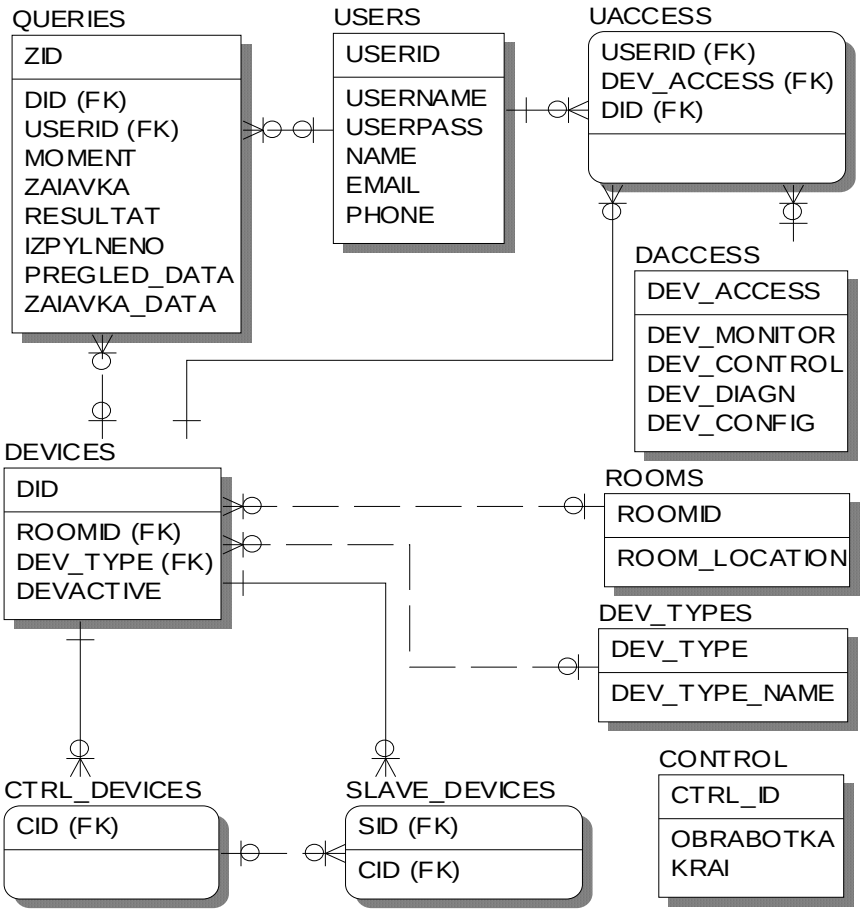

Fig. 5. Database model.

- DEVICES –stores data about the devices (did), their location (roomid) and their type (dev_type), as well as data about their use condition (devactive);
- DACCESS – stores different combinations of methods of access to the devices. There are methods for access for monitoring (dev_monitor), control (dev_control), diagnostics (dev_diagn) and configuration (dev_config).
- UACCESS – stores the access method to the device in a remote station;
- CTRL_DEVICES – stores data about the existing CM (cid);
- SLAVE_DEVICES – contains a division of the SM (sid) in the CM (cid).

The DB contains a stored procedure (obrabotki). It completes the functions for the processing of the requests by commands coming from the remote stations to the end-devices. The procedure does that by the CM and the SM. The procedure ensures outward software support (Dr), which is a part of the system software support of Windows operating system. Dr sends commands and completes a data exchange with the CM EX9188E2D. All the requests in the line of waiting ones are processed in a packet. The requests are grouped by station, regardless of the moment of their receiving. When the processing is started, a filed (krai) is established.

That field reports that the processing of a packet of requests has been started. The procedure writes down the result or the processing conditions of each request in a result field (result) of the request, marks that the request has been completed (izpylneno) and writes down the moment of processing (zaiavka_data). The process connected with the starting and the executing of each consecutive packet of requests is done by the DB functions for completing tasks which have been planned in time and case. The configuration and the adjustment of the task depend on the number, the reaction time of the devices and the number of the remote stations.

3.2. Particularities during the asking and the completing of software support for data exchange by a control module

Collecting data from the devices, their configuration, the adjustment and the device control are realized by the software support (Dr) with the help of the CM EX9188E2D. The CM itself has its specialized software support (Pr3), which allows an autonomous control of the SM and at the same time it considerably expedites data collection and exchange. Furthermore, it includes some procedures for safety which take the control of the SM in case of critical and failure situations (for instance, critical temperature, failure in the net devices). The algorithm, which Pr3 defines during the data collection from the analogous inputs of the SM, is particularly important. The temperature, humidity and sound detecting sensors are connected to them. The opportunity for Dr to be located in a distant from the CM place in the structure is another particularity (fig.1). That means that one BS can control a number of CM located in deferent places in the net. Moreover, in accordance with the requests of the remote stations a procedure of the DB (SQL) in the BS determines to which of the CM to send the request for a further execution.

3.3. Particularities of the software support, designed for the remote stations

The software support designed for the remote stations gives the users the opportunity to receive access to the Web, sending requests for monitoring, adjustment, configuration and control over the end-devices (sensors and relays) located in the net. In that connection, the software support must have the necessary modules. Any particular station uses them according to the established access to the system. They are written in a Web-oriented program language – PHP and they have access to the DB. By an Apache Web-server or another one which is able to interpret PHP scripts, they are accessible via the global Internet. It is possible for the Web-server, in which the software support for the remote stations is stored, to be installed in the same server, together with the DB. The software support consists of three main modules:

- CONTROL – it makes possible a remote station to send requests containing commands for adjustment, configuration and control to the end-devices located in the net. These operations are limited depending on the access rights of the remote station to the system as a whole and on the method of access to a particular device.
- ANALYSE – it makes possible analyzing the data from the end-devices in order to do some further operations. These operations could be planned directly by the user or by establishing specific parameters of the system.
- OPERATOR – it gives the opportunity of a dynamic monitoring of the results of the requests sent to the module CONTROL, a monitoring realized by a remote station. It is the data collected and processed by the different sensors, the condition after a control command has been completed.

4. CONCLUSIONS

The represented Web-based information-controlling system makes possible collecting, processing and analyzing data by the end-devices located in the global Internet. It ensures monitoring, adjustment, configuration and control of the devices through the Internet. The system integrates the advantages of the Web, the information systems and the control of end-devices. In addition, the system gives the following important opportunities:

- Registers some expected but unwanted changes in a room using different kinds of sensors;
- Suggests a net structure which allows the control of end-devices in a room from remote places. The control of a part of them is closely connected with the reported data.
- Responds to some critical or failure situations, which occur in the communication network, planning the necessary actions;
- Offers a model of a DB, ensuring saving, searching and processing the data from the end-devices. That model guarantees safe and reliable processing of the requests by commands received from the remote stations and sent to the end-devices. It contains a procedure for processing a request packet, received from the remote stations. The procedure gives access to the CM located in different places on the Internet. In this way a great number of the functions and procedures of the other applications, which have access to the DB, are taken.

- Work in real time;
- Support of a simplified and protected from illegal access user's interface. It ensures the possibility for a remote station to analyze the reported results from the end-devices. Besides, it sends requests for adjustment, configuration and control of the devices. These operations are limited depending on the access rights of the remote station to the system as a whole and its access method to a particular end-device.

With the specific architecture of the connection of a Web-applications and database, database model and architecture of software support, the presented Web-based information-controlling system solves need and problems at the manufacturing systems for the controlling and monitoring processes from distant junctions (operative, controlling computer stations and so on) at Internet. Also, the presented system is used in educational process of students in a department of "Automation, information and control system" at Technical University of Gabrovo, Bulgaria. So, students have an opportunity for preparation over controlling and monitoring processes in manufacturing system from distance (Internet).

REFERENCES

[1] Giev, St., (2003). *Industrial networks for communication and control*, Technical university – Sofia, Sofia (in Bulgarian).

[2] *EX9017*, TOPSCCC PRODUCTS CO,.LTD., available at: <http://topsccc.com/product/module/ex9017.htm>

[3] *EX9065D*, TOPSCCC PRODUCTS CO,.LTD., available at: <http://topsccc.com/product/module/ex9065D.htm>

[4] *EX9188END Series Hardware & Software Manua*l, TOPSCCC PRODUCTS CO,.LTD., available at: <http://topsccc.com/download/module/9188e/9188E%20Software%20Menu.pdf>.

[5] *Humidity temperature sensors*, Humirel, available at: <http://www.humirel.com/Humidity_temperature_sensors.php>.

[6] *16F88 ADC sound sensor*, Loonaweb, 2007, available at: <http://www.sirloon.net/loonaweb/sirblog/16f88-adc-sound-sensor>.

[7] *Miniature movement alarm unit*, Hygrosens instruments, available at: <http://www.hygrosens.de/english/shop/list.html?tx_ttproducts_pi1%5BbackPID%5D=233&tx_ttproducts_pi1%5Bcat%5D=64>

[8] *RAS Series*, Sun Hold Electric Inc., available at: <http://www.sunhold.com/ras.html>.

[9] Karpova, I. (2007). *Projection relational database*, available at: <http://rema.44.ru/ resurs/study/dbprj/ dbprj.html> (in Russion language).

[10] Digo, S.M. (1995). *Projection and application database application*, Finances and statistics, (In Russian).

[11] *Database projection*, Shishedjiev, FMI, available at: <http://fman.tu-sofia.bg/download/BAZIDANNI/ Development.ppt> (in Bulgarian language).

Author:

PhD, Aldeniz RASHIDOV, Assist. Professor, Technical University of Gabrovo, Bulgaria, Automation, Information and Control Systems Department,
E-mail: aldeniz@tugab.bg