

Development of Intelligent Computer System and Database for Microclimate Monitoring and Control

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Abstract—Intelligent computer system for monitoring and control of microclimate parameters (temperature and/or relative humidity) using novel technologically modified nanostructured sensors were realized on specialized system on a chip. The local database with regular recording of information in memory was developed. Obtained data can be analyzed by two-processor sub-systems.

Keywords—intelligent system, database, microclimate monitoring, control.

I. INTRODUCTION

In the modern development of information technology the cyber-physical systems (CFS, i.e. complex platform related components for integration processes of physical and cyber worlds) are popular [1-4]. These CFSs are widely used in industrial control systems and management [5], for control and communication of components in network systems [6] wireless devices [7], security systems, navigation, intelligent buildings, power management, etc. [2-4]. Regardless of the architectural features of CFS, one of the components is intelligent sensor information and measuring components [8]. Sphere of their applications is constantly expanded. Sensors of temperature, pressure, humidity, ionizing radiation, gas pollution of the atmosphere - it is an incomplete list of sensors for their basic functionality. A special place in this list belongs temperature and humidity sensors (electronic devices to quantify the temperature and absolute/relative humidity), as monitoring and control of these parameters of the environment is an important task within using of CFS, relevance successful solution of which overemphasized.

Recent advances in related fields of science and technology have stimulated increased interest in the study of sensor elements. However, effective work of CFS is possible only if the provision of high-quality primary information. This requires a fundamentally new sensors based on modern

functional nanomaterials with new physical effects [9-14], the use of sensors arrays highly sensitive, accurate and stable measurement channels [15,16].

Significant work towards the creation of such sensor systems to control temperature, humidity, gases, pressure, light, were made known global manufacturers, including E + E Electronic, Honeywell, Sensorsoft, etc. This work is dedicated to the development of intelligent computer system (or CFS) using previously obtained technologically modified temperature, humidity and integrated temperature/humidity sensors based on functional ceramic nanomaterials [17-19] and database for microclimate monitoring and control.

II. INTELLIGENT COMPUTER SYSTEM

Hardware of computer system for monitoring and control of microclimate parameters was implemented on modern element base with modular organization working in the real time and can be used to complementation of database on environmental conditions. The microcontroller CY8C29466-24PVXI (programmed system on a chip, PSoC) contains all necessary modules and manages the work of all components.

This system can be installed both indoors and outside, it provides measurement data processing and the relative humidity and temperature [20-22]. The basic requirements applying to the system: modularity of structure to connect new sensors, functionality in automatic mode, obtaining and initial processing of measured data, transmitting of measured data to a personal computer (PC) at its request in the automatic mode, acceptance and performance of PC commands (time synchronization, power on/off system calibration sensors, etc.), creation and support of local database for a long time with automatic accumulation of new data, open architecture hardware and software to build devices and embedding of new algorithms for environmental control [20].

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Designed intelligent microprocessor system for microclimate monitoring and control contains level of sensors (humidity, temperature sensors and integrated temperature-humidity sensors, Fig. 1). Signals from sensors transform into an electrical signal and fed to the input of analog-to-digital converter (ADC). The including scheme provides harmonization of output signals from sensors in the region of ADC. In addition to ADC the read-only memory (ROM), random access memory (RAM), processor and indicator (to application in domestic purposes) are connected to the system bus. These devices are typical microprocessor system in which the work program is stored in ROM, their implementation is in the processor and the data are stored in RAM.

The additional corrective scheme for including of active sensor elements are used to more accurate and linear accordance impressions and provide of nominal parameters (voltage/current) temperature and relative humidity sensors.

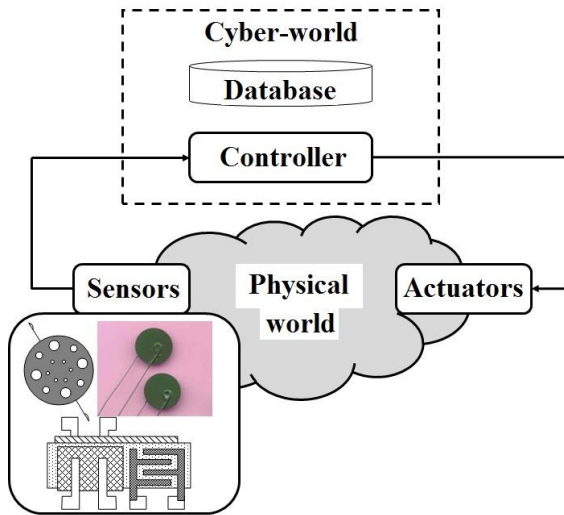


Fig. 1. Prototape of CFS for microclimate control using nanostructured sensors

Electrical principal circuit of system for monitoring and control of temperature and humidity is shown in Fig. 2. The CY8C29466-24PVXI microcontroller is used to measurement, calculation, processing and transmission of information via COM port using a level converter MAX-232. The 2x16 LCD display is applied to output of the measured values. Obtaining data from sensors is carried out with P0 [3] and P0 [5] ports and digitized by built ADC. There are micro-keys to change parameters and output of information in display.

To management of proposed system the software for microcontroller CY8C29466-24PVXI is developed using specialized PSoC Designer 5.4 program and C programming language. Analog and digital sub-systems with modules and connections implemented in PSoC Designer 5.4 as well as customized global resources are shown in Fig. 3. As was shown early in [20-22], proposed CFS can be placed indoors or outside. However, such system can be modified by adjusting their functionality by implementing a dual-system device (system or sub-system). The first sub-system can be placed inside to measure of temperature and relative humidity or integrated temperature-humidity of environment simultaneously.

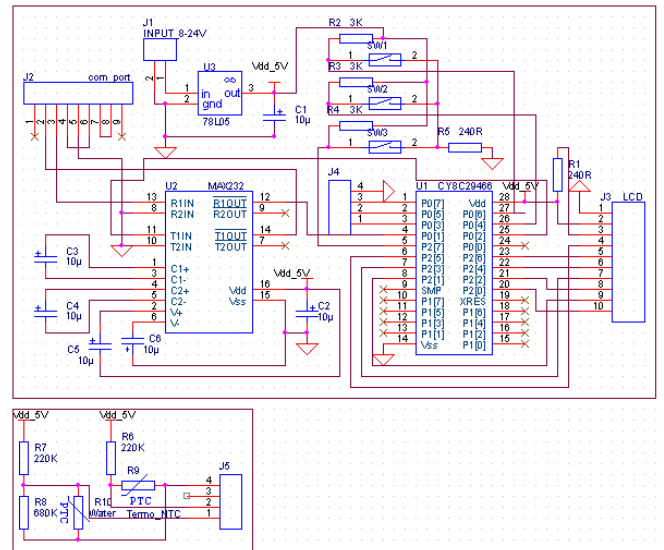


Fig. 2. Electrical principal circuit of system for monitoring and control of temperature and humidity based on PSoC

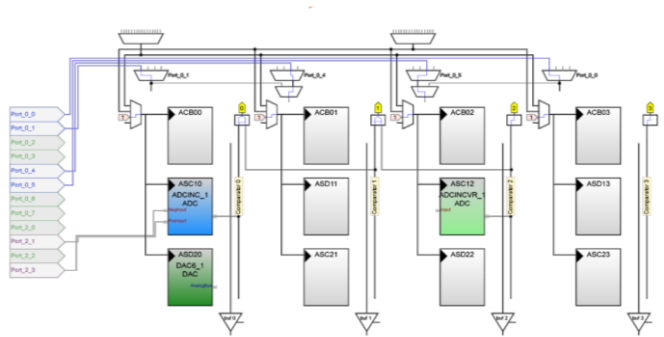
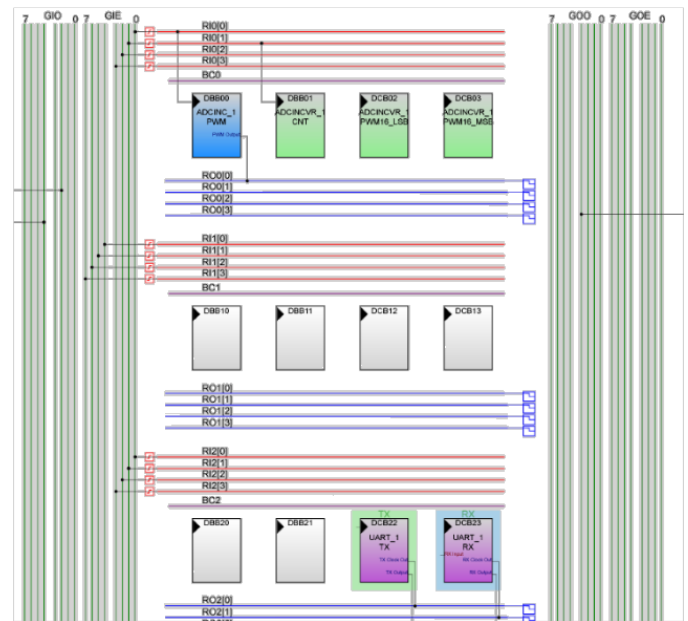


Fig. 3. Realization of modules and connections in intelligent system for microclimate monitoring and control in PSoC Designer 5.4

This sub-system is determined to save data via RX + TX433: wireless module to another module that will be placed indoors. The second sub-system will be contained nonvolatile memory for data record from the first system and displayed on the LCD. If information output from the first system, information from the second system is recorded in nonvolatile memory and conversely. Data are presented as parameters with time codes and number of systems from which these data were received. The working algorithm of system is shown in Fig. 4.

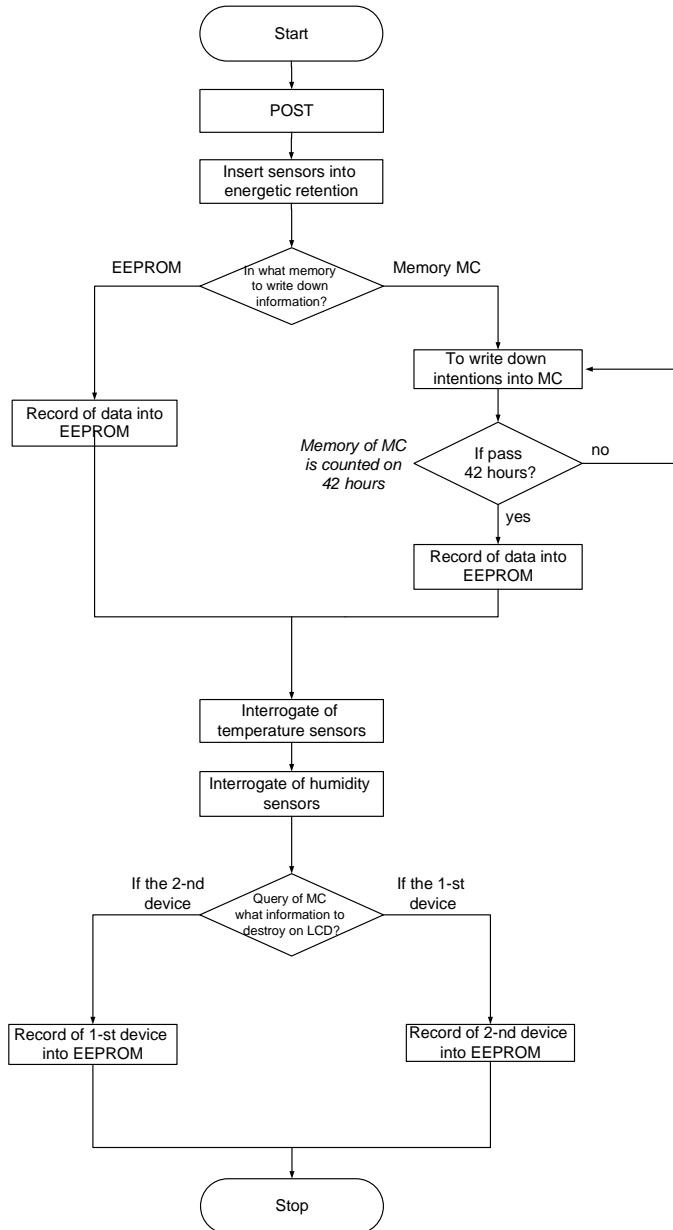


Fig. 4. Algorithm of information data treatment for computer-aided information systems

Structural diagram of systems with two sub-systems realized on PSoC is presented in Fig. 5. It also contains an interactive menu for display data from both sub-systems (placed outside and indoors).

III. DATABASE DESIGNING FOR REGISTRATION AND CONTROL OF MICROCLIMATE PARAMETERS

Software for system was created based on object-oriented language (java). Such choice will provide the necessity of work of the program on any calculable machines as well as simplification of programming process, time of implementation and increase of reliability. The system consists of hierarchy of objects. The “EnvironmentalMonitoring” class is based [20].

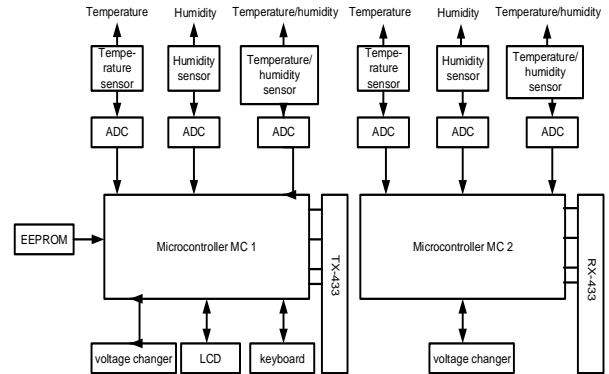


Fig. 5. Functional scheme of microprocessor information measuring system

All other classes are succeed from it that provides connection of the program with vehicles facilities for the control environments and its subsequent implementation. The main window of the program allows to begin a new session, i.e. creation of new database with fixing of time and date of its creation or connecting fact to the existent base. Each 5 minutes the program polls port and fixes the information obtained from RS-232 in database, simultaneously executing data analysis. If amount of the measured indexes exceeds the level of the set values, the system executes the intermediate interrupt and warns a user about exceeding of possible information. The system also provides fixing of exceeding information in a base. It works in a few modes: registration and control of temperature, relative humidity, as well as simultaneous registration and control of temperature and relative humidity.

In the case using of intelligent systems with sensors located in different places (complex control), the measuring modules will be able independently automatically to accumulate, partly to work over and memorize the previous information obtained from sensor. The system provides exchange of information with the central terminal intended for the centralized working and accumulation of information from all complexes. One operator can serve central terminal as well as system.

System software proposed interactive work regime with an operator. It's will allow distantly to set all parameters for measurements, change intervals between measurements as well as to get information about work of each of sensors in an user-friendly form. In the ordinary mode each complexes will be able a few times per days to give the query. Obtained information will act on a central terminal without operator. In this case, complex must compare information from sensors with thresholds and give the report on a central terminal. The basic program window allows to begin a new session and to create a new database. Information obtained from RS-232

updates up 5 min. Structural scheme of connection of transmitter and receiver with program is shown in Fig. 6.

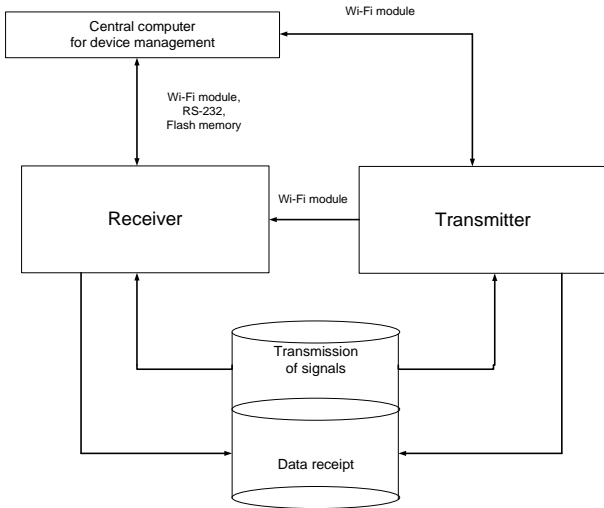


Fig. 6. Structural scheme of connection of transmitter and receiver with program

To visualization of program Visual.NET. library written in Visual Studio was used. This program consists of two windows: (1) program load window (Fig. 7) with name of the program, number of free sensors, and information whether we have access to our device, (2) the main window that displays information about connection of device to the computer, graphical dependences, etc. [20].

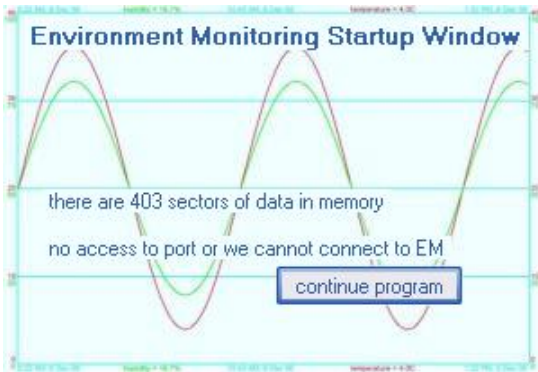


Fig. 7. Start program load window

CONCLUSIONS

Intelligent CFS for microclimate control and monitoring using novel technologically modified nanostructured humidity- and temperature sensors was designed to monitor, collect, process, transmit, store and analyze of information on the state of the environment, forecasting their changes and development of recommendations for making decisions on the prevention of negative changes state of the environment.

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