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THE USE OF LABVIEW ENVIRONMENT FOR THE BUILDING OF SUPERVISION SYSTEM CONTROLLING THE CLIMATIC AND TECHNICAL PARAMETERS IN FARM ROOMS

Marcin Buczaj, Andrzej Sumorek

Department of Computer and Electrical Engineering
Lublin University of Technology, Nadbystrzycka 38A, 20-618 Lublin
email: m.buczaj@pollub.pl; a.sumorek@pollub.pl

Summary. Nowadays, the modern farms operate like the small manufacturing facilities specialized in the production and preliminary processing of agricultural products. The compliance with precisely determined production and storage conditions in the objects and in individual rooms is required in order to achieve required qualitative indicators of the products. This article presents the control system for the principal climatic and technical parameters in selected rooms existing at the farm. LabView environment has been used for the building of such system. The acquisition of parameters was carried out basing upon the information and signals received from the sensors supporting the measuring cards. The actual as well as archived parameters occurring in individual rooms can be displayed on the computer screen via built-in interface. Thanks to this solution, the farmer has the opportunity to review of and to supervise over the autonomous control systems operating in individual rooms.

Key words: control and supervision systems, processes inspection, LabView environment.

INTRODUCTION

The modern machines as well as maintenance of precisely determined production and storage conditions for the products are the elements indispensable to improve the production effectiveness of the farm. The purpose of every room and building object at the farm is to perform different specific functions and tasks [Kuboń M. 2007]. The objects existing at the farm can be subdivided into the following groups: the buildings for livestock; utility (storage) buildings, workshops (garages) and residential buildings. All these rooms are characterized by diversified hazards to be considered as well as by the climatic and technical parameters to be maintained.

Actually the tasks to be performed by the modern electric installations installed in the farm buildings are not limited only to the reliable supply of electric energy with required parameters. The specialized systems are expected to exercise the control over the object status and to control the operation of the devices installed in this system [Buczaj M. 2009b]. Therefore the electric installations are equipped with the control systems enabling the performance of the functions and procedures intended by the user. The purpose of these systems is to perform assumed tasks associated with the operation of the lighting, heating and ventilation in the object; to perform the role of processes control systems and to enable the permanent supervision over the processes occurring in specified rooms for the user [Buczaj M. 2010, Horyński M. 2006, Petykiewicz 2001].

The first control systems for the electric equipment operation in the farm buildings made it possible to turn on and off the energy receivers by means of the switches only. Thanks to the technological progress and introduction of relay and contact systems it is possible to perform more complex functions (e.g. startup of energy receivers in cyclic mode). When the generally available sensors appeared on the market, it became possible to create the control algorithms enabling the automatic adaptation of the actuators settings on the basis of information received from the detection and measuring elements of the system. The logic functions have been introduced into the control systems after the application of digital systems. The extension of the control systems capabilities in the form of comprehensive expert systems, database systems and even in the form of systems based upon the artificial intelligence systems became possible as a result of the introduction of microprocessor techniques.

At the moment, there are several specialized systems available on the market and enabling the accomplishment of an assumed control algorithm. The disadvantage of such solution consists in their being highly autonomous. Every such system controlling the assumed and set parameters operates independently. This system is equipped with a specific interface (different for each system) to ensure the communication with the user. The systems operate in a manner supplying a large amount of detailed data concerning the process controlled for the user. Owing to the lack of compatibility, the user is unable to determine what is going on in other rooms or what is the impact of the changes of parameters occurring in one system or another.

This article presents the concept of a virtual supervision system enabling the control and monitoring of the autonomous control systems applied at a farm. Therefore it will be possible to improve the comfort of use of the systems, to increase the work safety and simultaneously to reduce the operation costs for such systems.

INTEGRATION AND INTEROPERABILITY OF CONTROL SYSTEMS

There are two principal kinds of the systems performing the control and management functions in the electric equipment applied at farms [Buczaj M. 2009a]:

- island system – the system based upon autonomous systems with one of the systems performing only precisely assigned tasks (e.g. controlling the building's heating of performing the alarm system functions only);
- integrated system – the system based upon information exchange, sharing individual systems infrastructure or upon centralized management system.

The functions of individual circuits are the same in the autonomous systems as in the integrated circuits. The requirement to be met by the heating control circuit is all the time to create desired thermal comfort in the room. The task of the alarm system elements is to generate an alarm signal in case of detected hazard for the users or for the property being protected. The difference consists in the fact that in case of an integrated system the signals origination from the input elements (detectors, sensors) are directed to the corresponding analysing and decision making system which controls the operation of individual output elements (actuators).

The system integration process is defined as the process consisting in the interoperability of individual installations included in the object and performing autonomous functions to create one system performing all functions assigned to individual parts being the components of the system.

The tasks of integrated systems consist in multiple functions control and in the actuators control in the building. The following circuits are particularly important:

– lighting control,
– heating control,
– ventilation and air – conditioning heating,
– equipment operation control and technological process control [Buczaj M., Buczaj A. 2009, Horyński M., Pietrzyk W. 2010],
– alarm system operation control (burglary and hold-up, fire alarm, access control system) [PN-EN 50131, PN-EN 50133, PN-EN 50136, Buczaj M. 2010, Buczaj M., Sumorek A. 2010].

The integration of the autonomous systems can be performed in the following manner [Buczaj 2009a]:

– through information exchange between the autonomous systems (Fig. 1),
– through the sharing of detection and decision making elements by the systems (Fig. 2),
– through the performance of the functions assigned to individual systems by the same control system (Fig. 3).

The integration of the systems through information exchange is the simplest manner of interoperability between the autonomous systems. All systems operate in an autonomous manner but they exchange the information about the statuses of determined inputs and outputs. In this case each autonomous system knows the statuses in determined points of the system is able to adapt its operation algorithm to determined conditions.

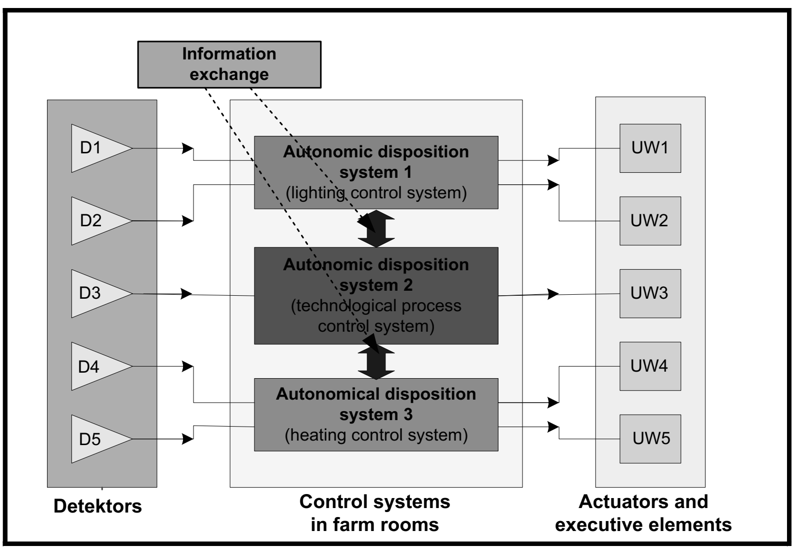

Fig. 1. The integration of the systems through information exchange

The integration of the systems through the sharing of detection and decision making elements consists in the connection of the elements constituting the common part between the systems to the central parts managing the operation of individual circuits. Such solution improves the ergonomic features of the system use, enables its better configuration and reduction of the installation costs owing to the elimination of redundant elements performing the same function but interoperating with only one autonomous system (e.g. with I&HAS system only). However, the power supply for shared elements (particularly detectors) and the hierarchy of commands supplied from the controllers (important in case of actuators) should be well considered.

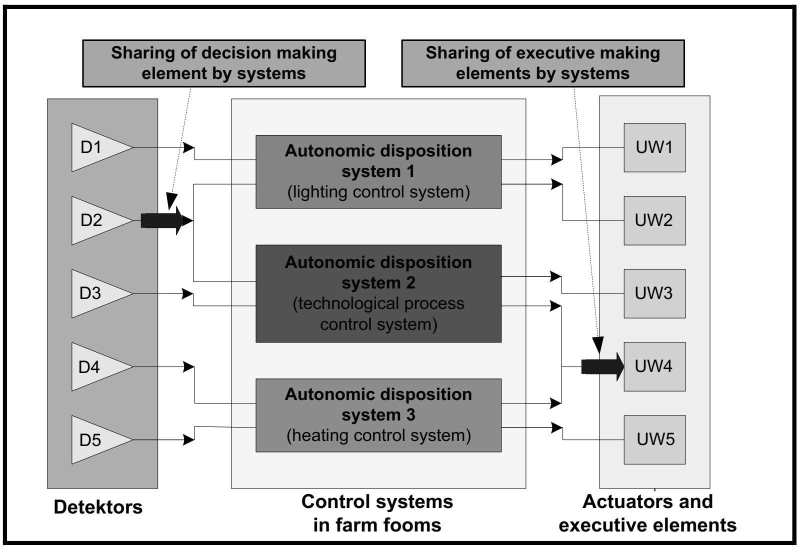

Fig. 2. The integration of the systems through the sharing of infrastructure elements

All problems associated with the autonomous systems disappear in case of the use of one system to control the operation of the whole system. All elements are connected to single controller. Thanks to such solution, there is only one supervising system having the access to all data originating from the detection elements and performing assumed functions in accordance with the operation status (mode) established by the user. The system is characterized by the lack of redundant procedures or by the shortest time of reaction to recorded events. Such solution creates much more opportunities in the building of the system operation control algorithm but it is usually associated with the necessity to know the programming languages or to cooperate with specialized service.

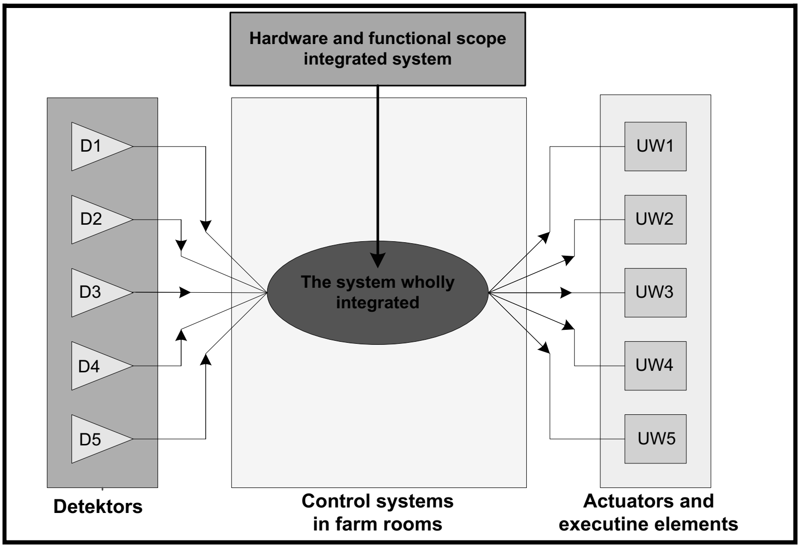

Fig. 3. The system wholly integrated in hardware and functional scope

Nowadays there are many kinds of systems enabling the performance of the function of the equipment operation automatic control systems. The most popular are the three basis groups of systems dedicated for the applications in the residential and other farm buildings [Antoniewicz B. i in. 1998, Brock S. i in. 2000, Buczaj M. Kowalik P. 2008, Horyński M. 2008, Horyński M., Pietrzyk W. 2008, Kasprzyk J. 2006]:

- the systems based upon EIB bus – applied in new installations and those mainly applied for the checking and control of climatic and lighting parameters,
- the systems based upon PLC controllers – used in case of adaptation of existing installation to the tasks of an integrated system and mainly used for the checking and control of process parameters occurring in the production processes,
- the systems based upon microprocessor built-in systems – applied in the control systems for individual machines and devices.

FUNCTIONAL ASSUMPTIONS FOR VIRTUAL SUPERVISION SYSTEM

The principal task to be performed by the virtual system under construction for the supervision over the status of infrastructure and conditions in the rooms existing in the farms is to enable the complex control of the climatic and technological process parameters exercised by the user. This task will be performed through the acquisition of measurement data collected by the supervision system from individual detection elements located in the rooms (climatic parameters) or directly in individual machines (technical parameters). Therefore the use of the model of an integrated system shared by the basic control system and by the supervising system for the same infrastructure elements will be the best solution to perform this task. Such solution will make it possible to limit the costs associated with the use of an additional system (checking supervision system). This system will be additionally characterized by identical signals transmitted to the control and supervision system enabling the correct evaluation of the situation existing in individual objects or rooms.

An additional function of the virtual supervision system additionally increasing the functionality of such system consists in the potential acquisition of measurement data and their archiving as well as the possibility to apply the mathematical models and calculation algorithms in order to determine an optimal work schedule for individual devices. It is possible to provide the program with an additional panel enabling the transmission of information about the necessity to perform planned inspections of the devices with the specification of the parts required for this purpose. The advantage of such system over a standard solution (independent autonomous systems) consists in the fact that all necessary data will be displayed and available for the user at the same location on the computer screen in order to enable more complete control over production processes occurring in the farm.

The organizational diagram of the virtual supervision system is illustrated in Fig. 4.

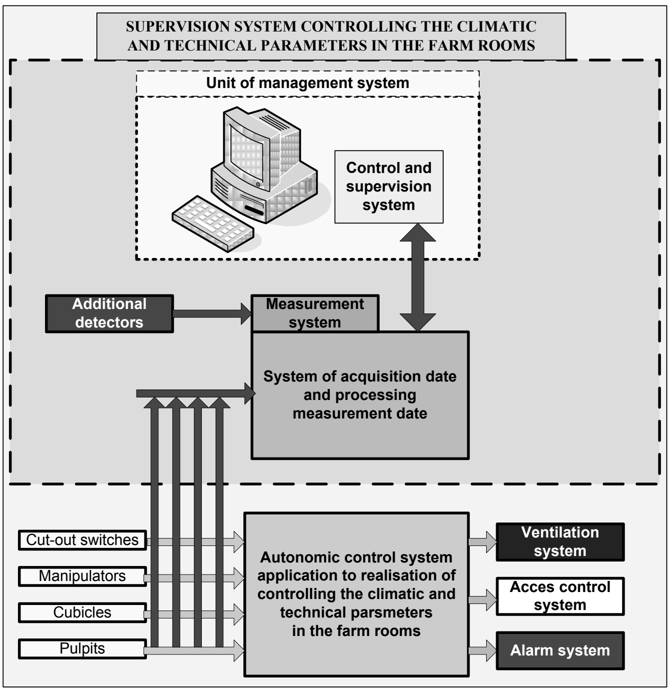

Fig. 4. The organizational block diagram of the system

The virtual supervision system controlling the climatic and technical parameters in the farm rooms consists of the following essential elements (Fig. 5):

– management unit – computer used for the system operation,
– existing control programs – designated autonomous systems supporting and performing the program determined by the system user (controllers, supplying and control systems etc.),
– detection elements – climatic and technical parameters sensors installed in sensitive points situated in the rooms being supervised and determining actual parameters in an area,
– actuators – the elements used in order to change the climatic and technical parameters in the rooms being controlled (e.g. motors, heaters, fans) as well as the systems informing about detected hazard or emergency comdition,

– intermediate elements participating in the data exchange between autonomous control systems and virtual supervision system – measuring cards used for data acquisition by the virtual supervision system.

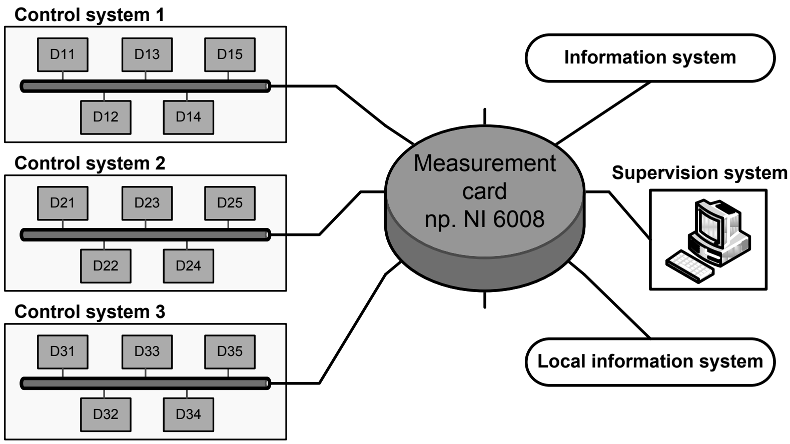

Fig. 5. Topology of the supervision system controllling the climatic and technological parameters in the farm rooms, D – detectors

VIRTUAL SUPERVISION SYSTEM CONTROLLLING THE CLIMATIC AND TECHNOLOGICAL PARAMETERS

The virtual supervision system controllling the climatic and technological parameters has been created on the basis of programmable LabView environment. LabView programming environment makes it possible to perform the complex functions in the processes encompassing the acquisition and archiving as well as measuring data processing and analysis. Therefore it is possible to freely create the program structures in measuring and simulation systems which are useful in scientific and research projects but also to create the applications enabling the building of modern control systems supervising the technological processes. This environment is characterized by great capabilities associated with the support of technological processes in the scope of measurements and control as well as with the individual approach to the creation of the systems served by many users [Nawrocki W. 2006, Tłaczała W. 2002].

Depending on their authorizations, the system access rights of individual users can be different. Therefore the system is stable and resistant to the activity of unauthorized persons. An additional advantage of applications created in LabView program consists in their individuality. It is possible to use certain schemes and to provide the programs with individual solutions. Therefore it is possible to adapt the application to sometimes dynamically varying situation in the farm (e.g. change of technology, change of production profile).

The system operation management and control application consists of the following elements:

– interface of the user (Fig. 6) – enabling (in accordance with authorizations) the system operation control, configuration change or the system operation checking,
– organizational diagram – internal relation between individual elements of application enabling the performance of tasks assigned by the user in the control panel (Fig. 7),

– I/O support (input and output devices support) – the system component responsible for data acquisition from the system detection elements and for the transmission of information to the devices ensuring the actuators operation control or to the system users (Fig. 8).

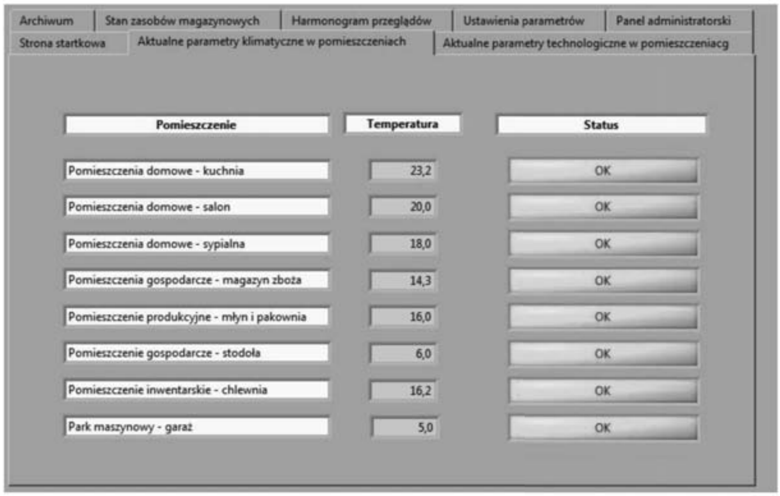

Fig. 6. User.s interface of the system

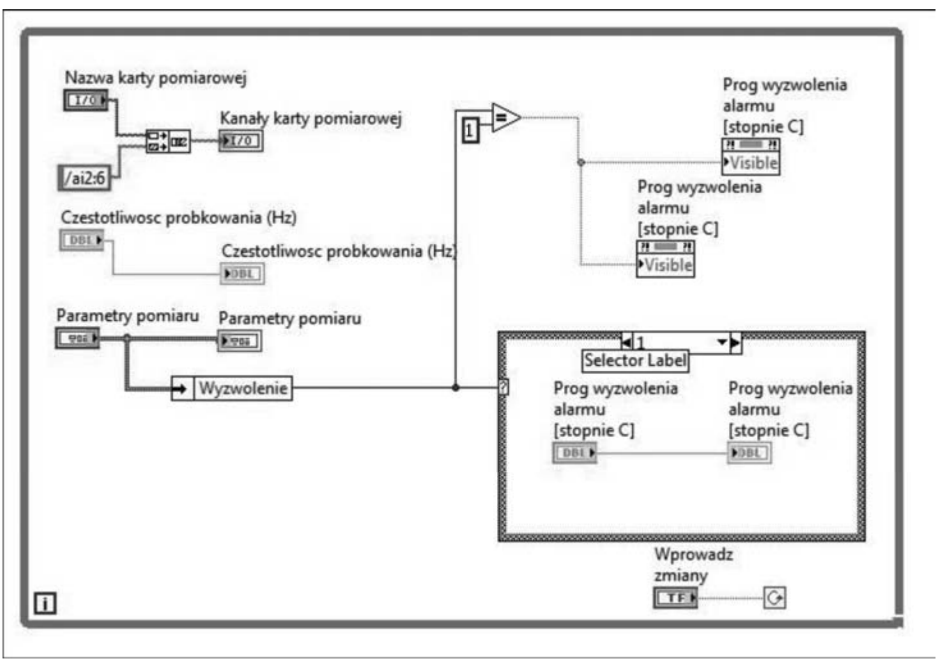

Fig. 7. The calibration date procedure of alarm threshold – a part of the head program

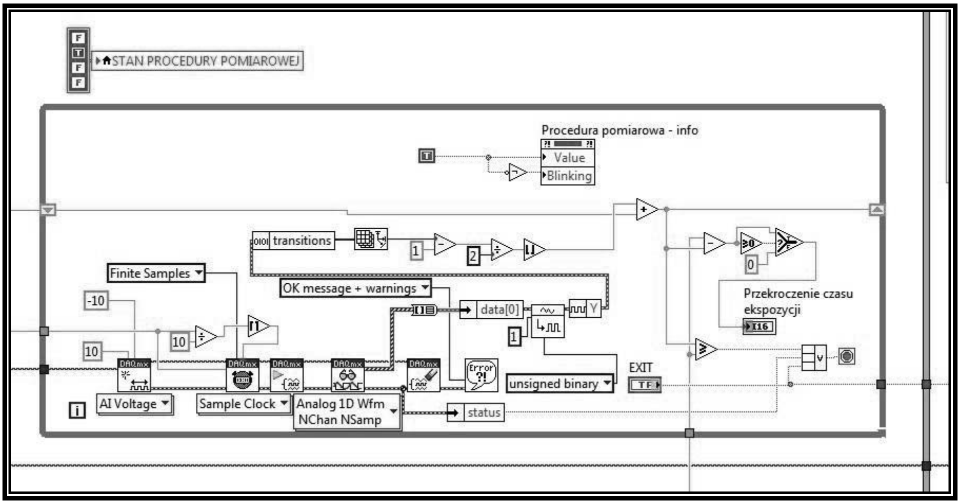

Fig. 8. One of the acquire measurement date procedure – a part of the head program

The proposed supervision system controllling the climatic and technological parameters in selected rooms at the farm can be operated in the automatic operation mode, in manual operation mode managed by the user at the work station and in emergency mode managed by the system user from the level of computer with installed supervision system. Thanks to such solution it is possible to optimize the system operation in normal conditions and to adapt to actual needs in case of occurred emergency conditions or conditions endangering the correct course of storage and production processes.

Except for the control and status checking for individual autonomous control systems, it is possible to provide the virtual supervision system with the events recording option. Therefore the work history is created for individual system elements installed in the farm and it is more easy to determine the reasons of occurred emergency conditions and to determine the periods of scheduled maintenance shudowns on the basis of the equipment operation time recording.

CONCLUSIONS

The analysis of capabilities and functionalities of the autonomous control systems, particularly those built on the basis of EIB and PLC systems of elements as well as on the basis of built-in systems demonstrated that said systems can support the virtual supervision system. Such interoperability is possible in the form of systems infrastructure sharing (particularly detection elements).

The systems integration through the creation of a uniform supervision system controlling the technical and climatic parameters occurring at the farm makes it possible to increase the capabilities of the whole management system. Thanks to the storage and processing of data from many autonomous systems, such systems enable the extension of their functions to tasks associated with planning and management of the production and storage process.

Owing to the application of the virtual supervision system integrated with the autonomous control systems applied for the execution of the production and storage processes at the farm it is possible to extend the scope of parameters and functions obtained by the user. Additionally the status of individual systems is monitored the supervision system and the user is provided with the complex access to information from one place.

Thanks to the application of LabVIEW software delivered by National Instruments, the user can have access of to advanced applications enabling the communication with external devices in several ways. In this system it is possible to use the serial and parallel ports, TCP/IP protocol as well as wireless connection with the devices. The last option increases the data transmission process efficiency. The systems are under uninterrupted control and the user is immediately informed thereof. Therefore the systems users are able to quickly localize the failure and to eliminate the defect source in case of a breakdown or danger status.

The application of LabVIEW environment for the building of the virtual supervision system makes it possible to create the systems adapting themselves to the individual needs of their user and, consequently, to implement such a system for various objects and various production processes.

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WYKORZYSTANIE ŚRODOWISKA LABVIEW DO BUDOWY SYSTEMU NADZORU KONTROLUJĄCEGO PARAMETRY KLIMATYCZNE I TECHNICZNE W POMIESZCZENIACH W GOSPODARSTWIE ROLNYM

Streszczenie. Nowoczesne gospodarstwa rolne to dzisiaj małe zakłady produkcyjne wyspecjalizowane w produkcji i wstępnym przetwórstwie produktów rolnych. Osiągnięcie wymaganych wskaźników jakościowych produktów wymaga przestrzegania w obiektach i w poszczególnych pomieszczeniach ściśle określonych warunków produkcji i przechowywania. W artykule przedstawiono system kontroli głównych parametrów klimatycznych i technicznych w wybranych pomieszczeniach występujących w gospodarstwie rolnym. Do budowy takiego systemu zostało wykorzystane środowisko LabView. Akwizycja parametrów odbywała się na podstawie informacji i sygnałów z czujników współpracujących z kartami pomiarowymi. Zbudowany interfejs umożliwia wyświetlanie na ekranie komputera aktualnych, a także archiwalnych parametrów występujących w poszczególnych pomieszczeniach. Dzięki takiemu rozwiązaniu rolnik ma możliwość wglądu i nadzór nad autonomicznymi systemami sterującymi działającymi w poszczególnych pomieszczeniach.

Słowa kluczowe: systemy sterowania i nadzoru, kontrola procesów, środowisko LabView.