THE SYSTEM OF REMOTE MONITORING AND CONTROL OF THE TECHNOLOGICAL PROCESS OF GRAIN STORAGE

Tuleshov A.K.
Merzoyana St., 29/1-82, Astana,
Kazakhstan, KZ-010010,
aman_58@mail.ru

Koshekov K.T.
Ubileinaya St., 3i-10, Petropavlovsk,
Kazakhstan, KZ-150000,
kkoshekov@mail.ru

Demyanenko A.V.
Abaya St., 7-48, Petropavlovsk,
Kazakhstan, KZ-150000,
demianenkoav@mail.ru

Savostin A.A.
Internatsionalnaya St., 10-8, Petropavlovsk,
Kazakhstan, KZ-150000,
alex_savostin@mail.ru

ABSTRACT

The system of remote monitoring and control of technological process of grain storage based on the application of wireless infocommunication technologies, methods and algorithms of collecting and analyzing of information signals and images, and a formation of the control actions on this basis is described in the paper. The object of automation is a technological process of grain storage in the granary of innovative type.

Key words: Grain storage, Granary of innovative type, Automated control system, Remote monitoring and control.

Introduction

An important factor for decreasing of the prime cost of grain storage and processing is the application of complex automation for all stages of the technological process.

Now the main automation directions of the existing granaries are reduced to introduction of the computerized automated complexes instead of the relay systems of the industrial control existing at many enterprises of this branch and to equipping of technological sites by modern automation and control devices of the qualitative grain characteristics [1].

The authors of the article carry out the research work (RW) financed by a grant of the Committee of Science of the Ministry of Education and Science of the Republic of Kazakhstan. A main objective of RW is the improvement of the grain storage process by the introduction of a complex of intellectual decisions including new wireless infocommunication technologies, innovative methods and algorithms of collecting, preprocessing and the analysis of information signals and images and formation on their basis of the control actions.

The automation object for approbation of the offered intellectual system of remote monitoring and control is the technological process of grain storage in the granary with horizontal silo of innovative type with a capacity up to 200 tons which experimental model is presented on Fig. 1.

In the considered granary the technology of horizontal silo is applied. That technology reduces the cost of granaries construction, improves the quality and increases period of grain storage, promotes decrease in the prime cost of grain and increase of its competitiveness.

The feature of the horizontal silo of innovative type is the method and the device for the grain unloading from a silo [2]. This method differs from the other ones in that the conveyor for the grain unloading from silo is in a silo, but not under it, and the additional underground floor for this purpose isn't necessary (Fig.2).

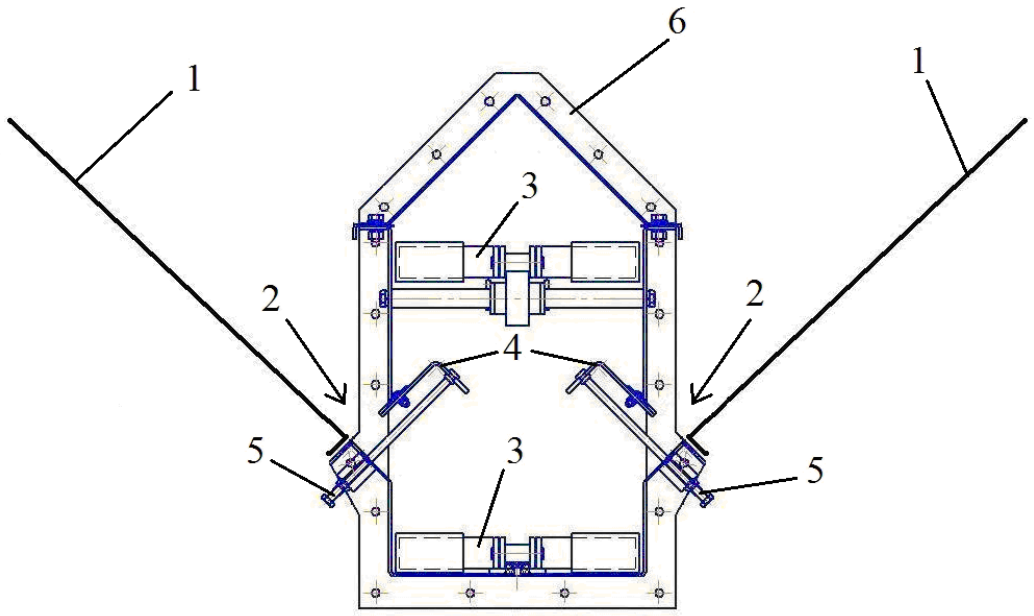
By inclined surfaces 1 (Fig.2) the grain arrives to loading slots 2 and through them on the lower branch of the scraper conveyor 3. For adjusting of the section of the loading slots in each section of unloading conveyor there is a regulated (by means of screws 5) barrier device 4. Each section of the unloading conveyor is equipped with a protective box 6 in which all components of the unloading conveyor are placed.

The developed granary [3] (Fig. 1) is transportable, it is equipped with an autonomous power source (wind-power unit), and an automated control system for key parameters of the technological process of grain storage [4]. Now there is an automated system of monitoring and control with the application of "wire" technologies. However, its operation demanded the modernization of a technological process in the following directions: rapid response to various emergency and critical technological situations, measurement of volume of the grain stored mass and the remote control of the parameters.

The authors of the article developed the wireless automated system of monitoring and control of the technological process of grain storage in the granary with horizontal silo of innovative type. It allowed carrying out more effectively demanded above modernization.

Figure 1: Experimental model of granary of innovative type

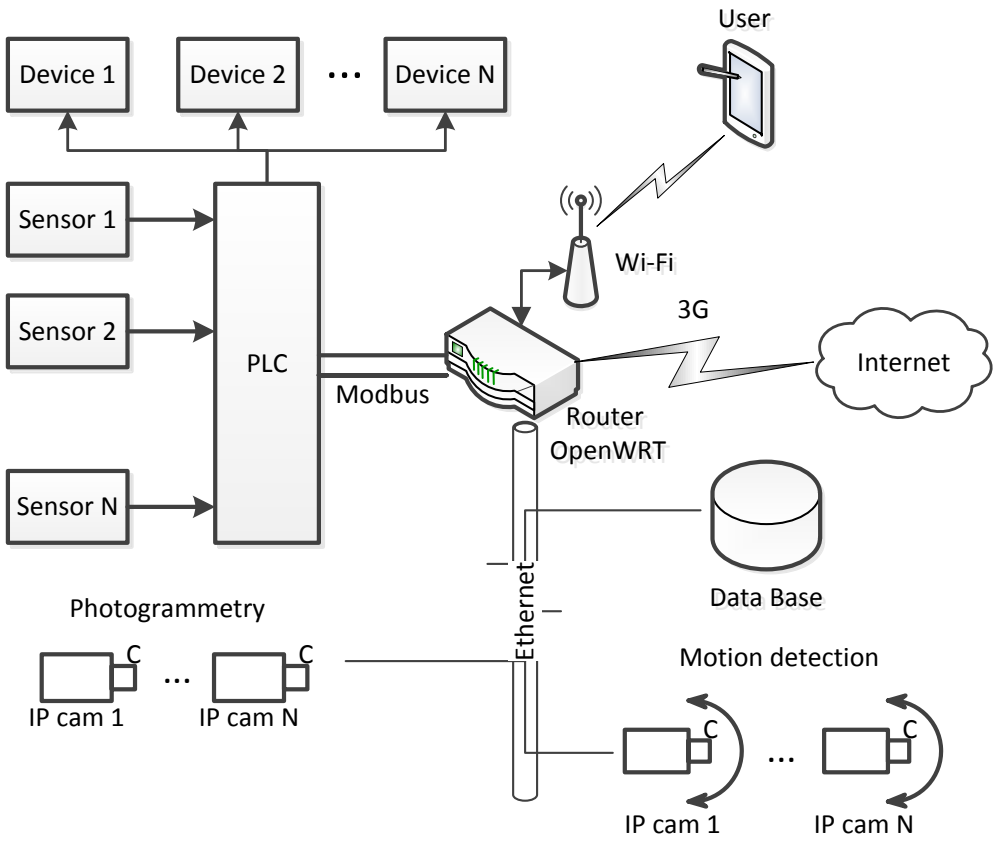
Figure 2: Unloading conveyor



1 – inclined floors of a horizontal silo; 2 – loading slots; 3 – a scraper conveyor; 4 – an adjustable barrier device; 5 –an adjusting screw of the adjustable barrier device; 6 – a protective box.

The structure of the wireless automated system of monitoring and control is presented on Fig. 3. Measuring sensors Sensor 1 – Sensor N make the collection of information about a condition of a technological process. Data from sensors are analyzed by the programmable logical controller PLC160 of the OWEN company production. This type of the controller completely provides the demanded computing power and enough types of interfaces, reliability and efficiency of the operational characteristics. On the basis of the data analysis from sensors according to developed algorithm the PLC generates signals of control for the actuation mechanisms Device 1 – Device N to keep the technological process within the established norms.

Figure 3: Structure of system of remote monitoring and control of technological process of grain storage in granary of innovative type



For remote monitoring and control of parameters of the technological process in the automated system the architecture of a data transmission network with an Internet access according to the standard 3G is used. This standard is chosen because of the most developed covering network in the Republic of Kazakhstan.

The management of a data transmission network is realized on tp-link wr1043nd router with the preset OpenWRT distribution kit on GNU/Linux kernel.

In the system a video surveillance over object by means of the Motion detection IP cameras IP cam 1 – IP cam N is realized. For this purpose as a part of the OpenWRT it is used SW Motion - the powerful free program for the detection of the movement on the camera. Given SW allows tracing the movement in a shot and at its detection to include the record into the network storage Data Base and to make a sending of pictures of the found object by the Internet.

Access to PLC is organized through the Modbus protocol – the open communications protocol based on architecture "master-slave". It is used for data transmission via consecutive RS-485, RS-422, RS-232 communication lines. The way of implementation of the Modbus-RTU protocol is executed by means of a shell-script and a binding in the form of a js-code.

By means of the Ethernet network and Webcams Photogrammetry IP cam 1 – IP cam N is realized the contactless system of 3D-measurements on a basis of the photogrammetric methods for determination of the grain stored mass.

The monitoring and control current data through discrete periods are transferred to the remote server on the Internet where they are accumulated in a database and are available to viewing and monitoring by the user. In case of an emergency and critical technological situation the data on the alarm are delivered to the user in the form of push-notices.

Being directly near object, the User gets an access to the saved-up data and control systems of the granary through the wireless connection on Wi-Fi. For this purpose the web server Lighttpd and PHP5 with the SQLite3 databases on the basis of a kernel of OpenWRT was developed.

For data confidentiality and prevention of unauthorized access to the Wi-fi networks the modern algorithms of enciphering of AES/CCMP are used. For the work with the Internet the use of the HTTPS protocol is provided. Data are packed into the cryptographic SSL or TLS protocol.

The remote server which is on a hosting in the Internet controls the data reception through the strictly certain periods and if through the specified period the data don't arrive the server generates the disturbing push-notice for the client. Thus control of serviceability of a security system and power supply of object is provided.

Conclusions

The intellectual system providing monitoring and control of such process parameters of the grain storage as the temperature and humidity of grain, the work of the transport equipment (conveyors), stability of power supply, security and fire alarm system, operating modes, load degree of a storage is developed.

Information transfer is provided with the application of a wireless communication systems 3G and Wi-Fi. The system includes the technology of parameters identification measurements of the grain storage. The technique of contactless three-dimensional measurements on the basis of photogrammetric approach allowing determining the grain amount which is available in storage by its various images view is applied.

The developed algorithms, program and hardware can be applied to the development of intellectual systems of remote monitoring and control by a wide range of agrarian objects and industrial complex.

Work is carried out within a grant on the scientific researches of the Committee of Science of the Ministry of Education and Science of the Republic of Kazakhstan.

References

Automated control system for the grain industry (2015). Retrieved July 21, 2015, from http://elites-montage.com.ua/acorn.php

Baibolov, K.B., Dilmagambetov, R.P., Dilmagambetov, Sh.N., Kozhakov, K.S. & Tuleshov, A.K. (2011). *Innovative patent №25280* (Republic of Kazakhstan).

Demyanenko, A.V., Dilmagambetov, Sh.N., Koshekov, K.T. & Tuleshov A.K. (2013). *Experimental model of granary with horizontal silo.* Paper presented at III International Conference "Science, Technology and Higher Education", held at Westwood, Canada, 16 October (pp. 41-42).

Demyanenko, A.V., Koshekov, A.K. & Koshekov, K.T. (2013). *Automated control system of technological process of grain storage in the experimental transportable model of granary of innovative type.* Paper presented at I International conference "Science and Education: Vectors of Development", held at Expert Methodological center, Cheboksary, Russia, 25 November (pp. 701-710).