ВІСНИК ПРИАЗОВСЬКОГО ДЕРЖАВНОГО ТЕХНІЧНОГО УНІВЕРСИТЕТУ
2020р. Серія: Технічні науки Вип. 41
p-ISSN: 2225-6733; e-ISSN: 2519-271X

АВТОМАТИЗАЦІЯ ТА КОМП'ЮТЕРНО-ІНТЕГРОВАНІ ТЕХНОЛОГІЇ

UDC 528.088.4 **doi: 10.31498/2225-6733.41.2020.226190**

© Mehdiyeva Almaz Mobil gızı*

DEVELOPMENT OF VIRTUAL MEASURING EQUIPMENT FOR CONTROL SYSTEMS

The article considers the issue of measurements, virtual devices, which is a topical issue of the time. The first step in control industry and technology is to take measurements. Virtual measuring devices have been studied, given that virtual devices are now widely used in industry. Control systems, which are a clear example of modern technology, are an ideal tool for obtaining high quality products in production and industry, as long-used analog control systems give way to digital control systems with high accuracy and wide range of functions. Taking all this into account, simulation modelling of this process was carried out: Technological processes in production areas operate continuously, one of which is the process of collecting a product or raw material in a tank or transferring it from a tank to a specific device. This process requires control of the product level in the tank, which must be automatic. Level measuring devices keep the level of the product in the tank stable and control the overfilling of the tank. Recently, there has been a blurring of the distinction between «real» and «virtual» devices. Almost any modern device has the ability to connect to a PC and software (software) included in the kit. By connecting such a device to a PC and using software, the user has the ability to control the device from a PC, store and process data, which turns the real device itself into a virtual part of the «virtual» device. The use of the LXI protocol in the devices eliminates the need to install software on the computer, since the communication software is located in the device itself. Thus, it has been shown that through the technology of virtual devices, it is possible to transform a standard personal computer, which is the creator of the program, and the whole set of control and measuring devices together into a complex of measurement and calculation with a wide range of functions. The advantages of the proposed virtual devices are: minimization of costs; simultaneous analysis of multiple measurements; installation of multi-channel distribution systems; simplification of automated systems.
Keywords: *control system, technological process, measuring device, virtual measuring device, level transmitter, information transmitter.*

Мехдієва Алмаз Мобіл кизи. Розробка віртуального вимірювального обладнання для систем контролю. *У статті розглядається питання вимірювань віртуальними приладами, яке є актуальним питанням часу. Першим кроком у галузі управління та технологій є проведення вимірювань. Віртуальні вимірювальні прилади були вивчені з огляду на їх широко використання у промисловості. Системи керування, які є яскравим прикладом сучасних технологій, є ідеальним інструментом для отримання високоякісної продукції у виробництві та промисловості, оскільки аналогові системи керування, що використовуються давно, поступаються місцем цифровим системам з високою точністю та широким спектром функцій. Враховуючи все це, було проведено імітаційне моделювання процесу: технологічні процеси на виробничих ділянках виконуються безперервно, одним з них є процес збору продукту або*

* *applicant, Azerbaijan State Oil and Industry University, Baku, Azerbaijan, ORCID: 0000-0002-3962-3980, almazmehdiyeva@yahoo.com*

p-ISSN: 2225-6733; e-ISSN: 2519-271X

сировини в резервуар або перенесення його з резервуара на конкретний пристрій. Цей процес вимагає контролю рівня продукту в резервуарі, який повинен бути автоматичним. Прилади для вимірювання рівня підтримують рівень продукту в резервуарі стабільним і контролюють переповнення резервуара. Останнім часом відбувається стирання відмінностей між «реальними» і «віртуальними» приладами. Практично будь-який сучасний прилад має можливість підключення до ПК і програмне забезпечення, що входить в комплект. При підключенні такого приладу до ПК і використанні програмного забезпечення, користувач має можливість управляти приладом, зберігати і обробляти дані, що перетворює сам реальний прилад вже у віртуальну частину «віртуального» приладу. Використання ж протоколу LXI в приладах дозволяє відмовитися від установки програмного забезпечення на комп'ютер, оскільки програмне забезпечення для зв'язку знаходиться у самому приладі. Таким чином, було показано, що за допомогою технології віртуальних приладів можна перетворити стандартний персональний комп'ютер, який є творцем програми, і весь набір контрольно-вимірювальних приладів разом у комплекс вимірювань і обчислень з широким спектром функцій. Перевагами запропонованих віртуальних пристроїв є: мінімізація витрат, одночасний аналіз множинних вимірювань, встановлення багатоканальних розподільчих систем, спрощення автоматизованих систем.
Ключові слова: *система керування, технологічний процес, вимірювальний прилад, віртуальний вимірювальний прилад, передавач рівня, передавач інформації.*

Description of the problem. The automation of technological processes consists of a number of tools and methods designed to manage various processes, without the use of laboratory. At present, the pace of development and progress of technology is such that any technological process can be carried out without human intervention. The constantly updated technological equipment and aggregates have a great impact on the development of industry, and the automation of production processes is almost the basis for the development of production and various industries.

Analysis of recent research and publications. Intelligent control systems, which are a clear example of modern technology, are an ideal tool for obtaining high quality products in production and industry, as long-used analogy control systems give way to digital control systems with high accuracy and wide range of functions. Taking all this into account, simulation modelling of this process was carried out: Technological processes in production areas operate continuously, one of which is the process of collecting a product or raw material in a tank or transferring it from a tank to a specific device. This process requires control of the product level in the tank, which must be automatic. Level measuring devices keep the level of the product in the tank stable and control the overfilling of the tank. The use of level gauges is used to monitor not only the level itself, but also the physical parameters of the product - the parameters that characterize it. The introduction of automatic control systems is the best solution to increase production efficiency. Extensive application of control systems is needed to increase production efficiency.

Purpose of the article is to study the development of virtual measuring equipment for control systems**.**

Presentation of the main material. Level meters are used to measure the level of liquid in closed and open tanks and devices of technological process. These sensors are designed to provide automated control of the level of liquid and granular products, as well as to transmit warning light and sound signals when the level of the controlled medium changes. Level meters are made as a single device or part of a technological device [1]. With the help of systems designed in conjunction with modern intelligent devices, it is possible to make accurate measurements, even in very difficult and dangerous conditions. Tanks are divided into two groups according to the position of use: tanks used in production and filling. Products from other tanks are poured into the tanks used in production. Therefore, the level of product in these tanks is constantly increasing. The sensor warns if there is a decrease in product level. In filling tanks, on the contrary, the level of the product always decreases. In this case, the level gauge warns if there is an increase in the level of the product in the tank. Radar-level level sensors, which are non-contact level sensors, are an ideal tool for solving the above-

p-ISSN: 2225-6733; e-ISSN: 2519-271X

mentioned problem. Measurement-study determines the quantitative ratios of the intended events, which allows to compare the final results of various discoveries and research. Measuring instruments (MV) – technological devices used in measurement and containing accurate metrological characteristics of the measured quantity. Verification of measuring instruments – is the determination by the official metrological body of the suitability for measurement of the given metrological characteristics of the technical means used and confirmation of compliance with the requirements. Accuracy of measurements is the degree to which the error of the unmeasured value of a physical quantity is close to zero. Measurement error is the sum of the principles and means by which the measurement method is used. A measuring device is a technical measuring instrument that obtains the value of a quantity measured at a predetermined interval. These devices are analog and digital due to the fact that they transmit the received information in the form of continuous or discrete signals. One of the new trends in the field of automation of measurement processes is the introduction of virtual computing for data collection and processing in advance. This trend is closely linked with the rapid development of modern information and computer technology. The virtual environment is a software module for recording data, ie to create virtual devices that are used in parallel with real devices in the measurement process. LabVIEW-program was created by the American company National Instruments [2-4]. LabVIEW – the environment was created thirty years ago and is still evolving. This program was originally designed for research laboratories. Today, Lab VIEW is an invaluable graphical programming language for millions of scientists, engineers and researchers. Designed for testing, various measurement processes, data generation and monitoring, LabVIEW is used to combine on-screen automation and measurement functions that make up its composition. The language used in LabVIEW is G. Features. With LabVIEW, a large graphical programming language, it is possible to increase the productivity of the automation process many times over. The process of creating a program in simple programming languages takes a long time. However, in the LabVIEW software package, this process only takes a few hours. The measurement system developed in LabVIEW is more efficient than a laboratory device because it uses various features of modern programming [5-7]. LabVIEW is a virtual device that performs the task. It has a library of functions that solve many programming problems, free from the daily work associated with the distribution of indicators, as well as ready-to-use subroutines. Places used. There is a wide range of applications such as medicine, food and light industry, automation of technological processes, automotive diagnostics, SCADA applications, statistics, physics, energy analysis, determination of chemical compounds, robotics, and the field of application continues to grow.

Data flow and graphical programming language. In object-oriented algorithmic programming environments, programming is based on writing the program interface by sequentially entering program code, while LabVIEW uses a graphical programming language. In this software environment, the algorithm allows you to eliminate a large number of syntactic errors, using a graphic icon in the formation of the block diagram. Using this method requires attention in programming a single data stream. The working algorithm of the program is developed, then it is left to draw a visual description of this algorithm – a block diagram, using the graphical language of programming. In this case, there is no need to think about cell memory, access ports, addresses, and other attributes. The data will be transmitted from block to block via wires, the data will be processed according to algorithms, an image will be obtained and stored in memory. Virtual device. If we equip any personal computer with several analog inputs, then we can turn it into a very powerful measurement system. A computer keyboard and monitor are more useful than an oscilloscope and multimeter, and allow you to use many services. Disk devices and flash cards play an important role in storing data. The printer is suitable for recording time-consuming processes. Also, the computing power and command system of personal computers allow you to process data with different types of complexity. When previous versions of the personal computer were converted into virtual devices, it was necessary to install some expensive and complex boards on the computer. Today, this method is still used in the automation of large industrial processes and large research laboratories. However, it is possible to achieve the desired result by connecting a small analog-to-digital converter to a parallel or serial port on a personal computer. Virtual tools are computer programs that interact with actuators and sensors and real objects [8]. These tools perform a set of functions of imaginary and real tools. A sensor is a simple device that receives information from an object, converts that information into electrical signals, and then

p-ISSN: 2225-6733; e-ISSN: 2519-271X

transmits it to a computer for processing. Virtual measuring instruments collect and analyse a single piece of data, while very sophisticated virtual instruments interact with objects in both directions. Here, the output signals are controlled by actuators (Figure 1).

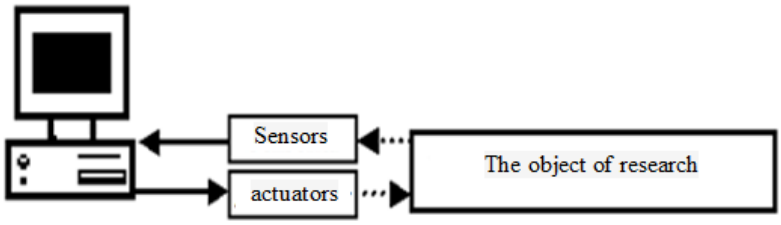

Fig. 1 – Description of a virtual device

The signals received by the computer are digital signals, while real signals are analog in nature. For this reason, converters are needed to switch from analog to digital and from digital to analog signal so that the computer can communicate with the object being searched. To solve this problem, the Analog Digital Converter (ADC) and Digital Analog Converter (DAC) boards in the systems are placed inside the computer. The device records the necessary information, monitors the set of indicators. The readings of all transmitters are entered into a computer that processes these indicators. The results are then displayed on a monitor and stored in the computer's external memory. The computer on which LabVIEW is written uses a Virtual Instrument that works with real indicators of the device's transmitters and monitors real changes in parameters. All results obtained in this program are displayed on the screen in the virtual front panel. The virtual measurement system can be assembled from different types of hardware and software. Various measuring instruments can be used to monitor any process or to test any device.

LabVIEW is a user-friendly software environment designed primarily for the needs of engineers. The LabVIEW environment is an extensive set of tools for data collection, analysis, processing and storage. Programs created in the LabVIEW environment consist of three parts: block diagram; front panel; pictogram.

It is possible to show the solution of the problem graphically with the block diagram. On the one hand, when the user controls the front panel, on the other hand, virtual tools work in the block diagram. The block diagram also controls real systems through hardware developed by NI. The block diagram is used to write code in the object-oriented programming language, to respond to forms prepared for the front panel user interface.

In the LabVIEW environment, the front panel is the user interface, which displays a graphical description of the virtual key, key, control and other indication elements.

A pictogram is a graphical representation of a virtual device in a block diagram. The icon allows you to functionally transform a virtual device into an object to be used in the block diagram of another virtual device.

The software assembled in the LabVIEW environment of a virtual device designed to control the liquid level in an oil-filled tank is shown in Figure 2 and Figure 3. The figure shows the front panel, block diagram and graphic description of the virtual device. The total capacity of the tank is 1000 liters. A measuring scale is used to control the level of oil in the tank. There are also lower and upper limits for the level of the tank. The upper limit is 900 liters, and the lower limit is 100 liters. If the level of the tank exceeds the upper limit or, conversely, reaches the lower limit, the user is alerted by a light signal. In addition, an alarm is sounded when the oil level in the tank reaches the upper limit, ie if there is a risk of oil overflow. Here, the oil level is visually displayed on the tank. The «stop» command is used to stop the program. An alarm diagram is also provided at the time of tank emptying and filling. Thus, a virtual measuring device was created by the proposed method and the issue of increasing the measurement accuracy was studied. Differences in the results at the end of numerous measurement studies indicated the presence of errors. We have proposed corrective filtering to eliminate measurement errors.

As a result of the research, a satisfactory result was obtained, and the errors were significantly reduced. The result is shown in Figure 4.

p-ISSN: 2225-6733; e-ISSN: 2519-271X

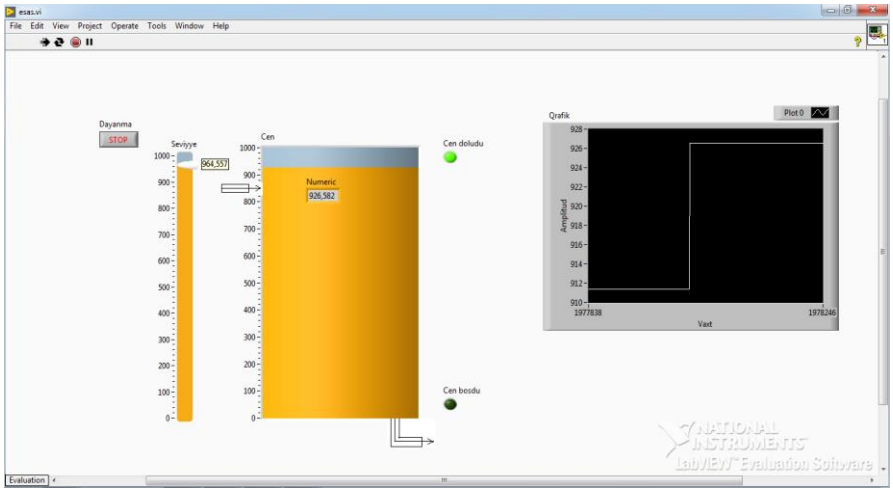

Fig. 2 – A virtual device that monitors the level of liquid in the tank

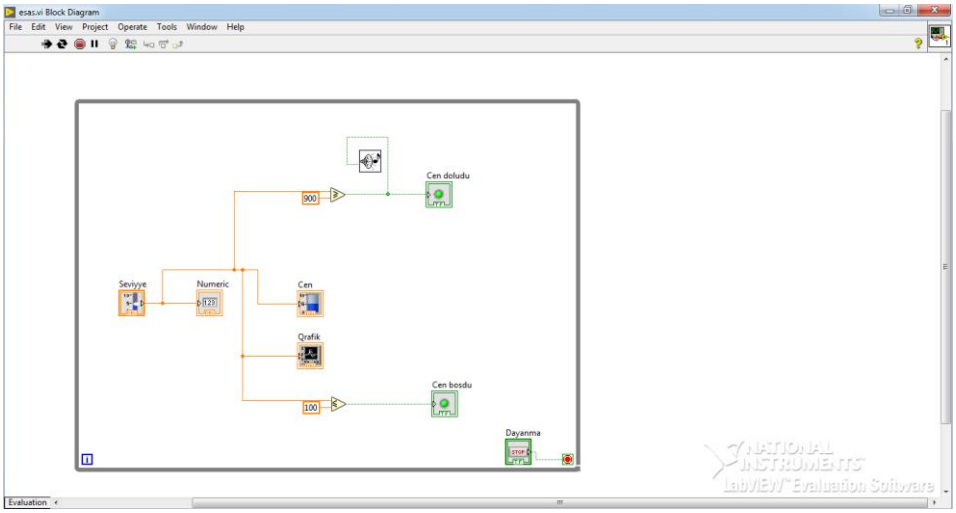

Fig. 3 – A virtual device that monitors the level of liquid in the tank

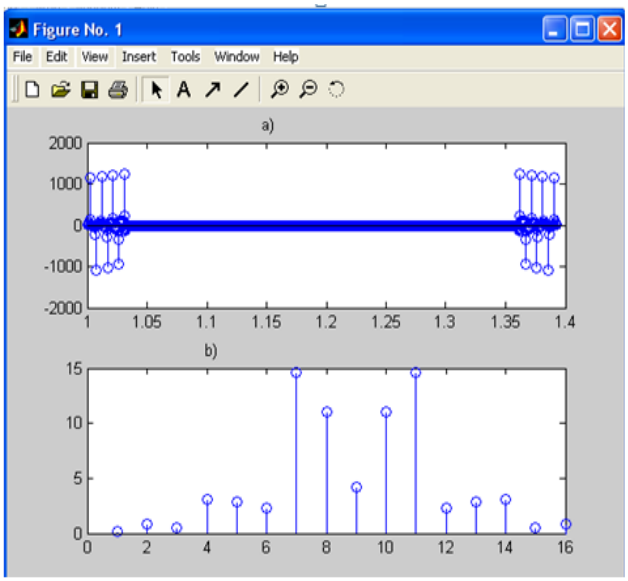

Fig. 4 – Spectrum of the input signal and spectrum after corrective filtration

p-ISSN: 2225-6733; e-ISSN: 2519-271X

Conclusions

1. The principle of operation and structure of measuring instruments used in level measurement were studied, appropriate measuring instruments were selected for use in different conditions.

2. It is proposed to use a radar-type level sensor, which has recently been developed and is considered the best in level measurement.

3. A virtual device has been developed to measure and monitor the level of liquid in the tank through the Lab VIEW program.

4. Proposed corrective filtering to eliminate measurement errors.

5. As a result of the research, a satisfactory result was obtained, and the errors were significantly reduced.

References:

1. Devine P. Radar level measurement – the user's guide, Burgess Hill, VEGA Controls Publ., 2004. 116 p.
2. Jerome J. Virtual instrumentation using LabVIEW. PHI Learning Publ., 2010. 54 p.
3. LabVIEW, Introductory Course – NCSA HDF5 (Hierarchical Data Format 5) Software Library and Utilities. 2003. 27 p.
4. Sensor Technology Handbook: edited by Jon S. Wilson. 2005. 704 p. **doi: 10.1016/b978-0-7506-7729-5.x5040-x**.
5. Vinogradova N.A., Listratov Ia.I., Sviridov E.V. *Razrabotka prikladnogo programmnogo obespecheniia v srede LabVIEW* [Development of applied software in the LabVIEW environment]. Moscow, MEI Publ., 2005. 47 p. (Rus.)
6. Druz'iakin I.G., Lykov A.N. *Tekhnicheskie izmereniia i pribory* [Technical measurements and instruments]. Perm', Permskii gosudarstvennyi tekhnicheskii universitet Publ., 2008. 412 p. (Rus.)
7. Kulakov M.V. *Tekhnologicheskie izmereniia i pribory dlia khimicheskikh proizvodstv* [Technological measurements and devices for chemical production]. Moscow, Mashinostroenie Publ., 1983. 424 p. (Rus.)
8. Vil'nina A.V., Vil'nin A.D., Efremov E.V. *Sovremennye metody i sredstva izmereniia urovnia v khimicheskoi promyshlennosti: uchebnoe posobie* [Modern methods and means of measuring the level in the chemical industry: a textbook]. Tomsk, TPU Publ., 2011. 84 p. (Rus.)

Перелік використаних джерел:

1. Devine P. Radar level measurement – the user's guide / P. Devine. – Burgess Hill : VEGA Controls, 2004. – 116 p.
2. Jerome J. Virtual instrumentation using LabVIEW / J. Jerome. – PHI Learning, 2010. – 54 p.
3. LabVIEW, Introductory Course – NCSA HDF5 (Hierarchical Data Format 5) Software Library and Utilities. – 2003. – 27 p.
4. Sensor Technology Handbook: edited by Jon S. Wilson. – 2005. – 704 p. – Mode of access: DOI: 10.1016/B978-0-7506-7729-5.X5040-X.
5. Виноградова Н.А. Разработка прикладного программного обеспечения в среде LabVIEW / Н.А. Виноградова, Я.И. Листратов, Е.В. Свиридов. – М. : Издательство МЭИ, 2005. – 47 с.
6. Друзьякин И.Г. Технические измерения и приборы / И.Г. Друзьякин, А.Н. Лыков. – Пермь: Издательство Пермского государственного технического университета, 2008. – 412 с.
7. Кулаков М.В. Технологические измерения и приборы для химических производств / М.В. Кулаков. – 3-е изд., перераб. и доп. – М. : Машиностроение, 1983. – 424 с.
8. Вильнина А.В. Современные методы и средства измерения уровня в химической промышленности: учебное пособие / А.В. Вильнина, А.Д. Вильнин, Е.В. Ефремов. – Томск: Изд-во ТПУ, 2011. – 84 с.

Reviewer: S.F. Cafarov
PhD in Engineering, associate professor, Azerbaijan State Oil and Industry University

The article was admitted on 17.09.2020