APPLICATION OF SMART SENSORS IN INDUSTRY

Turgunbaev A., Usmanova H.A., Sheina N.E.
Tashkent State Technical University named after Islam Karimov

Abstract: The article discusses intelligent sensors that play a key role in modern industrial production, providing high efficiency, reliability and automation of processes. These devices, equipped with built-in data processing algorithms and communication capabilities, allow not only to measure physical parameters such as temperature, pressure, vibration and level, but also to analyze information in real time.

Keywords: smart sensors, industrial production, data processing algorithms, parameters

INTRODUCTION

The application of smart sensors in industry is reflected in various fields, including product quality management, equipment condition monitoring, production process optimization, and predictive analytics. For example, in the production cycle, smart sensors can immediately detect deviations from the norm, which helps to respond to abnormal situations in a timely manner and prevent equipment shutdowns.

The rapid development of microprocessor technology, the growth of microprocessor power with their simultaneous sharp reduction in price make it economically advantageous to include them in sensors of any type. In recent years, the name "intelligent sensors" has been assigned to sensors with a built-in microprocessor. Over time, intelligent sensors will become increasingly multifunctional automation tools in industry, for which even the term "sensor" itself will become incomplete and simply conditional.

METHODS

An intelligent sensor is an electronic device based on the combination of sensitive elements, signal conversion circuits and microprocessor technology.

With the advent of Industry 4.0, the importance of smart sensors in industrial applications has surged. These devices allow for real-time data collection and analysis, improving decision-making processes and operational efficiency.

Smart sensors— these are adaptive sensors that contain operating algorithms and parameters that can be changed by external signals, and in which, in addition, the metrological self-control function is implemented.

The smart sensor is a microelectronic mechanical system (MEMS) that integrates sensors, microprocessors and actuators. Its main characteristics are:

1- Its core is to organically combine the information detection function of the sensor with the information processing function of the microprocessor, which compensates for the performance deficiency of traditional sensors.

2- It can realize the functions of information processing, information memory, logical thinking and judgment through advanced software development for the collected raw sensitive information, thereby realizing self-calibration, self-compensation, etc., and finally convert the raw information into a certain standard digital format and send it to the user through standard communication protocol.

3- Since the embedded microprocessor can not only completely implement the functions of various software, but also can perform tasks that are difficult to perform by hardware, it greatly reduces the complexity of manufacturing sensors, improves the performance of sensors and reduces costs.

RESULTS

A distinctive feature of intelligent sensors is the ability to self-recover and self-learn after a single failure. In English-language literature, sensors of this type are called "smart sensors".

Today, an intelligent sensor is understood as a sensor with built-in electronics, including: ADC, microprocessor, digital signal processor, system on a crystal, etc., and a digital interface with support for network protocols for communication. Thus, an intelligent sensor can be included in a wireless or wired sensor network, thanks to the self-identification function in the network along with other devices.

In recent years, the development of intelligent sensors has been moving in several directions.

1. New measurement methods that require powerful computing inside the sensor. This will make it possible to place sensors outside the measured environment, thus increasing the stability of readings and reducing losses during operation. The sensors have no moving parts, which increases reliability and simplifies maintenance. The design of the measurement object does not affect the operation of the sensor, making installation cheaper.

2. Wireless sensors are undoubtedly promising. Moving objects distributed in space require wireless communication with their automation equipment and controllers. Radio-technical devices are becoming cheaper, their quality is improving, wireless communication is often more economical than wired. Each sensor can transmit information during its individual time interval (TDMA), at its own frequency (FDMA), or with its own coding (CDMA), Bluetooth finally.

3. Miniature sensors can be built into industrial equipment, and automation tools will become an integral part of the equipment performing the technological process, rather than an external addition. A sensor with a volume of several cubic millimeters will measure temperature, pressure, humidity, etc., process the data, and transmit the information to the network. The accuracy and quality of the devices will increase.

4. The advantage of multi-sensor sensors is obvious. One common converter will compare and process data from several sensors, i.e. not several separate sensors, but one, but multifunctional.

5. Finally, the intelligence of the sensors will be improved. Value prediction, powerful data processing and analysis, complete self-diagnosis, fault prediction, maintenance recommendation, logical control and regulation.

In Figure 1 have shown the network interface of the intelligent sensor, which allows not only to connect it to the network, but also to configure it, select the operating mode, and diagnose the sensor. The ability to remotely perform these operations is an advantage of intelligent sensors, they are easier to operate and maintain.

Figure 1 shows a structural diagram that reflects the main blocks of an intelligent sensor, the minimum required for the sensor to be considered as such. The incoming analog signal (one or more) is amplified, then converted into a digital signal for further processing.

1. Depending on the specific smart sensor design and use case (e.g. IoT application), you may need additional components or different configurations.

2. Use software tools such as Microsoft Visio, Lucidchart or online diagramming tools to create visual representations based on this description.

These tasks provide a clear understanding of how to structure the network interface diagram for a smart sensor.

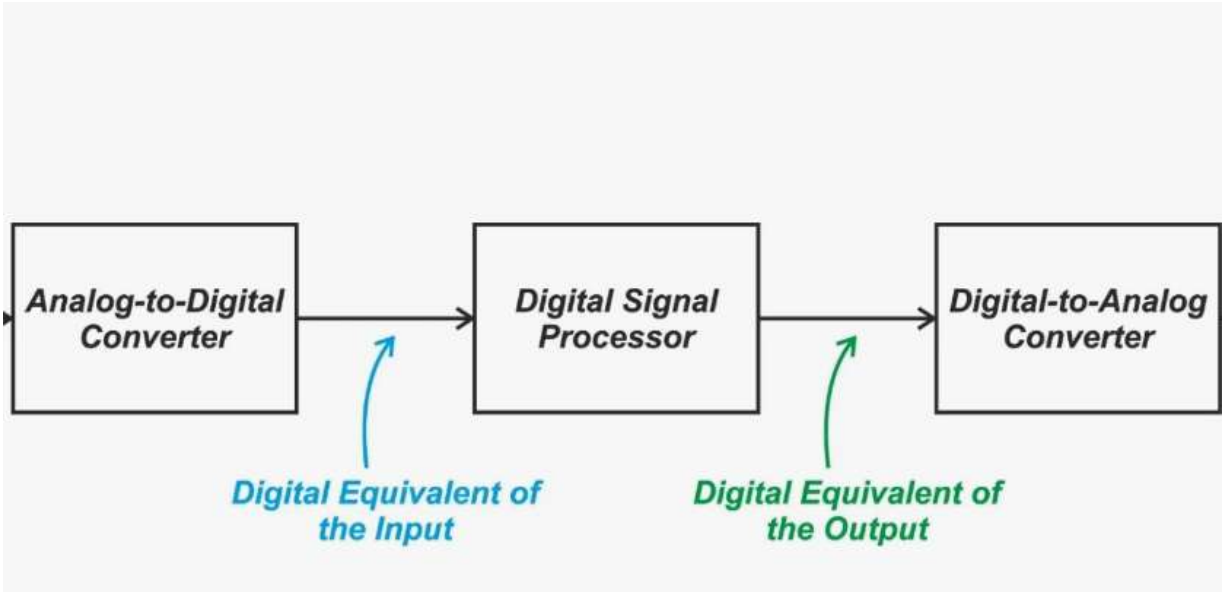

Fig. 1. Structural diagram of the network interface of the intelligent sensor

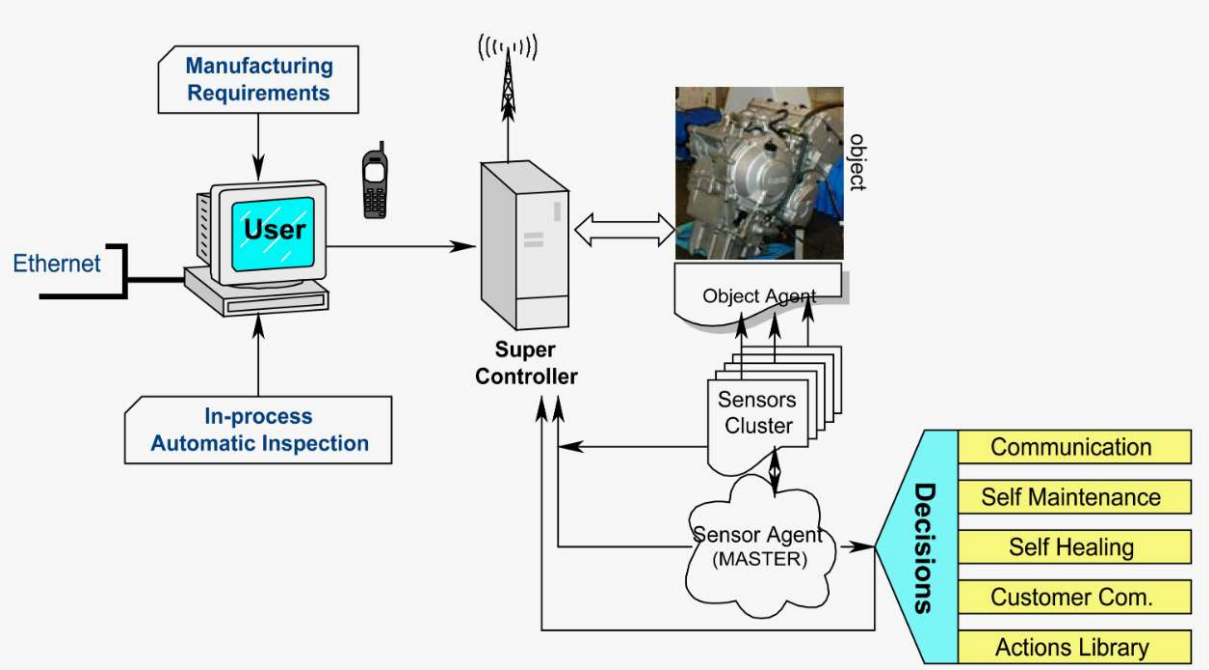

Fig. 2. Structural Intelligence for sensor

The computer network contains calibration data, the microprocessor compares the received data with the calibration data, corrects them, and converts them into the required units of measurement - this compensates for the error associated with the influence of various factors (zero drift, temperature effect, etc.), while simultaneously assessing the state of the primary converter, which may affect the reliability of the result obtained.

The information obtained as a result of processing is transmitted via a digital communication interface, according to the user protocol. The user can set measurement limits and other sensor parameters, as well as receive information about the current state of the sensor and the results of the measurements taken.

Integrated circuits (systems on a chip) today include, in addition to the microprocessor, memory and peripheral devices such as precision digital-to-analog and analog-to-digital converters, timers, Ethernet, USB and serial port controllers. Examples of such integrated circuits include ADuC8xx from Analog Devices, AT91RM9200 from Atmel, MSC12xx from Texas Instruments.

Distributed networks of intelligent sensors enable real-time monitoring and control of parameters on complex industrial equipment, where technological processes are constantly changing their state dynamically.

There is no single network standard for intelligent sensors, and this is a kind of obstacle to the active development of wireless and wired sensor networks. However, today many interfaces are used: RS-485, 4-20 mA, HART, IEEE-488, USB; industrial networks are working: ProfiBus, CANbus, Fieldbus, LIN, DeviceNet, Modbus, Interbus.

The main thing that the integration of sensors into a network provides is the ability to access measurement information via software, regardless of the type of sensor and how a specific network is organized. The result is a network that serves as a bridge between the sensors and the user (computer), helping to solve technological problems.

In Figure 2 I have shown a pyramid of an intelligent measurement system.

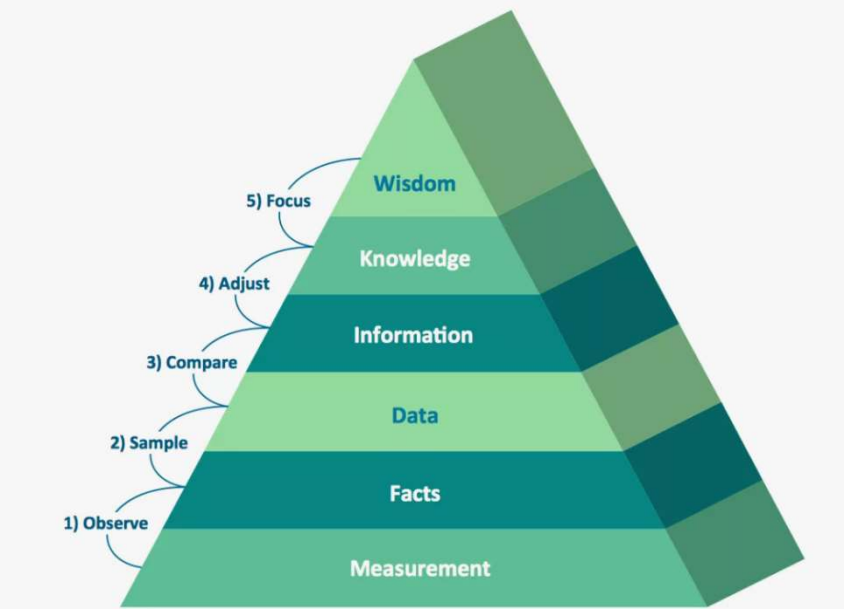

Fig. 2. Pyramid of the intelligent measurement system

ANALYSIS

Thus, an intelligent measuring system can be represented by three levels: sensor level, network level, software level. The first level is the level of the sensor

itself, a sensor with a communication protocol. The second level is the level of the sensor network, a bridge between the object of the sensor's work and the process of solving the problem.

Modern sensors, which are the most important parts of microprocessor control systems for technological objects and production as a whole, are gradually transforming from single-functional means of determining current values of measured quantities into multifunctional automation tools that solve a whole range of other problems in diagnostics, conversion of measurement information, execution of simple control algorithms, etc.

DISCUSSION AND CONCLUSION

In conclusion, smart sensors are vital to modern industrial operations, offering significant benefits in various areas such as quality management and predictive maintenance. Their ability to provide immediate feedback in abnormal situations is critical to optimizing production processes and ensuring equipment reliability.

Additionally, smart sensors facilitate real-time data collection and analysis, enabling companies to make informed decisions swiftly. By integrating these sensors into existing systems, organizations can enhance operational efficiency, reduce downtime, and ultimately lower costs. The continuous monitoring capabilities of smart sensors also contribute to improved safety standards by identifying potential hazards before they escalate.

In summary, embracing smart sensor technology is not just a trend but a strategic move that empowers businesses to thrive in an ever-evolving industrial landscape. By leveraging these tools effectively, companies can position themselves at the forefront of industry advancements while enhancing their overall performance.

REFERENCES

1. Aleinikov A.F. Sensors (promising directions of development): textbook / A.F. Aleinikov, V.A. Gridchin, M.P. Tsapenko. - Novosibirsk: Publishing house of NSTU, 2001. - 176 .

2. Itskovich E.L. Modern intelligent sensors for general industrial purposes on the CIS market. - M., 2005.

3. Rannev G.G. Intelligent measuring instruments: textbook for students of higher educational institutions / G.G. Rannev. - M .: Publishing center "Academy". 2010. - 272 p. 4. Romanov V.N., Sobolev V.S., Tsvetkov E.I. Intelligent measuring instruments. - M .: RIC "Tatiana's Day", 1994. 5.http://www.metran.ru

4. A. Turgunbaev, XA Usmanova, NE Sheina Metrological and improvement of intelligent sensors on the basis of certification. printed Technical science and innovation. Tashkent. 2020. No. 1. RR 160-165. 6 pages

5. A. Turgunbaev, XA Usmanova, NE Sheina Principles of construction of electromagnetic elements and analysis of static characteristics of the electromagnetic converter. printed Innovations in the oil and gas industry. Branch of the Russian State University of Oil and Gas (National Research University) named after I.M. Gubkin in Tashkent. VOL. 3, No. 1.2022. pp. 62-69.

6. PM Matyakubova, A. Turgunbaev, XA Usmanova, NE Sheina Verification and calibration of measuring instruments printed Textbook. – T.: "Fan va technologylar nashriyot-matbaa uyi," 2020. - 176 pp.

ISBN 978-9943-6284-0-3. 176 pp.

7.. A.Turgunbaev, O.Kh.Abdurakhmanov Main principles of integrated quality management when selecting employees. print International Journal of Innovative Research in Science, Engineering and Technology. Volume 11, Issue 12, December 2022. pp. 14285-14287. p-ISSN: 2347-6710 DOI:10.15680/IJIRSET.2022. 3 pages

8. Айтбаев Т. А., Абдурахманов А. А., Эшмурадов Д. Э. АНАЛИЗ ХАРАКТЕРИСТИК СУЩЕСТВУЮЩИХ КОНСТРУКЦИЙ И ВЫРАБОТКА

ТРЕБОВАНИЙ К ТЕРМОДАТЧИКУ //Теория и практика современной науки. – 2021. – №. 1. – С. 19-26.

9. Matyakubova P.M., Sheina N.E. “Methods and means of measurement (PART III). Guidelines for performing laboratory work. T.: 2024-125 p.

10. Alijon Abdurakhmanov, Norkhuja Nizomov ANALYSIS OF AVAILABLE INNOVATIVE METHODS OF MEASURING AND CONTROLLING THE QUALITY OF ENERGY SUPPLY IN DIGITAL TECHNOLOGY FACILITIES // SAI. 2024. №Special Issue 17. URL: https://cyberleninka.ru/article/n/analysis-of-available-innovative-methods-of-measuring-and-controlling-the-quality-of-energy-supply-in-digital-technology-facilities (дата обращения: 29.11.2024).