Development and Improvement of Systems of Automation and Management of Technological Processes and Manufactures

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Abstract:
The development of means and systems of industrial automation, taking place along with the widespread use of modern information technologies, makes it possible to identify trends characteristic of this field of science and technology, and to predict the directions by which the most important changes will occur in the near future. It is shown that the main trend is a constant increase in the level of built-in artificial intelligence in control systems. From the standpoint of the most demanded and relevant areas of research and development, the driving forces and trends in the development and improvement of industrial automation systems are analyzed.

Keywords: *industrial automation, process management, enterprise management standards, operational dispatch management, business processes*

1. Introduction

Industrial automation is defined as the unification of all machines, processing systems, test installations and production sites, which are automated because of technological progress, which, on a global scale, is driven largely by growing economies around the world. The growth of the technological segment of many industrial and industrial enterprises stimulates the global growth of the Industrial automation market: products and solutions for industrial automation are manufactured in large varieties, each of which differs from the other by type of automation, control and metering devices, computers, analyzers, operation and geographic scale.

2. Driving Forces and Trends in the Development of Industrial Automation

The problem of algorithmization the management of production processes, reinforced by the powerful development of electronic and computer technology, has generated an abundant flow of research and fruitful developments in the field of control theory in general and in particular, optimization of management of production processes.

The concept of centralized production management, which dominated the initial stages of automation, required the use of extremely complex multiparameter and multiply connected control algorithms, for which the computing power of the existing computers was insufficient [1–2].

The emerging contradiction in the creation of an effective system of algorithmic support led to the need for a transition to a decentralized distributed control system in which individual problems of industrial production could be solved with a certain degree of autonomy by local means of automated or automatic control. This approach was realized due to the appearance of personal computers and the extensive use of industrial logic controllers [3].

However, any decentralization of management can remain effective only within certain limits. Fundamental principles of the system approach required a new round on the way to the centralization of management. As a result, new production standards for enterprise management and production – (resource management) – ERP, ERP-II, MRP-II, EAM, etc., have emerged.

The development of appropriate algorithms for managing technological processes led to the creation of a concept of a human-machine interface, divided into SCADA (Supervisory Control and Data Acquisition) and DCS (Distributed Control System) technologies.

At the same time, various solutions were developed for the construction of an operational control system for the standard MES (Manufacturing Execution Systems).

Strategic changes in the principles of automated control of industrial production led to the corresponding changes in the structure of control algorithms. At the same time, if the content part of the algorithms for managing technological processes and production remained unchanged, then their optimization component underwent significant changes and resulted in a number of new developments, united by a common APC (Advance Process Control) methodology [4].

General processes of globalization of systems and increasing their openness updated in recent years, the establishment of information management systems in industrial enterprises, where the global Internet network has come, local and corporate networks have been developed and technological and technical systems are being upgraded. These processes have triggered a request for comprehensive information on the various aspects of the industrial enterprise's activities– the information that is needed to support the acceptance of decisions [5–7].

To reflect on the practical implementation of the current methodology for the construction, implementation and operation of integrated information management systems in the chemical and oil and gas industries, in Uzbekistan, a class of full-featured integrated advanced Management Systems (Advance Process Control) with MMI/SCADA (man Mashine Interface Supervisory) management technologies control and data Acquisition is a man-machine interface/data collection and dispatch management system within a distributed multi-tier architecture.

Modern chemical and petrochemical plants are complex, multifunctional enterprises, where the main production facilities are interacting and the main production of auxiliary, but not secondary, facilities, services and installations.

The various automation systems (automated PI, automated power, automated warehouse, automated sale, automated personnel, CAM) are an integral part of ensuring and supporting the functioning of modern production, with the ultimate aim of providing a factory-level solution to the problems of efficient production.

These include the operation and development of the enterprise, taking into account the changing operating conditions, both in terms of market conditions, environmental conditions and internal (need to upgrade aggregates, automated pi, reengineering of management tasks and business processes) [8].

The system and interrelatedness of the various aspects of the enterprise's activities are becoming increasingly important in addressing these problems.

Typically, by displaying a hierarchy of enterprise automation systems, a single pyramid is drawn, based on the field automation system, above the technology systems (material flow management). At the very top, the ERP system (resource management), in the middle of MES, is the system (operation and Dispatch control).

Many specialists, considering such management as valid only in the analysis of local technical problems, are of the opinion that at least three pyramids should be used in the definition of the class of the Factory Information Management System). The Automated field of control is presented in the form of a broad ring, on the outside of which the three types of automation object space is located– the main production that provides the economic and social sphere of the enterprise. Within the ring there is a field of management decision, making that takes into account the full range of criteria – technological, technical, economic and social.

Such pyramids reflect vertical hierarchical relationships. The closer you get to the center of the circle, the fewer the links, the Pyramid narrows, but the more saturated and intense the horizontal function constraints become, the more difficult the tasks are. While there are almost one crochet measurement and management tasks on the periphery of the automation circle (sufficiently robust in local closed systems, tested instruments and known algorithms), the center is the assessment and management tasks that require complex algorithms.

The problem of creating control systems based on the use of modern analytical information technologies and oriented on the use of complex mathematical tools for the analysis of multidimensional situations, to forecast their development and to develop optimized recommendations is still a topical IIMS [9].

In order to address design problems, management analysis, development forecasts, new approaches are needed, and more sophisticated technical and integrated research is being developed.

Existing technical solutions Honeywell provide the ability to create a single integrated information management system (IIMS) for complex production [10].

An analysis of the development of modern systems and means of industrial automation highlights a number of trends in this area of science and technology that can be used to anticipate possible areas where the most important changes will occur in the near future. Among the major trends in the development of automation systems and tools are the following.

Widespread dissemination of industrial networks for "field" automation devices, which are digital sensors and converters, actuators, frequency-controlled transmission devices and other equipment [3]. The main trend here is the constant increase in built-in artificial intelligence, which previously provided for the normal conversion of an analog signal into a digital network. Digital functions are now increasingly complicated:

- Solving the complex processing problems of multiple signals simultaneously;
- inline calibration, self-diagnose and maintenance of the actual state of automation equipment [11].

In the near future, it is to be expected that an important leap forward is the establishment of "field" regulators. You can see that the digital part of the actuator spends the broad functions of traditional regulators, whose statutes come from the top-level subsystems of the management hierarchy. Such solutions allow a fairly successful transition to a truly distributed management system. The emergence of management systems of this architecture provides a significant increase in the reliability and vitality of the control, lowers the cost of the control controller by reducing the need for I/O modules, and dramatically reduces the need for cable products.

An important phenomenon is the emergence of the latest models of digital sensors with radio output. This solution offers significant benefits, ranging from cable savings to significant reductions in capital costs for new construction. However, developers will have to solve a number of problems related to immunity, security of information from unauthorized access, etc.

At present, the boundaries between control and telemechanic can be observed. Modern industrial automation tools allow for the creation of both classical controls and systems for the management of geographically distributed objects on the same software and hardware. However, a specific feature of the control architecture is the inclusion of additional hardware in the tap, such as locks, communications servers, protocol converters, etc.

An important trend in the development of automation systems is the need for one enterprise to integrate itself into a single information system of control and diverse, yet local, energy accounting systems.

Integration is now carried out on heterogeneous software through the creation of a separate subsystem of automated. This approach brings together a variety of devices for the commercial accounting systems of different producers with individual exchange protocols, which is an extremely laborious work. The solution to the problem is to increase the intelligence of digital multiparametric sensors.

A significant increase in the requirement for integrated Automation of Energy and Electrical Equipment (AEEE) is a feature of the recent stages of industrial development. In this regard, the task of integrating the control and AEEE enterprises into a single information system has come to the fore. As long as these types of control are created in a very different way, a tap should be expected to allow a homogeneous set of software and technical tools to configure both control and AEEE [10, 12].

One of the most important ways to significantly increase the efficiency of industrial enterprises is to create integrated enterprise management systems covering all levels of management (from process to finance) and operating in real time. The challenge is to implement the classic enterprise management Pyramid, which includes ERP levels, MES, DCS (Control), covering the automation of all business processes of the enterprise [13]. However, in the practical solution of this task, it has been found that the pyramid needs to be given another level– the level of consolidation of real-time data across the enterprise as a whole. Systems at this level should ensure that data are collected, preprocessed and archived from the grassroots automated and many others. It is likely that new and increasingly improved, competing software from leading producers will emerge in the near future to address this pressing issue.

In recent years, another new area of activity has emerged for professionals in the MES system (Management Enterprise Systems), which implement core functions ranging from routine dispatch and the calculation of techno-economic indicators to resource and production planning as a whole [14–15].

There is now a trend towards a dramatic increase in the size of management systems new requirements for minimizing the total cost of systems, which can only be achieved by the emergence of innovative automation software (SCADA, PIMS-Plant Information System) that supports real-time distributed database operations. The task of implementing the project for the creation and implementation of such large-scale automated is not trivial in itself and requires strict adherence to modern international standards for project management.

The above trends do not exhaust all the many ways in which the systems and means of automation are being developed, but they are nevertheless paramount to the nearest time [16–17].

An example of a single integrated information Management System (IIMS) is the ISUB system at the Kandym (Uzbekisatan) gas complex, which is planned to be put into operation in 2018.

The basis of the IIMS in the proposed solutions from Honeywell is the software-hardware platform Experion.

The Experion platform contains many different integrated hardware and software solutions, depending on the needs of the management environment. The Experion architecture is highly scalable, and the need for a given system node is conditioned by the required characteristics of the system.

The Experion system supports most modern industrial communications protocols and has the necessary level of openness of interfaces required for integration with related systems and information systems of other business processes.

A unique feature of the Experion software platform is the complete seamless integration of industrial safety subsystems, including automated fire and gas detection and fire-fighting systems, as well as automated complexes of engineering and safety equipment.

For example, the technical solution Experion Industrial Security (EIS) is a top-level software-based platform that combines access control, video surveillance, real-time monitoring and verification, perimeter intrusion detection, employee health, and dynamic acoustic sensing. However, this classical model, which includes the main subsystems of the Security Engineering Complex (SEC), is not dogmatic. The Experion software and hardware platform provides maximum flexibility for interfaces and has a full range of tools to integrate the full spectrum of modern industrial safety subsystems.

The Human-Machine Interface (HMI), provided by the Experion system, ensures the efficient interaction of operational data in unstaffed situations. The system provides a complete set of software for signaling, monitoring of the state of the system's technical means, a set of standard displays for configuration and navigation throughout the system, and a versatile apparatus for configuring user displays.

Another interesting trend of modernity, also implemented in the Kandym Gas Processing Complex (GPC) project, is the information complex of the ASMP or MES systems.

ASUP is built as a system integrating subsystems that perform special functions related to individual business processes and to the work of individual business units.

The Kandym Gas complex's automated management system for the enterprise is designed to:

– Centralized operational control of production and auxiliary facilities of the Kandym group of Kandym gas plant deposits;
– Providing methodology and tools to improve the management of production processes for gas production, preparation, transfer and marketing of products, and to maintain reservoir pressure.

One of the ways to further modernize a modern industrial facility may be to output the enterprise information model to the information cloud Honeywell.

Although that the conceptual architecture of the Experion system is built on the basis of the classical model of information management systems, and yet the approach used to create the software and hardware of the Experion system is sufficiently flexible and adaptable to the rapidly changing scientific and technological advances.

The concept of the Industrial Internet of Things (IIOT) is becoming an increasingly frequent theme of the reports and reports of the world's scientific communities every day. The concept of IIOT solves the most pressing issues of improving the overall efficiency of equipment, reducing the cost of operating an enterprise, optimizing supply chains and increasing the productivity of processes at a fundamentally new level, fundamentally changing the approach to these issues.

And here, the decisions of Honeywell, which is also one of the pioneers in implementing the concept of the Industrial Internet of Things and a recognized international expert in the field of IT-applications for industrial enterprises, with a vast experience and an information resource for the comparative analysis of the models and modes of operation of various industrial enterprises, they have been at the forefront of scientific and technological thinking. For users who want to extract more value from their data without getting to expensive and long-running large data analysis projects, the analysis tools integrated into the Honeywell solution can easily detect abnormal patterns and automatically track them. And the tasks of optimizing the operation of equipment to improve its productivity and service life, through a package of Honeywell solutions, are performed by comparing the performance of the equipment and the efficiency of the tools in the various industrial plants and making the necessary recommendations to the users.

The market for industrial automation worldwide has become more attractive to organizations' investments. The use of robots in industrial controller mechanisms is an established trend. On the other hand, the way to increase the introduction of industrial equipment for control and automation is open, and in the global industrial automation market, there is an interesting and legitimate trend in the use of new innovations and technological solutions, including research and development in some of the rapidly growing industries, which then become an integral part in other directions.

Consider some aspects (A–D) of industrial automation, which are traceable to the world industrial automation market, and which can be defined as the basis for development trends (these are the dimensions of these companies, as: ABB Ltd. (Sweden), Honeywell International Inc. (United States), Siemens AG (Germany), Mitsubishi Electric Corporation (Japan), General Electric Company (USA), Schneider Electric SE (France), Rockwell Automation, Inc. (US), FANUC Corporation, the Mitsubishi Electric Corporation, Toshiba Machine Corporation LTD, Yokogawa Electric Corporation (Japan), Emerson Electric Company, Rockwell Automation, Inc.)

(a) A reduction in the proportion of human participation in the interfaces in many processes and production (which, on the one hand, results in the loss of jobs in many industries, but the availability of innovative research reveals the potential for industrial automation in the creation of jobs in other auxiliary segments, such as after-sales services, the installation of an automation system and the development of software for the management of industrial automation).

(b) The main parts (details) used in the industrial automation market are the drives, measuring sensors, tracking and tracing sensors, metering units, servos and DC engines, industrial communications systems and robotic levers. There is an increasing role for automation, and the presence of such automation devices is becoming more common in the coming years, as a programmable logical controller (PLC), programmable automation controller (PAC), or a production computer (industrial PC), which causes factors such as faster response times and higher performance when investing in production automation.

(c) On the basis of various types of automation, the world market for industrial automation segmented in such areas as distributed management systems (DCS, Distributed control System), programmable logical management systems (PLC, Programmable logic control system), machine vision systems, production systems (MES, manufacturing execution System), Human-machine interface (HMI, Man Machine Interface), movement control and data collection (SCADA, Supervisory Control and Data Acquisition), Product lifecycle Management (PLM , Product lifecycle Management), production asset management, numbered software-based routers (CNC, Computer numerical control), electronic control blocks (ECU, electronic control units), and other types. In addition, the world market for industrial automation segment (segments covered by the global industrial automation Market) is as follows: in the areas of automation and transport, metallurgy and mining, oil and gas, pulp and paper, hydropower, energy and electricity, chemical, material and food, measuring and control (for example, the demand for environment and construction technologies, heavy industry, energy) is growing rapidly [18].

(d) Regional perspectives on the Global Industrial Automation market: by region, the global industrial automation market is divided into five geographical areas, namely, North America, Europe, Asia and the Pacific, the Middle East and Africa, and South America.

Europe now occupies the bulk of the market, followed by the Asia-Pacific region, North America, the Middle East and Africa and South America. The Asia-Pacific region is expected to grow rapidly with the growth of trade with North America and Europe.

3. Conclusion

Note that as these technologies evolve, analysts can evaluate and evaluate various opportunities. Examples of risk are the use of these technologies, before their viability and use in specific areas is proven, in determining what is valuable and when to invest.

Basically, the information provided and the analytical information allow us to implement solutions to increase the productivity and efficiency of production processes for many industries and areas in the field of automation.

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