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Bachelors of Information Technology

INDUSTRIAL CONTROL

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What is Industrial Automation

In this module I intend to show which are the basis of industrial automation so that one knows what industrial automation is because it is important the operator in the industry and what are the main components of an automated system. At the end, we will recognize the main groups of sensors, actuators, controllers and HMI interfaces existing in the market and better understand how this set of components are added to form machines and automated equipment.

1 - Objectives of the Industrial Automation

The main objective of industrial automation is to create mechanisms that are capable of producing the best product at the lowest cost. Some objectives to be sought in the industrial automation projects are:

- Improving *productivity* of a company increasing the number of items produced per hour in order to reduce production costs and increase quality.
- Improve working conditions of people eliminating hazardous work and increased safety.
- Perform operations that would be impossible to control intellectually or manually.
- Improving the availability of products as it can provide necessary quantity at the right time.
- Simplify operation and *maintenance* so that the operator does not need to have great expertise when handling the production process.

2 - What is an Automated System?

The industrial automation system is a procedure by which the production tasks are performed by human operators are transferred to a set of technological elements taking into account possible contingencies which might occur while considering the safety and quality.

More and more industrial production, generation and distribution of energy, transport and many others require an increasing number of new systems and automated machinery. This is due to increased production, the lower costs of automation components and machines, the quality and stability of new products and the need to replace dangerous and monotonous work of operators.

In the past, automated systems were systems, which are controlled individually each process of a plant but over time, these systems have the ability to be opened to cover more processes to optimize operation of the entire plant. Currently, an automated system consists of two main parts:
Operational part

The operational part in industrial automation is a part of the system that acts directly in the process and is a set of elements that cause the machine to move and perform the desired operation. These elements which form the operating part is the drive and pre-drive devices as motors, cylinders, compressors, valves, pistons and also detection devices such as inductive sensor, capacitive sensor, vision sensor, an ultrasonic sensor, etc.

Part Control

That portion control is the programmable portion of the system is usually implemented with the help PLC (Programmable Logic Controller). In the past this logic was made with electromagnetic relays, timers, electronic boards and logic modules. Today, with the increased volume of data and electronic components, the most common is the use of PLCs and industrial computers to control machines and processes. PLC is considered the brain in the industrial automation, for he is able to communicate with all the components that make up this system in order to recognize the inputs, process logic and update the outputs at all times.

In the figure below, you can see better how an industrial automation system:

![Diagram](image)

In Figure the operator, who is the person operating the machine or process, view the information by the information output elements, makes its decisions and commands the input elements of order which in turn are processed by the control system. The control triggers pre actuators and actuators that interfere in the process and the sensors and transducers give the information to the control if everything is going according to plan. I will show below all the elements that make up each box shown in this figure.
3 - Sensors and Actuators

Just as humans need the senses to perceive what is happening around them in industrial automation machines need sensors and transducers to capture the information. In addition to measuring variables, these components must be able to distinguish the variation of certain magnitudes of the system and the actual physical state of other components.

The devices responsible for converting the physical magnitudes in electrical transducers are called. It is worth remembering here that the difference between sensor and transducer is that the sensor detects a variation in the medium and the transducer converts the variation in electrical magnitude. So we can say that many sensors are also currently transducers but not all transducers are sensors. The transducers can be classified according to the type of signal transmitted:

**Transducers Binaries:** With these devices is all or nothing. Or it is actuated or not (1 or 0). Some examples are: inductive sensor, contactor, capacitive sensor, limit sensor or level switches.

**Numerical Transducers:** Broadcast numerical values in the form of binary combinations (Gray, BCD, etc.). An example is the absolute encoder which reads the angular position of a winding drive where as the encoder rotates, it generates a binary combination that represents the amount of spins he gave, can this information be interpreted by the PLC.
**Analog transducers:** They provide a continuous signal proportional to the value of magnitude. Examples of this type are pressure transducers, temperature sensors, ultrasonic sensor for measuring distance or level Laser Micrometer and diameter measurements.

### 4 - Actuators and Pre Actuators

The actuator is the final control element in response to a command signal received, acts on the variation of the final element of the process. An actuator converts the energy connected to it in a useful automation for the industrial environment and they can be classified into electrical, pneumatic and hydraulic.

The electric actuators are suitable for rotating and angular movements, with or without speed control. These devices must be supplied with electric power to operate and some examples are DC motors, induction motors and servo motors.

The pneumatic actuators, on the other hand, are suitable for applications requiring short linear movements needed for example in transferring operations, cover assembly, grips, positioning products mats, etc. tires are called for need to be fed with compressed air.

Already the hydraulic actuators are used mostly when the force required is too high or when a machine idling requires precise control (even so, in the latter case, the hydraulic actuators tend to be replaced by servo motors). They are called hydraulic for being fed with fluid (hydraulic oil).
The actuators used in industry are more cylinders and alternating current motors and are most often controlled by PLCs or controllers. For example, the PLC can trigger a solenoid valve that releases the air to make the pneumatic cylinder to fire. On the other hand, the PLC can control one or contactor drive frequency so that the motors are driven. Even with all the control tools, you can still find actuators that are controlled directly by the operator.

Pre actuator term applies in cases where it is necessary a control signal amplification so that the actuator can be triggered. In the two examples I mentioned above we can identify pre actuators as the solenoid valve, the contactor and the inverter.

4 - Control System

As I said, the commands of the automated systems have undergone a revolution over the years has seen the development of new processors, devices with high storage capacity and HMIs with touch and remote start features. First, let's understand how it all started with wired technologies and logic modules to evolve to the PLCs and computers.

**Wired technology**

It consists of interconnecting relay with the input and output devices so that the logic can be designed with combinations of series or parallel elements so that the operator is created. These elements can be relays, valves or logic boards.

This was the first solution adopted in industrial automation, but with the passage of time was being abandoned by present drawbacks as little flexibility to accept future modifications or adaptations and the fact that this kind of demanded solution large spaces for lease of electrical panels. And you can imagine how these systems were expensive and difficult to carry out maintenance. Consider the case of a failure, you have to keep checking the logic relay by relay or find out which valve or plate was the problem.
In a simpler industrial automation at low cost, however, this solution may still be viable. Still should be analyzed as well as a PLC currently costs the equivalent of 20 relays or 8 valves and still have the advantage that you can set it the way you want, leaving the well lean solution.

Devices that can be used in wired technology are:

**Electromagnetic relays**

Electromagnetic switching relays have a very similar structure with a contactor wherein all the contacts are designed for the same current, which is generally low.

**Logic Modules Tyres**

If based on the use of compressed air, and elements such as solenoid valves, detectors, cylinders, pressure commands and pilot operated valves. The main advantage of this method is that it is not affected by electromagnetic interference. We also have applications in environments that need industrial automation, but the risk of explosion is high. Imagine an underground mine that need automation, but that any spark could cause an explosion. In this case, it can be implemented with the pneumatic technology, eliminating the risk of accident due to automatism.

Moreover, logical implemented with pneumatic technology require much space, producing noise in the environment and require air networks tablets supplied by compressors which obviously require maintenance, because the supply air should be constant and follow pressure and humidity patterns. In Figure below we can see some pneumatic elements being that the valves and blocks and cylinders can compose logical.

If you want to know software for simulation of pneumatic technologies, it is worth knowing the FluidSim available free at http://www.festo.com/didactic/.

If there is a need for more power and precision, the pneumatic technology are replaced by hydraulic, due to the fact that oil is an incompressible fluid. For you to better understand what I’m talking about, just pick up a syringe with air, cover the tip of it and tighten. Even without the air out, you can move the piston due to air compress, which does not occur with hydraulic fluid. Thus, the hydraulic
technology provides greater accuracy and supports applications requiring much larger forces as those required in hydraulic presses.

**Static Integrated Technology**

Plates are designed to perform a specific logic. Thus, after being designed, they are implemented in printed circuit boards and allocated in the industrial automation system to perform its function. You can still see panels with logic boards in some industries with old equipment, but this technology is in disuse due to the evolution of programming components. As it is based on the use of integrated circuits and logic gates TTL and CMOS, can present some problems as needs of different voltage levels, are susceptible to electromagnetic interference and being inflexible because printed circuits can not be modified after implemented.

**Scheduled technologies**

Advances of microprocessors in recent years strongly favored the spread of programmed technologies and the expansion of automation and automated machinery. The actual equipment used for this purpose are:

**a – computers**

A computer as part of an industrial automation control has the advantage of being highly flexible process modifications and secondly to have been specifically designed for industrial environment has the disadvantage of being brittle when placed in the production line. For this reason they were developed industrial computers with more robust and withstand aggressive environments. The only downside currently observe that some companies not to employ industrial computers in control is that your job requires teams with IT knowledge, automation and processes. However, this situation is changing rapidly with the concept of industry 4.0 that has in one of its premises fusion of automation technology (AT) with information technology (IT).
As I said before, the CLP is considered the brain of industrial automation to control equipment and processes. Its advantage is that it has the characteristics of a computer, but the difference has been specially designed for industrial environments of the cleanest to the most aggressive. Another advantage it has is that programming is more intuitive with the use of ladder logic (programming logic that reproduces the electrical diagrams into logical blocks and function blocks).

Another difference with respect to the computer, is that the firmware (software) of a PLC is very adapted to the management of faults and defects that may be internal damage, power failures or failed connections of the way cards to ensure the safety of people and facilities in case of failure. The PLC also has high flexibility due to the possibility of expansion inputs, outputs, and communication can also be performed with various industrial devices. The main advantages of PLCs are:

- Flexibility and adaptation to the process;
- They are standard hardware produced on a large scale;
- Small size;
- Structured and distributed control;
- Communication with different devices;
- They have simulation and debugging tools;
- They provide the possibility of online change;
- Easy installation and maintenance.

5 - Orders Input Elements

In industrial automation, input elements in order allow the operator to order a command to the system and can be classified into 2 categories:

**Binaries** are the simplest way to give the command. If the operator wants to operate, it can push the buttonhole and want to shut down, it can simply press the pushbutton again. Besides pushbuttons, switches and switches may be
used. Again, the torque is 1 or 0. If the button is pressed sending the signal 1, when unscrewed send a signal 0 to the control system.

**Numeric (or alphanumeric):** As the binary is yes or no, numeric allow the entry of any kind of information by numbers or letters. Some examples are the pots and keypads.

6 - *Information output elements*

Since the output elements of information in industrial automation are responsible for the control system of communication with the operator. The vast majority are visual elements such as flags and HMIs and screens as well as the input can also be classified in binary and alphanumeric categories. Below are some examples:

**Binaries:** provide information of yes or no, on or off and some examples are the flags, alarms or sirens;

**Numeric and alphanumeric:** Let the viewing numbers and texts and are very useful to view process data like levels, which is connected or not, what part of the process does not have adequate performance, etc. Some examples are LCD displays, monitors and HMI, and the HMIs allow both the viewing and the input information.
Automação industrial

O que é? 

- Busca sempre os últimos avanços tecnológicos
- Está continuamente em evolução
- Ligada diretamente com o mundo digital

O que é Automação industrial?

Podemos conceituar a automação como sendo a junção das ferramentas necessárias para produzir um determinado item, fazendo com que haja pouca ou nenhuma intervenção do trabalho humano.

Controle de Sistema Produtivo

É um processo em fluxos contínuos de produção que integra vários mecanismos para produzir um item.

Máquinas auto reguláveis

Com controle em feedback, estas máquinas apresentam alta performance e precisão em processos produtivos.

Computação

Máquinas eletrônicas computadorizadas e interconectadas.

Arquitetura de Automação

![Diagrama de Arquitetura de Automação]

Alguns Dispositivos de Controle

- CLP - controlador lógico programável: É um processador; ele é responsável por processar todas as informações coletadas em campo e realizar o controle de processo.
- Supervisor: É um software que apresenta aos operadores as informações coletadas através do CLP e dispositivos agregados.

Conclusão

Os sistemas de automação industrial são de fundamental importância em qualquer processo produtivo. Além de melhorar significativamente a produção, fornecem um maior entendimento do negócio e do ambiente fabril, possibilitando a empresa analisar, monitorar e controlar suas etapas produtivas.
Conclusion

As we can see, industrial automation systems are of fundamental importance in any production process as well as significantly improve production, provides a greater understanding of the business and industrial environment, enabling the company to analyze, monitor and control its production steps. Currently it is very common to use HMIs and SCADA systems that collect important information production and makes the database storage so that they can be analyzed by historians systems and BI tools (Business Intelligence). Also being an increasingly common reality in companies see this information integrated with management systems (SAP, TOTVS and Microssiga) as this integration greatly facilitates the generation of important indicators for business and increases the speed and agility in the decision-making company making it more competitive.
Bibliography


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