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INDUSTRIAL AUTOMATION WITH PLC

INDUSTRIAL AUTOMATION

Due to the rapid advances in technology, all industrial processing systems, factories, machinery, test facilities, etc. turned from mechanization to automation. A mechanization system needs human intervention to operate the manual operated machinery. As new and efficient control technologies evolved, computerized automation control is being driven by the need for high accuracy, quality, precision, and performance of industrial processes.

Automation is a step beyond mechanization which makes use of high control capability devices for efficient manufacturing or production processes.

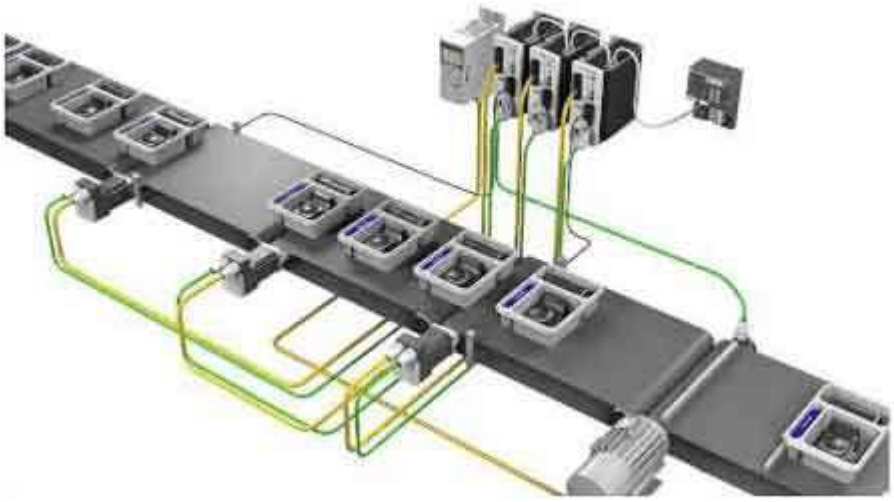
What is Industrial Automation?

Industrial automation is the use of control devices such as PC/PLCs/PACs etc. to control industrial processes and machinery by removing as much labour intervention as possible, and replacing dangerous assembly operations with automated ones. Industrial automation is closely linked to control engineering.

Automation is a broad term applied to any mechanism that moves by itself or is self-dictated. The word 'automation' is derived from ancient Greek words Auto (means '*self*') Matos (means '*moving*'). As compared with manual systems, automation systems provide superior performance in terms of precision, power, and speed of operation.

In industrial automation control, a wide number of process variables such as temperature, flow, pressure, distance, and liquid levels can be sensed simultaneously. All these variables are acquired, processed, and controlled by complex microprocessor systems or PC based data processing controllers.

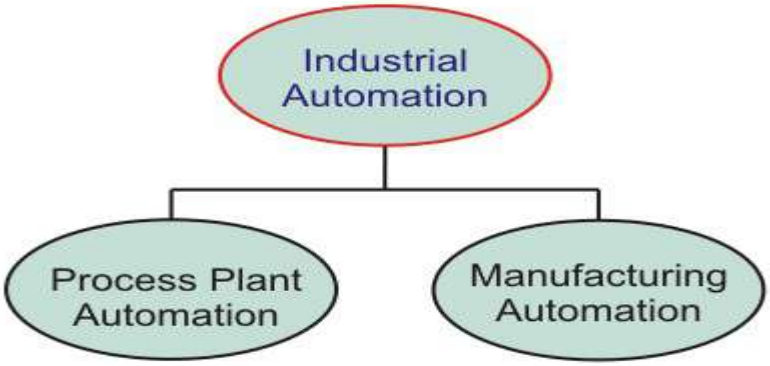
Control systems are an essential part of an automation system. The various types of closed-loop control techniques ensure the process variables to follow the set points. In addition to this basic function, the automation system employs different other functions such as computing set points for control systems, plant start up or shut down, monitoring system performance, equipment scheduling, etc. The control systems combined with monitoring adapted to the operating environment in the industry allow for a flexible, efficient, and reliable production system.



The automated system needs special dedicated hardware and software products for implementing control and monitoring systems. In recent years, a number of such products have been developed from various vendors which providing their specializing software and hardware products. Some of these vendors are Siemens, ABB, AB, National Instruments, Omron, and so on.

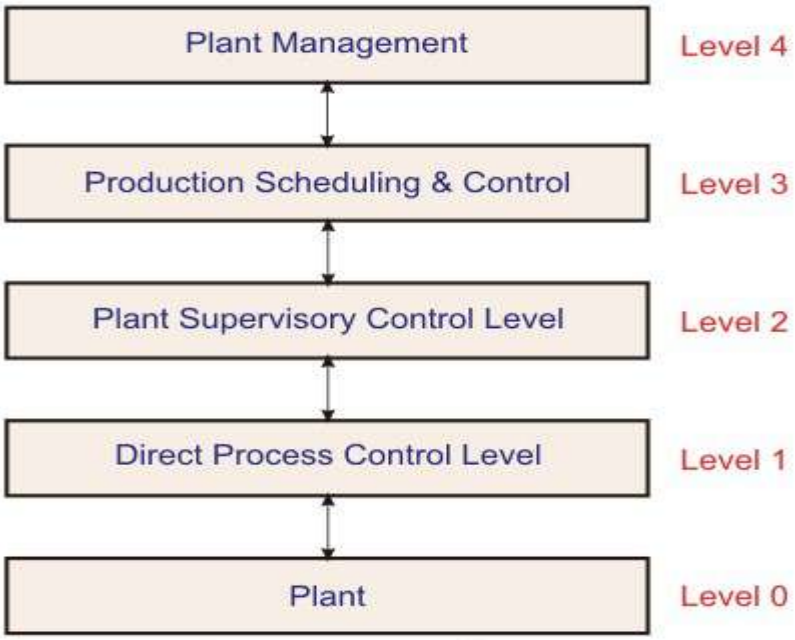
Types of Industrial Automation:

Industrial automation is the use of computer and machinery aided systems to operate the various industrial operations in a well-controlled manner. Depends on the operations involved, the industrial automation systems are majorly classified into two types, namely process plant automation and manufacturing automation.



Process Plant Automation:

In process industries, the product results from many chemical processes based on some raw materials. Some of the industries are pharmaceuticals, petrochemical, cement industry, paper industry, etc. Thus the overall process plant is automated to produce the high quality, more productive, high reliable control of the physical process variables.



Process Plant Automation System Hierarchy

The above figure shows the process automation system hierarchy. It consists of various layers representing widespread components in a process plant.

Level 0 or Plant: This level consists of machines that are closest to processes. In this, sensors and actuators are used to translate the signals from the machines and physical variables for the purpose of analysis and to produce the control signals.

Direct Process Control: In this level, automatic controllers and monitoring systems acquire the process information from sensors and correspondingly drives the actuator systems. Some of the tasks of this level are-

- Data acquisition
- Plant monitoring
- Dara checking
- Open and closed-loop control
- Reporting

Plant Supervisory Control: This level commands the automatic controllers by setting the targets or set points. It looks after the control equipment for optimal process control. Some of the tasks of this level are:

- Plant monitoring performance
- Optimal process control
- Plant coordination
- Failure detection, etc.

Production Scheduling and Control: This level solves the decision-making problems like resource allocation, production target, maintenance management, and so on. Tasks of this level include:

- Production dispatch
- Inventory control
- Production supervision, production reporting, etc.

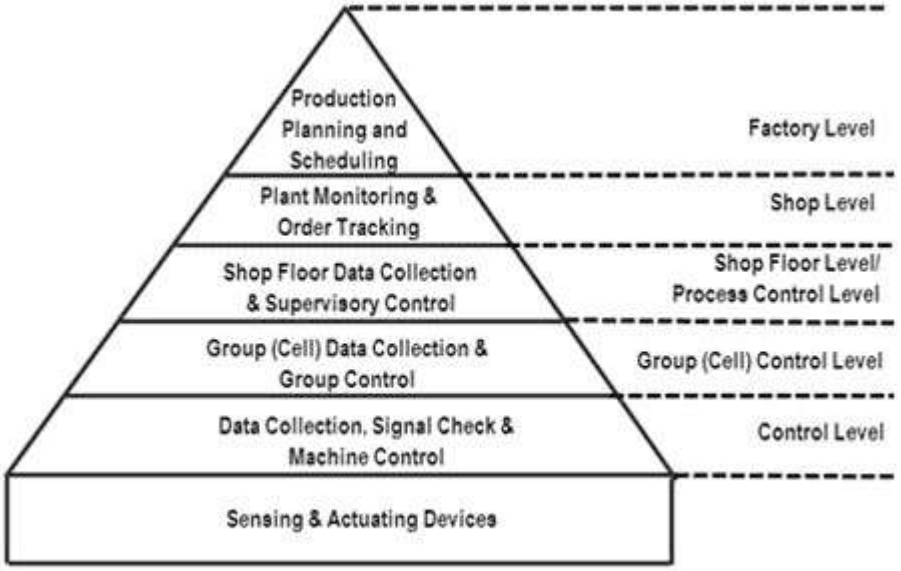
Plant Management: This is the higher level of the process plant automation. It deals more with commercial activities than technical activities. Tasks of this level include-

- Market and Customer analysis
- Orders and sale statistics
- Production planning
- Capacity and order balance, etc.

Manufacturing Automation System:

The manufacturing industries make the product out of materials using machines/robotics. Some of these manufacturing industries include textile and clothing, glass and ceramic, food and beverages, paper making, etc. New trends in manufacturing systems have been using automation systems at every stage such as material handling, machining, assembling, inspection, and packaging. With computer-aided control and industrial robotic systems, manufacturing automation becomes very flexible and efficient.

The figure below shows the manufacturing automation system hierarchy in which all functional levels are automated by using different automation tools.



Manufacturing Automation System Hierarchy

Below is an explanation of each level in the manufacturing automation system hierarchy:

Machinery Level: In this level various sensing and actuating devices controls the manufacturing process. It is an instrumentation level of machine control. Tasks of this level include data collection, signal check, and machine control.

Cell or Group Level: This is another automation level at which the operation of a group of machines within manufacturing cells are co-ordinated. Various automated controllers like PLCs are employed for such control of machines.

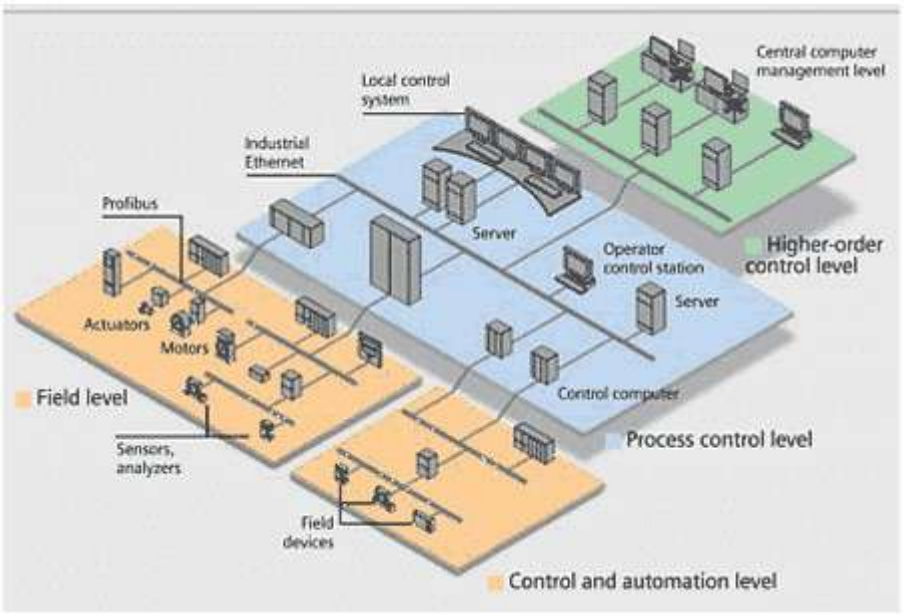
Shop Floor Level: It is a supervisory automated level where supervision and coordination of several manufacturing cells are carried out.

Plant Level: This automation level performs the activities of production monitoring, control, and scheduling, etc. HMIs employed at this level facilitate control of all the manufacturing process variables remotely.

Enterprise Level: This level does all the management related activities such as production planning and scheduling, etc.

Industrial Automation Equipment:

Industrial automation (IA) is an integrated, flexible, and low-cost system platform that consists of various equipment and elements which perform a wide variety of functions like sensing, control, supervision, and monitoring related to industrial processes. The figure below shows the structure of industrial automation which describes the various functional elements of IA.



Sensing and Actuating Elements:

The_sensors or sensing elements convert the physical process variables such as flow, pressure, temperature, etc. into electrical or pneumatic form. Various sensors include thermocouples, Resistor Temperature Detectors (RTDs),_strain gauges, etc. The signals from these sensors are used for processing, analysing, and decisions in order to produce the control output. The various control techniques are implemented to produce the required output by comparing the current sensed process variable with set values. Finally, the controllers produce the computed outputs and are applied as electrical or pneumatic signal inputs to the actuating elements. Actuators convert the electrical or pneumatic signals to the physical process variables. Some of the actuators include control valves, relays, motors, etc.

A special category of the instruments is smart instruments which are integrated systems of sensing or actuating elements with the capability of communicating with field buses. These smart devices consist of a signal conditioning circuit internally and facilitate connecting directly to the communication link in the industrial bus system.

Control System Elements:

These are the microprocessor-based electronic controllers or simply industrial computers that accept the signals from various sensors as well as command signals from supervisory systems or from human operators. These controllers can be continuous control systems or sequential/logic control depends on the structure of control nature. The controller processes the sensing values and supervisory values and depends on the control structure, it produces the control output to various actuating devices.

A modern type of control device used in automation systems is the Programmable Logic Controller (PLC). PLCs come with dedicated software so that these are capable of being programmed to perform corresponding control operations. PLCs have rugged CPU, digital I/O, analog I/O, and communication modules such that they can operate at industry environment conditions to control the various process parameters.

Human Machine Interface or operator interface is a graphical interface for the operators which displays the process information such as process variable status, logging results to the database, generating alarm signals, etc. SCADA is one of the graphical user interfaces which remotely controls industrial operations. Also, Distributed control systems (DCS) provide their own HMI for the graphical display of various industrial parameters.

Supervisory Control Elements:

Supervisory control performs higher-level control over the automatic controllers which further controls the smaller subsystems. The major elements of this level process station PCs, and Human Machine Interfaces. These process station PCs are responsible for functions like setpoint computations, performance monitoring, diagnostics, start-up, shutdown, and other emergency operations.

Human Machine Interface or operator interface is a graphical interface for the operators which displays the process information such as process variable status, logging results to the database, generating alarm signals, etc. SCADA is one of the graphical user interfaces which remotely controls industrial operations. Also, Distributed control systems (DCS) provide their own HMI for the graphical display of various industrial parameters.

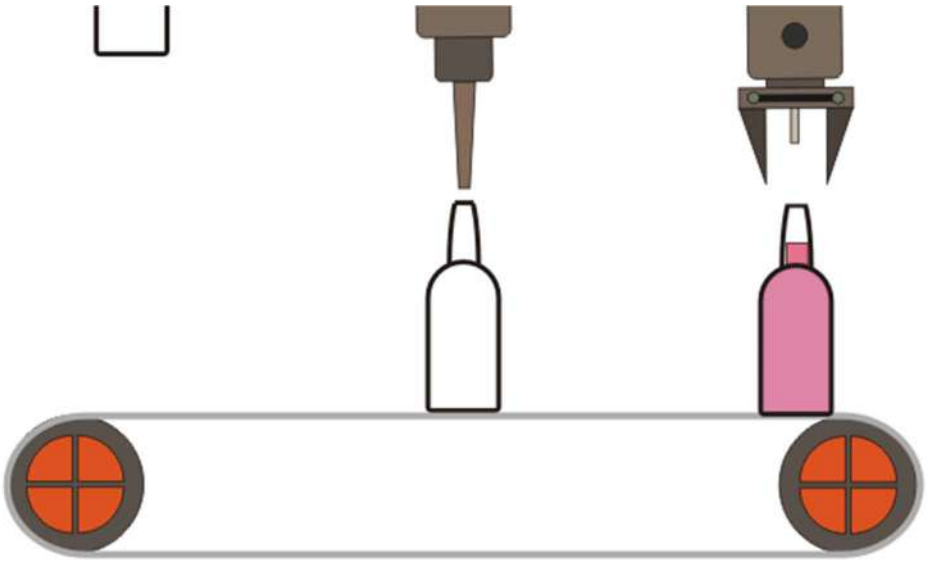
Advantages of Industrial Automation:

Manufacturers face many challenges in today's globally competitive business landscape. Some of these challenges include harsh manufacturing environments (*in a world which is increasingly focused on safety – and rightly so*), increasingly complex supply chains, meeting the latest energy efficient standards, and competing with companies with very small marginal costs. Many of these reasons drive manufacturers towards industrial automation. The advantages of Industrial Automation include:

- Increased labor productivity
- Improved product quality
- Reduced labor or production cost
- Reduced routine manual tasks
- Improved safety
- Assisted remote monitoring

Increased Labor Productivity:

Automation increases the production rate by producing greater output for given labor input. It is not possible for human workers to work for long hours without losing accuracy. On the other hand, without compromising on accuracy, automated control systems able to work for long hours. Hence increased productivity and efficiency per hour of labor input.



Improved Product Quality:

One of the chief benefits of automation is that the reduction of the fraction defect rate. With the manual operation of the manufacturing process, there may be a compromise on the quality specifications of the product. But the automation system performs operations with greater conformity and uniformity to the quality specifications. By using the automation systems, industrial processes are controlled and monitored at all stages in order to produce a qualitative end product.

Reduced Labor or Production Cost:

The automated systems help the industries to save a great deal in the long term by substituting automated machinery in place of human labor so that unit production cost is reduced. Automation equipment running smoothly or uniformly 24 × 7 not only increases productivity but also consequently results in an excellent return on investment by saving salaries, workforce costs, pensions, and costs with employees. The automated system also reduces the labor shortage by substituting automated operations in place of labor.

Reduced Routine Manual Tasks:

In many industrial applications, process variables like temperature, liquid level, pressure, etc. are to be periodically monitored as a routine task to maintain their set levels. Thus an automation system creates the automatic working condition by employing closed-loop control systems.

Improved Safety:

By implementing an automated system, work is made safer by transferring the worker from an active participation location in the process to the supervising role. The automated machines are able to work in hazardous environments and other extreme environments. Also, these systems make use of industrial robots in place of human workers, especially in life-threatening conditions (chemical and high-temperature conditions). Thus an industrial automation system prevents accidents and injuries to the workers.

Assist Remote Monitoring:

Most of the industrial operations have to be controlled remotely for convenient and long-distance monitor and control of process variables. For such cases, automated systems provide a communication link between the process area and supervising (monitor and control) area, thereby allowing operators to control and monitor the industrial processes from a remote location. The best example of this remote control is the automated electric power grid control.