Course of "Industrial Control System Security"
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Introduction – part 2

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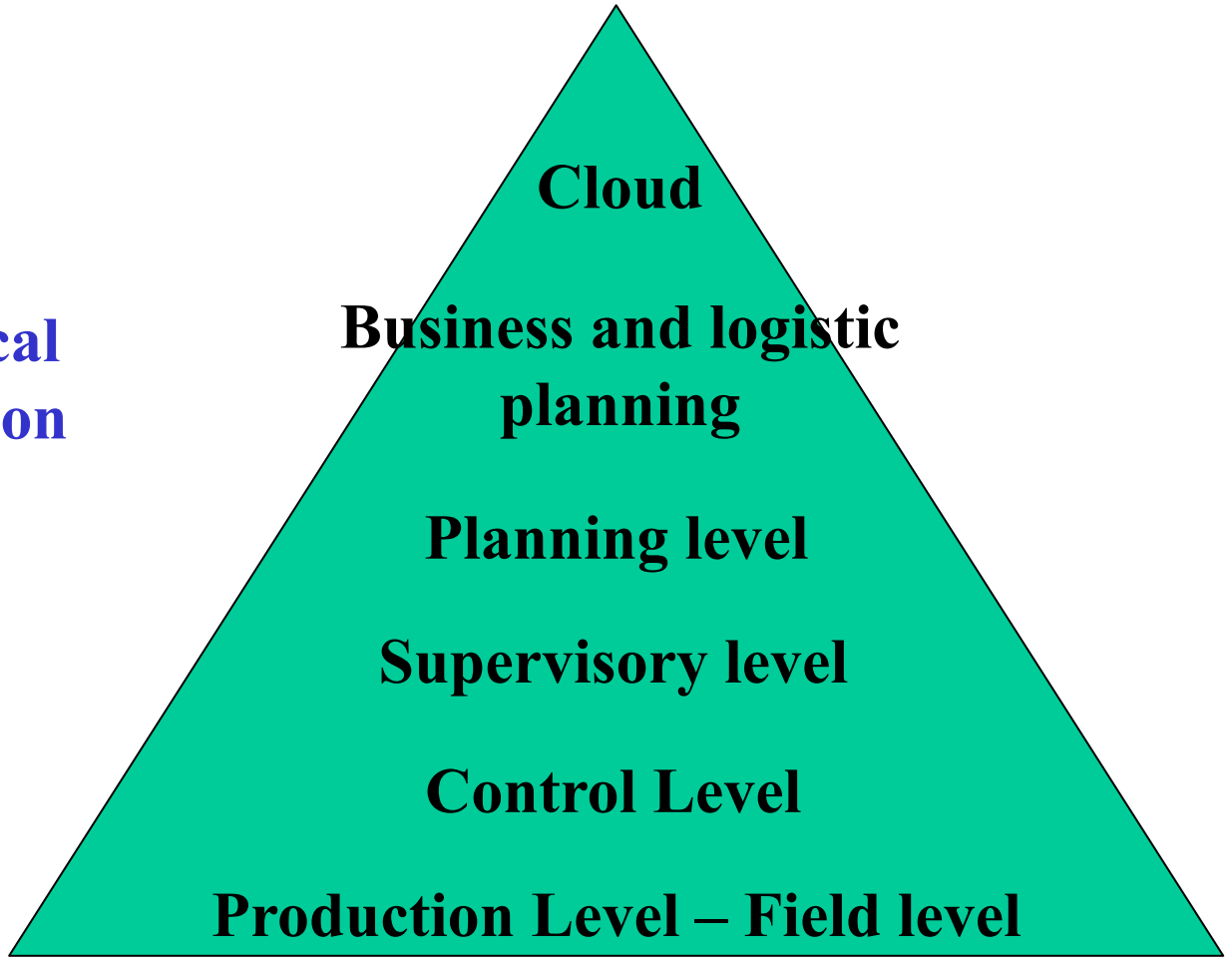
Team code: **09tkpu5**

Computer Integrated Manufacturing (CIM) approach

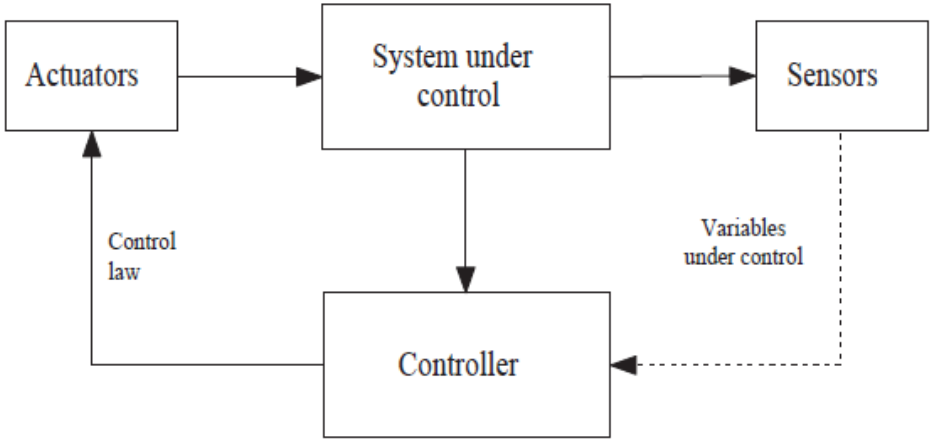
… using computers to control the entire production process

hierarchical organization



(Local) control system at field level: components

An active control system (manual or automatic) can be logically divided in three parts:



Sensors:

whose aim is to measure of the quantities of interest (related to the variables under control) in order to evaluate the behavior of the system under analysis

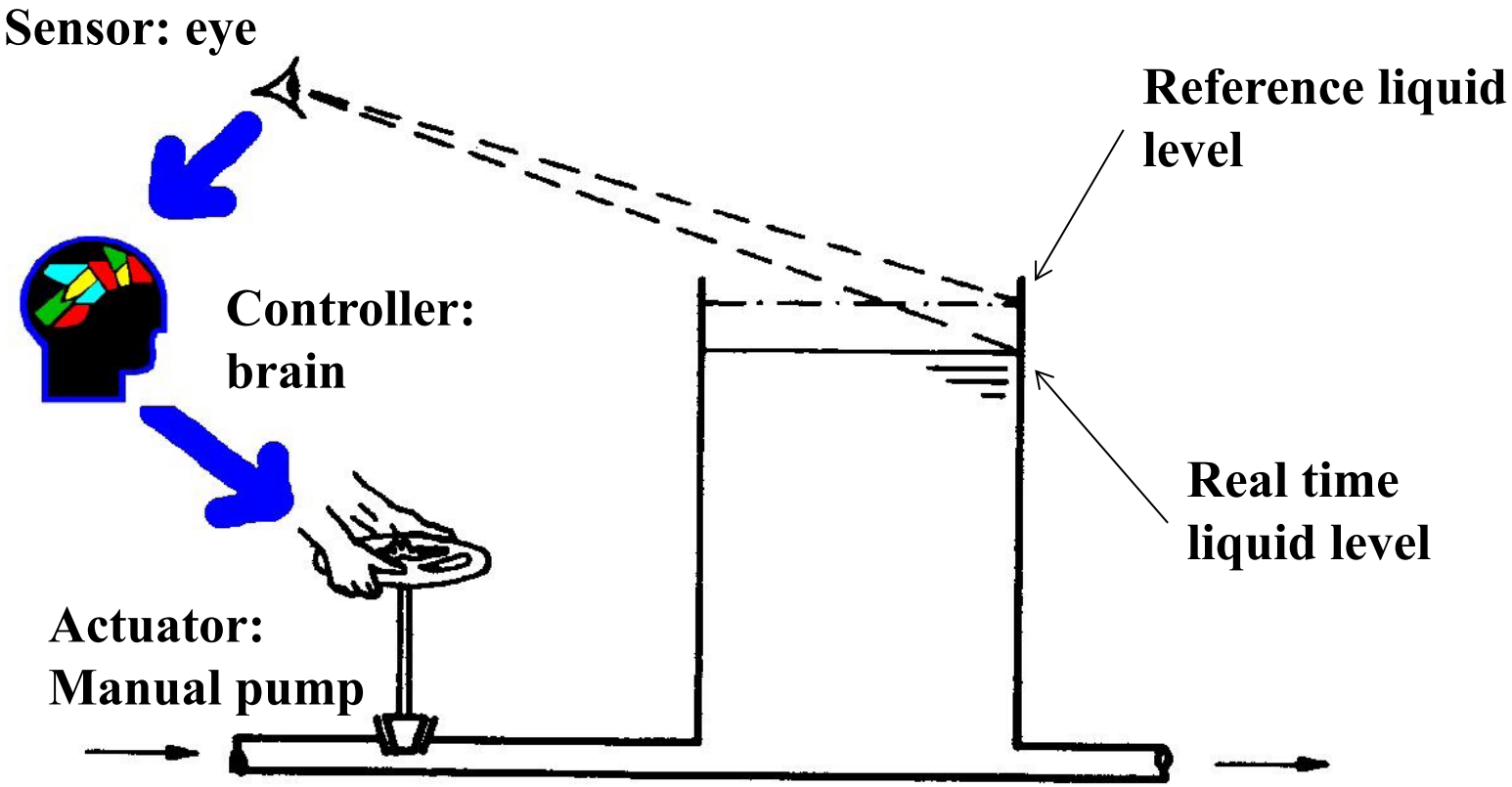
Controller:

whose aim is to impose the desired behavior to the system under control, making use of the values of the sensed variables (if available).

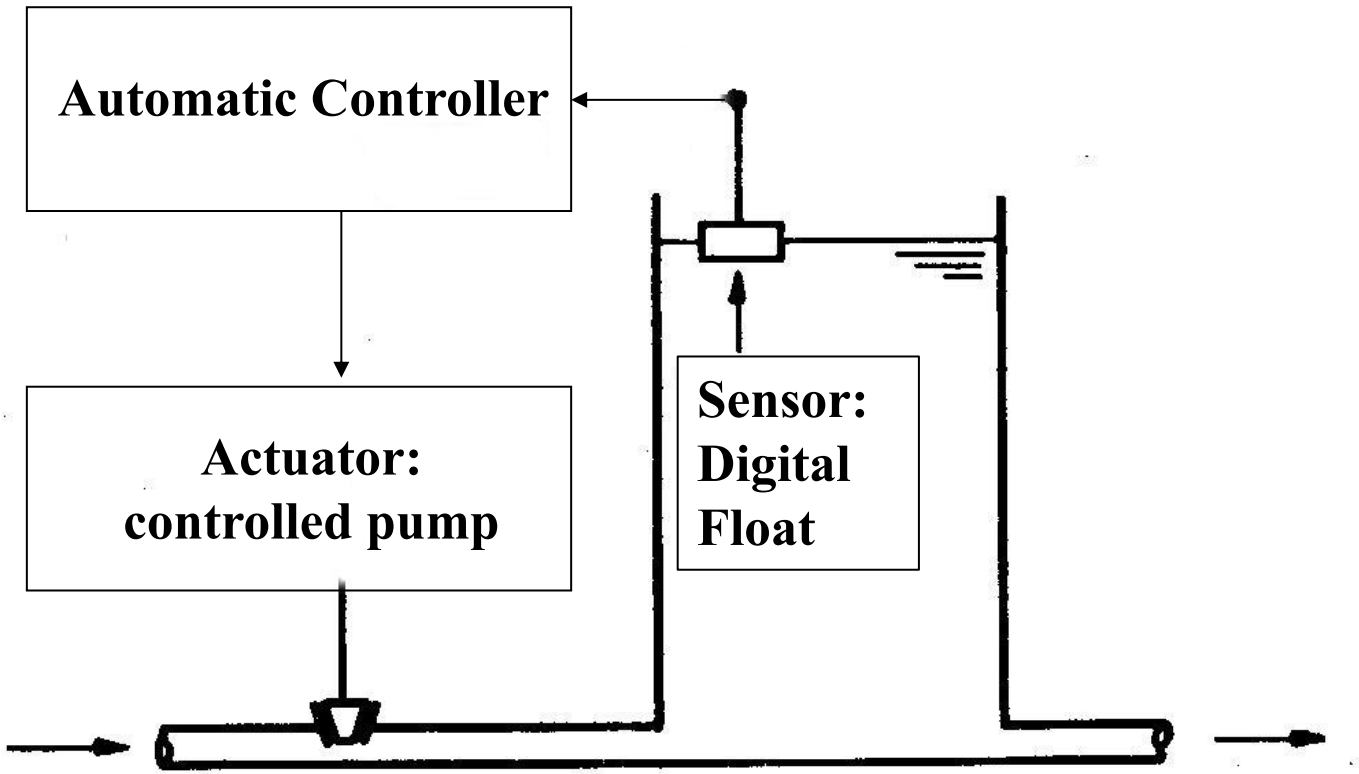
Actuators:

whose aim is to implement the computed control actions on a set of ***control variables*** (related but usually not coincident to the variables under control)

Example: Tank liquid level manual control



Example: Tank liquid level automatic control



...past issues

- Until the early 1950s, the spread of automation was limited by two factors:
  - The difficulty in creating control devises capable of executing complex algorithms.
  - The difficulty in making sensors, actuators and controllers communicate each other.
- Indeed, at first, controllers were made up of sophisticated mechanical or pneumatic devices, which allowed only the implementation of simple processing algorithms.

...nowadays

- New information technologies led to a revolution in automation systems.
- The availability of powerful, versatile and low-cost processing systems (microprocessors) allows the implementation of complex decision-making algorithms.
- The simplification of the exchange of information between the various devises of an automation system, via computer networks and the availability of "intelligent"/smart actuators and sensors, have made easier the problems of design and implementation, and therefore to reduce the costs of automation systems.

Automation methodologies and technologies

- Automation, as seen, is a science applied to the most different fields.
- So, is it possible to develop an automation discipline, or even an automation technology, with general characteristics rather than particular application context?
- In reality, despite the diversity of application contexts, it is possible to identify the existence of common features and problems among the various automated processes.
- It is with reference to these common characteristics that the methodologies and techniques of automation have developed.

Automation methodologies

- The goal of automation methodologies is the design, in abstract and formal terms, of the algorithms on which the control systems decide the actions to be performed on the process to be automated.
- This requires the choice of the quantities to be measured and the type of actions to be adopted on the system.
- Finally, the methodologies aim to evaluate, also in abstract terms, the performances achieved by the automated system.
- These methodologies provide with common approaches that can be applied to different problems.
- Obviously, knowledge of the main operating characteristics of the system to be automated is very important, but also the role played by automation methodologies is equally important.

Automation technologies

- The goal of automation techniques is the development of the physical devices that implement the sensors, the controllers, and the actuators.
- Sensors and actuating devises, which interface directly with the process, are closely linked to the application -> their choice, therefore, requires specific expertise on the process to be controlled.
- Regarding control devises, the use of Information Technologies (ITs) can now be considered consolidated, and this also due to the simplicity with which these devices can be made to communicate with intelligent sensors and actuators through appropriate communication networks.
- An in-depth knowledge of ITs is therefore to be considered an necessary skill for an automation expert.

Automation disciplines

- **Methodological disciplines** dealing with**:**
  - architectural design of the automation system (definition of the different control systems and their interactions);
  - design of control algorithms;
  - performance evaluation of the automation system.

Note that the design and performance evaluation are achieved in an theoretical way, using mathematical models of both the process to be regulated and the control devices (actuators, sensors, processing system and control algorithms).

A main role for designing the automatic control system is determined by "**Systems Theory**", which deals with the description of systems through mathematical models and the analysis of their behavior.

Automation disciplines

- **Technical disciplines** deal with the implementation of the automation system:
  - choice of measurement systems;
  - choice of actuation systems;
  - choice of hardware and application software of the processing system;
  - SW implementation of control algorithms;
  - assembly of the entire automation system;
  - commissioning of the system..

Course contents

- This teaching module will tackle issues concerning both automation methodologies and technologies.

As shown in previous slides, contents regarding methodologies of automation will tackle in the first part of the course, i.e.

- Analysis of linear dynamic system in the time and frequency domains.
- Key concepts in control: Negative feedback control systems, PID controllers.

Contents regarding automation technologies will tackle in the last part of the course, i.e.

- Industrial sensors and actuators, Programmable Logic Controllers, Control networks
- Systems for Monitor and Supervision (SCADA) - Cybersecurity model