Sistem Kendali
(Control System)

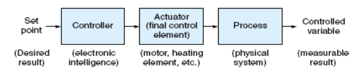
pendahuluan2

Prepared by AHA

Definisi Sistem Kendali

- Suatu sistem kendali terdiri atas sub sistem dan prosessnya yang dibangun untuk mengendalikan output dari proses tersebut.

Input; stimulus → Control system → Output; response
Desired response — Actual response



Sejarah Sistem Kendali dalamPeradaban Manusia

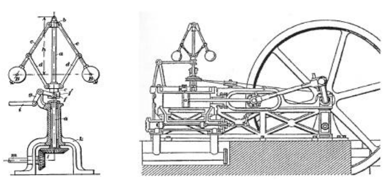
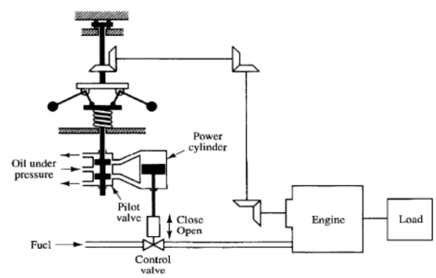
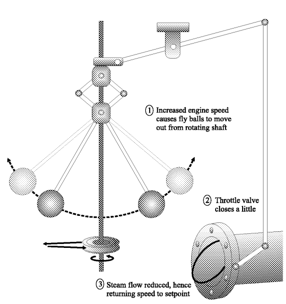


Figure 1.2: The centrifugal governor and the steam engine. The centrifugal governor on the left consists of a set of flyballs that spread apart as the speed of the engine increases. The steam engine on the right uses a centrifugal governor (above and to the left of the flywheel) to regulate its speed. (Credit: Machine a Vapeur Horizontale de Philip Taylor [1828].)



Watt's fly ball governor



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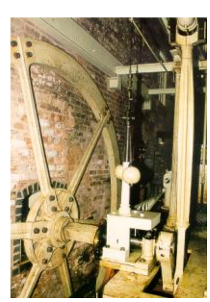


This photograph shows a flyball governor used on a steam engine in a cotton factory near Manchester in the United Kingdom.

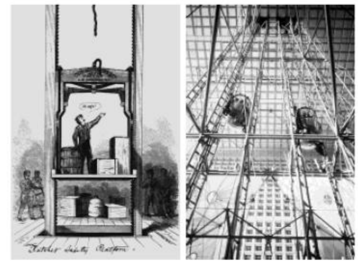
Of course, Manchester was at the centre of the industrial revolution. Actually, this cotton factory is still running today.

Watt's fly ball governor

This flyball governor is in the same cotton factory in Manchester.
However, this particular governor was used to regulate the speed of a water wheel driven by the flow of the river. The governor is quite large as can be gauged by the outline of the door frame behind the governor.

Elevator

a. Early elevators were controlled by hand ropes or an elevator operator. Here, a rope is cut to demonstrate the safety brake, an innovation in early elevators;
b. Modern Duo-lift elevators make their way up the Grande Arche in Paris, driven by one motor, with each car counterbalancing the other. Today, elevators are fully automatic, using control systems to regulate position and velocity.



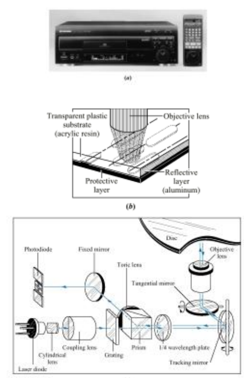
(a) (b)

Rover was built to work in contaminated areas at Three Mile Island in Middleton, PA, where a nuclear accident occurred in 1979. The remote controlled robot's long arm can be seen at the front of the vehicle.

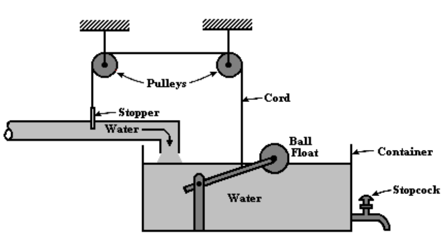
Photo © Hank Morgan/Rainbow/PNI.

a. Video laser disc player;
b. objective lens reading pits on a laser disc;
c. optical path for playback showing tracking mirror rotated by a control system to keep the laser beam positioned on the pits.

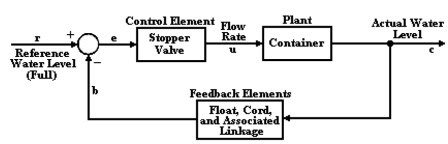
(c) Pioneer Electronics, Inc.



Simple water level control system



Block diagram representation



Control system integration

Success in control engineering needs to examine the following issues:

- plant, i.e. the process to be controlled
- objectives
- sensors
- actuators
- communications
- computing
- architectures and interfacing
- algorithms
- accounting for disturbances and uncertainty

Plant: The process to be controlled

The physical layout of a plant is an intrinsic part of control problems. Thus a control engineer needs to be familiar with the "physics" of the process under study.

This includes a rudimentary knowledge of the basic energy balance, mass balance and material flows in the system.

Control design objectives

Before selecting sensors, actuators or controller architectures, it is important to know the goal of the closed-loop control system: for example,

- what does one want to achieve (energy reduction, yield increase,…)
- what variables need to be controlled to achieve these objectives
- what level of performance is necessary (accuracy, speed,…)

Sensors

Sensors are the *eyes* of control enabling one to *see* what is going on.

Indeed, one statement that is sometimes made about control is:

If you can measure it, you may be able to control it.

Actuators

Once sensors are in place to report on the *state* of a process, then the next issue is the ability to affect, or actuate, the system in order to move the process from the current state to a desired state.

Controller architecture and algorithm

Finally, we come to the real *heart* of control engineering i.e. the algorithms that connect the sensors to the actuators. One should never underestimate this final aspect of the problem.

As a simple example from our everyday experience, consider the problem of playing tennis at top international level. One can readily accept that one needs good eye sight (sensors) and strong muscles (actuators) to play tennis at this level, but these attributes are not sufficient. Indeed eye-hand coordination (i.e. control) is also crucial to success.

Overall control systems

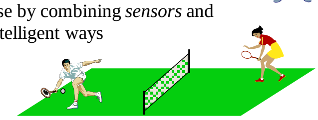
In summary, one can say that:

Sensors provide the eyes and actuators the muscle, but control science provides the finesse.

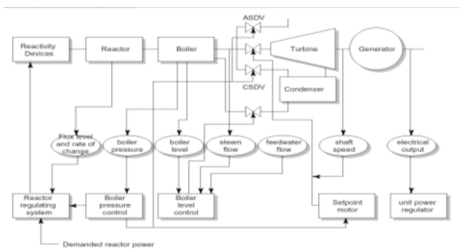
- **Better Sensors**
  Provide better *Vision*

- **Better Actuators**
  Provide more *Muscle*

- **Better Control**
  Provides more finesse by combining *sensors* and *actuators* in more intelligent ways



Control loops in a nuclear power plant



Process Control

Figure 1.7
A closed-loop oven-heating system.

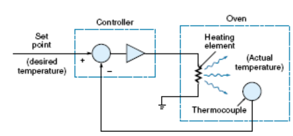
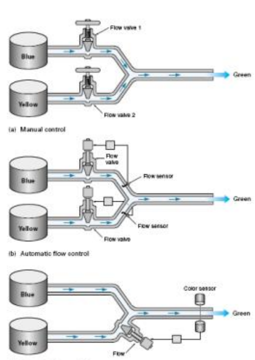
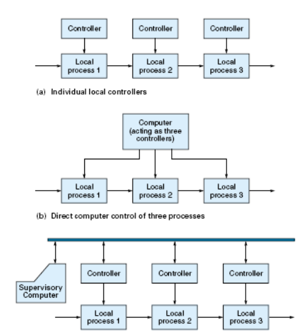


Figure 1.8
Process control in mixing paint.



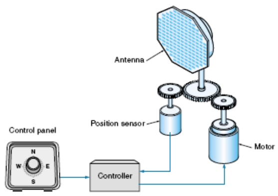
Process Control
In Mixing Paint

Figure 1.9
Approaches of multiprocess control.



Motion Control

Motion control is a broad term used to describe an open-loop or closed-loop electro-mechanical system wherein things are moving. Such a system typically includes a motor, mechanical parts that move, and (in many cases) feedback sensor(s). Automatic assembling machines, industrial robots, and numerical control machines are examples.

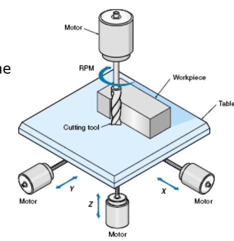


Remote Antenna Positioning System

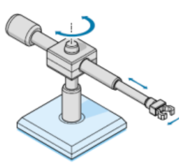
Numerical Control

- Numerical control (NC) is the type of digital control used on machine tools such as milling machines.

NC in milling machine

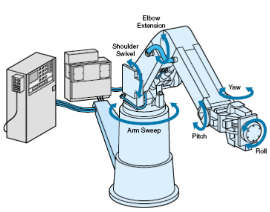


Robotics



Pick & Place robot

Large Industrial Robot



Perkataan Wilbur Wright
ke Western Society of Engineers th 1901 , yang mengilustrasikan peran teknik kontrol dalam pengembangan pesawat terbang

Men already know how to construct wings or airplanes, which when driven through the air at sufficient speed, will not only sustain the weight of the wings themselves, but also that of the engine, and of the engineer as well. Men also know how to build engines and screws of sufficient lightness and power to drive these planes at sustaining speed ... Inability to balance and steer still confronts students of the flying problem ... When this one feature has been worked out, the age of flying will have arrived, for all other difficulties are of minor importance