HARDWARE

Seneca

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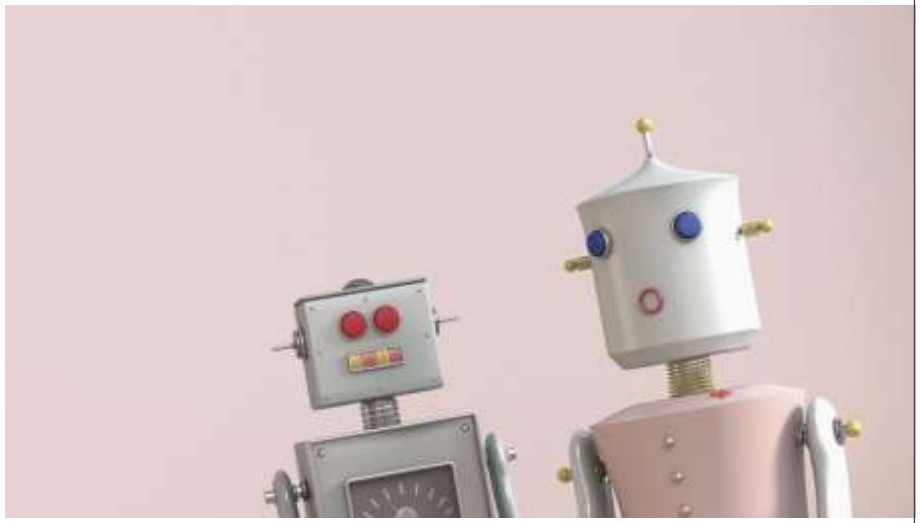
Summer 2022



Grounding Power Equipment

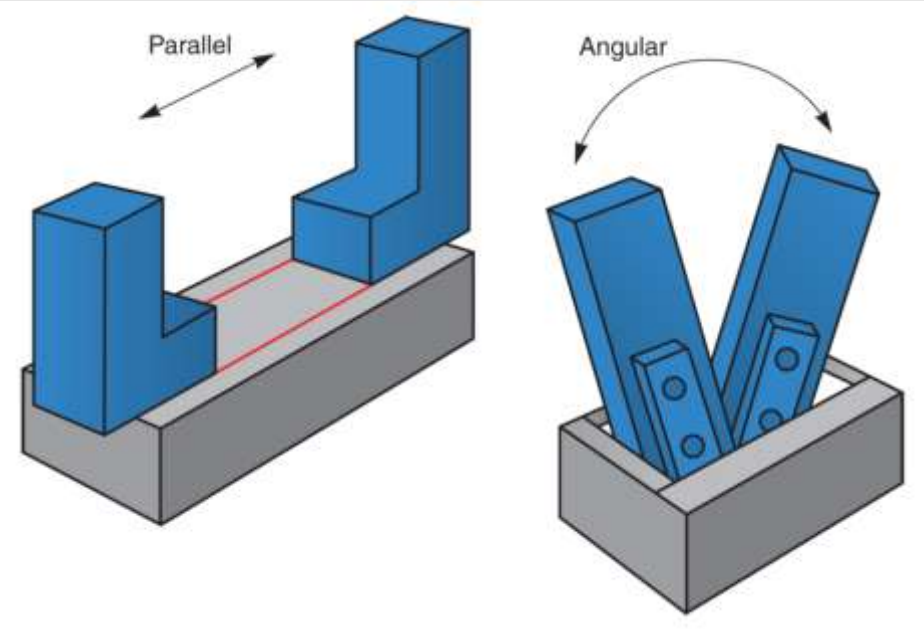
- Ground fault circuit interrupter (GFCI) turns off electrical circuit when safety hazard occurs

- Post safety rules in work area
- Wear required personal protective equipment

End-Effectors

The last link of the robotic arm that interact with the environment is called an end-effector.

Source: www.advancedmanipulator.com



Source: wikipedia.org/wiki/File:Endeffector.png

Classifications of End effector

- Two Major Classifications:

- Gripper
  - Mechanical Grippers
  - Collet Grippers
  - Vacuum Grippers
  - Electromechanical Grippers

- Tools
  - Welding Tools
  - Material Application Tools
  - Machining and Assembly tools

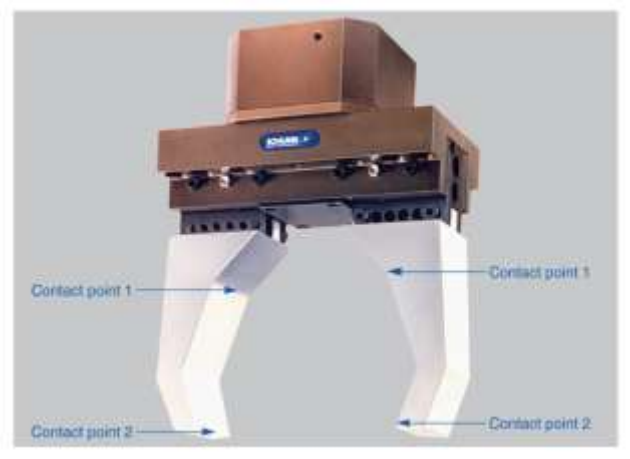
Gripper Types

Gripper End Effectors			
Gripper Type	**Gripper Configuration**	**Gripper Movement**	**Internal/External Gripping**
Mechanical finger	Two-finger Three-finger Four-finger	Parallel or angular	Internal and external
Collet	Round Square Hexagonal	360° clamping contact	Internal and external
Vacuum	One or more suction cups	Vacuum/suction	External
Electromechanical	Permanent magnet Electromagnet	Magnetic attraction	External

Goodheart-Willcox Publisher

Grippers

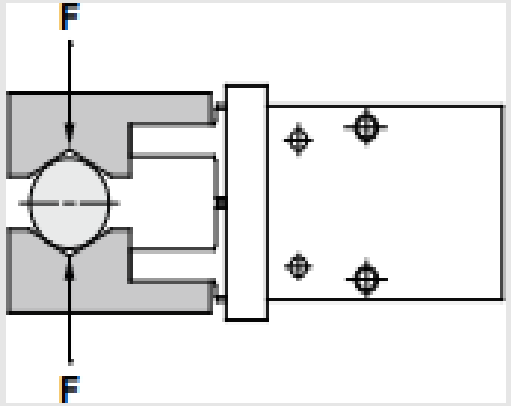
- V-shaped fingers with two points of contact on each finger



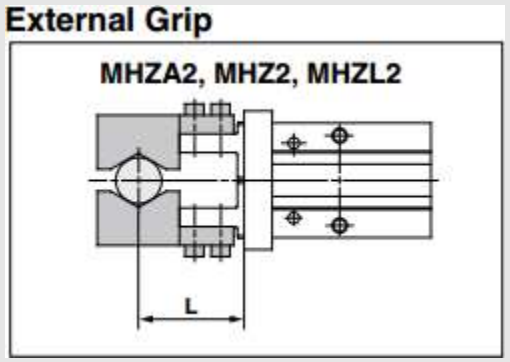
- Three-finger grippers
  - Human thumb, index finger, and third finger

Schunk-USA

GRIPPER FORCE

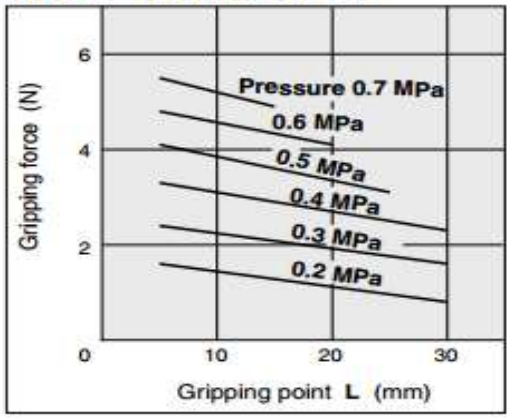


External Grip

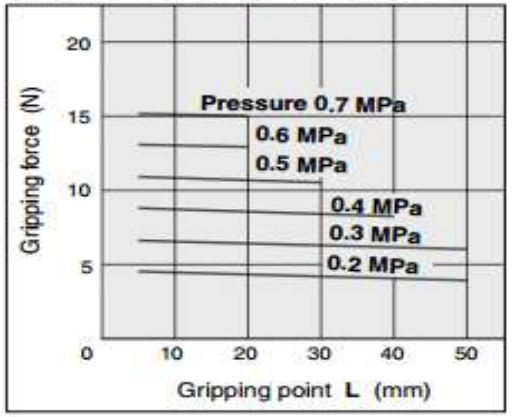


External Gripping Force

MHZ2-6D/MHZA2-6D

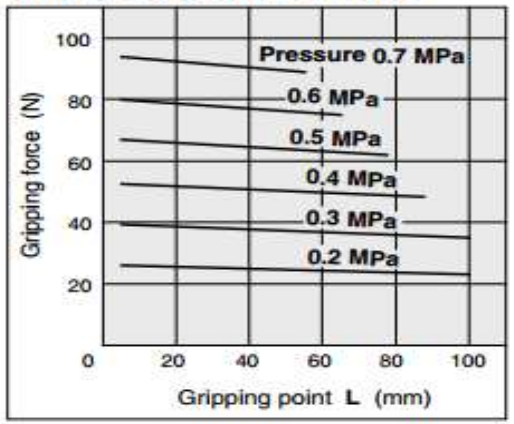


MHZ2-10D/MHZL2-10D

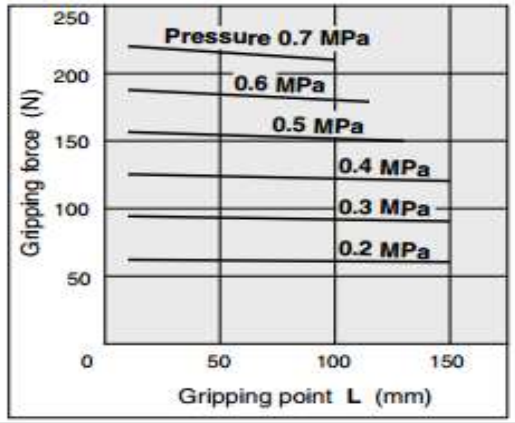


External Gripping Force

MHZ2-25D/MHZL2-25D



MHZ2-32D



Example 1

Calculate the 2-finger gripper force required to hold the mass of 5 Kg.
Consider coefficient of friction μ=0.2 and factor of safety (fos=4)?

Solution :

$$F = \frac{mg}{n\,\mu} \times fos \qquad F = \frac{(5)(9.8)}{(2)(0.2)} \times (4) = 490\ N$$

Where,
M = mass in Kg
G = gravitational accelerations
N = number of fingers
μ = Coefficient of friction
fos = factor of safety

Example 2

Calculate the force of a 2-finger gripper. If the gripper is holding a block of 5Kg and moving with an acceleration of $3\ m/s^2$. Consider the coefficient of friction $\mu = 0.2$ and factor of safety (fos) is 4

Solution :

$$F = \frac{ma}{n\,\mu} \times fos$$

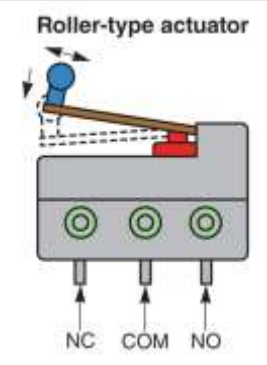
$$F = \frac{(5)(9.8+3)}{(2)(0.2)} \times (4) = 640\ N$$

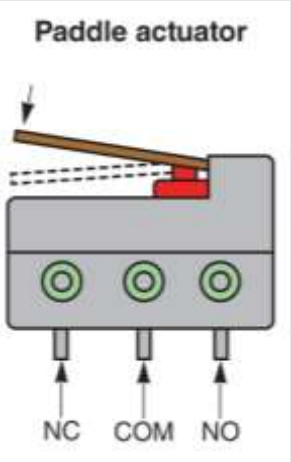
Where,
M = mass in Kg
G = gravitational accelerations
N = number of fingers
μ = Coefficient of friction
fos = factor of safety

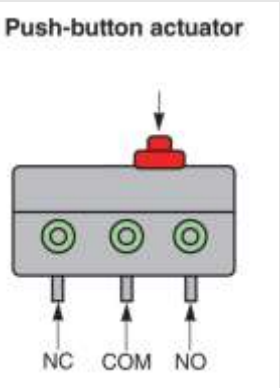
Note: If additional acceleration is given for moving the mass then
g = 9.8 + additional acceleration value

Proximity Sensors

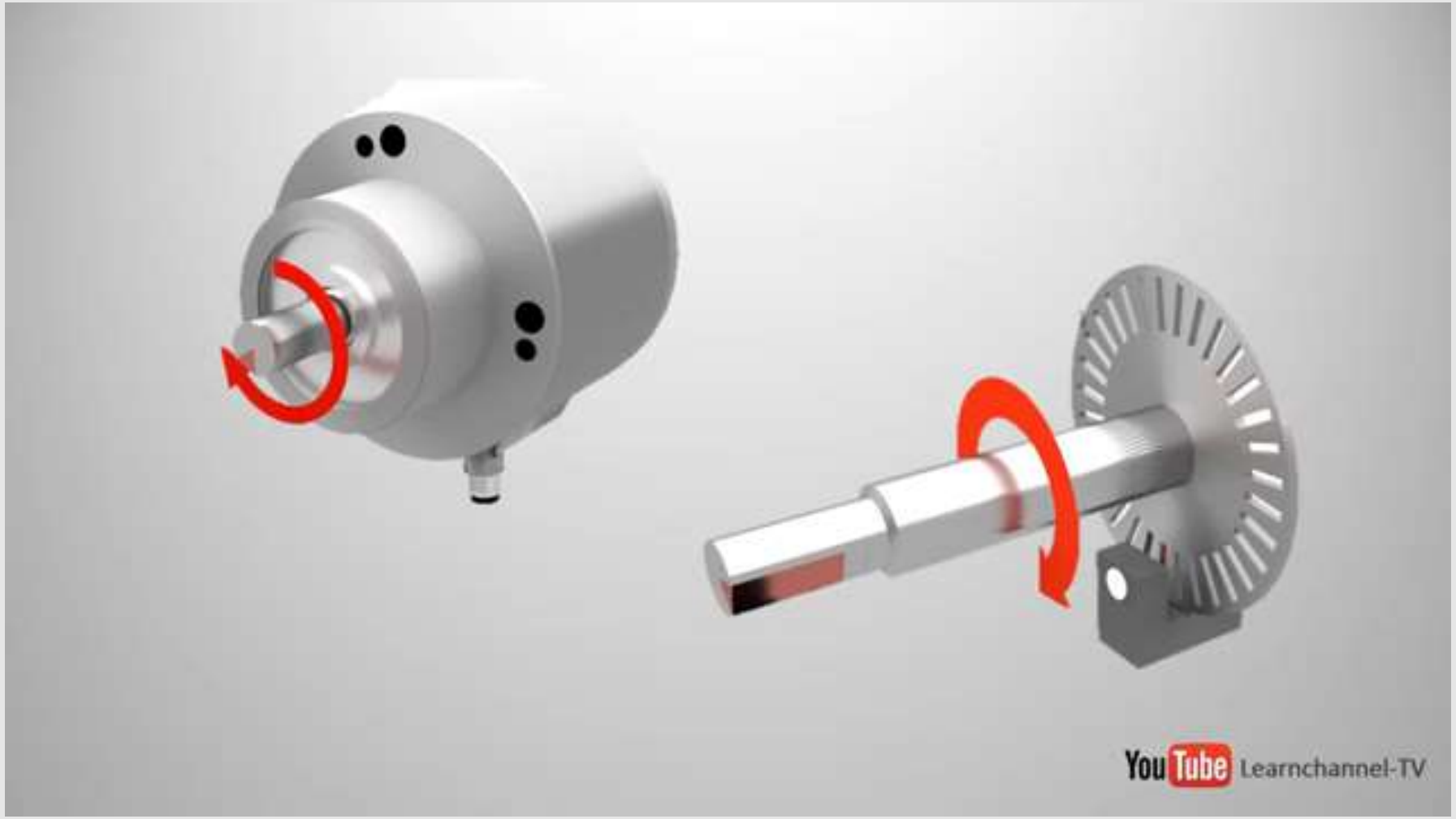
- Detect absence or presence of an object
- *Optical proximity sensors*
  - Measure light reflected from an object
  - Use incandescent lights or *light-emitting diodes (LEDs)*
- *Eddy current proximity sensors*
  - Magnetic field induces eddy currents into nearby conductive material
- *Acoustical proximity sensors* react to sound
  - Nearby objects interfere with sound waves
- *Touch-sensitive proximity sensors* react to capacitance
  - Changes frequency of an electronic circuit



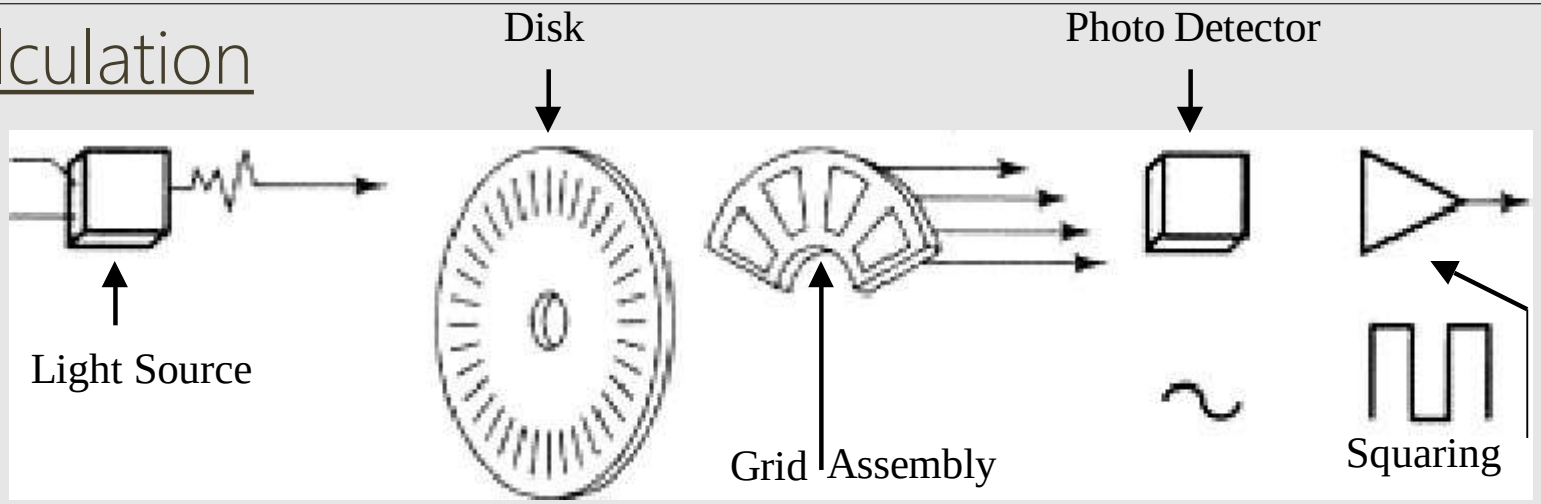




Encoder



Encoder Calculation



Question 1:
If an optical encoder has 8 slits and it gives 5 output pulse signals then determine the resolution of the encoder and angular displacement of the joint where the encoder is attached.

Answer:
R = 360 ° / number of slits = 45°
Angular displacement = R x number of outputs
= 45° x 5 = 225°

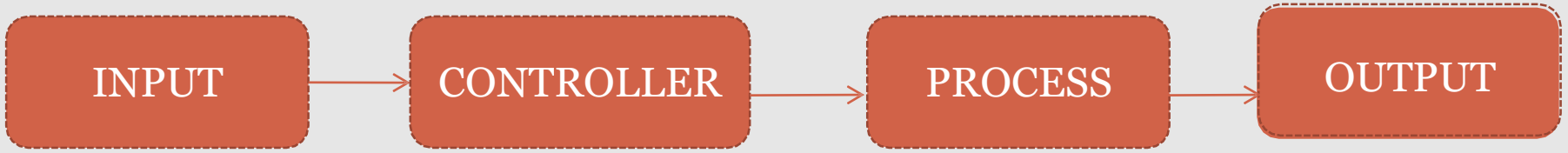
Question 2:
If an optical encoder has 10 slits and it is giving 200 output pulses in 2 minutes then determine the speed of the joint in rpm and rps.

Answer:
In one minute: 200/2 = 100 pulses / min.
In one complete revolution total pulses : 10
Therefore,
10 pulses = 1 rev (round).
100 pulses per min= 10 *rpm*
10 *rpm* = 10/60 = 0.16 *rps (round per second)*

Introduction on Controls

Open Loop Control System

A control system in which the control action is totally independent of output of the system then it is called **open loop control system**



Open loop Control system normally depends on time slice. Each action divides in set of times to produce the desire results

Example of Open Loop System

- **Electric Hand Drier –** Hot air (output) comes out as long as you keep your hand under the machine, irrespective of how much your hand is dried.
- **Automatic Washing Machine –** This machine runs according to the pre-set time irrespective of washing is completed or not.
- **Bread Toaster –** This machine runs as per adjusted time irrespective of toasting is completed or not.
- **Automatic Tea/Coffee Maker –** These machines also function for pre adjusted time only.
- **Timer Based Clothes Drier –** This machine dries wet clothes for pre – adjusted time, it does not matter how much the clothes are dried.
- **Traffic Signals**- Signals turn on or off irrespective the load of traffic

Advantages and Disadvantages of an Open Loop Control System

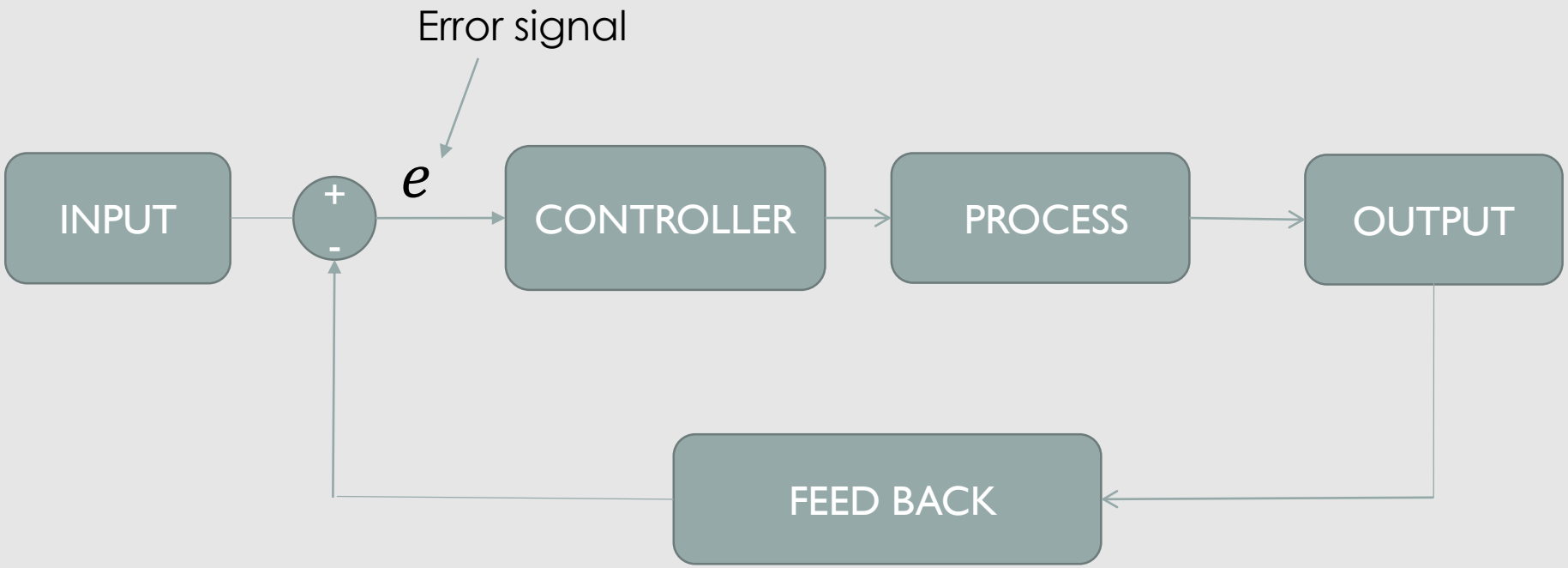
Advantages

- Simple in construction and design.
- Economical.
- Easy to maintain.
- Generally stable.
- Convenient to use as output is difficult to measure.

Disadvantages

- They are inaccurate.
- They are unreliable.
- Any change in output cannot be corrected automatically.

Close Loop Control System



Examples of Closed Loop Control System

Automatic Electric Iron – Heating elements are controlled by output temperature of the iron.

Water Level Controller– Input water is controlled by water level of the reservoir.

Missile Launched & Auto Tracked by Radar – The direction of missile is controlled by comparing the target and position of the missile.

An Air Conditioner – An air conditioner functions depending upon the temperature of the room.

Thermostat Heater– It operates depending upon the temperature which it controls.

Advantages and Disadvantages Of Closed Loop Control System

Advantages

- Highly accurate as any error arising is corrected due to presence of feedback signal.
- Facilitates automation
- This system is less affected by External disturbances

Disadvantages

- They are costlier
- They are complicated to design
- Required more maintenance
- Stability is the major problem and more care is needed to design a stable closed loop system