
# Introduction to Robotics
# CSE 461

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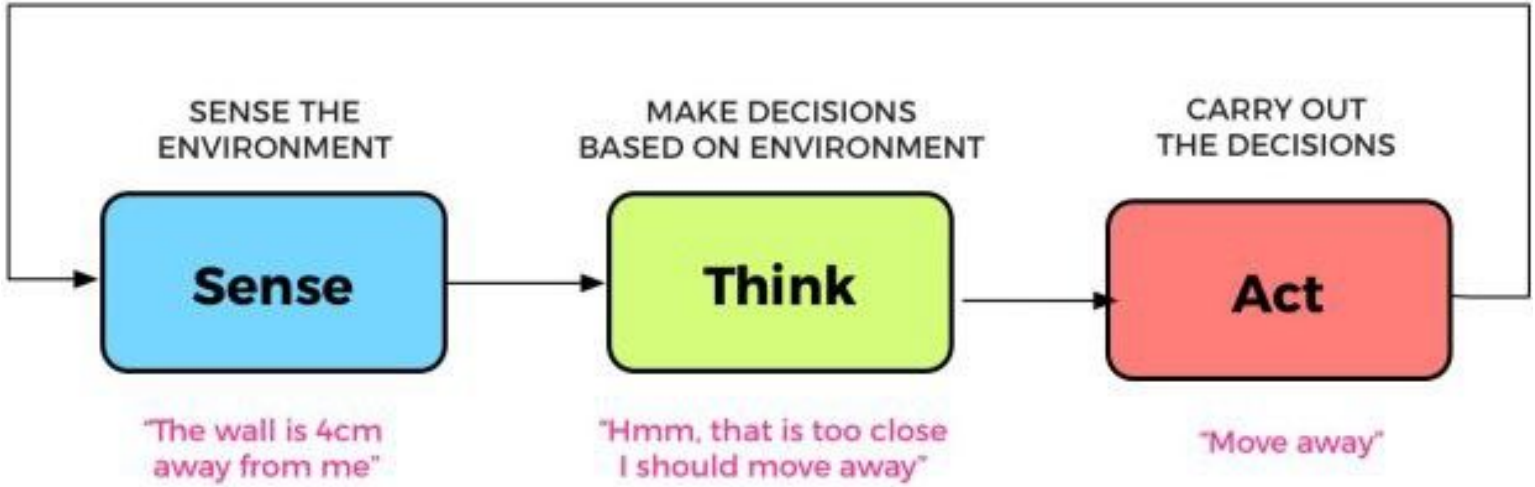
Brac University
Lecture 3: Chapter 1(Introduction to robotics: basics)

# Previous Class

1. Primitives

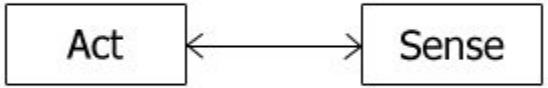
# Recall


SENSE THE ENVIRONMENT
MAKE DECISIONS BASED ON ENVIRONMENT
CARRY OUT THE DECISIONS
Sense
Think
Act
"The wall is 4cm away from me"
"Hmm, that is too close I should move away"
"Move away"

# Paradigms of Robotics


Olympic Games

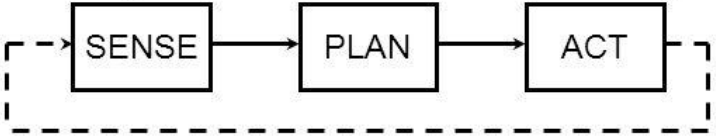
# Reactive Paradigm




| Robot Primitives | INPUT | OUTPUT |
|---|---|---|
| SENSE | Sensor Data → | Sensed Information |
| PLAN | | |
| ACT | Sensed Information → | Actuator Commands |

# The Hierarchical Paradigm

S,P,A organization of Hierarchical Paradigm

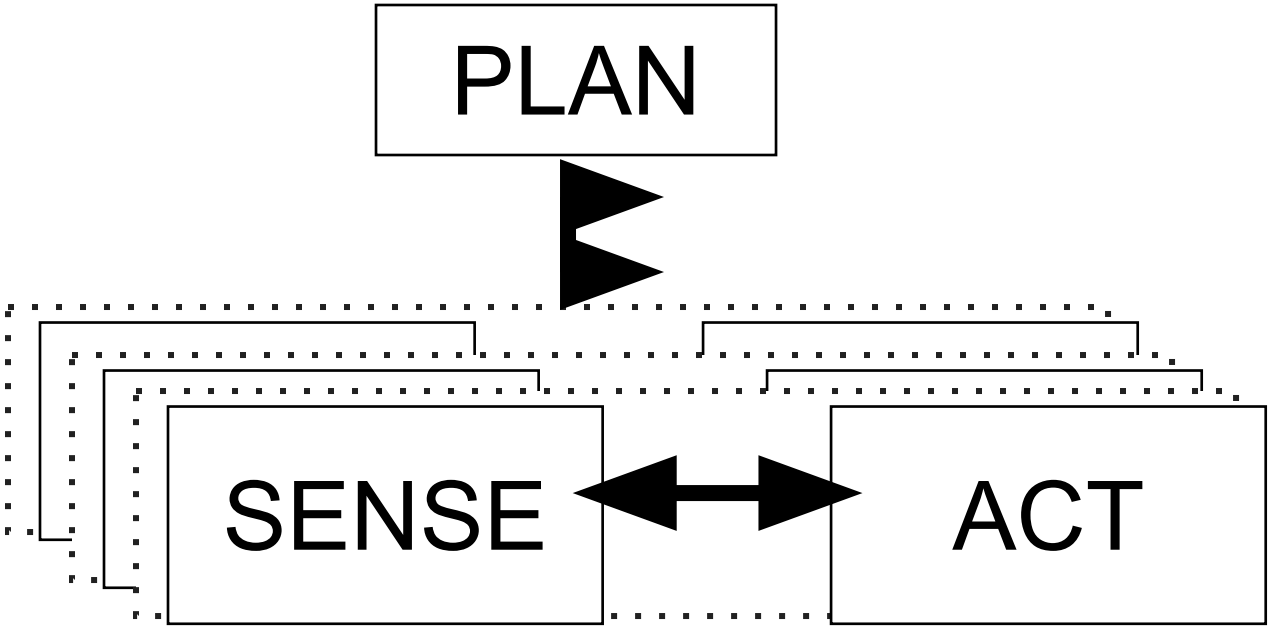



Alternative description of how the 3 primitives interact in the Hierarchical Paradigm

| ROBOT PRIMITIVES | INPUT | OUTPUT |
|---|---|---|
| SENSE | Sensor data → | Sensed information |
| PLAN | Information (sensed and/or cognitive) → | Directives |
| ACT | [redacted] directives → | Actuator commands |


Robot for Human Welfare

# Hybrid deliberative/reactive paradigm



# Advantages

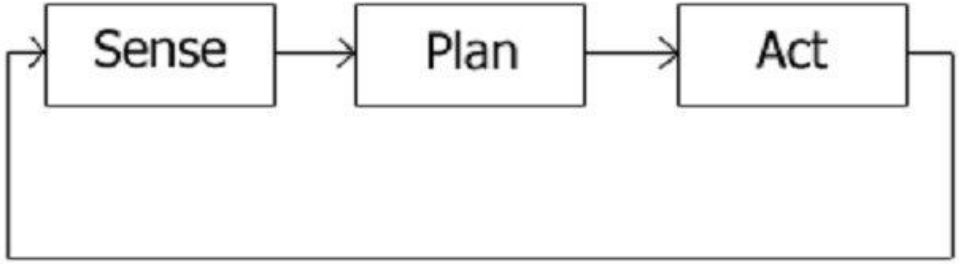
- Asynchronous processing technique allows to function Independently
- Planner can slowly compute next goal while robot can perform reactive task

# Local and Global Model

- Reactive for Local control
- Deliberative for Global control

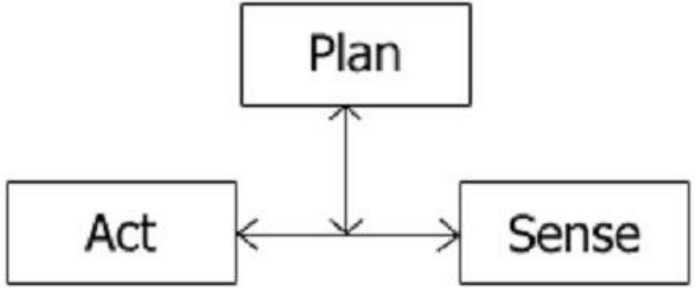
- However; Robot behavioral management requires to know its current mission, state and environment beside path-planning, map-making, monitoring etc. So, both local and global models are required to be considered for a robot performance.

Hierarchical/deliberative paradigm




The reactive paradigm

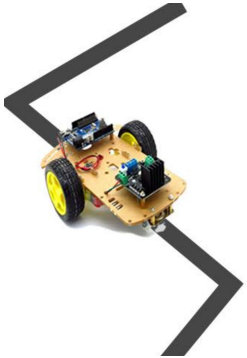

Hybrid deliberate/reactive paradigm



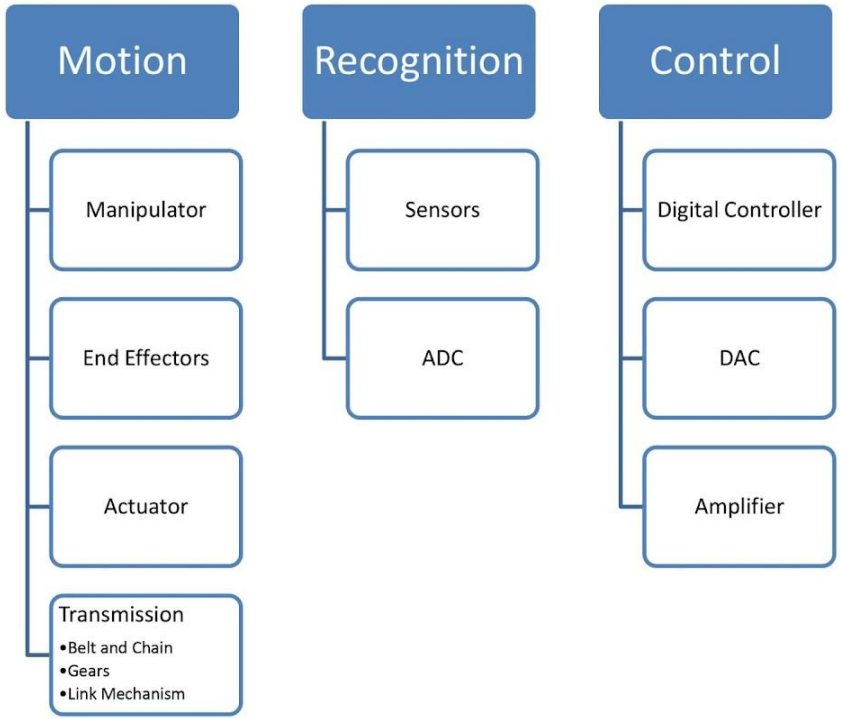
# Group Activity

A : Line Following Robot

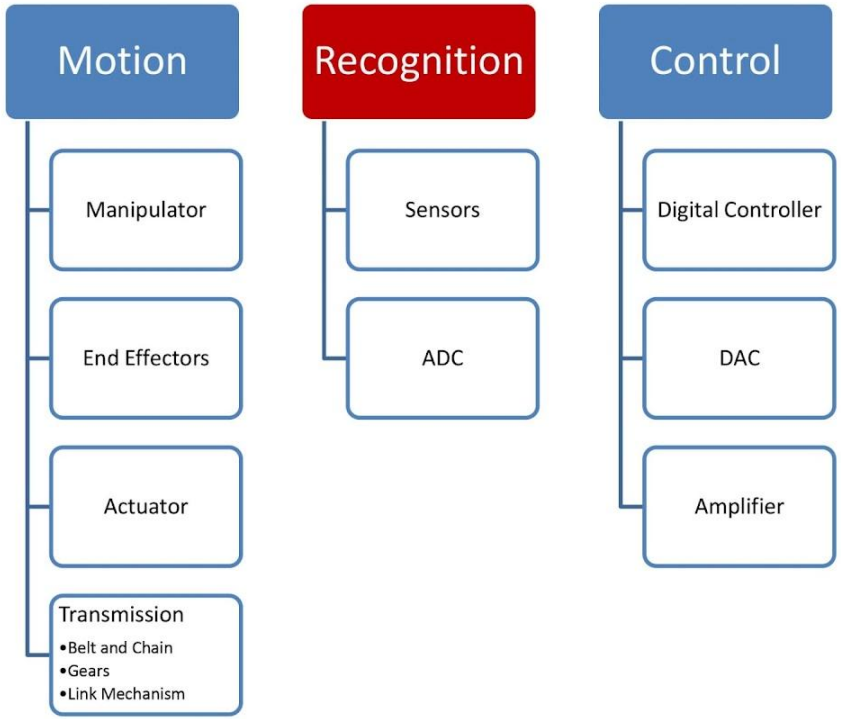
B : Mini Baymax



# Subsystems


Motion
Manipulator
End Effectors
Actuator
Transmission
•Belt and Chain
•Gears
•Link Mechanism
Recognition
Sensors
ADC
Control
Digital Controller
DAC
Amplifier

# Subsystems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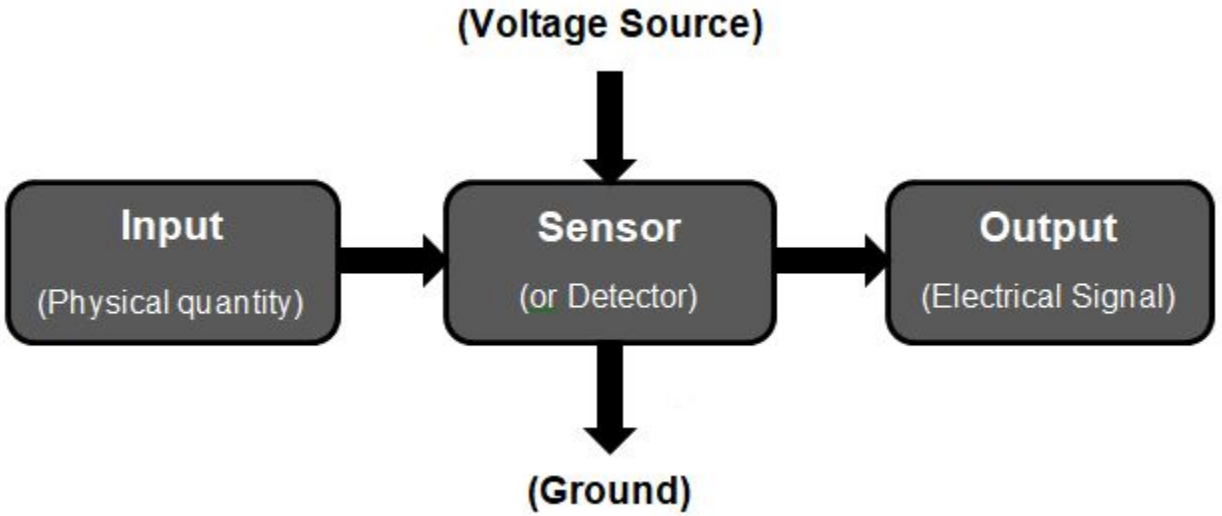
# Sensor

A sensor is a device that detects or measures physical, chemical, or biological properties of the environment or a system and converts them into a signal that can be processed or analyzed.



# Sensor Examples

Recognition

| Physical Property | Sensor |
| --- | --- |
| contact | switch |
| distance | ultrasound, radar, infrared |
| light level | photocells, cameras |
| sound level | microphone |
| rotation | encoders and potentiometers |
| acceleration | accelerometers gyroscopes |

# More Sensor Examples

Recognition

| Physical Property | Sensor |
| --- | --- |
| magnetism | compass |
| smell | chemical |
| temperature | thermal, infra red |
| inclination | inclinometers, gyroscopes |
| pressure | pressure gauges |
| altitude | altimeters |
| strain | strain gauges |

## Active sensors

## Passive sensors

# Ultrasonic Sensor

Converts electrical energy into acoustic wave, which is an ultrasonic wave travelling at above 18kHz frequency.

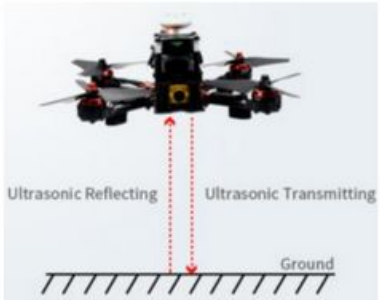
- HC-SR04 operates at 40kHz

a microcontroller is used for communication with an ultrasonic sensor.


HC-SR04 Ultrasonic Sensor
(*Source: Digikey*)

Applications

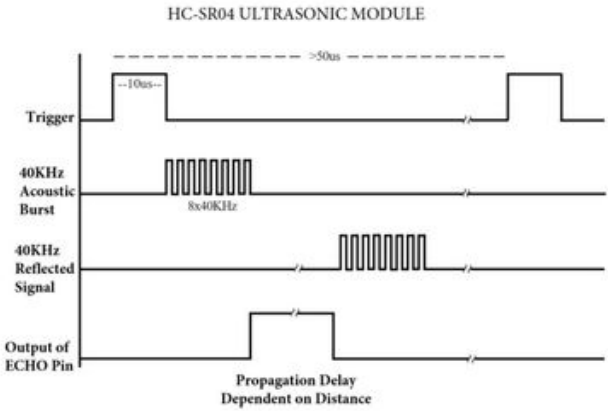
- Measure wind speed and direction
- Navigation of UAV
- Measure tank depth




Ultrasonic sensor measuring height during drone's flight.
(*Source: RadioLink*)

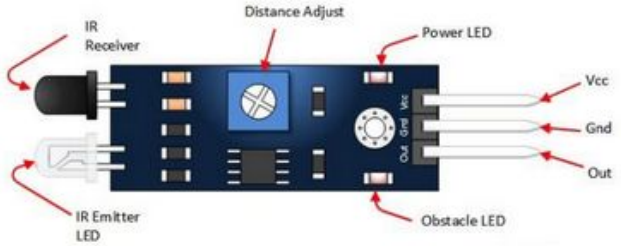
# Ultrasonic Sensor: How It Works??

1. a microcontroller is used for communication with an ultrasonic sensor.
2. To begin measuring the distance, the microcontroller sends a trigger signal to the ultrasonic sensor. The duty cycle of this trigger signal is 10µS for the HC-SR04 ultrasonic sensor.
3. When triggered, the ultrasonic sensor generates eight acoustic (ultrasonic) wave bursts and initiates a time counter.
4. As soon as the reflected (echo) signal is received, the timer stops. The output of the ultrasonic sensor is a high pulse with the same duration as the time difference between transmitted ultrasonic bursts and the received echo signal.

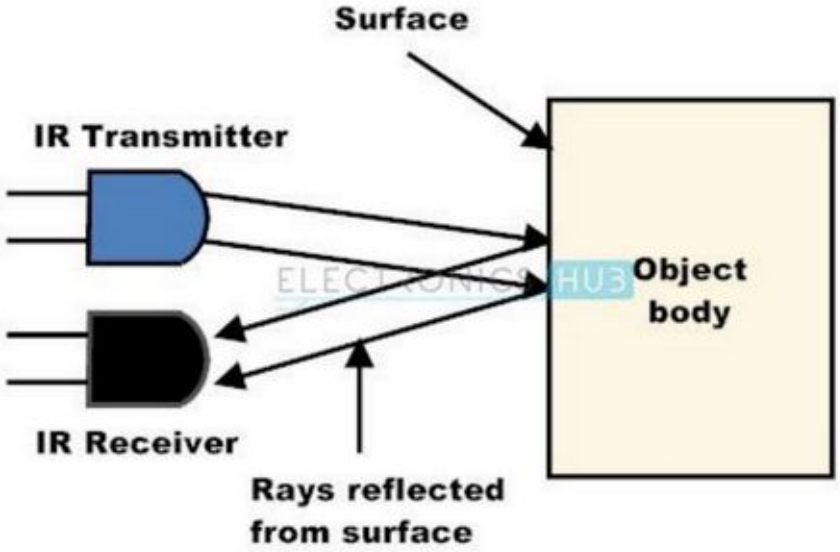


# Infrared Sensors

- An electronic device that can detect and measure infrared (IR) radiation in the environment
- Anything that emits heat (everything that has a temperature above around five degrees Kelvin) gives off infrared radiation
- Applications
  - TV Remote
  - Motion Sensing
  - Proximity Sensing



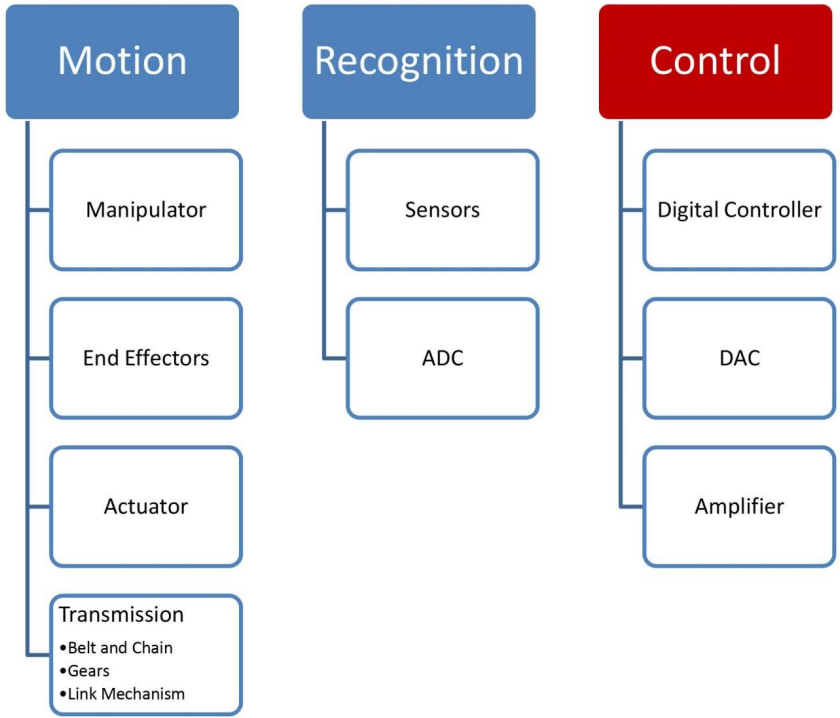
# Infrared Sensors: How Active Sensing Works



# Lidar

- Laser generates an optical pulse(*Up to 200,000+ pulses/second*)
- After reflecting off an object, the pulse returns to the receiver sensor
- High-speed counter measures the time of flight from the start pulse to the return pulse
- Time measurement is converted to a distance
- An onboard computer records each laser's reflection point, translating this rapidly updating "point cloud" into an animated 3D representation of its surroundings.

# Subsystems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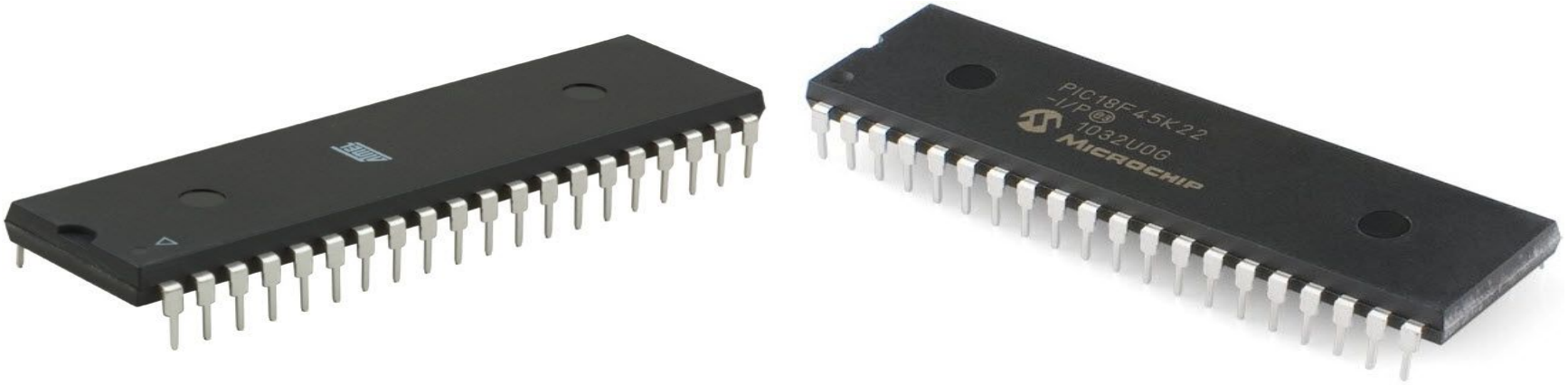
# Microcontrollers

A microcontroller is a small, integrated circuit that contains a processor, memory, and input/output peripherals.



# Arduino


ARDUINO


ARDUINO
MEGA
2560
ARDUINO.CC
COMMUNICATION
POWER
ANALOG IN
DIGITAL

# Arduino

Arduino Uno

Arduino Leonardo

Arduino Mega 2560

Arduino LilyPad

Arduino Mega ADK

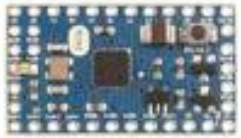
Arduino Fio

Arduino Ethernet

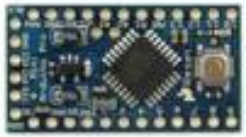
Arduino Pro

Arduino BT

Arduino Nano

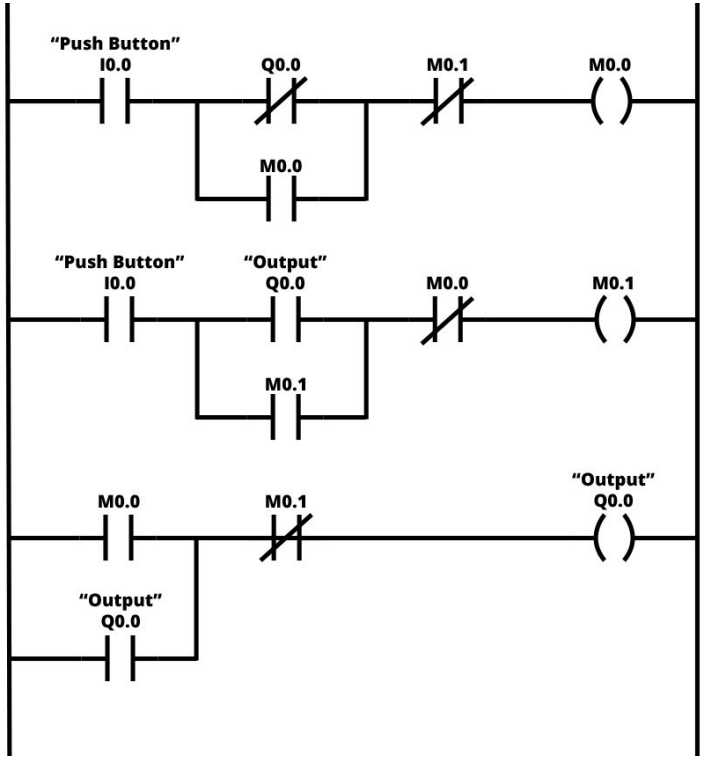


Arduino Mini

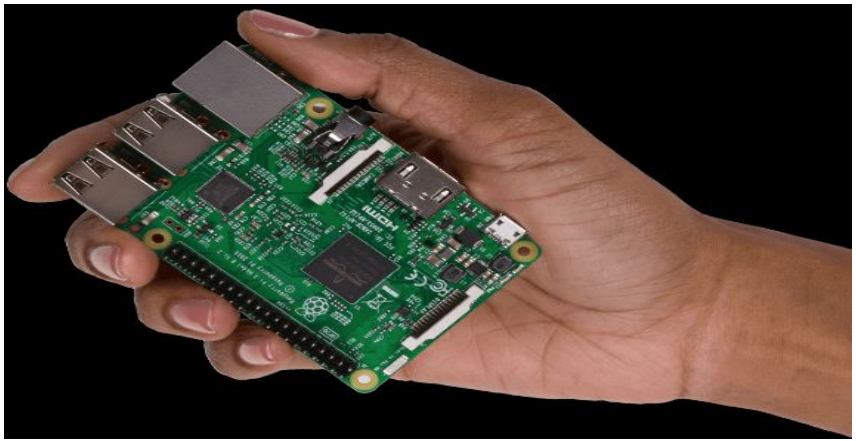


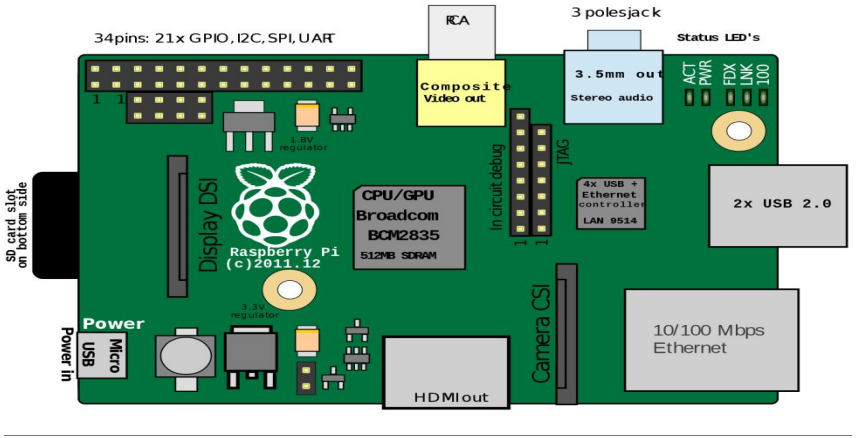
Arduino Pro Mini

# Programmable Logic Controller (PLC)



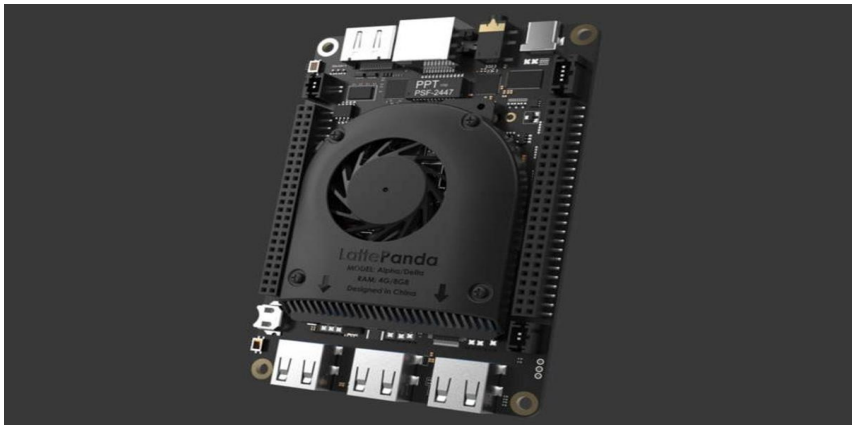

# Single board Computer





# Raspberry PI 4, Tinkerboard


# Little Panda and Jetson nano




# Let’s talk about a dream !

https://www.youtube.com/watch?v=fn3KWM1kuAw

# Next Class

- Subsystem (Motion)

Thank You