Introduction to Robotics
CSE 461

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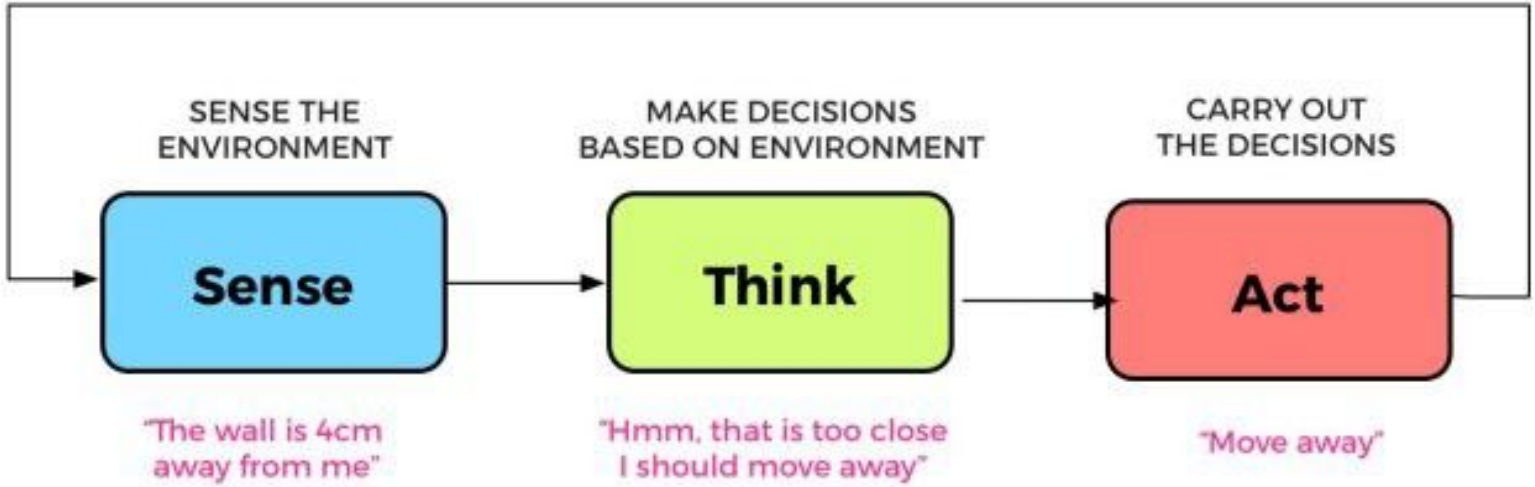
Brac University
Lecture 3: Chapter 1(Introduction to robotics: basics)

Previous Class

1. Primitives

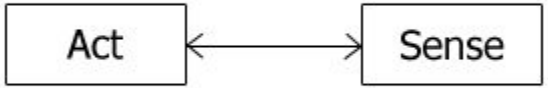
Recall


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

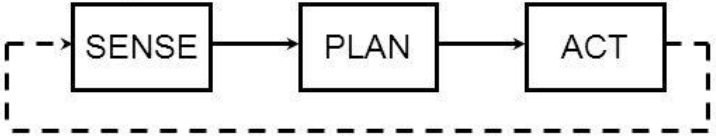
Reactive Paradigm



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

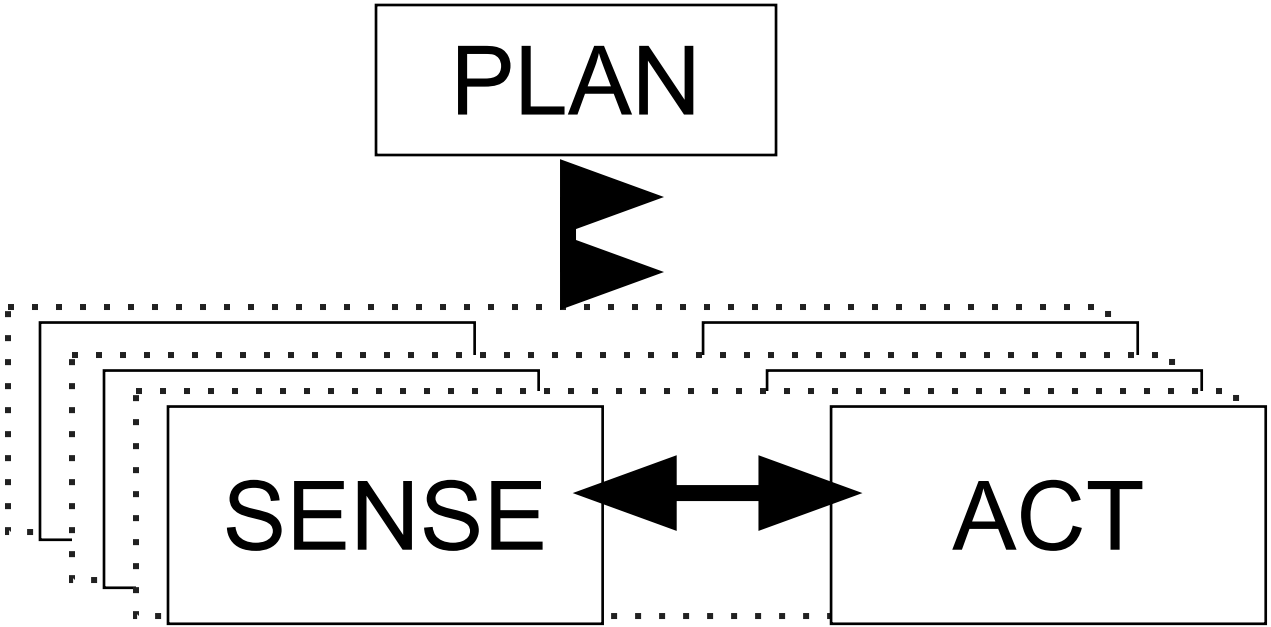


Alternative description of how the 3 primitives interact in the Hierarchical Paradigm

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

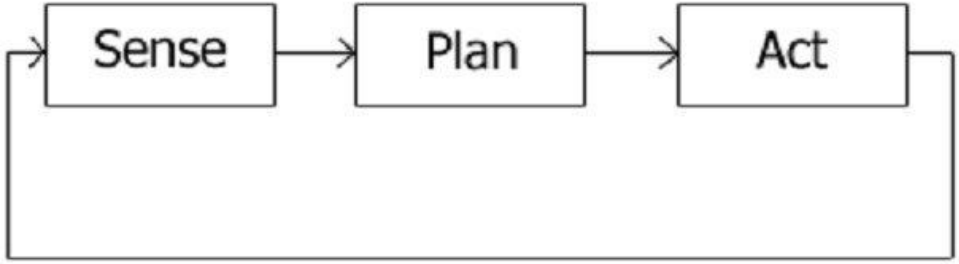
- Asynchronous processing technique allows to function Independently
- Planner can slowly compute next goal while robot can perform reactive task

Local and Global Model

- Reactive for Local control
- Deliberative for Global control

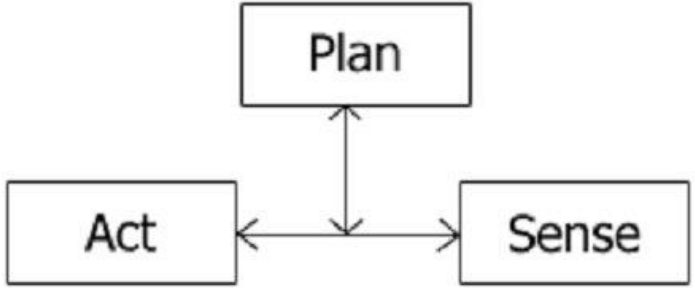
- However; Robot behavioral management requires to know its current mission, state and environment beside path-planning, map-making, monitoring etc. So, both local and global models are required to be considered for a robot performance.

Hierarchical/deliberative paradigm



The reactive paradigm

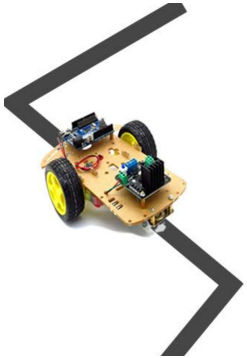
Hybrid deliberate/reactive paradigm



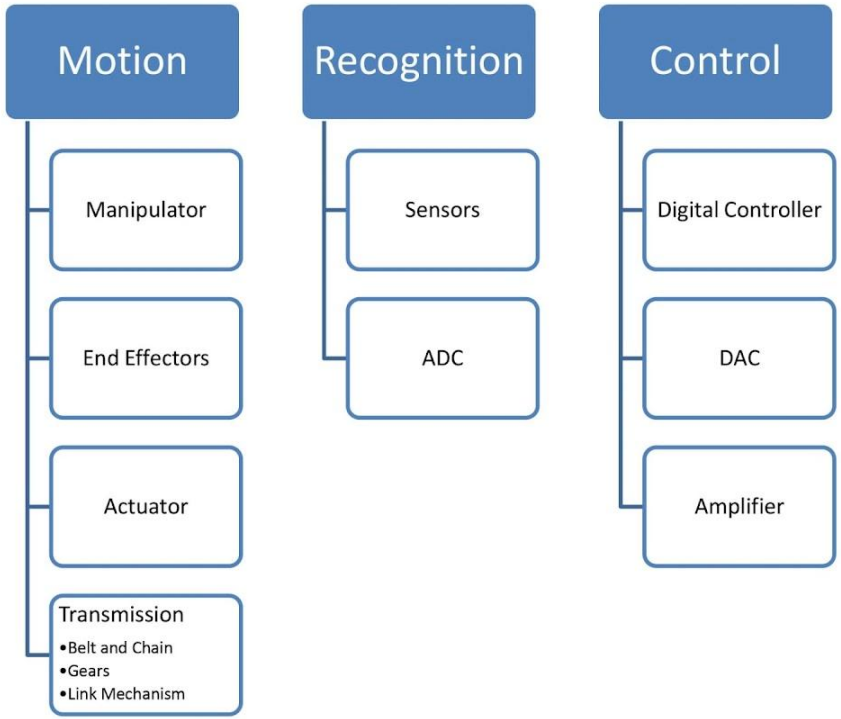
Group Activity

A : Line Following Robot

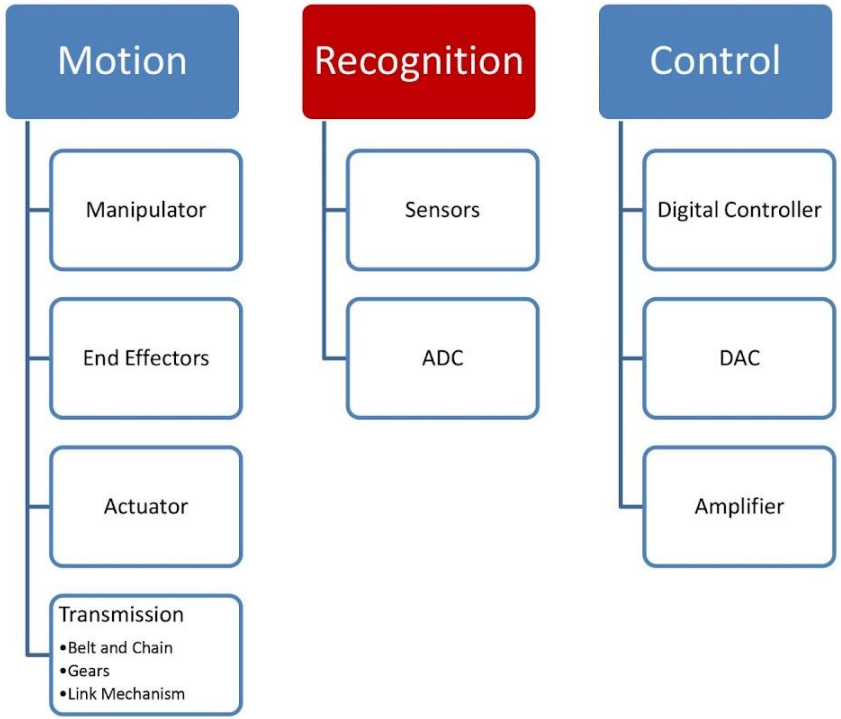
B : Mini Baymax



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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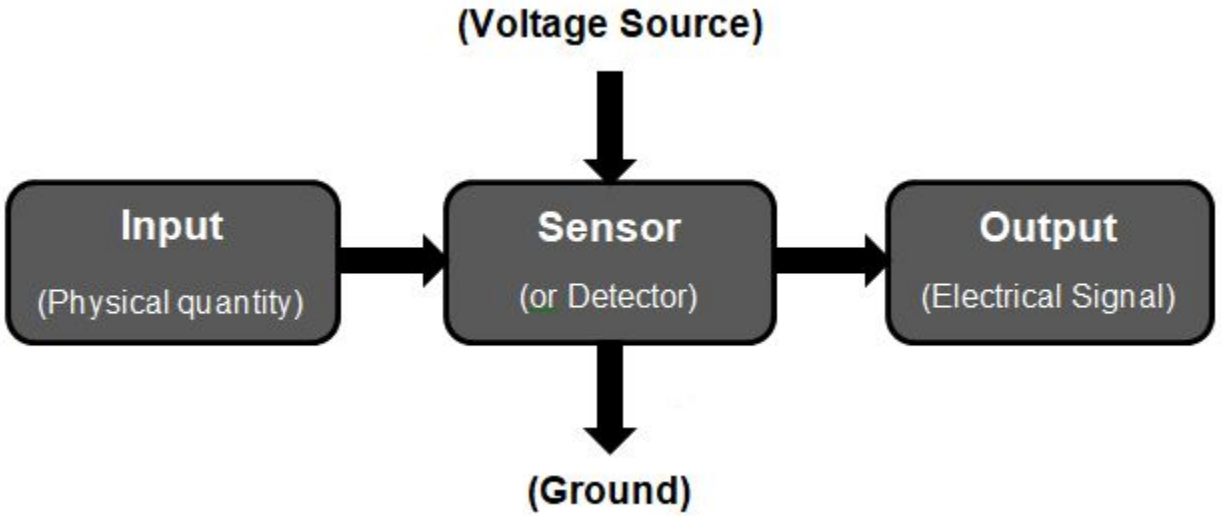
Sensor

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.

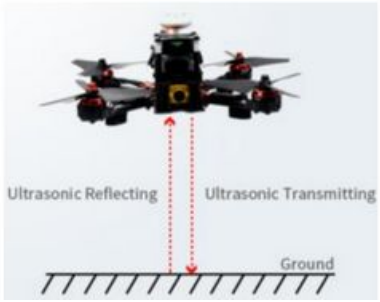
- HC-SR04 operates at 40kHz

a microcontroller is used for communication with an ultrasonic sensor.

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

Applications

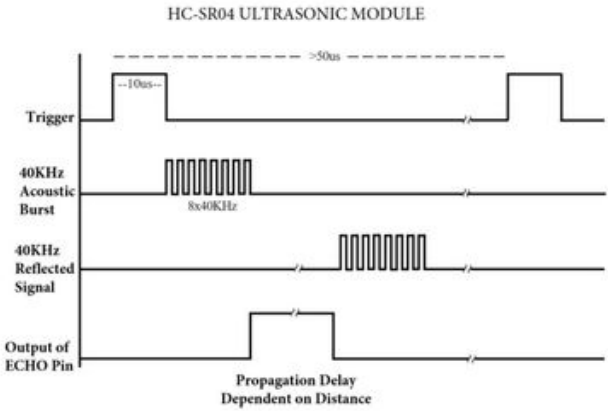
- Measure wind speed and direction
- Navigation of UAV
- Measure tank depth



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

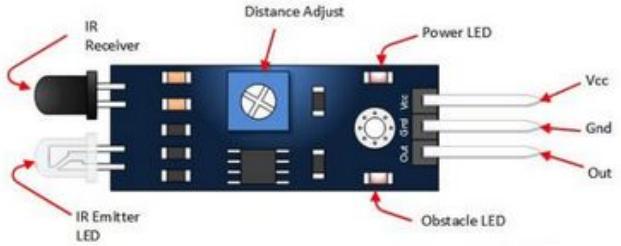
Ultrasonic Sensor: How It Works??

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.

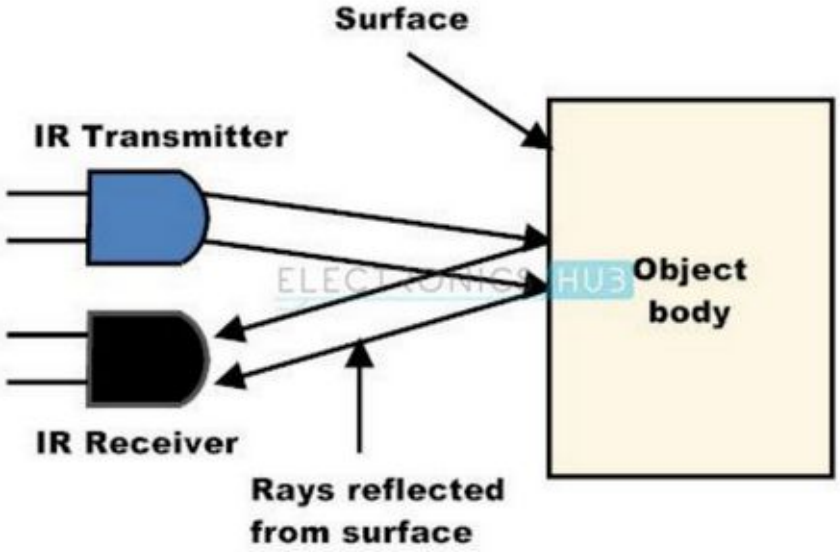


Infrared Sensors

- 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



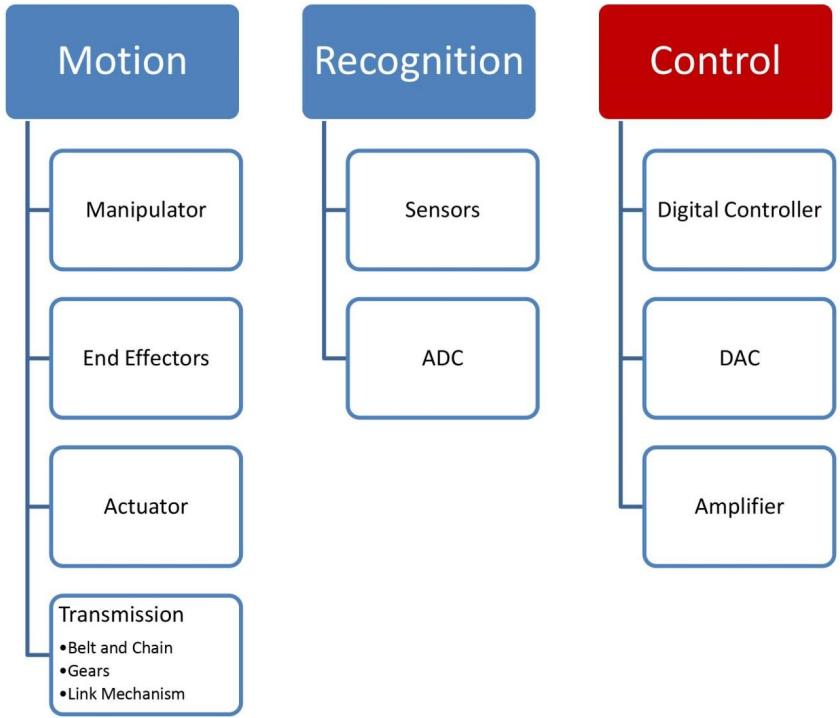
Infrared Sensors: How Active Sensing Works



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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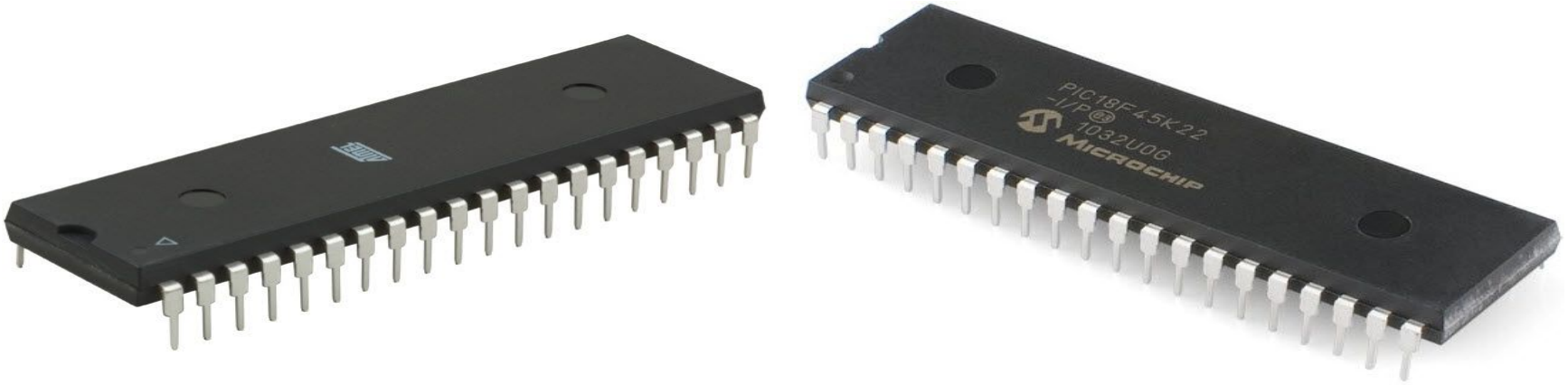
Microcontrollers

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

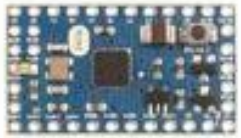
Arduino Fio

Arduino Ethernet

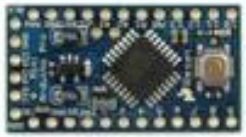
Arduino Pro

Arduino BT

Arduino Nano

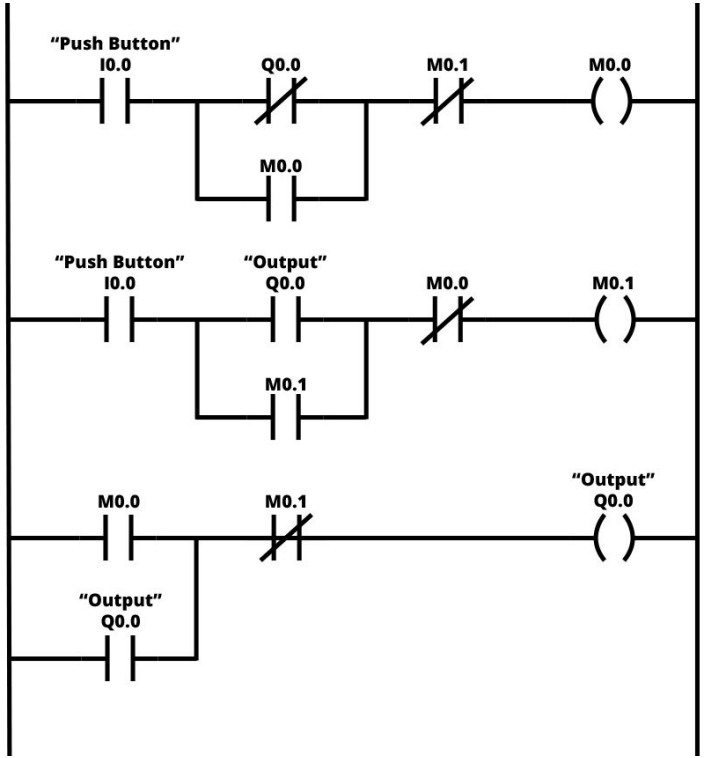


Arduino Mini

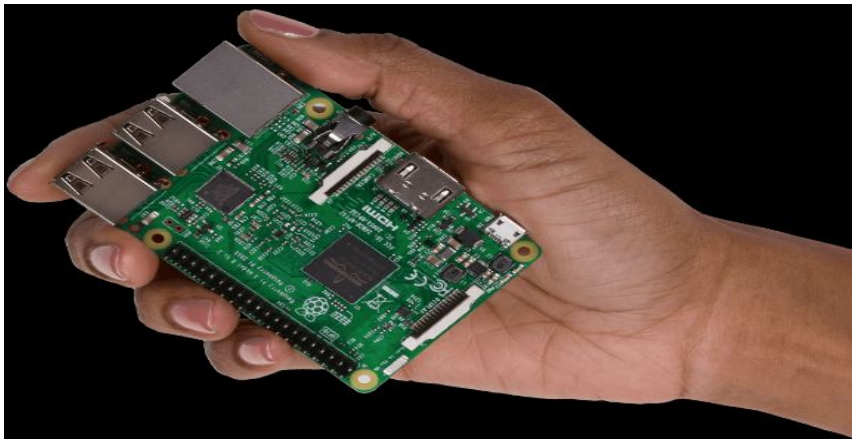


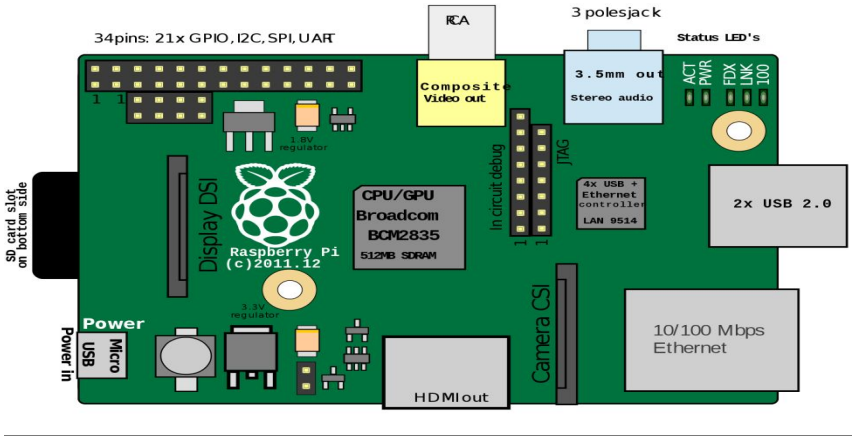
Arduino Pro Mini

Programmable Logic Controller (PLC)



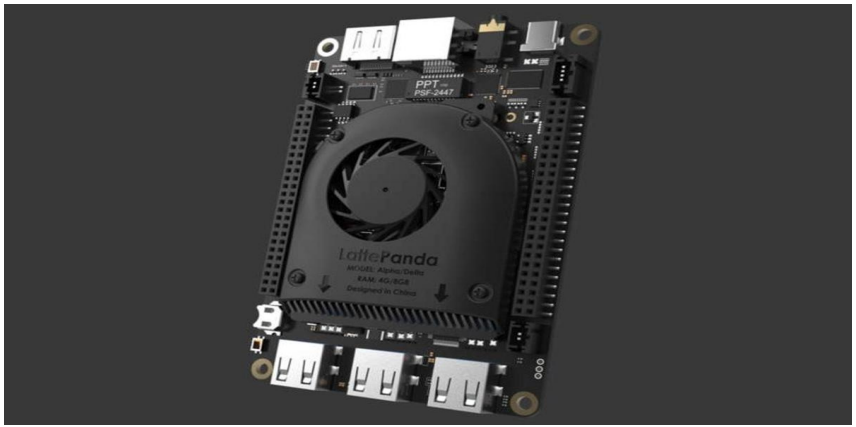
Single board Computer





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