DEC50122 EMBEDDED ROBOTIC

BY:
Ts. SITI ZALINA BINTI MOKHTAR
FADILAH BINTI MAT ASSAIN@HASHIM

POLITEKNIK
MALAYSIA
PORT DICKSON

DEC50122
EMBEDDED ROBOTIC

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PATRON
Mohamad Isa Bin Azhari
Director, Politeknik Port Dickson

ADVISORS
Dr. Nor Haniza Binti Mohamad
Deputy Director (Academic), Politeknik Port Dickson

Munirah Binti Md. Nujid
Head of Electrical Engineering Department, Politeknik Port Dickson

EDITOR
Ts. Siti Zalina Binti Mokhtar
Head of Electronic Engineering (Computer) Programme, Politeknik Port Dickson

FACILITATORS
Nin Hayati Binti Mohd Yusof

WRITERS
Ts. Siti Zalina Binti Mokhtar
Fadilah Binti Mat Assain @ Hashim

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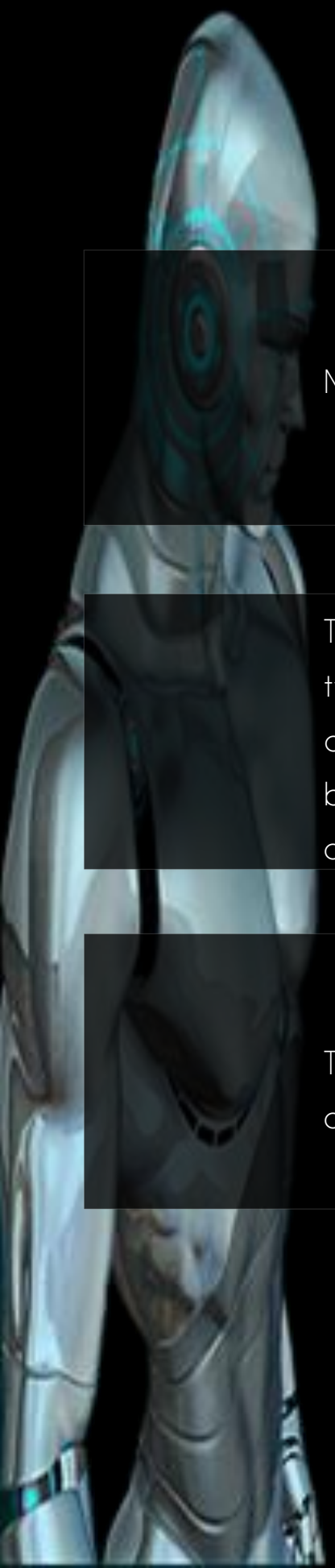
TUTORIAL

Chapter 1: Introduction to Robotic and Controller



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1. Mobile Robot Descriptions.
2. The classification of mobile robot types:
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   b. Aerial
   c. Underwater
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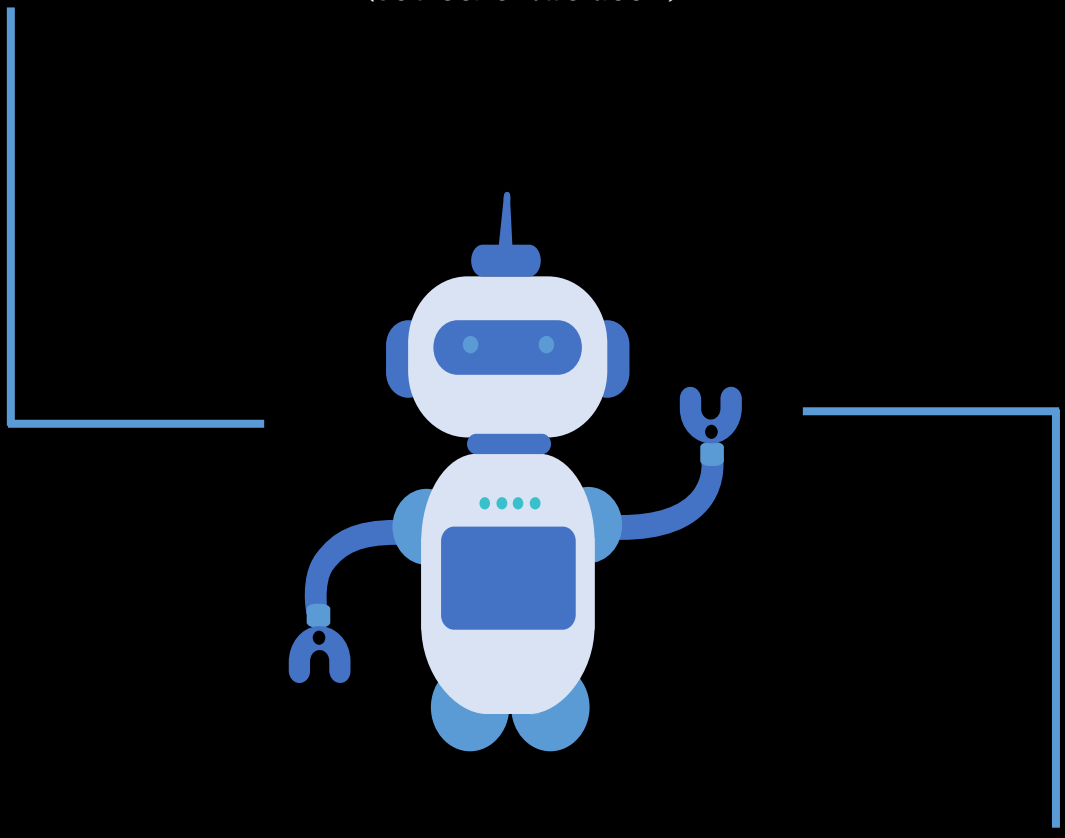
01 Mobile Robot Descriptions

> A mobile known as able to move or be moved freely. Meanwhile the robot is a machine resembling a human being. Mobile robot is a self-moving machine that can move around in a certain environment.
>
> *(Source: Wikipedia)*

A robot mounted on a movable platform that transports it to the area where it carries out tasks.

(Source: answers.com)



A mobile robot is a self-contained machine that can navigate a landscape with both natural and man-made obstacles. It has wheels/tracks or legs on its chassis, as well as a manipulator for moving work components, tools, or special gadgets. To carry out various pre-planned procedures, a pre-programmed navigation strategy that takes into consideration the current state of the environment is used.

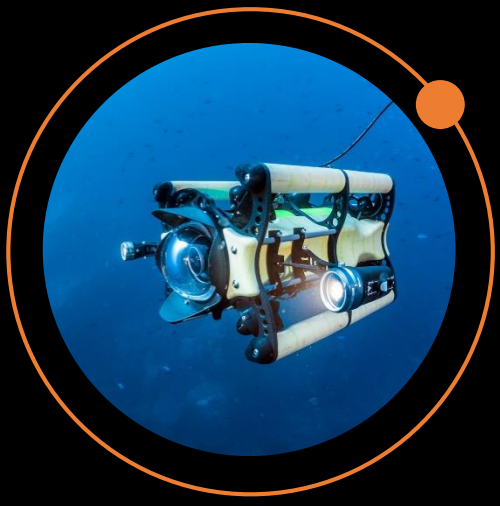
(Source: G.Dudek, M.Jenkin, G.Dudek, M.Jenkin, G.Dudek, M.Jenkin, (Cambridge, United Kingdom) Computational Principles of Mobile Robotics

02

The classification of mobile robot types

Land Robot

Aerial Robot



Underwater Robot

Land Robot

Wheeled and legged mobile robots are the most common types of land-based mobile robots.

Wheeled robots have one or more driven wheels, as well as passive or caster wheels, and maybe guided wheels.

To drive most mobile robot designs, two motors are required (and steer).

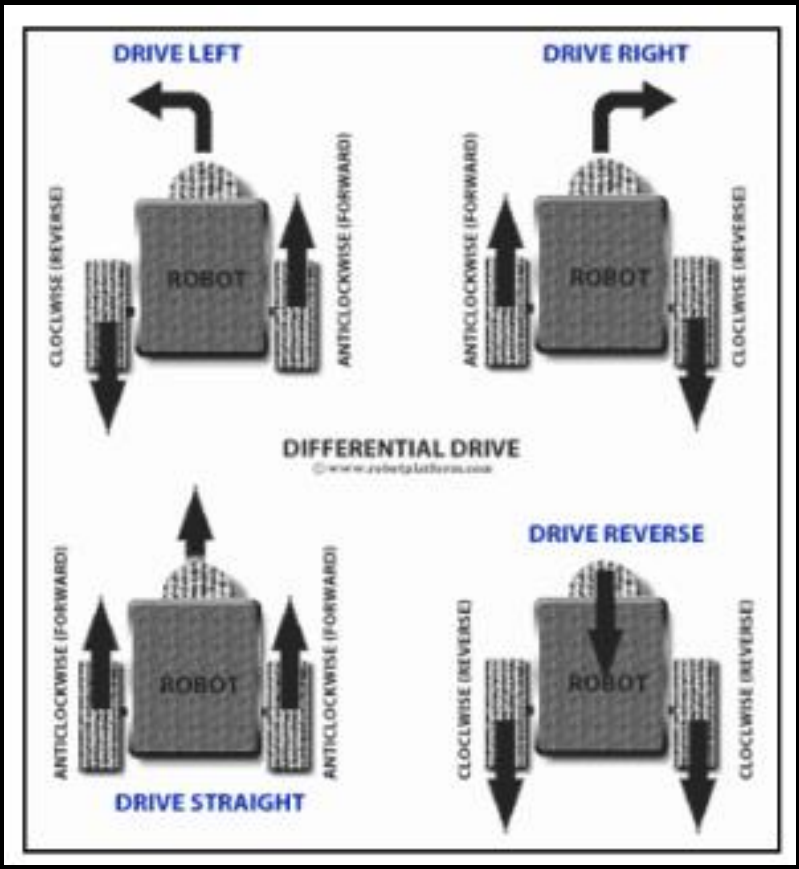
There are several ways in driving and steering wheeled mobile robots, but the famous one among them are differential drive and Ackermann steering drive.

Land Robot – Differential Drive

Differential drive is a mechanism in which the robot's right and left sides each have two powered wheels.

Thanks to the combination, the specific robot can be driven to the straight, in a curve position, or turn on the spot according to the order.

The motors and wheels are fixed in place and do not need to be turned to achieve cornering with this configuration. As a result, the robot mechanics have been considerably simplified in design.



Differential drive design

Land Robot – Ackermann Steering Drive

Ackermann steering is a rear-drive passenger car's conventional drive and steering arrangement.

A differential box drives both rear wheels, while one motor steers both front wheels at the same time.

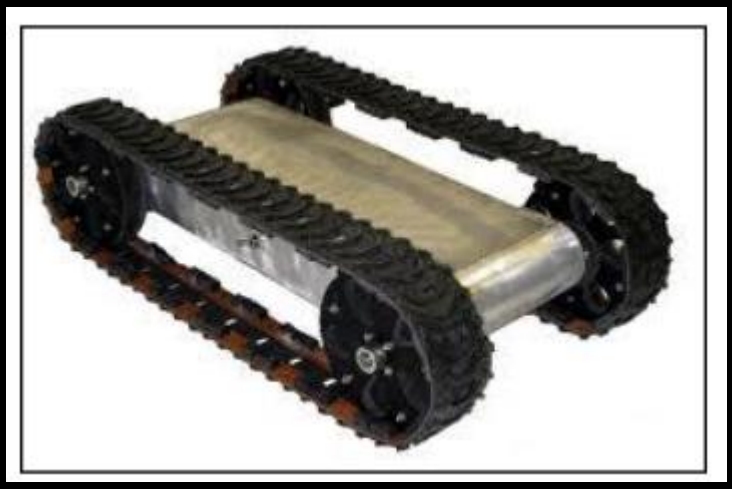
Ackermann steering design

Land Robot – Ackermann Steering Drive

The requirement for all wheeled robots to drive on a street or other level surface is a challenge.

Tracked robots are more adaptable and capable of navigating through difficult terrain. They can't navigate as precisely as a wheeled robot, though. Two motors are required for tracked robots, one for each track.

Other designs of driving and steering mobile robots are skid steering, synchronous drive, Omni- directional drive, articulated drive and independent drive.



Tracked robot

Land Robot – Six Legged Robot

They can negotiate difficult terrain and climb up and down stairwells, for example, just like tracked robots.

Legged robots come in a variety of designs, depending on how many legs they have.

Legged robots design can be two, three, four, six, or eight legs, depending on their design and requirements of task.

Six legs robot

Land Robot – Four Legged Robot.

It will be easier to stay balanced if you have more legs. In the illustration, a six-legged robot is depicted. A robot, for example, can be programmed to always have three legs on the ground or land base and three legs in the air depending of the task and situation.

All the robot designed, will remain stable as long as its center of gravity is contained within the triangle formed by these three legs, which is supported by a tripod comprised of the three legs now on the ground.

The less leg, the more difficult to the robot because legs are use for walk and balance; a robot with only four legs, for example, must be handled carefully to avoid tipping over.

Because three legs are required, a biped (two-legged robot) cannot do the same operation with a supporting triangle.

Robot with four legs

Aerial Robot

Autonomous planes, often known as UAVs (Unmanned Airborne Vehicles), are one sort of aerial mobile robot..

UAV is an aircraft that operates without human pilot onboard. Instead, it is controlled miles to thousands of miles away from the base station.

Some military forces currently use unmanned aerial vehicles (UAVs), sometimes known as drones, extensively in modern combat.

Besides for combat use, UAVs are also used to carry out remote sensing job such as analyzing pollution, weather and do city planning.

Australia, China, Germany, Israel, Pakistan, the Soviet Union, the United Kingdom, and the United States are among the countries that use a high number of UAVs.

The US Air Force uses the Predator UAV (USAF)

Underwater Robot

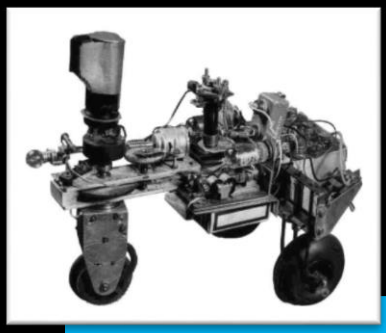
- Underwater mobile robots include autonomous underwater vehicles, remotely operated underwater vehicles, and fish robots, to mention a few.
- A robot that moves underwater without the assistance of a human operator is known as a self-driving underwater vehicle (AUV).
- An underwater vehicle that can be controlled remotely (ROV), on the other hand, is an uninhabited underwater vehicle that must be controlled by a human operator aboard a ship.
- A group of cables connects the ROV to the ship, carrying electrical power, video, and data transmissions between the operator and the vehicle.

Underwater Robot

- Detecting manned submarines in military missions, examining microscopic life in science applications, and creating precise maps of the seafloor for commercial purposes are all tasks of the AUV and ROV.

- A robotic fish on the other hand, is a robot that imitates the look and the characteristics of a fish. There are many purposes of developing the robotic fish and one of them is to carry out underwater operation such as monitoring the pollution level at harbors and send the information to the shore.

Evolution of Mobile Robotic in World History



1950

1990

2000

2018

Karel Capek originated the term "robot" in his play R. U. R. (Rossum's Universal Robots) in 1920. Robots, especially mobile robots, began to be built in huge numbers all around the world after that.

Evolution of Mobile Robotic in World History

1950

Grey Walter (University of Bristol, UK) designed three-wheeled turtle-like mobile robotic vehicles. These cars had a light sensor, a touch sensor, a propulsion motor, a steering motor, and two vacuum tube analogue computers. Even with this modest design, Grey demonstrated that his turtles have complex behaviors. He named his turtles "Machina Speculatrix" in honor of their speculative urge to explore their surroundings.

1969

The first vision-controlled mobile robot was Shakey (Stanford University). Shakey was given simple tasks to complete: • To distinguish an object with one's gaze • To travel to the object designed• To take action on the object (for example, to push it over).

Evolution of Mobile Robotic in World History

1979

In 1979, the Stanford Cart, which had been in development since 1967, walked through a room filled with chairs without the need for human interaction. Hans Moravec recreated the Stanford Cart in 1977, incorporating stereo vision. Photographs were taken from various angles by a television camera mounted on a rail on the cart's top and relayed to a computer. The distance between the cart and the obstructions in its path was calculated by the computer.

1989

The Mobile Robots Group at MIT has introduced Genghis, a walking robot. It gets its name from the manner it walks, which is dubbed the "Genghis gait."

Evolution of Mobile Robotic in World History

1996

P3 introduced by *Honda's P3* (predecessor to Honda's Asimo).

2000 - now

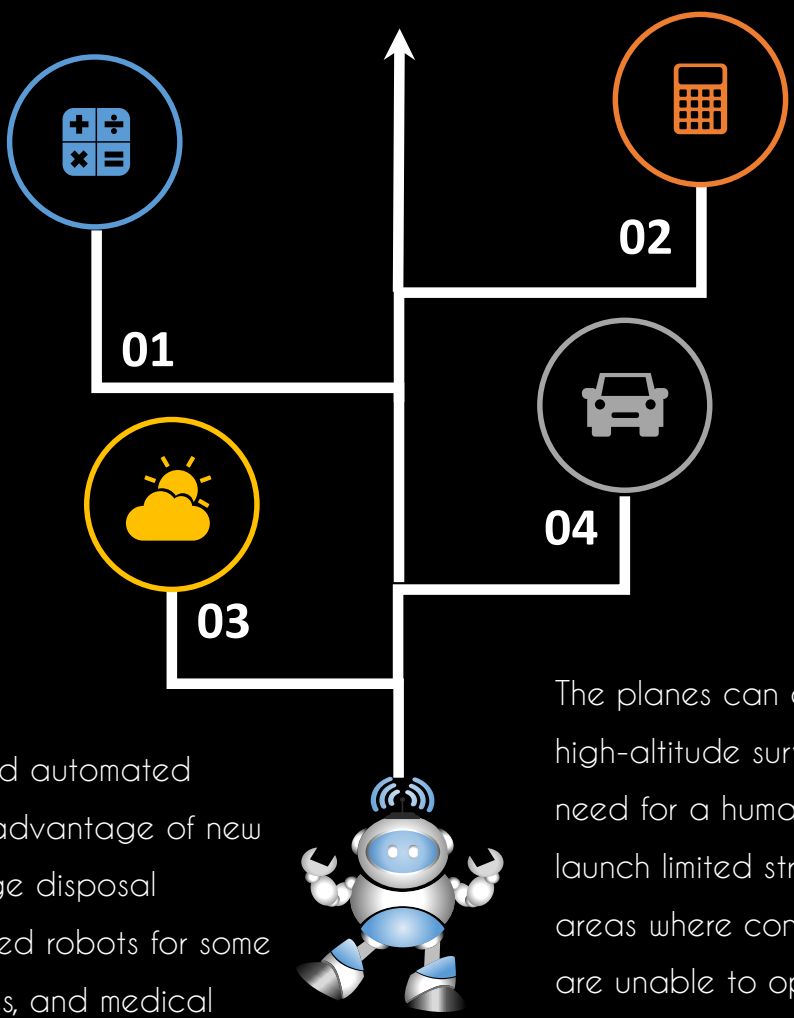
Robot Soccer

Stair Climbing Robots

03 The significance of embedded controllers in mobile robotics

Humans have delegated risky and routine activities to automated robots, resulting in greater production. Because robots never tired, factories have added extra shifts.

The military has tried a number of robotics projects, the most successful of which are the Predator and Reaper unmanned aerial surveillance vehicles, which allow a pilot to control the robot from a distance.



Farmers have utilized automated harvesters to take advantage of new technology, garbage disposal companies have used robots for some of their dirtier chores, and medical professionals have benefited from advances in aided surgical robotics.

The planes can conduct long-term high-altitude surveillance without the need for a human pilot, and they can launch limited strikes on targets in areas where conventional aircraft are unable to operate.

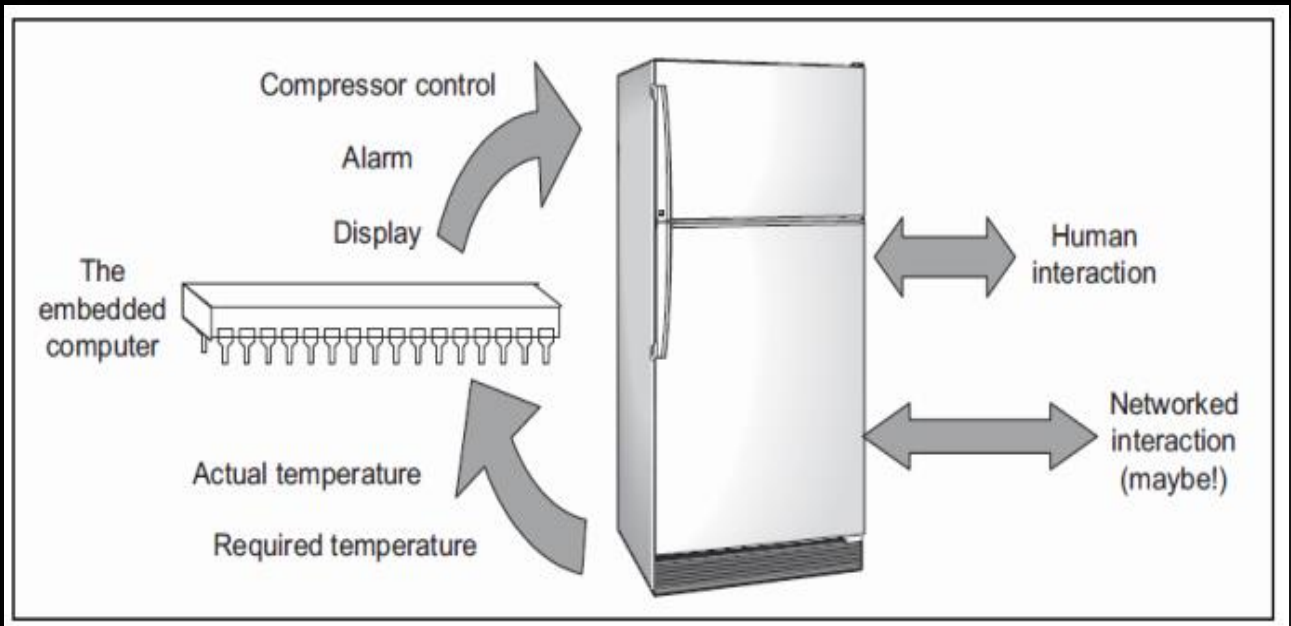
"A system in which a computer is integrated but whose primary function is not computational," defines an embedded system.

T. Wilmshurst (2001). An Introduction to Small-Scale Embedded System Design. Palgrave is a publisher based in the United Kingdom (ISBN 978-0-333-92994-0)

The following are some well-known embedded system examples:

HOME	OFFICE AND COMMERCE	VEHICLES
Washing Machine	Photostat Machine	Door mechanism
Fridge	Attendance Machine	Climate Control
Burglar alarm clock	Printer to print out	Brakes (ABS, EBD)
Microwave oven	Scanner machine	Engine control (VVT-I, i-VTEC)
Air conditioner		Car electronic entertainment
Toy and Game		

Some familiar examples of embedded systems are as follow:



Embedded system application example 1: The domestic refrigerator

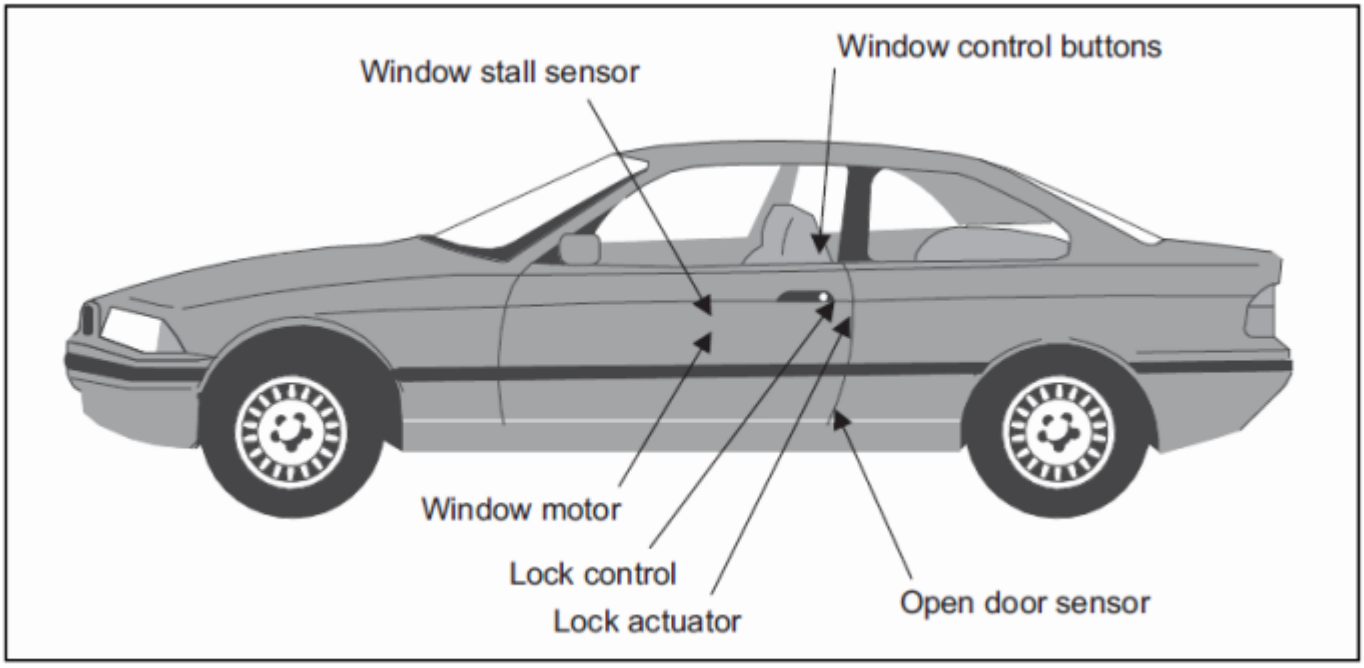
It must maintain a somewhat consistent and low interior temperature. This is accomplished by comparing the vehicle's internal temperature to the required temperature. A compressor decreases the temperature by turning it on.

One or more sensors are required for temperature measurement, as well as any signal conditioning and data collecting circuitry required.

An electronic interface is required to manage the compressor, which accepts a low-level input control signal and converts it to the electrical drive required to turn the compressor on and off.

In most cases, the user is unaware that there is a computer hidden inside the refrigerator!

Some familiar examples of embedded systems are as follow:



Embedded system application example 2: A car door mechanism

One pair of sensors is for the door lock, while the other is for the window.

The window motor and the lock actuator are the two actuators. An automobile door may appear to be a self-contained embedded system.

If the driver attempts to pull away while the door is unlocked, central locking or an alarm can be activated.

The importance of embedded controllers in mobile robotics

01

Equip the robot with 'brain' to process the data obtained through the sensors and react using actuators.

Allow the mobile robots to be programmed to perform various kind of tasks according to the human's desire and the ability of a robot

02

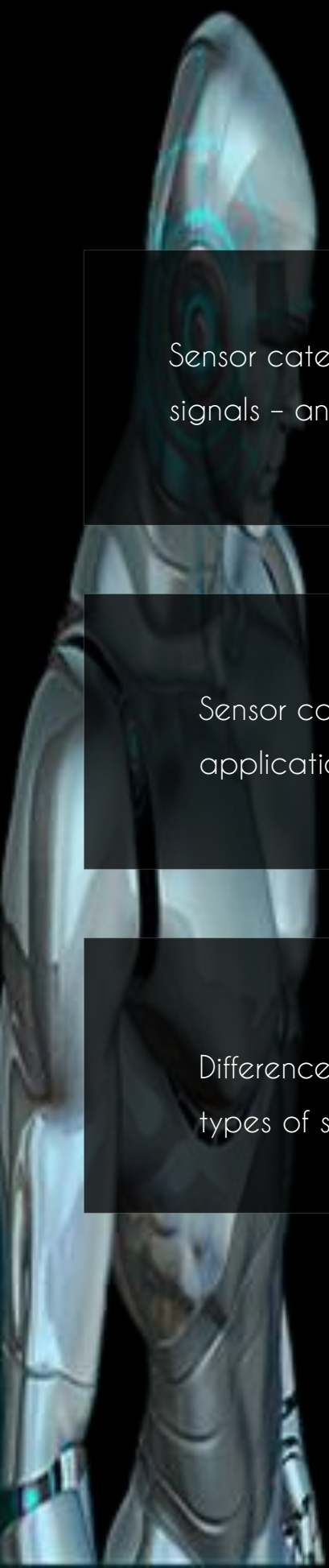
03

Making the robots function autonomously according to the program they had received.

Allow the mobile robots to be sophisticated and advanced in features.

04

Chapter 2: Sensors and Actuators



Contents

Sensor and Actuator Categories

1. Sensor categories according to their output signals – analog versus digital sensor.
2. Sensor categories according to their applications.
3. Difference between passive and active types of sensors.

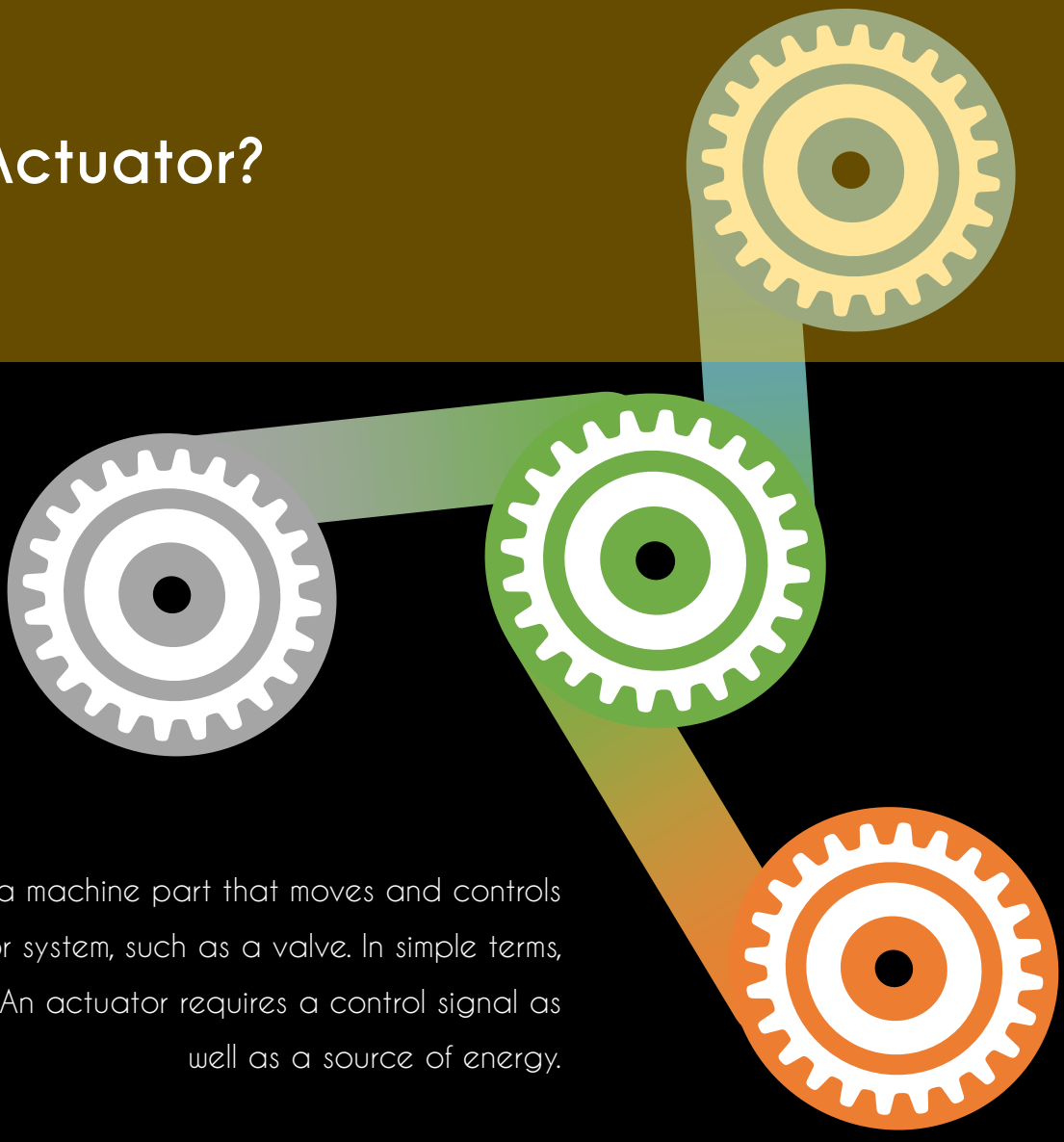
What is Sensor?

Sensors are high-tech gadgets that detect and respond to electrical and optical impulses.

The continuous output signal of analogue sensors is proportional to the measured value. Accelerometers, pressure sensors, light sensors, sound sensors, and temperature sensors are examples of analogue sensors that come in a range of shapes and sizes.

(For instance, temperature, blood pressure, humidity, speed, etc.) into an electrically quantifiable signal. The sensor converts the physical parameter.

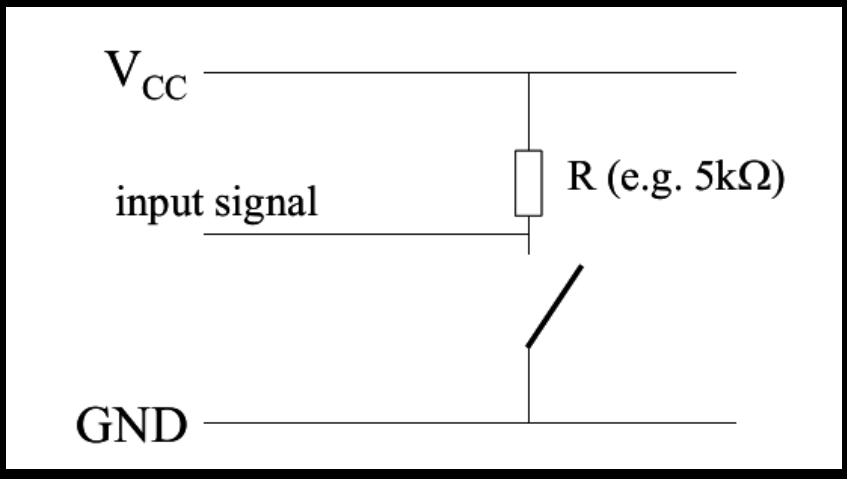
What is Actuator?



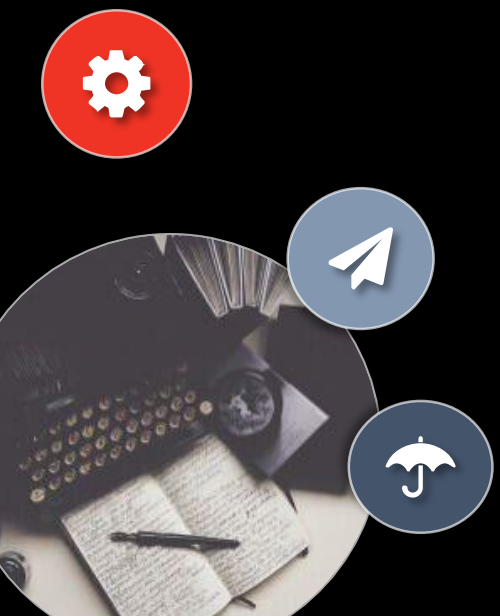
An actuator is a machine part that moves and controls a mechanism or system, such as a valve. In simple terms, it's a "mover." An actuator requires a control signal as well as a source of energy.

Sensors function and application:

- **Binary sensor**: Sensors of the most basic form. They only return one bit of data, either a 0 or a 1.



- Unless the switch is actuated, a pull-up resistor will output a high signal. An "active low" setting is what it's called.



Analog Sensors

Analog output signals are produced by a variety of sensors rather than digital signals. To link such a sensor to a microcontroller, an A/D converter is necessary. Examples:

- Microphone
- Infrared distance sensor,
- Barometer sensor with analogue compass

The analogue sensors' output signal is proportional to the observed value.

Two points in a range.

0-10 volts (also known as 2-10V, 4-20ma, and 0-20ma) is a popular analogue signal.

Digital Sensor

Digital sensors, on the other hand, are more complex and precise than analogue sensors. A wide range of output signals can be generated by digital sensors. There are several alternatives available, including a parallel interface (8 or 16 digital output lines), a serial interface (RS232 standard), or a synchronous serial interface.

Operate at only two points.

Produced or reflected by the sensor is binary.

An on/off or open/closed function.

Analog Digital Converter

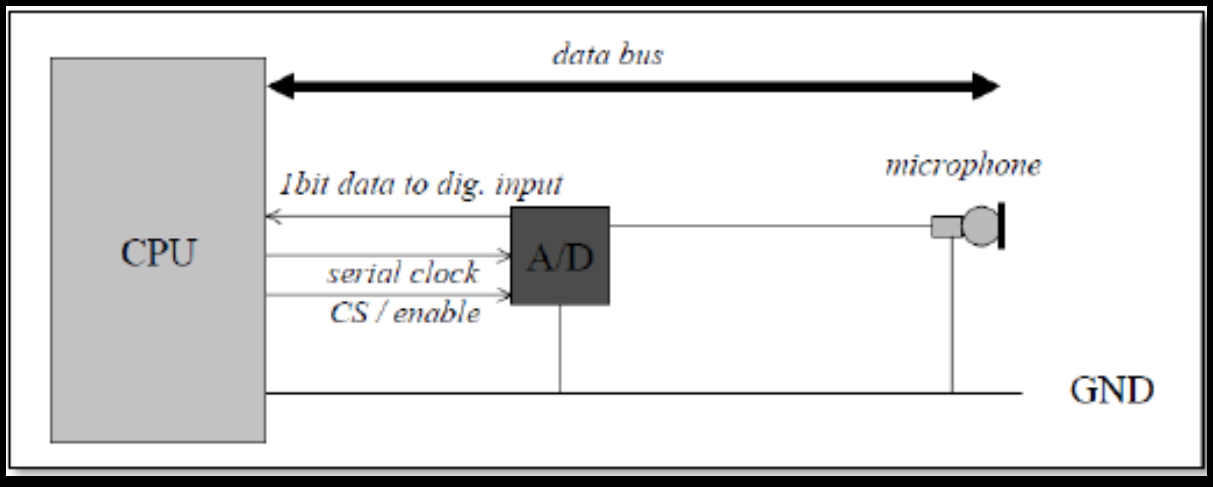
Analog to Digital Converter

An A/D converter is a device that converts analogue signals into digital values. An A/D converter has the following characteristics:

- An accuracy
- Speed

Multiplexer in A/D Converter

A multiplexer is included in many A/D converter modules, allowing many sensors to be connected and their data to be read and converted afterwards. The A/D converter module also has a 1 bit input line in this case, which allows synchronous serial transmission (from the CPU to the A/D converter) to designate a specific input line.

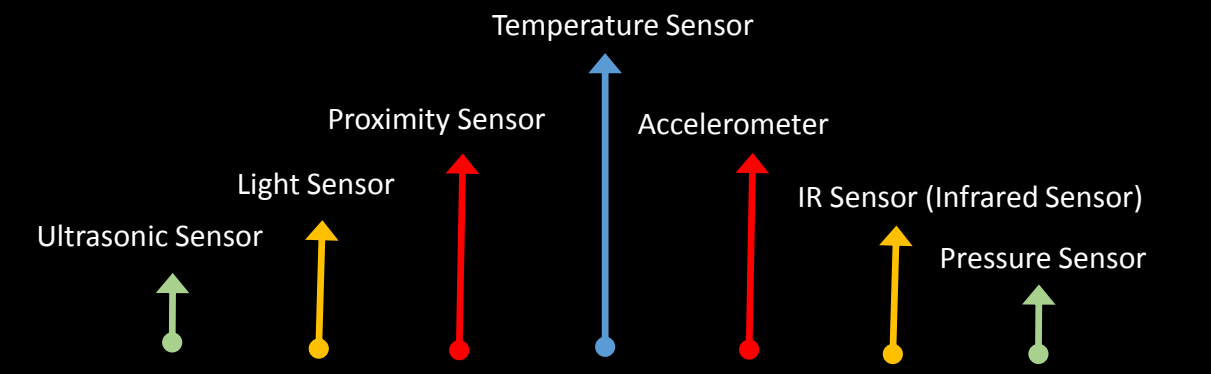


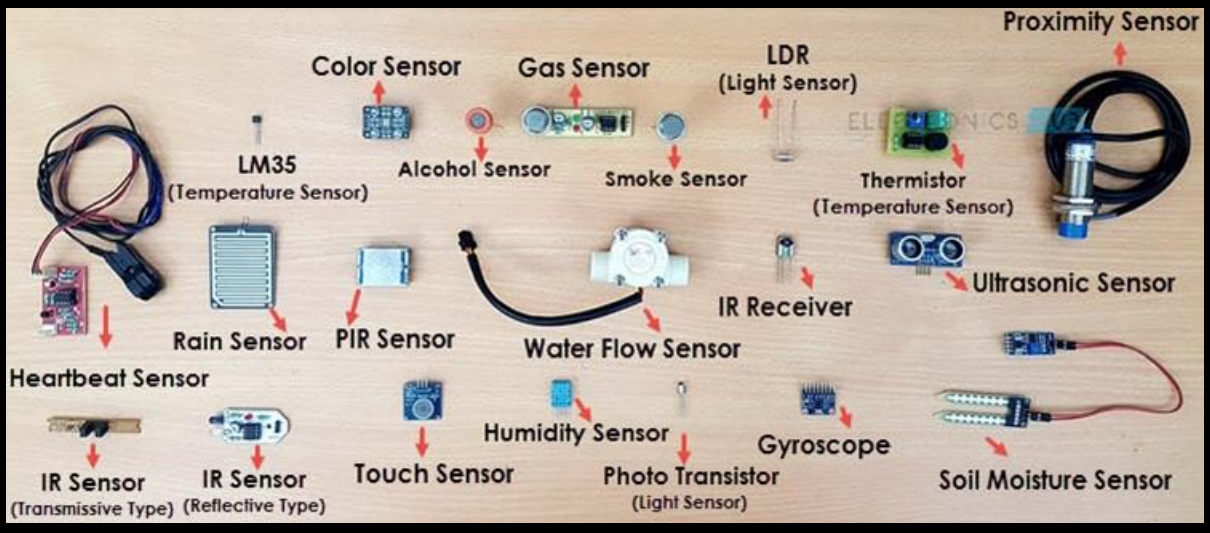
A/D converter interfacing

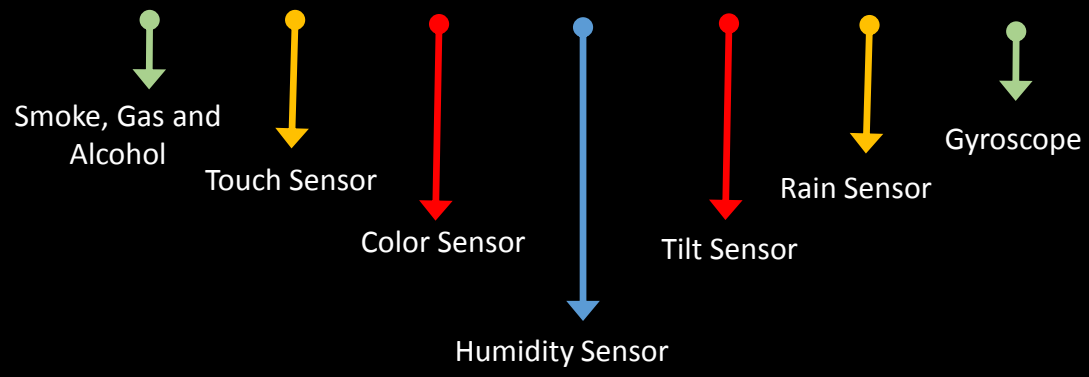
02

Sensor categories according to their applications

Temperature, resistance, capacitance, conduction, heat transfer, and other physical qualities are all measured by these sensors.



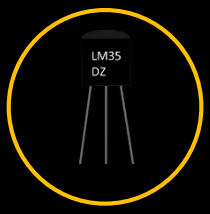




Sensor and Application

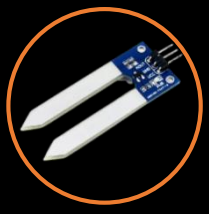
Temperature sensor

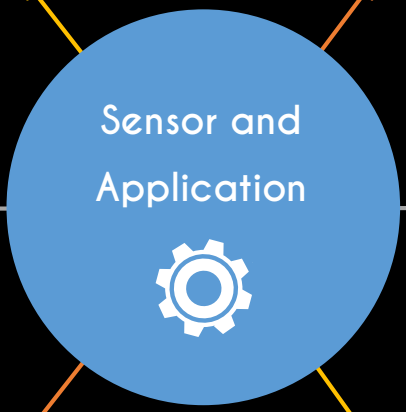
Computers, cellphones, autos, air conditioning systems, and other industries, to name a few..



Humidity sensor

Printers, air conditioning systems, fax machines, cars, weather stations, freezers, food processing equipment, and so forth.





Proximity sensor

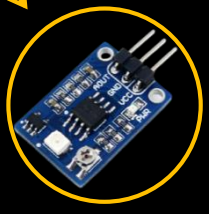
Parking sensors, ground proximity in aircrafts.

Infrared sensor

Gas analyzers , item counter.

PIR sensor

Automatic door opening system, automatic lighting applications.



UV sensors

Ultraviolet tester, outdoor ultraviolet detector, germicidal lamp.

Temperature Sensor

Equipment used to manufacture medicinal medications, heat liquids, or clean other equipment must maintain a specified temperature.

Application

- **Motor**

The majority of these require temperature monitoring to ensure that the motor does not overheat.

- **Computers**

Temperature sensors are used to keep the system from overheating.

Proximity Sensors

A proximity sensor detects the presence of nea rby items without the need for physical touch.

Optical Proximity Sensor

Inductive Proximity Sensor

Ultrasonic Sensor

Capacitive Proximity Sensor

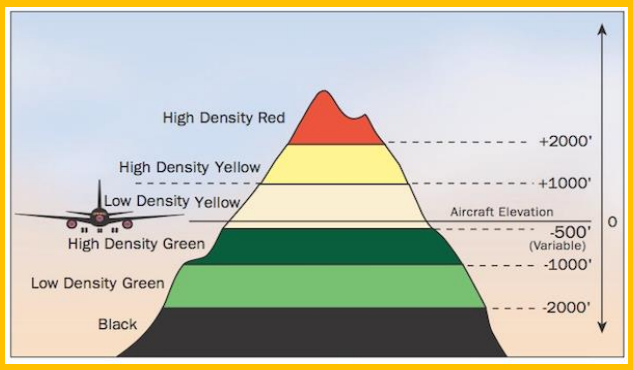
Application

- **The Parking Sensors**

For parking, systems installed on car bumpers assess distance to other automobiles.

- **The Ground Proximity Warning System**

For aviation safety, a ground proximity warning system is used.



Infrared Sensor (IR Sensor)

A basic electrical device that produces and detects infrared radiation in order to locate specific items or obstacles within its range is known as an IR sensor. Heat and motion dete ction are two of its features.

Application

- **The Gas Analyzers**

The absorption properties of gas in the IR region are used to determine gas density.

- **The Item Counter**

The items are counted using the direct incidence approach. Between the transmitter and the receiver, a constant radiation is maintained.

PIR Sensors

PIR sensors detect general movement but do not reveal who or what moved.

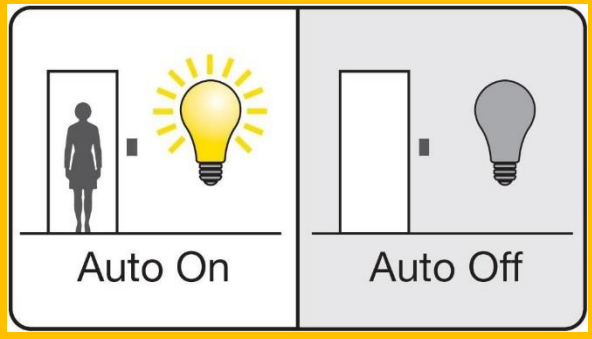
Application

- **Automatic door opening system**

These devices open the door when a person approaches it and close it as he walks away or enters.

- **Automatic lighting applications**

When a person enters a room, the lights automatically turn on, and when the person departs the room, the lights automatically switch out.



Ultraviolet Sensor (UV Sensor)

As the ambient ultraviolet intensity rises, so d oes the output voltage.

Application

- **Ultraviolet tester**

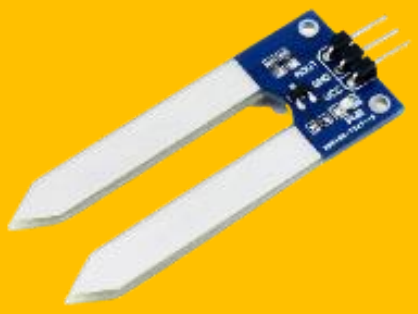
UV radiation tests are used to evaluate products and components in the presence of sun radiation. Products and components are exposed to ultraviolet light in a controlled environment during this process. To replicate ultraviolet radiation and simulate months or years of exposure, a solar simulator is employed.

- **Germicidal lamp**

Used to produce ozone for water disinfection.

Humidity Sensors

A humidity sensor is a device that detects an d measures the amount of water vapour in a n environment. To detect relative humidity, TE Connectivity (TE) produces a full variety of c alibrated and amplified RH sensor solutions.



Application

- **Humidity Sensor in Industrial Food Process**

Humidity sensing is critical, especially in industrial food processing control systems. Water vapour has an impact on a variety of physical, chemical, and biological food processes.

- **Soil Moisture in Agriculture System**

The low-power design of the intelligent soil moisture sensor improves system monitoring and protection; it has calculation and storing capabilities, and can perform more complex monitoring of soil moisture and moisture conditions in response to environmental changes. In the agricultural industry, it is commonly employed. There are no unique environmental requirements, and both indoor and outdoor options are available.

Sensor Categories

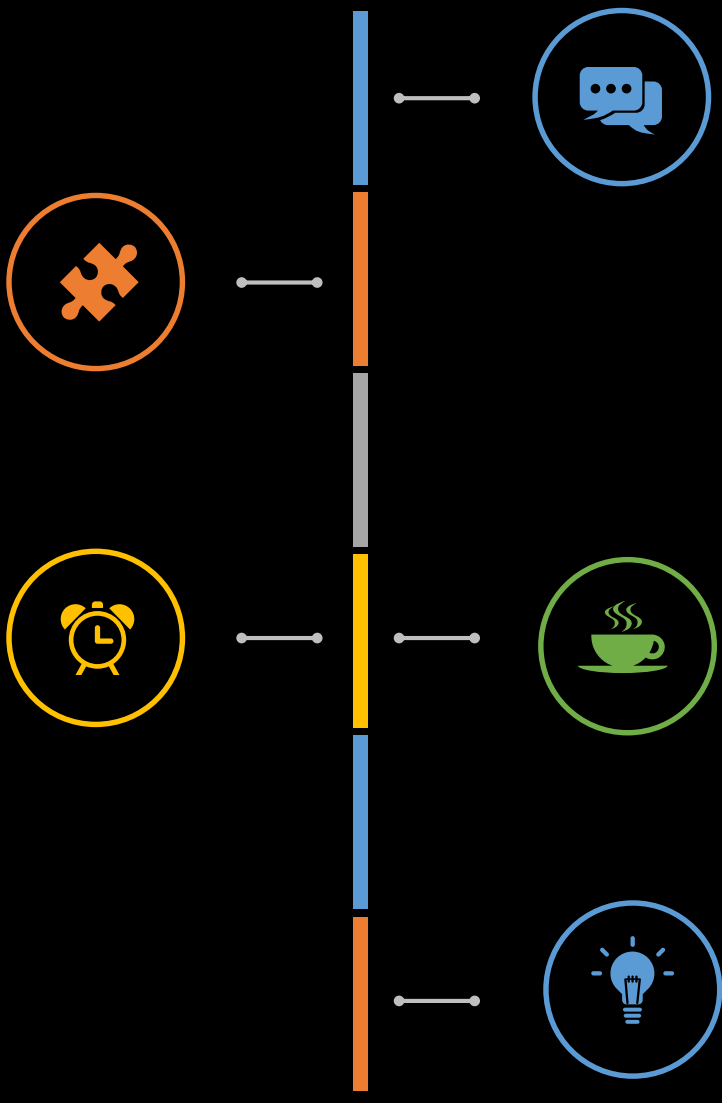
Characteristics to look for in a sensor for a certain application.

1. It necessitates the use of the proper measurement method.

Measurement technique - detect range: can measure distance (ultrasonic sensor).

2. The right size and weight

Size and weight: If our application is needed to be small and mobile, then we need to choose the right sensor for the purpose.



3. Temperature range and power consumption are both important considerations.

Operating temperature range: If the application exceeds the limit, the sensor maybe damaged.

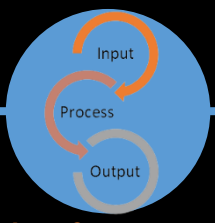
4. The right price range

Price must be in consideration to choose the suitable sensor with application.

5. Research and development

Do some research of the specification through the datasheet of that sensor.

Sensors category according to the output signals and applications.



What is the Sensor Output?

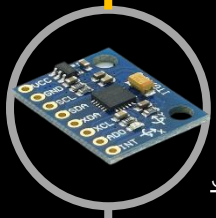
What is the Sample of Sensor Application

Sensor Output:
Binary signal (0 or1)

Sample of Sensor Application:
Tactile sensor

Sensor Output:
Analog signal (e.g 0 … 5V)

Sample of Sensor Application:
Inclinometer



Sensor Output:
Timing signal (e.g. PWM)

Sample of Sensor Application:
Gyroscope

Sensor Output:
Serial link (RS232 or USB)

Sample of Sensor Application:
GPS module, PS2 remote controller

Sensor Output:
Parallel link

Sample of Sensor Application:
Digital camera, printer

03 Difference between passive and active types of sensors

- The light or illumination source used by active sensors is their own. It accomplishes this by sending out a wave and measuring the backscatter it gets. Passive sensors, on the other hand, measure the reflected light from the sun. Passive sensors measure the energy when the sun shines; however, more on this will be discussed later.

ACTIVE SENSOR

- To work, it needs to be connected to a power source.
- At the same time, transmit and detect energy.
- Have your own light or illumination source. It actively puts out a wave and measures the backscatter that is reflected back to it.
- Examples of other active sensor-based technologies include: scanning electron microscopes, LIDAR, radar, GPS, x-ray, sonar, infrared and seismic.

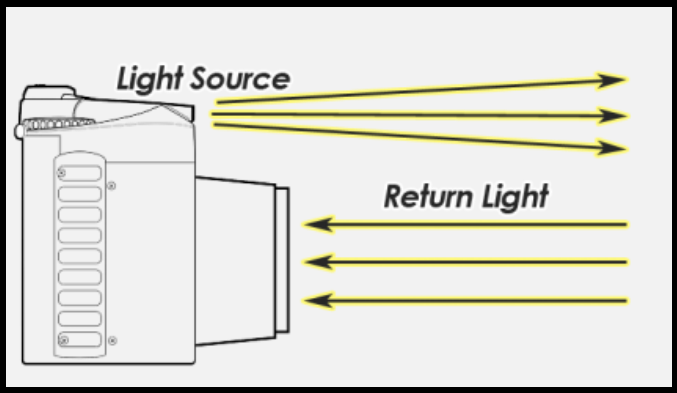
PASSIVE SENSOR

- There is no need for an external power source to generate the output signal.
- Not only transmit energy but only detects the energy, transmitted from an energy source.
- Calculate the amount of reflected sunlight emitted by the sun. Passive sensors monitor the energy emitted by the sun when it shines.
- Examples of passive sensor-based technologies are photographic, thermal, electric field sensing, chemical, infrared and seismic.

Example

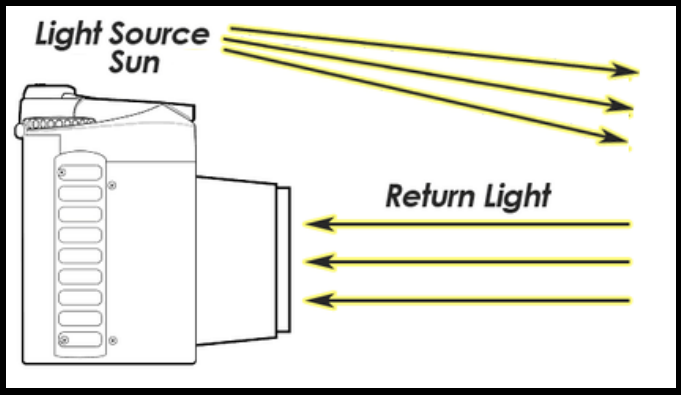
Cameras function as both passive and active sensors.

When you take a picture with the camera flash turned on, what exactly happens? The camera's own light source is transmitted to the target and reflected back to the lens. This is the light that your camera has captured.

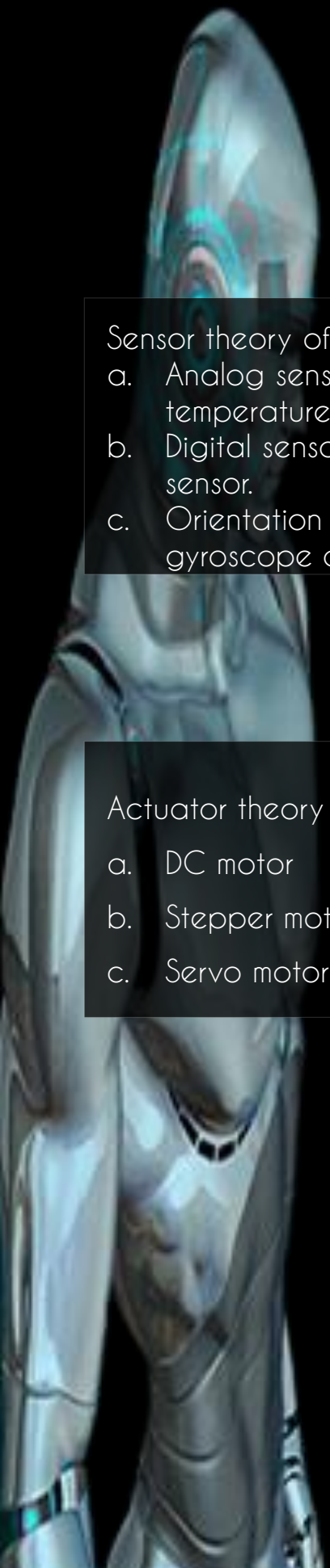


Example of an Active Remote Sensing Camera

Active remote sensing is similar to using a handheld camera with the flash on. Active remote sensing, on the other hand, can be carried out by Earth-orbiting satellites or aerial equipment. The camera's sensors become activated when a photographer uses flash. It lights up the object and measures how much energy is reflected back to the camera. The camera becomes a passive sensor when the photographer does not use the flash. The camera relies on the sun's naturally emitted light because it does not send its own light source.



Passive remote sensing camera example



Contents

Sensor and actuator theory of operation

Sensor theory of operation for the following :

a. Analog sensor – potentiometer or light or temperature sensor.
b. Digital sensor – tactile or distance or motion sensor.
c. Orientation or velocity sensor – compass or gyroscope or accelerometer or IMU sensor.

4

Actuator theory of operation for the following:

a. DC motor
b. Stepper motor
c. Servo motor

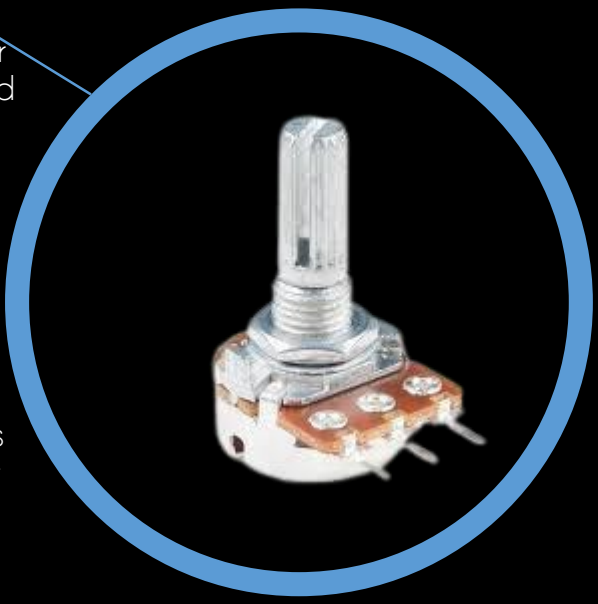
5

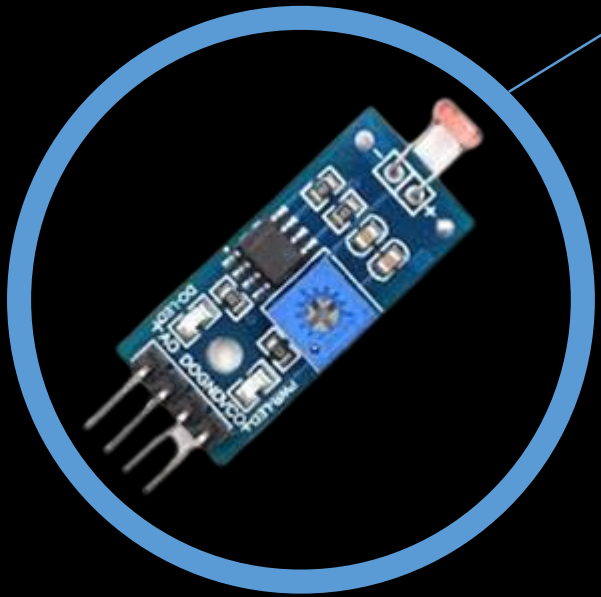
Analog Sensor

Potentiometer or Light or Temperature Sensor

POTENTIOMETER

- A three-terminal resistor with a sliding or revolving contact that may be adjusted to operate as a voltage divider. When only two terminals, one end and the wiper, are used, it acts as a variable resistor or rheostat.
- Is a voltage divider that is used to calculate electric potential? (voltage).
- Possessing direct control over enormous amounts of power (more than a watt or so). Instead, they're used to adjust the level of analogue signals (for example, volume controls on audio equipment) and as electronic circuit control inputs.





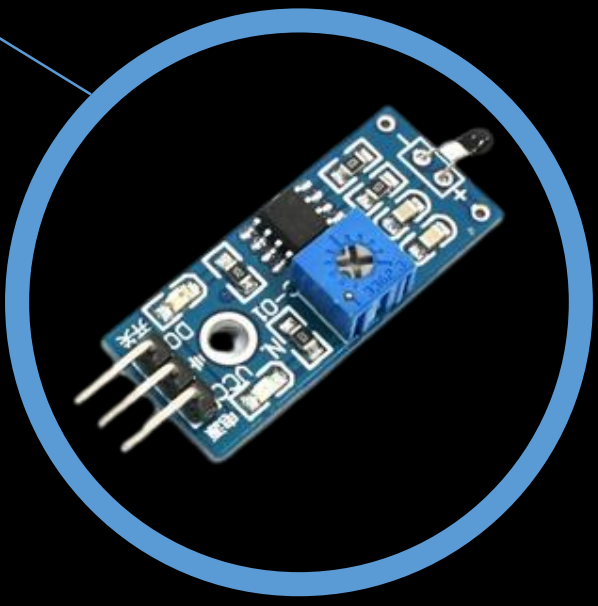
LIGHT SENSOR

- The amount of light that strikes the sensors is detected by light sensors.
- Photo-resistor, cadmium sulfide (CDS), and photocell are some of the several varieties.
- (LDR) can be used as an analogue light sensor to automatically turn on and off loads based on the quantity of light falling on it during the day. Lower light levels enhance LDR resistance, while higher light levels decrease it.

Analog Sensor

Potentiometer or Light or Temperature Sensor

TEMPERATURE SENSOR



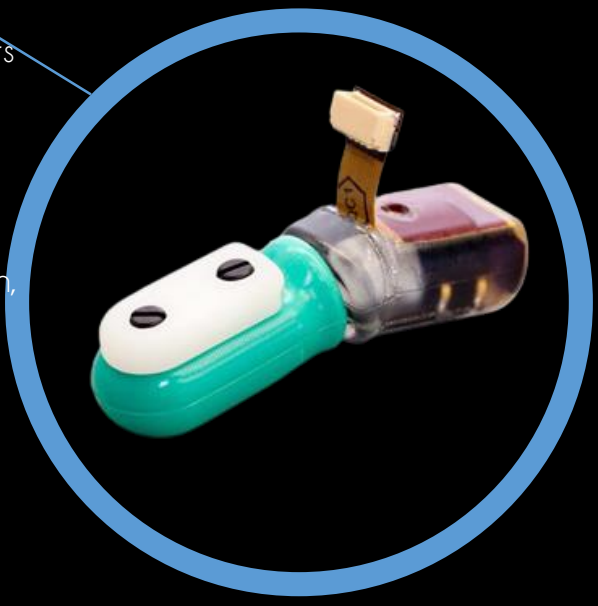
- The temperature sensor are uses an RTD (resistance temperature detector) or a thermocouple to measure temperature.
- Collects temperature data based on a specific source, transform to form that may be understood through a device or observer.
- Over a wide temperature range, it can detect solids, liquids, and gases.
- Types of Non-Contact Temperature Sensors — These temperature sensors employ convection and radiation to monitor temperature changes.
- Temperature is measured via an electrical signal using a thermocouple or RTD (Resistance Temperature Detectors).

Digital Sensor

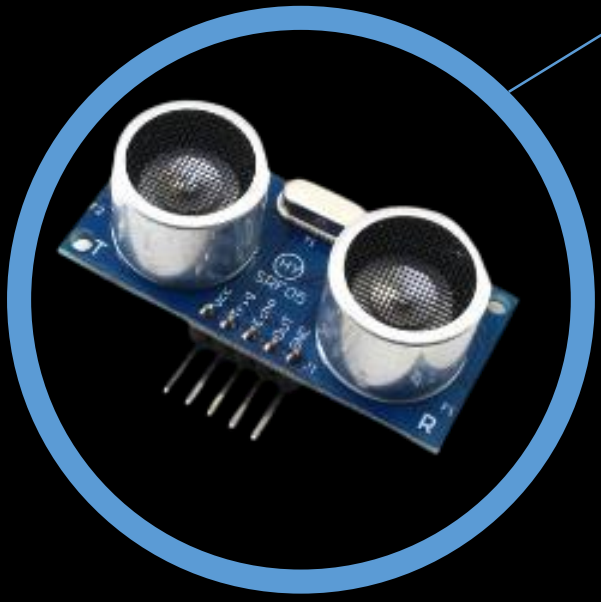
Tactile or Distance or Motion Sensor

TACTILE SENSOR

- A tactile sensor is a device that gathers information from physical contact with the environment.
- Tactile sensors are based on the cutaneous touch sense, which can detect inputs like mechanical stimulation, temperature, and pain.



DISTANCE SENSOR



- From a distance of 2 cm to 10 cm (0.8" to 4"), this little digital distance sensor identifies objects.
- Because of its quick response time, small size, and low current draw, this sensor is an excellent choice for non-contact object detection, and our compact carrier PCB makes it simple to integrate into any project.

Digital Sensor

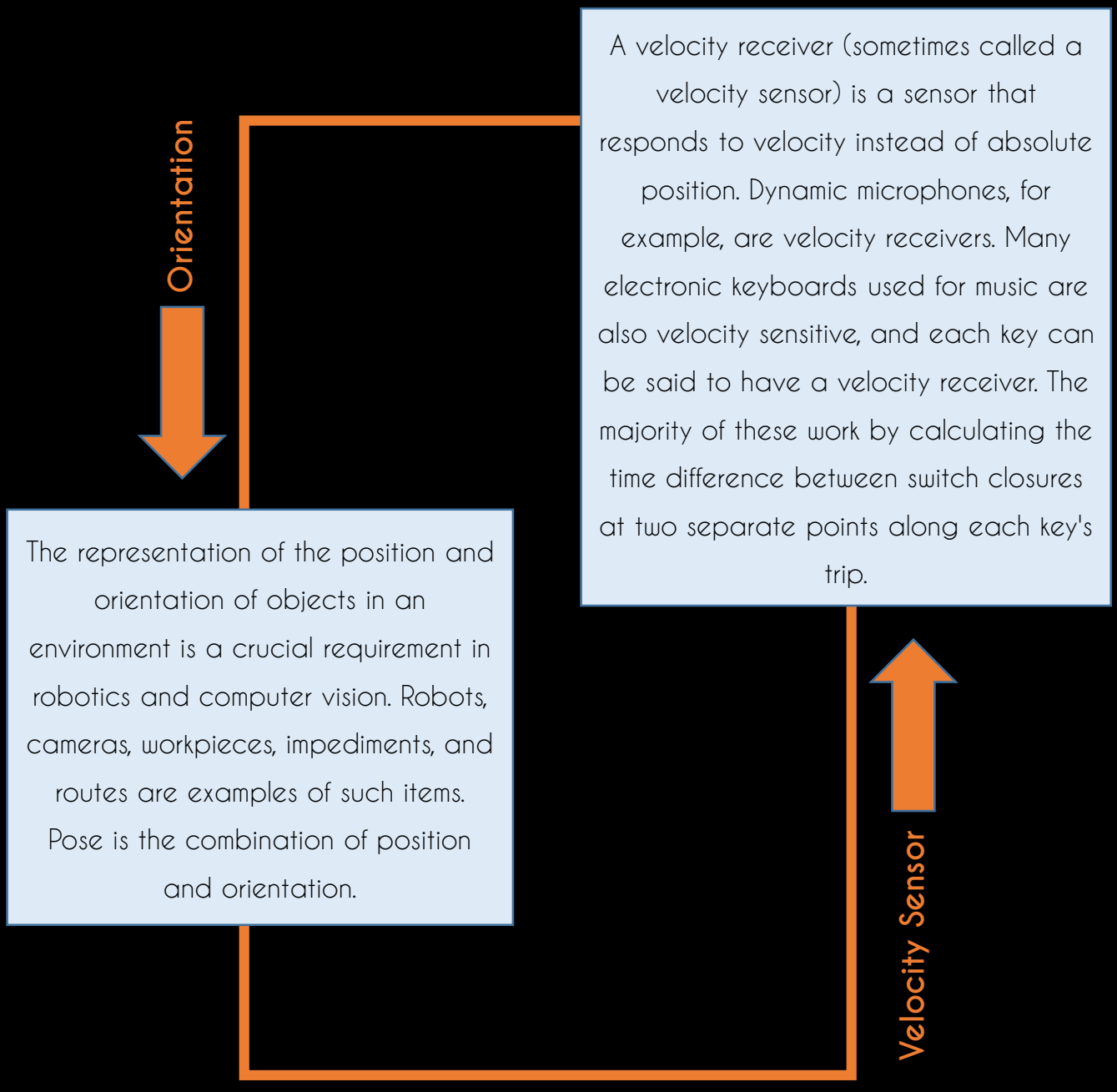
Tactile or Distance or Motion Sensor

MOTION SENSOR

- A motion sensor detects moving things, such as humans.
- This type of device is commonly employed as part of a system that automates a procedure or alerts a user to movement in a specified area.

Orientation or Velocity Sensor

Compass or Gyroscope or Accelerometer or IMU Sensor



Orientation or Velocity Sensor

Compass or Gyroscope or Accelerometer or IMU Sensor

COMPASS

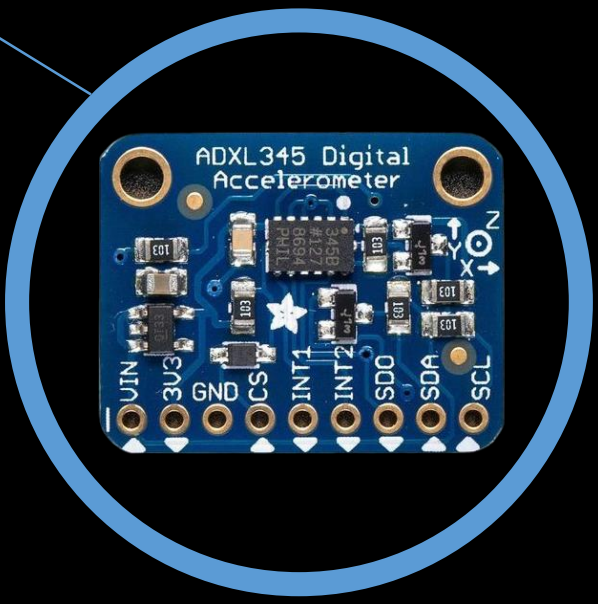
- A compass is a navigational and orientation tool that shows direction in reference to the cardinal directions (or points).
- The directions North, South, East, and West are commonly shown as abbreviated initials on the compass face by a design known as a compass rose.
- A rose can be aligned with the corresponding geographic directions when using the compass; for example, the "N" mark on the rose points northward.
- In addition to (or occasionally instead of) the rose, compasses frequently provide marks indicating angles in degrees. North is 0 degrees, and the angles grow clockwise, thus East is 90 degrees, South is 180 degrees, and West is 270 degrees.

Orientation or Velocity Sensor

Compass or Gyroscope or Accelerometer or IMU Sensor

ACCELEROMETER

- A gadget that measures appropriate acceleration is known as an accelerometer.
- Proper acceleration is the acceleration (or rate of change of velocity) of a body in its own instantaneous rest frame.
- An accelerometer is not the same as coordinate acceleration, which is acceleration in a given coordinate system.
- An accelerometer at rest on the Earth's surface, for example, will register an acceleration of g 9.81 m/s2 straight upwards due to Earth's gravity (by definition).
- Accelerometers can be found in a wide range of industries and scientific sectors.
- Highly sensitive accelerometers are used in inertial navigation systems for aircraft and missiles to detect and monitor vibration in spinning devices.

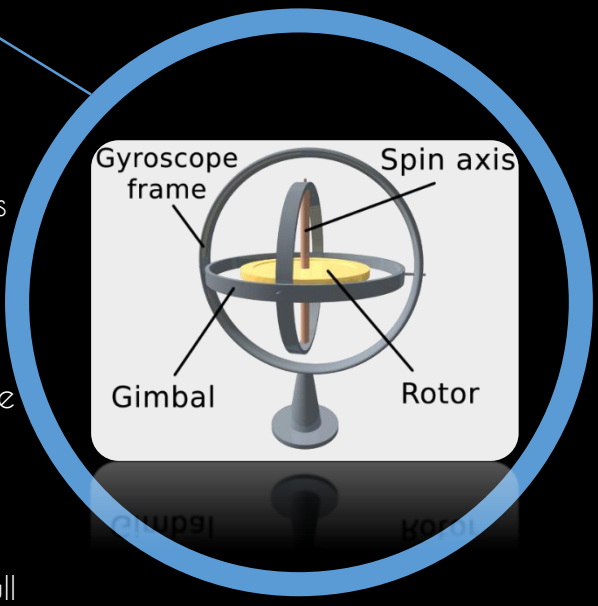


Orientation or Velocity Sensor

Compass or Gyroscope or Accelerometer or IMU Sensor

GYROSCOPE

- A gyroscope is a device that measures or maintains angular velocity and orientation.
- It's a spinning wheel or disc with an axis of rotation (spin axis) that can take on any orientation.
- According to the conservation of angular momentum, tilting or rotating the mounting has no effect on the orientation of this axis when spinning.
- Inertial navigation systems, such as the Hubble Telescope, or inside the steel hull of a submerged submarine, are examples of gyroscope applications.
- Gyroscopes are also utilized in gyro theodolites to maintain orientation in underground mining because of their precision.
- Gyroscopes can be used to build gyrocompasses that complement or replace magnetic compasses (in ships, aero planes and spacecraft, and vehicles in general), to aid with stability (bicycles, motorcycles, and ships), or as part of an inertial guidance system (bicycles, motorcycles, and ships).

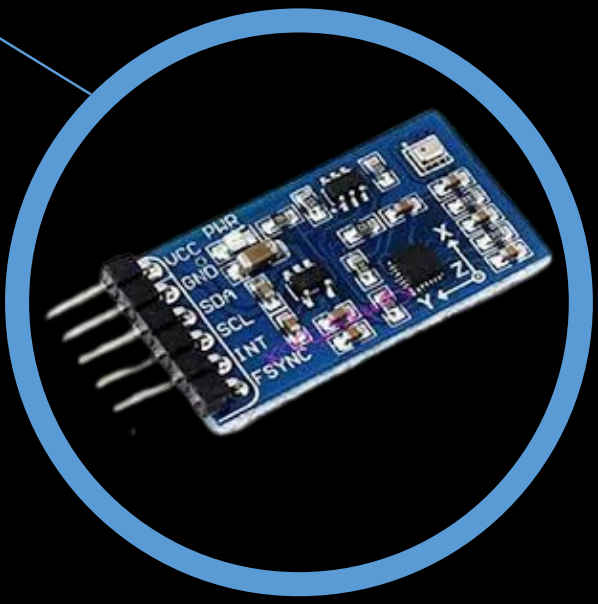


Orientation or Velocity Sensor

Compass or Gyroscope or Accelerometer or IMU Sensor

IMU SENSOR

- An inertial measurement unit (IMU) is an electronic device that detects and reports a body's force, angular rate, and sometimes orientation using a combination of accelerometers, gyroscopes, and sometimes magnetometers.
- IMUs are often used to control aircraft, such as unmanned aerial vehicles (UAVs), and spacecraft, such as satellites and landers (an attitude and heading reference system).
- IMU-enabled GPS devices are now possible thanks to recent advancements.
- When GPS signals are unavailable, such as in tunnels or within buildings, or when there is a lot of electrical interference, an IMU allows a GPS receiver to work. A WIMU (wireless IMU) is a type of wireless IMU.



Orientation or Velocity Sensor

Compass or Gyroscope or Accelerometer or IMU Sensor

The Gyroscope, The Accelerometer and The Inclinometer

- Tracked robots, balanced robots, walking robots, and autonomous planes all require orientation sensors to identify a robot's orientation in 3D space.

- For measuring two or all three axes of orientation, two or three sensors of the same model can be combined. The following are the different types of sensors:

Accelerometer – A device that measures acceleration along a single axis.

The rotational change of orientation on one axis is measured with a gyroscope.

Inclinometer – A device that measures the absolute angle of rotation around a single axis.

DC Motor

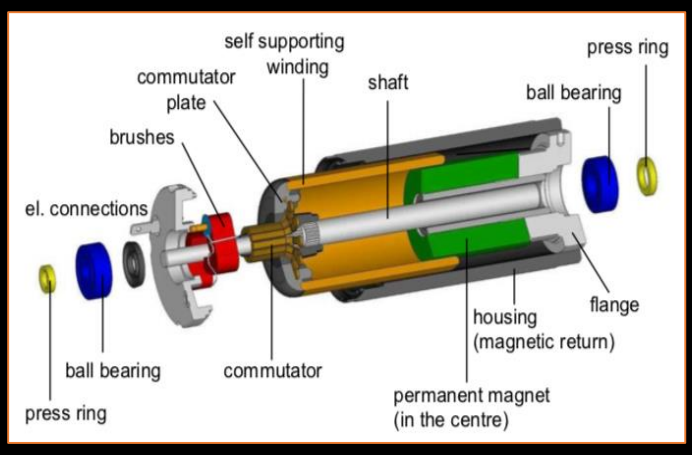
DC electric motors are by far the most common propulsion method in mobile robots. DC motors are quiet, clean, and powerful enough to accomplish a variety of tasks. They're a lot easier to control than pneumatic actuators, which are normally used when really high torques are required and external pressure pumps are available - which isn't often the case with mobile robots.

A DC motor is any revolving electrical machine that transforms direct current electrical energy into mechanical energy.

DC motors have an internal mechanism that changes the direction of current flow in a part of the motor on a regular basis, either electromechanically or electronically.

The process of converting direct electricity from the batteries into the alternating current required to generate motor activity in a motor.

A DC motor's speed can be adjusted across a wide range by altering the supply voltage or the current intensity in the field windings. The process of converting direct electricity from the batteries into the alternating current required to generate motor activity in a motor.



DC Motor VS AC Motor

An electric motors are the machines that use rotational force to transform electrical energy (from either stored electricity or a direct electrical connection) into mechanical energy. The following are the two main types of electric motors:

DC Motors
Which are powered by direct current

Advantages

- Simpler installation and maintenance.
- High startup power and torque.
- Fast response, stopping, and acceleration.
- Availability in several standard voltages.

AC Motors
Which are powered by alternating current

Advantages

- Low startup power demands that also protect components on the receiving end.
- Controllable starting current levels and acceleration.
- Add-ons such as a variable frequency drive (VFD) or a variable speed drive (VSD) that can control speed and torque at various stages of operation.
- High durability and longer life spans.
- Multi-phase configuration capabilities.

DC Motor VS AC Motor

DC Motors
Which are powered by direct current

AC Motors
Which are powered by alternating current

Disadvantages

High maintenance – care required to maintenance the mechanical interface used to get current to the rotating field.

Not suitable in very clean environment – vulnerable to dust which decreases performance.

Inability to operate at low speeds – the standard AC motors should not be operated at speeds less than 1/3 of base speed.

Poor positioning control – positioning control is expensive and crude with AC motors too. Even a vector drive is very crude when controlling the standard AC motor.

Stepper Motor

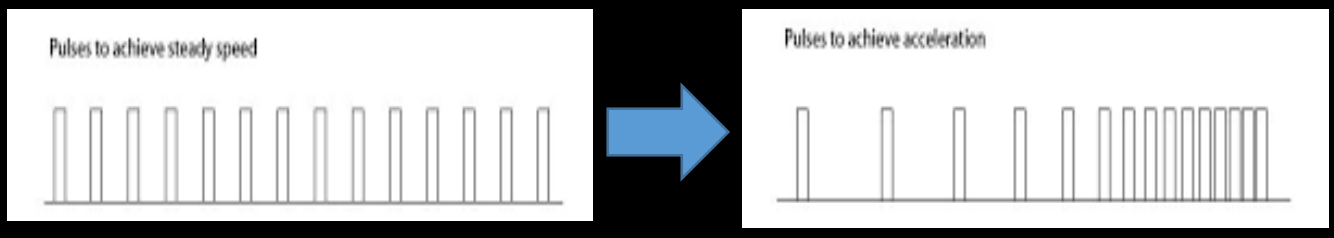
Stepper motors differ from regular DC motors in that they have two independent coils that may be controlled independently. As a result, stepper motors can be directed by impulses to take exactly one step forward or backward, rather than a smooth continuous motion like a standard DC motor. Every revolution has an average of 200 steps, resulting in a 1.8-degree step size. Some stepper motors provide half steps, resulting in even smaller step sizes. The speed of a stepper motor is also restricted by a maximum number of steps per second, which varies depending on the load.

Stepper motors are the motor of choice for many precision motion control applications.

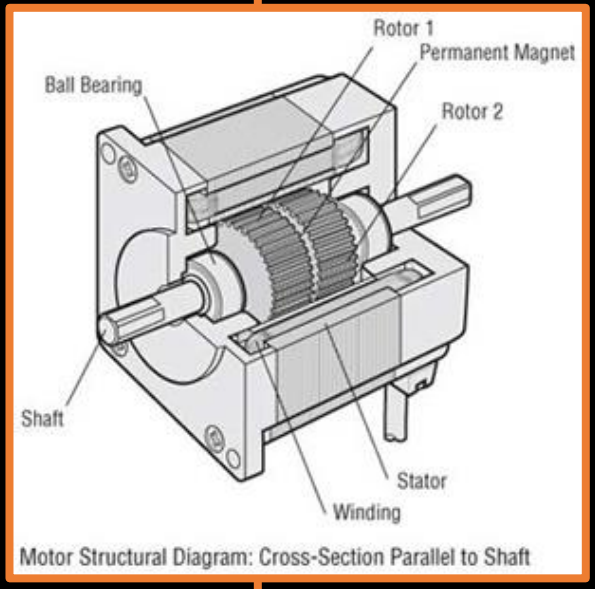
The position of the motor can be guided to move and hold at one of these steps without the need of a position sensor or an open-loop controller as long as the motor is suitably scaled for the application in terms of torque and speed.

A brushless, synchronous electric motor that translates digital pulses into mechanical shaft rotation is known as a stepper motor.

When compared to the effort necessary to regulate the velocity and position of ordinary DC motors, stepper motors appear to be a straightforward choice for manufacturing mobile robots. Stepper motors, on the other hand, are rarely utilised to drive mobile robots because they lack load and speed feedback (for example a missed step execution). Stepper motors have a lower weight-to-performance ratio than DC motors, in addition to requiring double the power electronics.



Stepper Motor



Motor Structural Diagram: Cross-Section Parallel to Shaft

Stepper Motor

Different between stepper motor and DC motor

THE BASIS	A STEPPER MOTOR	A DC MOTOR
The nature of loop	The stepper motor works in an open loop.	Closed loop operation is used by DC motors.
The Controlling	Microprocessors make it simple to control.	Controlling a DC motor is difficult.
The Brushes	They are brushless motor.	DC motor contains brushes.
The Motion and displacement	It moves in small steps, with resolution restricted to the size of the step.	They have a constant displacement and can be precisely regulated.
The Response time	The response time is excessively long.	When compared to a stepper motor, feedback control with a DC motor provides a much faster response time.
An Effect of Overloading	If a stepper motor is overloaded, it can slip, and the fault is undetectable.	It is possible to identify an overload.

Advantages and disadvantages of stepper motor

Advantages

- Simply plug it in and go. It's simple to set up and utilize.
- The motor will stop if anything breaks.
- In comparison to other motion control systems, it is inexpensive.

Disadvantages

- Ineffectiveness. Regardless of load, the motor consumes a significant amount of energy.
- Low precision. At maximum load, 1:200, and at modest loads, 1:2000.
- At moderate to high speeds, the motor is extremely noisy..

Servo Motor

On occasion, DC motors are referred to as "servo motors." The term "servo" does not refer to this. A servo motor is a high-performance DC motor that can be used in a closed control loop, or "serving application." This type of motor must be able to handle quick changes in position, speed, and acceleration, as well as have a high intermittent torque rating.

A servo, on the other hand, is a DC motor with integrated electronics for PW (pulse width) control that is commonly used in hobbyist applications like model aero planes, cars, and ships.

A servo is made up of three wires: VCC, ground, and the PW input control signal. Unlike PWM for DC motors, the input pulse signal for servos is not translated into a velocity. It's an analogue control input that determines the servo's needed rotational disc head location. Unlike a DC motor, the disc of a servo cannot rotate constantly. It rotates just around 120 degrees around its axis.

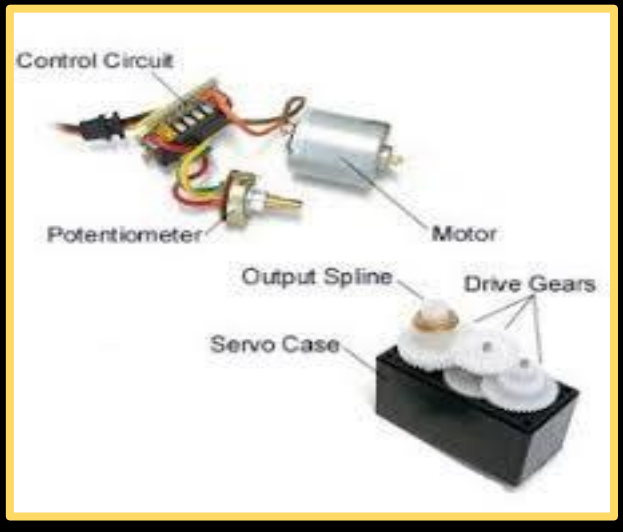
A servo combines a DC motor with a rudimentary feedback circuit, which commonly uses a potentiometer to sense the servo head's current position.
Servo motors can be used in a variety of ways, including assisting your robots in walking, moving remote-controlled boats, and driving cars. A motor and a potentiometer attached to the output shaft, as well as a control board, are the essential components of a servo. By delivering a coded signal to the servo, the output shaft can be moved to specific angular positions.

In radio controlled airplanes, servos are used to position control surfaces such as elevators and rudders.

Specific Applications:
- ❑ Building a small walking robot is one of the applications.
- ❑ For small robots, making grippers or other mechanisms.
- ❑ Small model aircraft have moving control surfaces.

Servo motor of speed
- ❑ The speed of the servo is expressed in seconds.
- ❑ A servo's 0-60 degree time is similar to that of a car's.
- ❑ The faster the servo operates, the lower the 60 degree time.

Servo Motor



Advantages and disadvantages of the servo motor

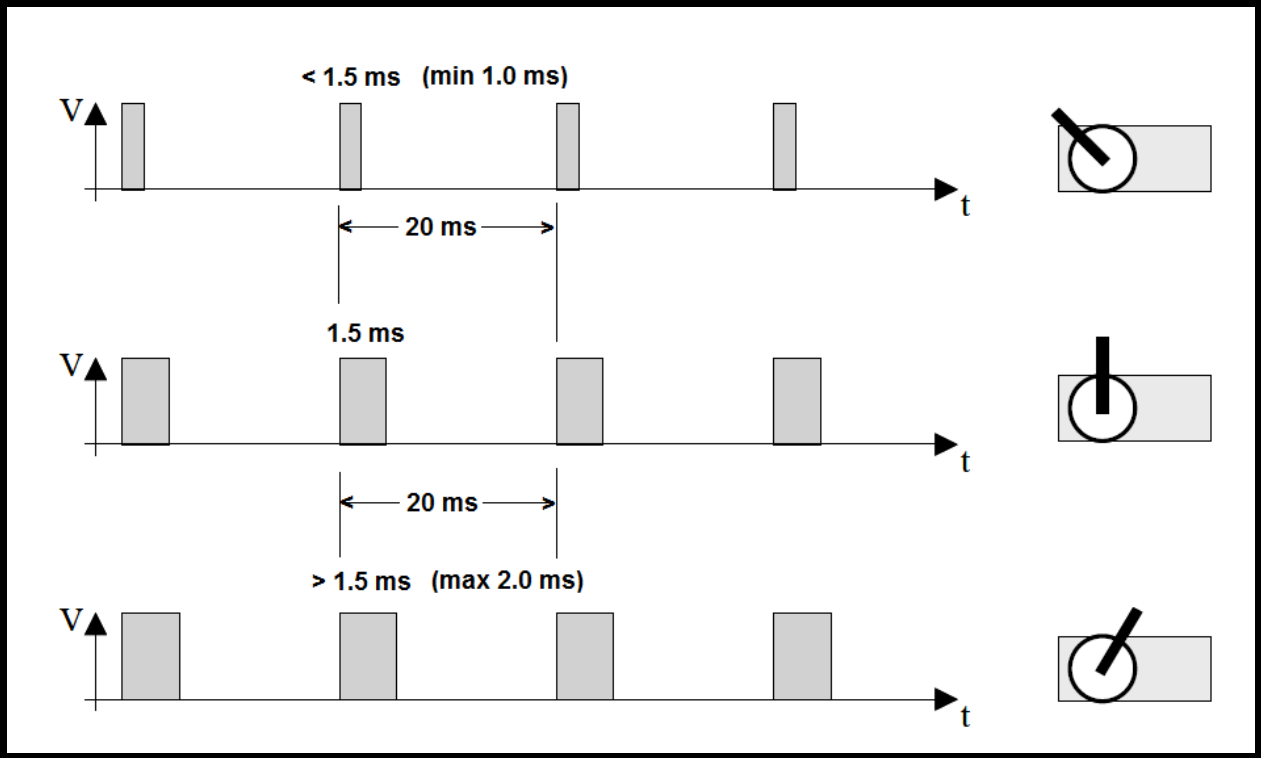
Advantages	Disadvantages
❑ The high output power in relation to the size and weight of the motor.	❑ Encoder is required since the problem is complex.
❑ High productivity. At light loads, it can reach 90 percent.	❑ To use peak torque, increase the power supply current by ten times the average.
❑ The motor does not overheat. Current consumption is proportional to load.	❑ Poor cooling of the motor. Motors that are not ventilated are readily polluted.

- The frequency of the PW signal used for servos is always 50Hz, therefore pulses are created every 20ms. The target position of the servo's disc is now determined by the width of each pulse (Refer figure).

- A width of 0.7ms, for example, will rotate the disc to its leftmost position (–120°), whereas a width of 1.7ms will rotate it to its rightmost position (+120°). The exact pulse length and angle values vary depending on the servo brand and model.

- Servos, like stepper motors, appear to be an excellent and easy robotics option. However, servos share the same flaw as stepper motors in that they do not provide any external feedback.

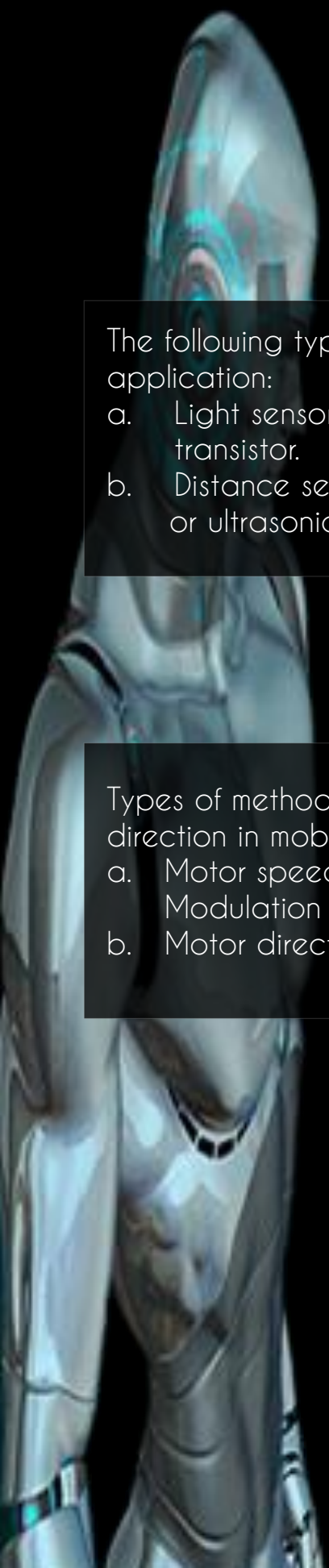
- When we apply a certain PW signal to a servo, we have no way of knowing when or if the servo will reach the required position, for example because of a too large load or an obstacle.



Stepper Motor

Different between DC Motor, Stepper Motor and Servo Motor.

DC MOTOR	STEPPER MOTOR	SERVO MOTOR
- Have two wire	- Have three wires	- Have three wires
- continuous rotation motor	- Uses a continuous rotation DC motor and integrated controller circuit	- Can be controlled more precisely than those of standard DC motors
- Run at high RPM	- Require an external control circuit or micro controller	- Assemble of four things
- Examples: computer cooling fan and radio controlled car wheels.	- Examples: computer scanner, image scanner	- Examples: Solar tracking system, Camera auto focus



Contents

Sensor and actuator in robotic application

The following type of sensors used in robotic application:

a. Light sensor – LDR or photodiode or photo-transistor.
b. Distance sensor – rotary encoder or infrared or ultrasonic sensor.

6

Types of methods to control motor speed or direction in mobile robots using the following :

a. Motor speed control – Pulse Width Modulation (PWM).
b. Motor direction control – H-Bridge.

7

06

The type of sensors used in robotic application for Light Sensor and Distance Sensor

Light Sensor – LDR or Photodiode or Photo-transistor

Light-dependent Resister (LDR)

Meaning: A device that allows a robot to determine the current ambient light level, i.e. how bright or dark it is. Light sensors are frequently used to detect light that is not visible to the naked eye, such as X-rays, infrared, and ultraviolet. An LDR is a component with a (variable) resistance that varies depending on the amount of light it receives. They can now be employed in light sensor circuits as a result of this.

Photodiode

A photodiode belongs to the photo junction device category, which is essentially a PN junction light sensor. They are typically composed of semiconductor PN junctions and are visible and infrared light sensitive. When light strikes a photodiode, it separates the electrons and holes, allowing the junction to conduct.

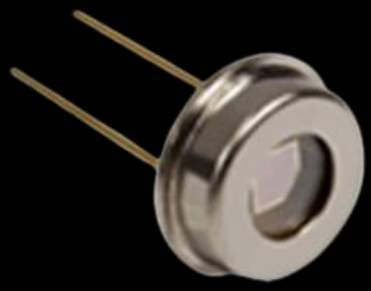


Photo-transistor

A normal transistor is an electrical component that regulates the flow of current by a specific amount based on current provided to it through another pin - there are three pins: collector, emitter, and 'base,' which controls how much current can pass through the collector to the emitter. A phototransistor, on the other hand, determines how much current can run through the circuit based on the amount of light it senses. In a dark room, the sensor only allows a minimal quantity of current to get through. When it detects a strong light, it allows more current to pass through.

Distance Sensor – Rotary Encoder or Infrared or Ultrasonic Sensor

Distance Sensor

A proximity sensor is a sensor that detects an object based on the object's distance from the sensor. This proximity sensor can detect things at distances ranging from 1 millimeter to several centimeters from the sensor. This sensor is commonly used in industrial plants, offices, and the robotics industry, among other places. Proximity sensors, as defined by their application, are sensors that can detect the presence of a metal or non-metal object without requiring physical touch.

Rotary Encoder

The angular position of a rotating shaft is determined by a rotary encoder, which is a sort of position sensor. According to the rotational movement, it generates an electrical signal, either analogue or digital.

Infrared Distance Sensor

A sharp distance sensor, also known as an infrared distance sensor, detects the presence of adjacent objects. This sensor takes a continuous distance reading and converts it to an analogue voltage that can be used to determine the distance between two objects. These sensors are ideal for short-range applications.

Ultrasonic Sensor

An ultrasonic sensor is a device that uses sound waves to determine the distance to an item. It determines distance by emitting a sound wave at a specified frequency and listening for it to bounce back.

07

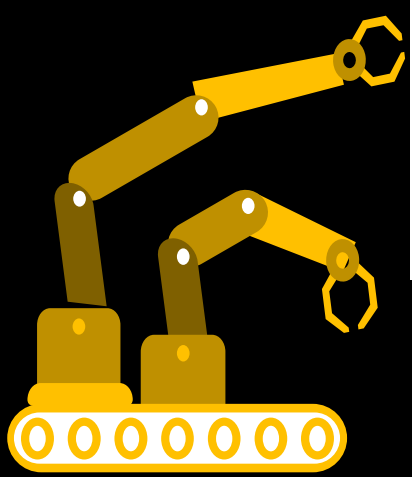
Types of methods to control motor speed or direction in mobile robots

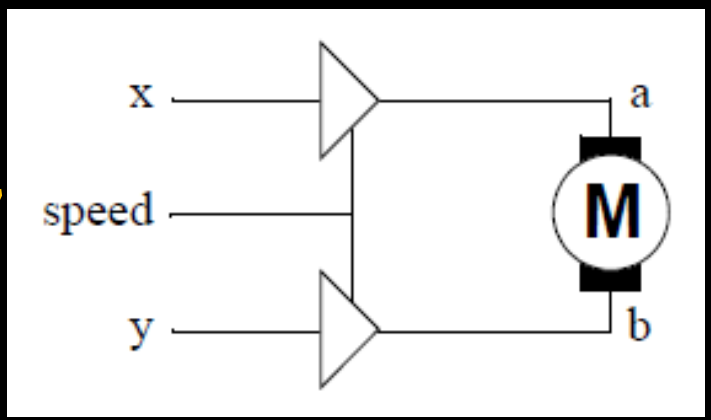
Motor Speed Control – Pulse Width Modulation (PWM)

PWM, or pulse width modulation, is a creative approach to avoid analogue power circuits by using the latency inherent in mechanical systems. Instead of an analogue output signal with a voltage proportionate to the desired motor speed, it is sufficient to generate digital pulses at the entire system voltage level (for example 5V). These pulses are generated at a specific frequency, such as 20 kHz, and are therefore undetectable to humans.

By altering the pulse width in software, we may modify the equivalent or effective analogue motor signal and so regulate the motor speed (see figure, top versus bottom). The motor system can be conceived of as a time-based integrator of digital input impulses. The quotient ton/period is the "pulse-width ratio" or "duty cycle."

> The motor can be stopped in two ways: by setting both x and y to logic 0 (or both to logic 1), or by setting speed to 0.

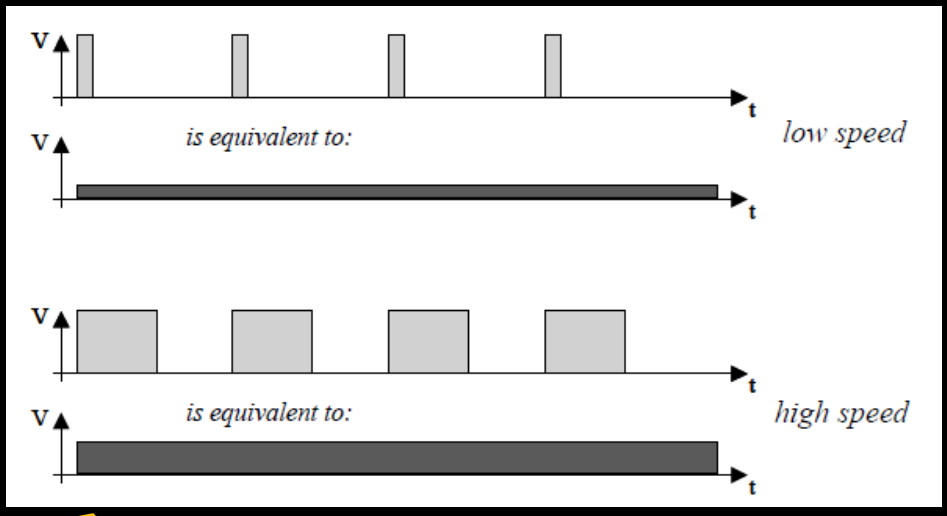


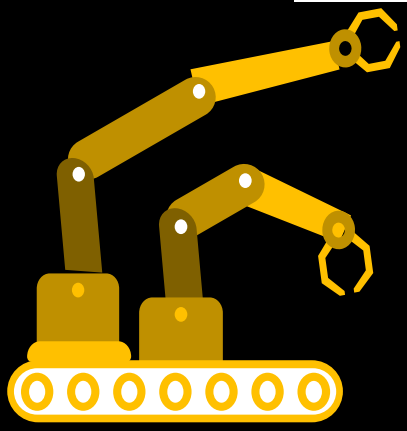


PWM can be created using software. To accommodate this action, many microcontrollers, such as the PIC16F877A, feature special modes and output ports. The PWM signal from the digital output port is then linked to the power amplifier's speed pin in figure.

We can now achieve the two goals we set forth earlier which is can move a motor either forward or backward, and can change its speed. On the other hand, we have no way of knowing what the motor's true speed is. It's worth mentioning that the real motor speed is affected not only by the PWM signal, but also by external factors like the load (for example, the vehicle's weight or the steepness its driving zone).

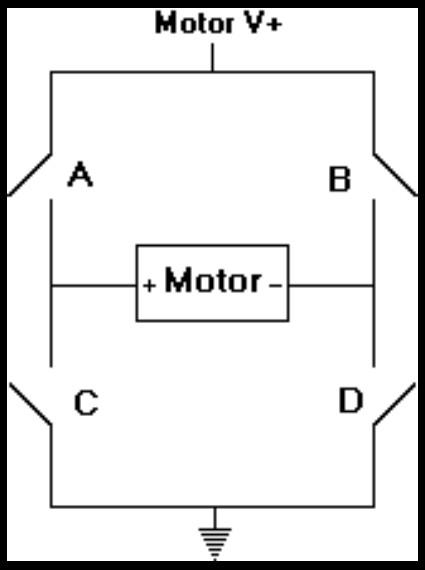
What we've done so far is referred to as open loop control. With the help of feedback sensors, we'll build closed loop control (often referred to as "control"), which is required to drive a motor at a desired speed under varying load.





Motor Speed Control – H-bridge (Motor Direction Control)

The ability to run a motor in either direction might be beneficial. With a motor like the one used in the tests thus far, this is straightforward. The shaft of such a motor will rotate in the other direction if the DC power connections are reversed. Switches placed in the following manner can be used to regulate direction:



Because of its shape, this arrangement is known as an H-Bridge. When the motor's + terminal is linked to Motor V+ and its - terminal is connected to ground, the motor will move forward. When the contrary is true, it will run in reverse. The motor will move forward if switches A and D are turned on. It will operate in reverse if you turn on switches B and C. All of this is included in the table below.

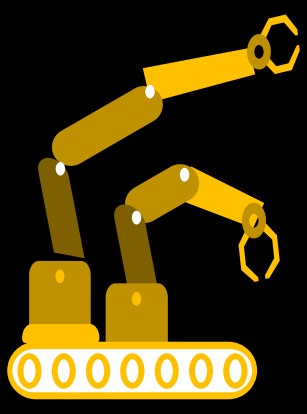
A	B	C	D	State	A	B	C	D	State
0	0	0	0	**Off**	1	0	0	0	**Off**
0	0	0	1	**Off**	1	0	0	1	**Forward**
0	0	1	0	**Off**	1	0	1	0	**SHORT!!**
0	0	1	1	**Brake**	1	0	1	1	**SHORT!!**
0	1	0	0	**Off**	1	1	0	0	**Brake**
0	1	0	1	**SHORT!!**	1	1	0	1	**SHORT!!**
0	1	1	0	**Reverse**	1	1	1	0	**SHORT!!**
0	1	1	1	**SHORT!!**	1	1	1	1	**SHORT!!**

To allow a motor to go forward and backward, an H-bridge is necessary. An H-bridge is built using a power amplifier chip in conjunction with the controller's digital output pins or an additional latch when using a microcontroller. This is necessary because the digital outputs of a microcontroller have very severe output power limits.

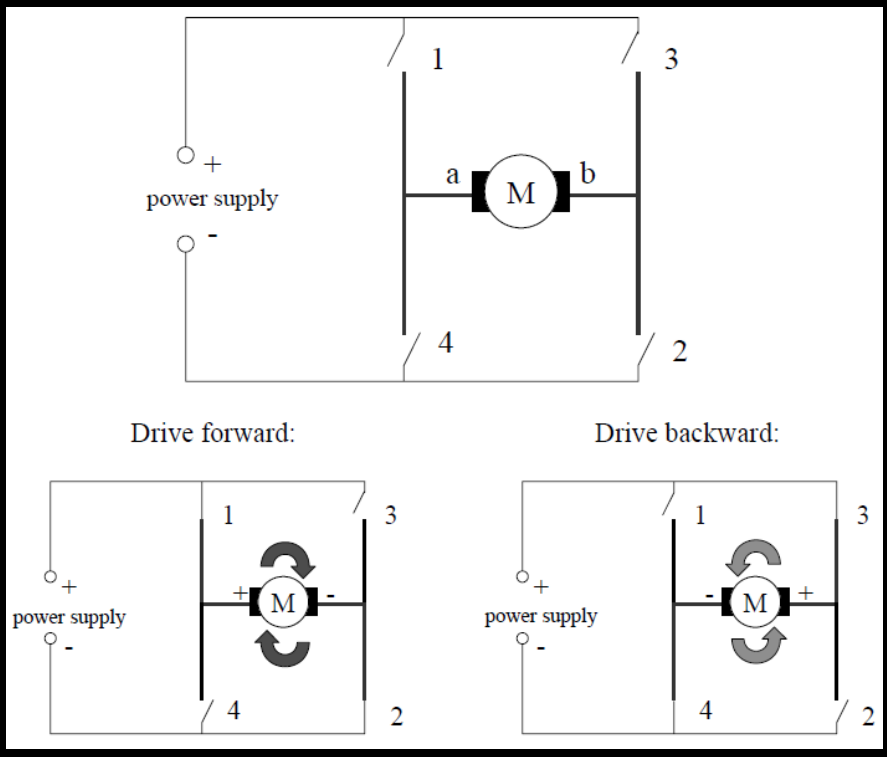
They can only be used to drive other logic chips; they can't operate a motor directly. Because motors consume a lot of power, connecting digital outputs directly to them can kill the microcontroller (for example, 1A or more).

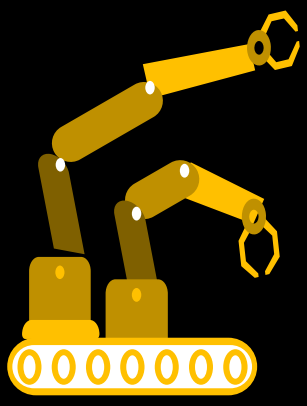
The L293D is a standard power amplifier chip from ST SGS-Thomson, containing two separate amplifiers. Figure 10 depicts the schematics. One of the two inputs x and y must be "+," while the other must be "–," in order to flip the input voltage. x and y can be linked directly to the microcontroller's digital outputs because they are electrically disconnected from the motor.

As a result, by changing output x to logic 1 and output y to logic 0, software may control the motor's direction. Because x and y are always diametrically opposed, they can be replaced by a single output port. The rotation speed can be specified using the "speed" input (see the following section on pulse width modulation).



Motor control:
We want a motor to be able to do two things in most applications:
. Make a forward and backward motion with it.
2. Change the speed of it.





TIME FOR A TUTORIAL!

LET'S ACCESS YOUR UNDERSTANDING OF OUR LESSON

1 Identify the classification of mobile robot types?

2 Define mobile robot system?

3 Describe land mobile robot type?

4 Explain how Differential Drive Steering works in directing the movement of a mobile robot.

5 Explain how the Ackermann Steering Drive works in terms of directing the movement of a mobile robot.

6 Give one disadvantage of Ackermann Steering Drive?

7 Explain the concept of the Legged Robot's functioning in terms of controlling the movement of a mobile robot.

8 Describe Aerial mobile robot type?

9 Describe underwater mobile robot type?

10 Explain function ROV and AUV for submarine military mission?

11 List year evolution of mobile robotic in world history?

12 Explain first mobile robot by Shakey?

13 Give significance of mobile robots in modern days?

14 Define significance of embedded controllers in mobile robotics?

15 List four familiar examples of embedded systems in usage?

16 Explain the importance of embedded controllers in mobile robotics?

17 List characteristic the right sensor for a particular application?

18 List types of sensors?

19 Sketch binary sensor function and application?

20 Define the term of sensor?

GET YOUR QUESTION HERE

21 Define the term of actuator?

22 Define binary sensor function and application concept?

23 Sketch sensors function and application for binary sensor?

24 Explain digital sensor in mobile robotic?

25 Define the term for analog sensor?

26 Define the term for digital sensor?

27 List six sensor categories according to their applications?

28 Differentiate between passive and active types of sensors?

29 Sketch analogue and digital converter interfacing?

30 List type of actuators used in robotic application?

31 Differentiate between the DC Motor, the Stepper Motor and the Servo Motor?

32 Explain an advantages the stepper motor in mobile robot design?

33 The polarity of a voltage applied to a load is switched using a H bridge. These circuits are commonly used to allow DC motors to run forward or backward in robotics and other applications. Sketch and label the H-bridge operation for forward and backward drive motor?

34 Define Pulse width modulation?

35 Define which software can be generated PWM?

36 List types of sensor used in robotic application for light sensor and distance sensor?

37 Describe Light-dependent Resister (LDR) in robotic application?

38 Describe photodiode in robotic application?

39 Describe photo – transistor in robotic application?

40 Explain distance sensor in robotic?

GET YOUR QUESTION HERE

41 Explain rotary encoder in robotic?

42 Explain infrared distance sensor in robotic?

43 Explain infrared ultrasonic sensor in robotic?

44 What are the two main methods for halting the motor?

45 Sketch are the main methods for halting the motor?

46 Sketch one way to control direction H-bridge motor speed direction control?

47 What is a robot?

a. A walking and talking machine
b. A gas powered and remote controlled machine
c. Any programmable machine designed to move and perform tasks
d. A statue

48 Is a device that a computer can use to sense the outside world?

a. Camera
b. Feeling sensor
c. Senses
d. Sensor

49 A robot that looks like a person is …….?

a. Robotic
b. Non-human
c. Humanoid
d. Human

50 A sensor that can detect vibration……..?

a. Shaker
b. Vibration sensor
c. Pressure sensor
d. Vibes sensor

51 A sensor that can detect distance between itself and another object?

a. Proximity sensor
b. Sound sensor
c. Pressure sensor
d. Chemical sensor

GET YOUR QUESTION HERE

52 Is a machine that turns quickly either mechanically or electrically?

a. Motor
b. Eyes
c. Joints
d. Turning Sensor

53 A mechanical muscle that turns instructions into movement .....?

a. Camera
b. Control system
c. Metal
d. Actuator

54 Robots are made with parts that mimic human and animal behavior.

a. True
b. False

55 The Wheels deliver electricity to power the robot.

a. True
b. False

56 Which of these is the part of the robot that interacts with the environment such as grasping or carrying objects?

a. Motor
b. End Effector/ Actuator
c. Sensor
d. Batteries

57 Robots must have a remote control.

a. True
b. False

58 Sensors allow a robot to roll around a surface.

a. True
b. False

GET YOUR QUESTION HERE

59 Which of these allows a robot to roll around a surface?

a. Lightbulbs
b. Batteries
c. Wheels
d. Processor

60 In 1921. this person invented the term “robot” for his play.

a. Leonardo da Vinci
b. Karel Capek
c. Thomas Edison
d. George Washington

61 iRobot's vacuum cleaner senses the environment and can be _____ to clean around a specific schedule, like when you are not home.?

a. Programmed
b. reminded

62 The _____ is the "brain" of the robot.

a. manipulator
b. mechanical structure
c. computer
d. inputs

63 5. The main source of power for most robots is _____.

a. Electricity
b. thermal energy
c. bio thermal energy

64 _____ provide input to the computer control program so that decisions can be made about what actions to take.

a. controller
b. Sensors
c. mechanical structure

GET YOUR QUESTION HERE

65 Sensors can detect all of these EXCEPT…?

a. temperature
b. pressure
c. distance
d. state of mind

66 A sensor is considered a _____.

a. mechanical structure
b. output
c. Input
d. controller

67 _____ involves the design, construction, and operation of a robot.

a. Robotics
b. Automation
c. Assembly line
d. Manufacturing

68 The 1st generation robots performed simple tasks or factory work that were _____ for people.

a. Dangerous or unpleasant
b. Destined
c. Unfit
d. Cumbersome or inconvenient

69 The science and technology behind the design, manufacturing and application of robots.

a. Computer Science
b. Robotics
c. Engineering Design Process
d. Manufacturing

70 What is the key component of motion system which causes a mechanical system to move?

a. sensors
b. manipulators
c. Actuators

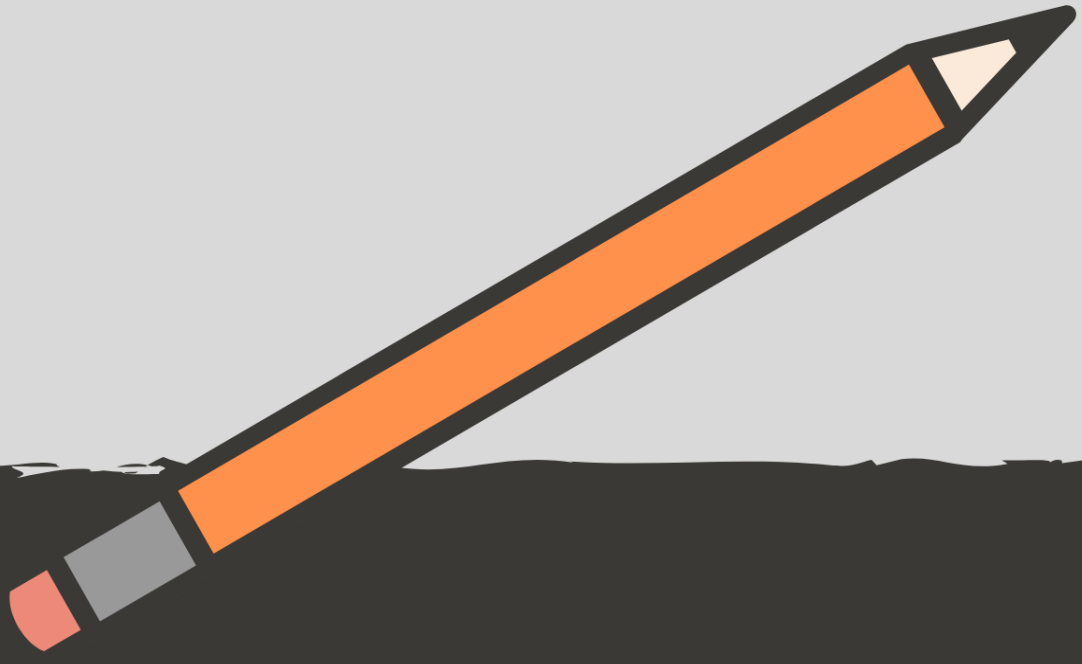
GET YOUR QUESTION HERE

CHECK YOUR ANSWERS

HERE'S AN IMPORTANT REMINDER:

FIND YOUR MISTAKES, CORRECT THEM!

You never know what you might miss if you don't.



1	▪ Land ▪ Area ▪ Underwater
2	▪ An automatic machine that is capable of movement in a given environment. ▪ A robot mounted on a movable platform that transports it to the area where it carries out tasks. ▪ A self-contained system capable of navigating a landscape with natural or man-made obstacles.
3	▪ Land-based mobile robots are normally consists of wheeled and legged robots. ▪ Wheeled robots have one or more driven wheels, as well as passive or caster wheels and, in some cases, steered wheels.
4	▪ The differential drive is a combination of two driven wheels that are located at the right and left side of the robot structure. ▪ The robot may be driven straight, in a curve, or turn on the spot thanks to this combination. ▪ The motors and wheels are in permanent positions in this configuration.
5	▪ Ackermann steering is a rear-drive passenger car's conventional drive and steering arrangement. ▪ One motor drives both rear wheels via a differential box, and one motor steers both front wheels at the same time.
6	▪ All wheeled robots have the problem of requiring a street or other flat surface to drive on.
7	▪ They can traverse across uneven terrain and climb up and down stairs, for example, just like tracked robots. ▪ Legged robots come in a variety of designs, depending on how many legs they have. ▪ Legged robots may appear in two, three, four, six and eight-legged form depending to their own design and specifications.

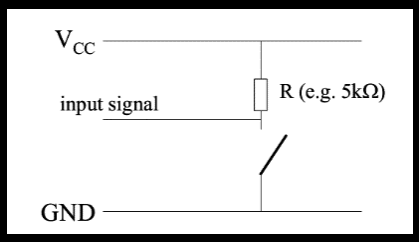
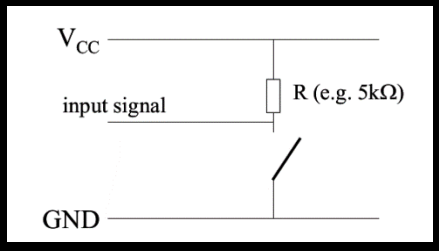
GET YOUR ANSWER HERE

8	▪ Autonomous planes or UAV (Unmanned Aerial Vehicle) are the example of aerial type of mobile robot. ▪ UAV is an aircraft that operates without human pilot onboard. Instead, it is controlled miles to thousands of miles away from the base station. ▪ The UAVs or sometimes called as drones are used extensively by some military forces in performing modern warfare nowadays.
9	▪ There are several examples of underwater mobile robots, namely remotely driven underwater vehicle, autonomous underwater vehicle and fish robot. ▪ A self-driving underwater vehicle (AUV) is a robot that travels underwater without the assistance of a human operator.
10	▪ Among the functions of the AUV and ROV are to detect manned submarines in military mission, analyzing the microscopic life in science application and making precise seafloor maps for constructing subsea infrastructure in commercial purpose. ▪ A robotic fish on the other hand is a robot that imitates the look and the characteristics of a fish. There are many purposes of developing the robotic fish and one of them is to carry out underwater operation such as monitoring the pollution level at harbors and send the information to the shore.
11	▪ 1950 ▪ 1990 ▪ 2000 ▪ 2018
12	▪ To use vision to recognize a thing. ▪ It must find a way to the thing. ▪ Perform an action on the object (such as pushing it over).

GET YOUR ANSWER HERE

13	▪ Humans have relinquished the tasks of risky and mundane jobs to automated robots, allowing for increased productivity. ▪ Extra shifts have been added to factories because robots never tired. ▪ Farmers have used automated harvesters to take advantage of new technology, the garbage disposal business has used robots in some of its dirtier chores, and the medical industry has benefited from developments in aided surgical robotics. ▪ The military has established a number of robotics initiatives, the most successful of which are the unmanned aerial reconnaissance vehicles Predator and Reaper, which allow a pilot to control the robot from a great distance.
14	A system that is managed by a computer integrated within it, but whose primary role is not computational.
15	▪ Washing machine ▪ Photostat machine ▪ Microwave ▪ Scanner
16	▪ Equip the robot with 'brain' to process the data obtained through the sensors and react using actuators. ▪ Allow the mobile robots to be programmed to perform various kind of tasks according to the human's desire and the robots' ability. ▪ Making the robots to function autonomously according to program they receive. ▪ Allow the mobile robots to be sophisticated and advanced in features.
17	▪ It necessitates the use of the proper measurement method. ▪ Size and weight are ideal. ▪ Temperature range and power consumption that are appropriate. ▪ The appropriate pricing range
18	▪ Internal – Passive, Active. ▪ External – Passive, Active.

GET YOUR ANSWER HERE

19	 Unless the switch is actuated, a pull-up resistor will output a high signal. An "active low" setting is what it's called.
20	Sensors are high-tech gadgets that detect and respond to electrical and optical impulses.
21	▪ An actuator is a machine component that is in charge of moving and controlling a mechanism or system, such as opening a valve. ▪ It is a "mover" in plain terms. ▪ A control signal and a source of energy are required for an actuator.
22	Sensors of the most basic form. They only return one bit of data, either a 0 or a 1.
23	
24	▪ Digital sensors, on the other hand, are typically more complicated and accurate than analogue sensors. ▪ Digital sensors can produce a variety of output signals. ▪ A parallel interface (8 or 16 digital output lines), a serial interface (RS232 standard), or a synchronous serial interface can all be used.
25	Analog output signals are produced by a variety of sensors rather than digital signals. To link such a sensor to a microcontroller, an A/D converter is necessary.

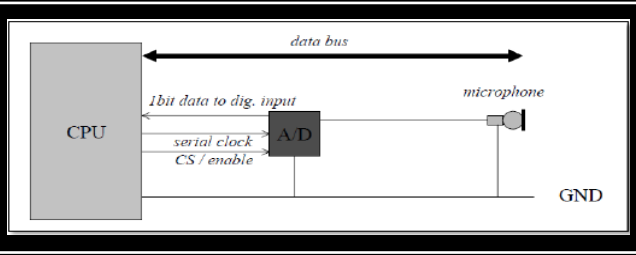
GET YOUR ANSWER HERE

26 Digital sensors, on the other hand, are typically more complicated and accurate than analogue sensors.

27
- A temperature sensor
- A humidity sensor
- A proximity sensor
- An infrared sensor
- A PIR sensor
- An UV sensor

28
- Each active sensor has its own light or illumination source.
- It actively puts out a wave and measures the backscatter that is reflected back to it.
- The sun's reflected sunlight is measured using a passive sensor.
- When there is sunlight, a passive sensor measures the energy, but more on that later.

29



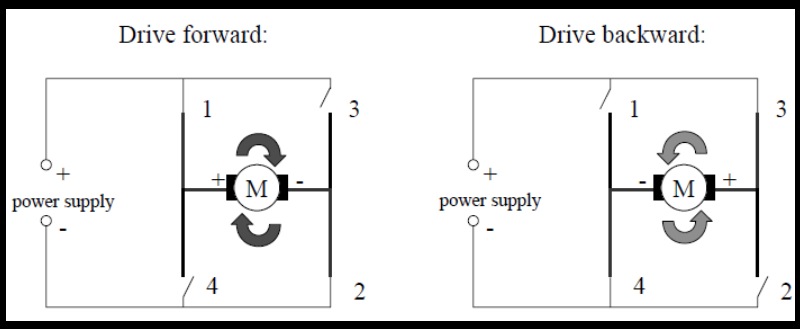
30
- Dc Motor.
- Stepper Motor.
- Servo Motor.

31

BASIS	STEPPER MOTOR	DC MOTOR
Nature of loop	Stepper motor operates in Open loop.	DC Motor operates in Closed loop.
Controlling	Easily controlled with microprocessors	DC motor control is not easy
Brushes	They are brushless motor	DC motor contains brushes.
Motion and displacement	Its motion is incremental and resolution is limited to the size of the step.	They have continuous displacement and can be controlled accurately.
Response time	Response time is slow	Feedback control with DC motor gives a much faster response time as compared to a stepper motor.
Effect of Overloading	Stepper motor can be slipped if overloaded and the error cannot be detected.	If an overload occurs, it can be detected.

32
- Simply plug it in and go. It's simple to set up and utilize.
- Safe. The motor will stop if anything breaks.
- In comparison to other motion control systems, it is
- inexpensive.

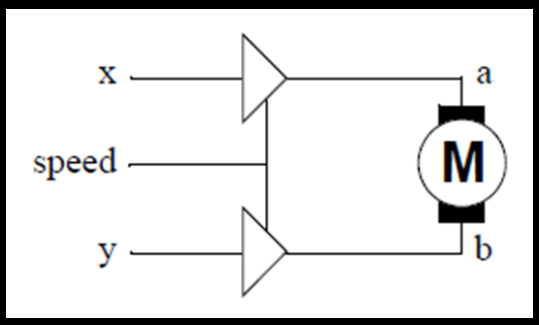
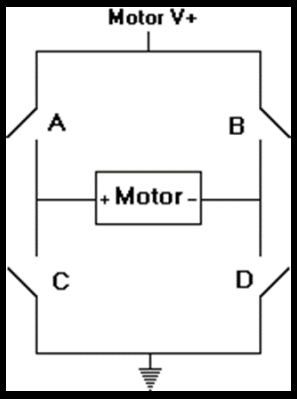
GET YOUR ANSWER HERE

33	
34	▪ Pulse width modulation, or PWM for short, is a clever way to circumvent analogue power circuits by taking advantage of the latency inherent in mechanical systems. ▪ It is sufficient to generate digital pulses at the whole system voltage level instead of an analogue output signal with a voltage proportional to ad of the desired motor speed (for example 5V). ▪ These pulses are created at a predetermined frequency, such as 20 kHz, and are hence inaudible to humans.
35	Many microcontrollers like the PIC16F877A to facilitate this activity, have particular modes and output ports.
36	▪ Light-dependent Resister (LDR). ▪ Photodiode. ▪ Photo- transistor.
37	Meaning: A device that allows a robot to determine the current ambient light level, i.e. how bright or dark it is. Light sensors are frequently used to detect light that is not visible to the naked eye, such as X-rays, infrared, and ultraviolet. An LDR is a component with a (variable) resistance that varies depending on the amount of light it receives. They can now be employed in light sensor circuits as a result of this.
38	A photodiode belongs to the photo junction device category, which is essentially a PN junction light sensor. They are typically composed of semiconductor PN junctions and are visible and infrared light sensitive. When light strikes a photodiode, the electrons and holes are separated, allowing the junction to form.

GET YOUR ANSWER HERE

39	▪ A normal transistor is an electrical component that regulates the flow of current by a specific amount based on current provided to it through another pin - there are three pins: collector, emitter, and 'base,' which controls how much current can pass through the collector to the emitter. ▪ A phototransistor, on the other hand, determines how much current can run through the circuit based on the amount of light it senses. ▪ In a dark room, the sensor only allows a minimal quantity of current to get through. ▪ When it detects a strong light, it allows more current to pass through.
40	▪ A proximity sensor is a sensor that detects an object based on the object's distance from the sensor. ▪ This proximity sensor will detect objects with close enough distances ranging from 1 mm to several centimeters from the sensor. ▪ This sensor is often implemented in industrial plants, offices, the robot world, and others. ▪ Based on its use, proximity sensors are sensors that are able to detect the presence of a metal or non-metal object without using physical contact.
41	The angular position of a rotating shaft is determined by a rotary encoder, which is a sort of position sensor. According to the rotational movement, it generates an electrical signal, either analogue or digital.
42	▪ Infrared Distance Sensor is also known as sharp distance sensor which is used to detect the presence of nearby objects. ▪ This sensor takes a continuous distance reading and converts it to an analogue voltage, which can be used to detect how close an item is. ▪ These sensors are ideal for short-range applications.
43	▪ An ultrasonic sensor is a device that uses sound waves to determine the distance to an item. ▪ It determines distance by emitting a sound wave at a specified frequency and listening for the sound wave to return.
44	▪ Logic 0 for both x and y (or both to logic 1). ▪ Set the speed to zero.

GET YOUR ANSWER HERE

45	
46	
47	c. Any programmable machine designed to move and perform tasks.
48	d. Sensor
49	c. Humanoid
50	b. Vibration sensor
51	a. Proximity sensor
52	a. Motor
53	d. Actuator
54	a. True
55	b. False
56	b. End Effector/ Actuator
57	b. False
58	b. False

GET YOUR ANSWER HERE

59	c. Wheels
60	b. Karel Capek
61	a. Programmed
62	c. Computer
63	a. Electricity
64	b. Sensors
65	d. State of mind
66	c. Input
67	a. Robotics
68	a. Dangerous or unpleasant
69	b. Robotics
70	c. Actuators

GET YOUR
ANSWER HERE

The End

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