Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software.

The Arduino is a board based on an ATMEL AVR microcontroller. Microcontrollers are **integrated circuits where instructions can be recorded** , which you write with the programming language that you can use in the Arduino IDE environment. These instructions allow you to create programs that interact with the circuitry on the board.

The most used microcontrollers on Arduino platforms are the Atmega168, Atmega328, Atmega1280, ATmega8 for their simplicity, but it is being expanded to Atmel microcontrollers with 32-bit ARM architecture and also to Intel microcontrollers.

In addition, Arduino boards also have other types of components called Shields or backpacks. It is a kind of boards that connect to the main board to add an infinity of functions, such as GPS, real-time clocks, radio connectivity, LCD touch screens, development boards, and many more elements. There are even stores with specialized sections on such items.

Arduino Architecture:

Arduino's processor basically uses the Harvard architecture where the program code and program data have separate memory. It consists of two memories- Program memory and the data memory. The code is stored in the flash program memory, whereas the data is stored in the data memory. The Atmega328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the bootloader), 2 KB of SRAM and 1 KB of EEPROM and operates with a clock speed of 16MHz.

Arduino Uno consists of 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button

Power Jack: It can operate on a external supply of 7 to 12V. Power can be applied externally through the pin Vin or by giving voltage reference through the IORef pin.

Digital Inputs: It consists of 14 digital inputs/output pins, each of which provide or take up 40mA current.

Analog inputs: It has 6 analog input/output pins, each providing a resolution of 10 bits.

Reset: It resets the microcontroller when low.

Operating Range: Typically operates at 5V or 3.3V depending on the model.

Sensitivity: Depends on the sensors or modules connected to it.

IR Sensor

The IR sensor or infrared sensor is one kind of electronic component, used to detect specific characteristics in its surroundings through emitting or detecting IR radiation.

An infrared sensor includes two parts namely the emitter & the receiver (transmitter & receiver), so this is jointly called an optocoupler or a photo-coupler. Here, IR LED is used as an emitter whereas the IR photodiode is used as a receiver. The photodiode used in this is very sensitive to the infrared light generated through an infrared LED. The resistance of photodiode & output voltage can be changed in proportion to the infrared light obtained. This is the fundamental IR sensor working principle.

IR sensors use three basic Physics laws like Planck's Radiation, Stephan Boltzmann & Wein's Displacement.

- Planck's Radiation Law defines that the temperature of any object is not equivalent to Zero
- Stephan Boltzmann Law defines that the whole energy which is generated at all wavelengths through a black body is associated with the total temperature.
- Wein's Displacement Law defines that the temperature of different objects emits spectra that are maximum at various wavelengths and inversely proportional with temperature

The IR sensor module includes five essential parts like IR Tx, Rx, Operational amplifier, trimmer pot (variable resistor) & output LED. The pin configuration of the IR sensor module is discussed below.

The main **specifications and features of the IR sensor** module include the following.

- The operating voltage is 5VDC
- I/O pins – 3.3V & 5V
- Mounting hole
- The range is up to 20 centimeters
- The supply current is 20mA
- The range of sensing is adjustable
- Fixed ambient light sensor

Types of IR Sensor:

The classification of IR sensors can be done based on the application which includes the following.

- Active Infrared Sensors
- Passive Infrared Sensors

Active IR Sensor

This type of sensor includes both the emitter & the receiver which are also known as transmitter & receiver. In most situations, a laser diode or LED is used as a source. For non-imaging infrared sensors, LED is used whereas laser diode is used for imaging infrared sensors.

Passive Infrared Sensor

Passive Infrared Sensor (PIR) includes detectors only and this kind of sensor uses targets like infrared transmitters or sources. Here, the object will radiate the energy & detects it through infrared receivers. After that, a signal processor is used to understand the signal to obtain the required data.

Sensitivity: Can be affected by ambient light and reflective surfaces.

Working voltage	3.3 to 5V DC
Operating voltage	3.3V: ~23 mA, to 5V: ~43 mA
Detection range	2cm – 30cm (Adjustable using potentiometer)
Active output level	The output is “0” (Low) when an obstacle is detected

IR Transmitter

- For transmitting IR LED of wavelength 940 nm to 950 nm are commonly used.
- This IR LED transmits the data from one end to and at another end there is an IR receiver to receive the data.

IR Receiver TSOP1738

- At the receiver end, the IR receiver receives data at 38kHz of the carrier frequency.
- Mainly, TSOP Receiver is use to receive data which support various transmitted code.
- The data rate of TSOP1738 is up to 2400 bps.

A **Passive Infrared (PIR) sensor** detects infrared radiation from objects in its field of view. It's commonly used in motion detectors and security systems3. PIR sensors are sensitive to changes in infrared radiation and can detect motion within a range of **up to 7 meters**.

 Working Principle: Detects motion by measuring changes in infrared radiation levels emitted by objects in its field of view.

 Operating Range: Typically up to 10 meters.

 Sensitivity: High sensitivity to infrared radiation changes, often adjustable for different applications.

DC Motor

- **Working Principle**: Converts electrical energy into mechanical energy through the interaction of magnetic fields.
- **Operating Range**: The operating range of DC motors varies widely depending on the specific motor, but they typically operate at voltages from **3V to 24V** and can handle currents from **100mA to several amps**.
- **Sensitivity**: Depends on the load and power supply.

Servo Motor

- **Working Principle:** A rotary actuator that allows precise control of angular position, velocity, and acceleration.
- **Operating Range:** It typically operates within a range of 0° to 180° and can be controlled using PWM signals. Typically operates between 4.8V to 6V.
- **Sensitivity:** High sensitivity to control signals for precise positioning.

Stepper Motor

- **Working Principle:** Converts electrical pulses into discrete mechanical movements.
- **Operating Range:** Varies widely; typically operates at 5V to 12V.
- **Sensitivity:** High sensitivity to input pulses, providing precise control over movement.

UV (Ultraviolet) Sensor

Ultrasonic sensors are electronic devices that calculate the target's distance by emission of ultrasonic sound waves and convert those waves into electrical signals. The speed of emitted ultrasonic waves traveling speed is faster than the audible sound. There are mainly two essential elements which are the transmitter and receiver. Using the piezoelectric crystals, the transmitter generates sound, and from there it travels to the target and gets back to the receiver component.

To know the distance between the target and the sensor, the sensor calculates the amount of time required for sound emission to travel from transmitter to receiver.

D = (T*C)/2

where D = distance, T = time, C = speed of the sound = 343 measured in mts/sec

Knowing the specifications of an ultrasonic sensor helps in understanding the reliable approximations of distance measurements.

- The sensing range lies between 40 cm to 300 cm.
- The response time is between 50 milliseconds to 200 milliseconds.
- It operates within the voltage range of 20 VDC to 30 VDC
- Preciseness is ±5%
- The frequency of the ultrasound wave is 120 kHz
- Resolution is 1mm
- The voltage of sensor output is between 0 VDC – 10 VDC
- Ambient temperature is -25^{0}C to +70^{0}C
- The target dimensions to measure maximum distance is 5 cm × 5 cm

Operating Range: Depends on the specific sensor model, often designed to detect UV light in the 200 nm to 400 nm range.

Sensitivity: High sensitivity to UV light, but may be affected by light intensity, angle of incidence and shape of target.

L298NH Motor Driver

- **Working Principle**: Dual H-bridge motor driver that allows control of the direction and speed of two DC motors.
- **Operating Range**: 5V to 46V, up to 2A per channel.
- **Sensitivity**: High sensitivity to control inputs, providing precise motor control.

L293D Motor Driver

- **Working Principle**: Quadruple half-H driver for controlling the direction and speed of DC and stepper motors.
- **Operating Range**: 4.5V to 36V, up to 600mA per channel.
- **Sensitivity**: High sensitivity to control inputs.
- L293D IC generally comes as a standard 16-pin DIP (dual-in line package). This motor driver IC can simultaneously control two small motors in either direction; forward and reverse with just 4 microcontroller pins (if you do not use enable pins).

2 & 4 Channel Relay

- **Working Principle**: Electromechanical switches that can control high-voltage devices with low-voltage signals from a microcontroller.
- **Operating Range**: Typically operates at 5V or 12V for the coil; the relay can switch higher voltages (e.g., 220V AC).
- **Sensitivity**: Relays are generally reliable and sensitive to control signals.