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# IOT and APPLICATIONS
# IS224AI-UG 4th sem
# 2022 scheme

Unit-IV

## Interfacing with Raspberry Pi and Arduino

**Reference Book:** Internet Of Things With Raspberry Pi And Arduino, Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, and Mahendra Swain, CRC Press, Taylor & Francis Group, 2020, ISBN: 13: 978-0-367-24821-5

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## Install Arduino IDE on Raspberry Pi

- The limitation with Raspberry Pi is the absence of analog ports onboard, which makes it inappropriate for the systems where analog sensors need to be read.
- To overcome this limitation, the Arduino integrated development environment (IDE) can be installed on Raspberry Pi, as Arduino has analog ports so these ports can be used to interface analog sensors.
- The Arduino IDE is available for most of the operating systems.
- How to install it on a Raspberry Pi3 model B with running Raspbian Jessie in the graphical user interface (GUI)??

# Steps to install Arduino in Pi



- 1. The first requirement is an active internet connection.
- 2. A screen, keyboard, and mouse need to be connected with Raspberry Pi.
- 3. Install the latest version of Arduino IDE using apt:

  ***sudo apt-get update &&sudo apt-get upgrade***

  ***sudo apt-get install arduino***

- 4. Connect an Arduino board to the Raspberry Pi using the appropriate cable and pull down the Raspbian main Menu and select Arduino IDE under the "Electronics" head. A blank window will
- open. Figure shows the blank window for Arduino IDE.
- 5. Click on Tools > Board > and select the appropriate board of Arduino.
- 6. To select the port of the Arduino that is connected, check the serial port under the "Tools" menu.
- The port name of Arduino is: */dev/ttyUSB0 or /dev/ttyACM0.*

rm -rf arduino-ide_2.3.2_Linux_64bit

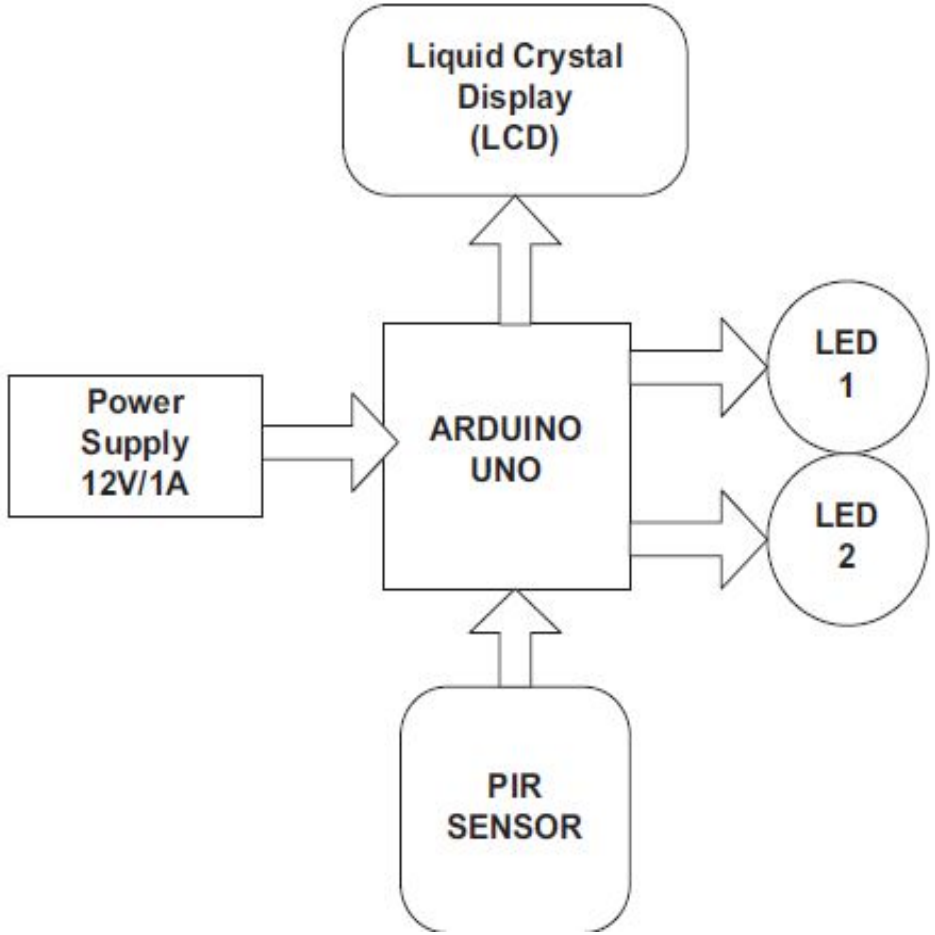
# Play with Digital Sensor



- After installing the Arduino IDE on Raspberry Pi, the sensors connected with the Raspberry Pi and Arduino can be read.
- The Arduino can simply act like the Arduino board, and Raspberry Pi acts as the computer when sensors are connected with Arduino. This can be understood with the help of a few examples.

## PIR Sensor

- The pyroelectric infrared (PIR) sensor module is used to detect motion.
- It has a Fresnel lens and motion detection circuit, which has a wide range of voltages supplied with less current drain.
- It has a high sensitivity and low noise.
- The output of the sensor is a transistor–transistor logic (TTL) active low signal.
- It detects motion by measuring the changes in infrared levels emitted by objects in its surroundings.
- This module has a detection range of 6 m and can be used in burglar alarms and the control systems.
- It is comprised of an Arduino Uno, a PIR sensor, a liquid crystal display, and an LED.
- The system is designed such that “RED LED” will be “ON” if motion is detected; otherwise, “BLUE LED” will be “ON.”




**PIR sensor connection**

- Connect Arduino GND to PIR Module GND.
- Connect Arduino +5 V to PIR Module +.
- Connect Arduino digital pin 2 to PIR Module digital out pin.

**LCD connection**

- Connect Arduino digital pin (13) to RS pin(4) of LCD.
- Connect Arduino digital pin (GND) to RW pin(5) of LCD.
- Connect Arduino digital pin (12) to E pin(6) of LCD.
- Connect Arduino digital pin (11) to D4 pin(11) of LCD.
- Connect Arduino digital pin (10) to D5 pin(12) of LCD.
- Connect Arduino digital pin (9) to D6 pin(13) of LCD.
- Connect Arduino digital pin (8) to D7 pin(14) of LCD.

**LED connection**

- Connect Arduino digital pin 7 to anode of RED-LED through 330-ohm resistor.
- Connect Arduino digital pin 6 to anode BLUE-LED through 330-ohm resistor.
- Connect cathode of both LEDs to Ground.

# Program for digital sensor



```
#include <LiquidCrystal.h> // include library of LCD
LiquidCrystallcd(13, 12, 11, 10,9, 8);  // attach LCD pin RS,E,D4,D5,D6,D7
to the given pins
int PIR_SENSOR_LOW=5;          // assign pin 5 as PIR_SENSOR_LOW
int RED_LED=7;                 // assign pin 7 as RED_LED
int BLUE_LED=6;                // // assign pin 6 as BLUE_LED
void setup()
{
pinMode(PIR_SENSOR_LOW, INPUT_PULLUP); // configure pin5 as an input and enable the internal pull-up resistor
pinMode(RED_LED,OUTPUT);               // configure pin7 as output
pinMode(BLUE_LED,OUTPUT);              // configure pin6 as output
lcd.begin(20, 4);              // set up the LCD's number of columns and rows
lcd.setCursor(0, 0);                   // set cursor to column0 and row1
lcd.print("MOTION SENSOR BASED "); // Print a message to the LCD.
lcd.setCursor(0, 1);                   // set cursor to column0 and row1
lcd.print("MOTION DETECTION ");        // Print a message to the LCD.
lcd.setCursor(0, 2);                   // set cursor to column0 and
```

```
void loop()
{
int PIR_SENSOR_LOW_READ = digitalRead(PIR_SENSOR_LOW);
// read the PIR value into a variable
if (PIR_SENSOR_LOW_READ == LOW) // Read PIN 5 as LOW PIN
{
lcd.clear();                           // clear the contents of the LCD
lcd.setCursor(0, 3);                   // set cursor to column0 and row2
lcd.print("MOTION DETECTED ");   // Print a message to the LCD.
digitalWrite(RED_LED, HIGH);           // Make pin7 to HIGH
digitalWrite(BLUE_LED, LOW);           // Make pin6 to LOW
delay(20);                             // delay of 20 mS
}
else //otherwise
{
lcd.clear();                           // clear the contents of the LCD
lcd.setCursor(0, 3);                   // set cursor to column0 and row3
lcd.print("MOTION NOT DETECTED "); // Print a message to the LCD.
digitalWrite(BLUE_LED, HIGH);          // Make pin 7 to HIGH
digitalWrite(RED_LED,LOW);             // Low pin6 to LOW
delay(20);                             // delay of 20 mS
}
```

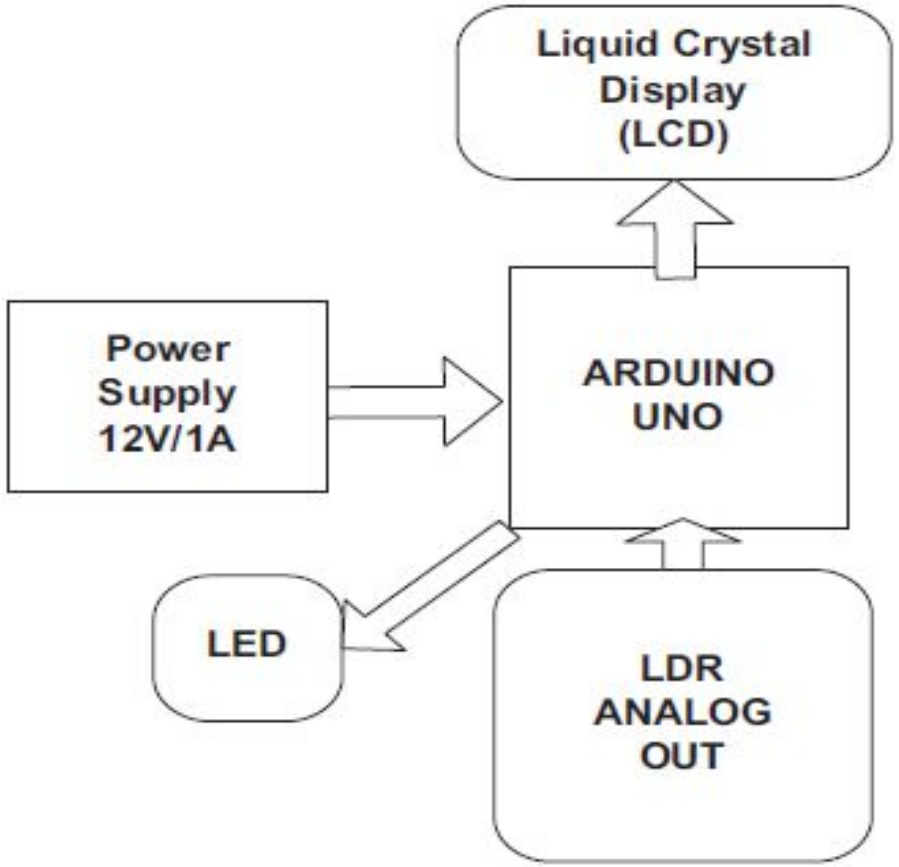
# Play with Analog Sensor



- To read the analog sensor with Arduino, simply connect the sensor to any of the analog pins of the board.
- To understand the workings of the analog sensor, an example of a light-dependent resistor (LDR) is explained here.
- An LDR has cadmium sulphide (CdS) photoconductive cells with spectral responses.
- The resistance of the cells decreases with the increase in light intensity.
- An LDR can be used in many applications, such as smoke detection, automatic light control, batch counting, and burglar alarm systems.
- Figure 6.4 shows the block diagram to interface the LDR with Arduino.
- It is comprised of an Arduino Uno, a power supply, a liquid crystal display, and an LDR.
- The system is designed to display the light intensity of an LCD.

**Light sensor connection**

- Connect Arduino GND to LDR module GND.
- Connect Arduino +5 V to LDR Module +.
- Connect Arduino A0 pin to OUT pin of sensor.




**LCD connection**

- Connect Arduino digital pin 13 to RS pin(4) of LCD.
- Connect Arduino digital pin GND to RW pin(5) of LCD.
- Connect Arduino digital pin 12 to E pin(6) of LCD.
- Connect Arduino digital pin 11 to D4 pin(11) of LCD.
- Connect Arduino digital pin 10 to D5 pin(12) of LCD.
- Connect Arduino digital pin 9 to D6 pin(13) of LCD.
- Connect Arduino digital pin 8 to D7 pin(14) of LCD.

**Sketch**

```
#include <LiquidCrystal.h> // include library of LCD
LiquidCrystallcd(13, 12, 11, 10, 9, 8); // attach LCD pin RS,E,D4,D5,D6,D7
to the given pins
intLDR_sensor_Pin = A0; // select the input pin for the potentiometer
intLDR_sensor_ADC_Value = 0; // variable to store the value coming
from the sensor
int RED_LED=7; // assign pin 7 to RED_LED
void setup()
{
lcd.begin(20, 4); // Initialise 20*4 LCD
pinMode(RED_LED,OUTPUT); // use RED_LED as an output
lcd.setCursor(0, 0); // set cursor of LCD at column0 and Row0
lcd.print("LDR based light"); // print string on LCD
lcd.setCursor(0, 1); // set cursor on LCD
lcd.print("intensity monitoring"); // print string on LCD
lcd.setCursor(0, 2); // set cursor on LCD
lcd.print("system at LPU"); // print string on LCD
delay(1000); // delay of 1000 mS
void loop()
{
LDR_sensor_ADC_Value = analogRead(LDR_sensor_Pin); // read the
value from the sensor
lcd.setCursor(0,2); // set cursor on LCD
lcd.print("ADC LEVEL+LDR:"); // print string on LCD
lcd.setCursor(17,2); // set cursor on LCD
lcd.print(LDR_sensor_ADC_Value); // // print value on LCD
if(LDR_sensor_ADC_Value>=100)
{
digitalWrite(RED_LED,HIGH); // make pin7 to HIGH
delay(20); // delay of 20 mS
}
else
{
digitalWrite(RED_LED,LOW); // make pin7 to HIGH
delay(20); // delay of 20 mS
}
}
```

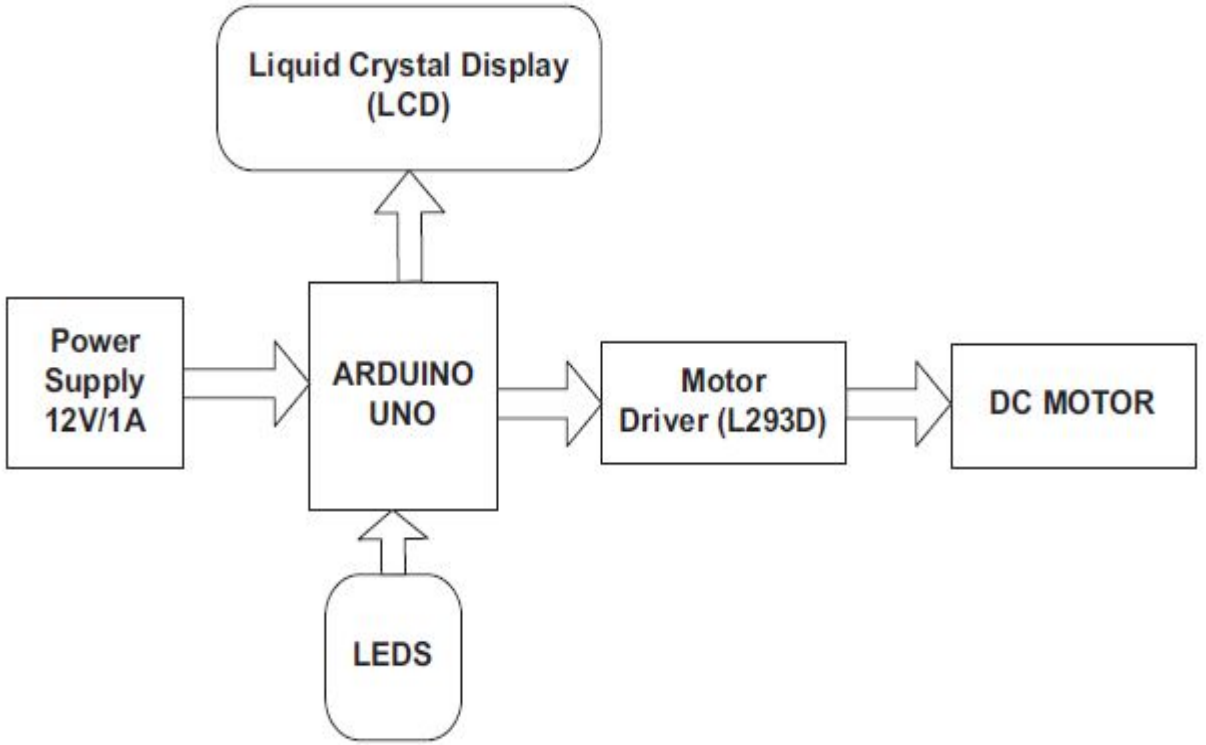
# Play with Actuators



- An actuator is a component of a machine that is used for moving and controlling a mechanism or system.
- A DC motor, stepper motor, and servo motor are commonly used actuators in the systems.

## DC Motor

- The DC-geared motors with 100 rpm 12 V are generally used for robotics applications.
- They have nuts and threads on the shafts to easily connect and internally threaded shafts for easy connection to the wheel.
- Figure shows the block diagram to interface the DC motor with Arduino.
- It is comprised of an Arduino Uno, a power supply, a liquid crystal display, a motor driver (L293D), and two DC motors.



- **L293D and DC motor connection**
  - Connect L293D pin 3 to +ve pin of DC motor1.
  - Connect L293D pin 6 to –ve pin of DC motor1.
  - Connect L293D pin 11 to +ve pin of DC motor2.
  - Connect L293D pin 14 to +ve pin of DC motor2.
- **L293D connection**
  - Connect Arduino GND to pins 4, 5, 12, 13 of L293D.
  - Connect Arduino +5 V to pins 1, 9, 16 of L293D.
  - Connect Arduino pin 7 to pin 2 of L293D.
  - Connect Arduino pin 6 to pin 7 of L293D.
  - Connect Arduino pin 5 to pin 10 of L293D.
  - Connect Arduino pin 4 to pin 15 of L293D.
  - Connect L293D pin 8 to +ve of 12V battery
- **LED connection**
  - Connect Arduino pin 7 to anode of LED1.
  - Connect Arduino pin 6 to anode of LED2.
  - Connect Arduino pin 5 to anode of LED3.
  - Connect Arduino pin 4 to anode of LED4.
  - Connect cathode of all LEDs to ground.

**LCD connection**

- Connect Arduino digital pin 13 to RS pin(4) of LCD.
- Connect Arduino digital pin GND to RW pin(5) of LCD.
- Connect Arduino digital pin 12 to E pin(6) of LCD.
- Connect Arduino digital pin 11 to D4 pin(11) of LCD.
- Connect Arduino digital pin 10 to D5 pin(12) of LCD.
- Connect Arduino digital pin 9 to D6 pin(13) of LCD.
- Connect Arduino digital pin 8 to D7 pin(14) of LCD.

***6.4.1.2***

```
int directionPin = 12;
int pwmPin = 3;
int brakePin = 9;

//uncomment if using channel B, and remove above definitions
//int directionPin = 13;
//int pwmPin = 11;
//int brakePin = 8;

//boolean to switch direction
bool directionState;

void setup() {

//define pins
pinMode(directionPin, OUTPUT);
pinMode(pwmPin, OUTPUT);
pinMode(brakePin, OUTPUT);

}

void loop() {

//change direction every loop()
directionState = !directionState;

//write a low state to the direction pin (13)
if(directionState == false){
 digitalWrite(directionPin, LOW);
//write a high state to the direction pin (13)
else{
 digitalWrite(directionPin, HIGH);
}

//release breaks
digitalWrite(brakePin, LOW);

//set work duty for the motor
analogWrite(pwmPin, 30);

delay(2000);

//activate breaks
digitalWrite(brakePin, HIGH);

//set work duty for the motor to 0 (off)
analogWrite(pwmPin, 0);

delay(2000);
}
```

***Sketch***

```
#include <LiquidCrystal.h> // include library of LCD
LiquidCrystallcd(13, 12, 11, 10,9, 8); // attach LCD pin RS, E, D4, D5, D6,
D7 to the given pins
int MPIN1= 7; // assign pin 7 as MPIN1
int MPIN2= 6; // assign pin 6 as MPIN2
int MPIN3= 5; // assign pin 5 as MPIN3
int MPIN4= 4; // assign pin 4 as MPIN4
void setup()
{
pinMode(MPIN1, OUTPUT); // make MPIN1 as an output
pinMode(MPIN2, OUTPUT); // make MPIN2 as an output
pinMode(MPIN3, OUTPUT); // make MPIN3 as an output
pinMode(MPIN4, OUTPUT); // make MPIN4 as an output
lcd.begin(20,4); // initialise LCD
lcd.setCursor(0, 0); // set cursor on LCD
lcd.print("DC Motor direction"); // print string on LCD
lcd.setCursor(0, 1); // set cursor on LCD
lcd.print("control system..."); // print string on LCD
delay(1000); // delay of 1000 mS
lcd.clear(); // clear the contents of LCD
}
void loop() // infinite loop
{
digitalWrite(MPIN1, HIGH); // make MPIN1 to HIGH
```



```
digitalWrite(MPIN2, LOW); // make MPIN2 to LOW
digitalWrite(MPIN3, HIGH); // make MPIN3 to HIGH
digitalWrite(MPIN4, LOW); // make MPIN4 to LOW
lcd.setCursor(0, 2); // set cursor on LCD
lcd.print("CLOCKWISE"); // print string on LCD
delay(2000); // delay of 2 sec
lcd.clear(); // clear the contents of LCD
digitalWrite(MPIN1, LOW); //make MPIN1 to LOW
digitalWrite(MPIN2, HIGH); //make MPIN2 to HIGH
digitalWrite(MPIN3, LOW); //make MPIN3 to LOW
digitalWrite(MPIN4, HIGH); //make MPIN4 to HIGH
lcd.setCursor(0, 2); // set cursor on LCD
lcd.print("ANTI-CLOCKWISE"); // print string on LCD
delay(2000); // delay of 2 Sec
lcd.clear(); // clear the contents of LCD
digitalWrite(MPIN1, LOW); // make MPIN1 to LOW
digitalWrite(MPIN2, LOW); //make MPIN2 to LOW
digitalWrite(MPIN3, HIGH); //make MPIN3 to HIGH
digitalWrite(MPIN4, LOW); //make MPIN4 to LOW
lcd.setCursor(0, 2); // set cursor on LCD
lcd.print("LEFT"); // print string on LCD
delay(2000); // delay of 2 Sec
lcd.clear(); // clear the contents of LCD
digitalWrite(MPIN1, HIGH); //make MPIN1 to HIGH
digitalWrite(MPIN2, LOW); //make MPIN2 to LOW
digitalWrite(MPIN3, LOW); //make MPIN3 to LOW
digitalWrite(MPIN4, LOW); //make MPIN4 to LOW
lcd.setCursor(0, 2); // set cursor on LCD
lcd.print("RIGHT"); // print string on LCD
delay(2000); // delay of 2 Sec
lcd.clear(); // clear the contents of LCD
}
```

# Servo Motor



- A servo motor is a rotary actuator used for precise control of the angular position.
- It is comprised of a motor coupled with a sensor for position feedback.
- It also requires a servo drive. The drive uses the feedback sensor to control the rotary position of the motor precisely.
- This is called a closed-loop operation. The high torque standard servo motor with metal gears and 360° rotation can provide 11 kg/cm at 4.8 V, 13.5 kg/cm at 6 V, and 16 kg/cm at 7.2 V.
- Figure shows the block diagram to interface the servo motor with Arduino.
- It is comprised of an Arduino Uno, a power supply, a liquid crystal display, a potentiometer (POT), and a servo motor.
- The system is designed to control the angle of the servo motor with the potentiometer.

**Servo connection**

- Connect Arduino GND to GND pin of servo motor.
- Connect Arduino +5 V to “+” terminal of servo motor.
- Connect Arduino pin(3) to PWM pin of servo motor.

**POT connection**

- Connect Arduino GND to GND pin of POT.
- Connect Arduino +5 V to “+” terminal of POT.
- Connect Arduino A0 pin to data out pin of POT.

**LCD connection**

- Connect Arduino digital pin (13) to RS pin(4) of LCD.
- Connect Arduino digital pin (GND) to RW pin(5) of LCD.
- Connect Arduino digital pin (12) to E pin(6) of LCD.
- Connect Arduino digital pin (11) to D4 pin(11) of LCD.
- Connect Arduino digital pin (10) to D5 pin(12) of LCD.
- Connect Arduino digital pin (9) to D6 pin(13) of LCD.
- Connect Arduino digital pin (8) to D7 pin(14) of LCD.

***Sketch***

```
#include <LiquidCrystal.h> // include library of LCD
LiquidCrystallcd(13, 12, 11, 10, 9, 8); // attach LCD pin RS,E,D4,D5,D6,D7
to the given pins
Servo myservo; // create servo object to control a servo
int POT_PIN = A0; // analog pin used to connect the potentiometer
int POT_PIN_ADC_LEVEL; // variable to read the value from the analog pin
```

- void setup()
- {
- myservo.attach(3); // attaches the servo on pin 9 to the servo object
- lcd.begin(20,4); // initialise LCD
- lcd.setCursor(0, 0); // set cursor on LCD
- lcd.print("Servo ANALOG write "); // print string on LCD
- lcd.setCursor(0, 1);// set cursor on LCD
- lcd.print("system at LPU....");// print string on LCD
- }

```
void loop()
{
POT_PIN_ADC_LEVEL = analogRead(POT_PIN); //
reads POT value
in the form of levels
POT_PIN_ADC_LEVEL = map(POT_PIN_ADC_LEVEL, 0,
1023, 0, 179);
// map the value //between 0 to 180 degree for servo
myservo.write(POT_PIN_ADC_LEVEL); // sets the servo
position
according to the scaled value
lcd.setCursor(0, 2); // set cursor on LCD
lcd.print("ANGLE:"); // print string on LCD
lcd.print(POT_PIN_ADC_LEVEL); // print value on LCD
delay(15); // delay of 15 mSec
}
```