A Report on

Temperature & Humidity Indicator Using Raspberry Pi

For

Mini Project 1-B (REV- 2021 'C' Scheme) of Second Year, (SE Sem IV)

In

Electronics & Telecommunication Engineering

By

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Name of Mini Project Guide

Temperature & Humidity Indicator Using Raspberry Pi

UNIVERSITY OF MUMBAI

AY 2021-2022

Name of Institute

St. Francis institute of technology

CERTIFICATE

This is to certify that the project entitled **Temperature & Humidity Indicator Using Raspberry Pi** is a bona fide work of

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submitted to the University of Mumbai in partial fulfillment of the requirement for the award of **Mini Project 1-B (REV- 2021 'C' Scheme) of Second Year, (SE Sem-IV)** in **Electronics & Telecommunication Engineering** as laid down by **University of Mumbai** during academic year **2021-22.**

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Sr. No. **Name of Topic** **Page Number**

1.INTRODUCTION:

1.1Need:

Temperature has an impact on almost all the activities surrounding us. A precise determination of temperature and more importantly relative humidity is a vital factor in countless industries and different fields of science. The temperature monitoring is crucial in lot of industries, like food industry, the workshop and pharmaceutical industry. Analog and digital Temperature sensors are available for sensing temperature for commercial purpose. Temperature sensors possessing temperature-dependent properties that can be measured electrically contain resistors, semiconductor mechanisms such as diodes, thermocouples, thermistors. This project aims at monitoring the real time temperature and relative humidity in a cost effective way.

1.2Definition:

This project is a proof-of-concept that industries can analysis and monitor temperature and humidity data for its machines and critical product over a using IOT technology. Here the monitoring node is raspberry pi. Programming language used for raspberry pi is Python. The Sensor utilized here is DHT11 temperature sensor. This sensor consists of thermistor and basic advantage of using DHT11 sensor is that it is economical and light in weight. The sensor is interfaced with the raspberry pi using jumper wires. The temperature is sensed using the sensor DHT11 and is read, stored and displayed by the raspberry pi kit with the help of LCD as well as Dashboard on computer screen.

2. Comparative study. (Similar projects done previously)

As we Know Temperature and Humidity is environmental aspect , its directly give impact on Human beings. Now a day measurements of Temperature and Humidity its very important in some of industries like food processing , Manufacturing Industries etc…

Based on that aspect some project came to monitor Temperature and Humidity and Analyse that data for Future reference and improvement as per industrial point of view. Temperature and Humidity Projects done Previously with the help of Arduino and LCD display. but their are some limitation like remotely monitoring temperature and Humidity data it was quite difficult to monitor data remotely base on Arduino. They require another hardware and programing is also complex.

So we done this project with help of Raspberry pi. Raspberry pi is a mini computer , Its like a processor cum controller, its provide wi-fi , Bluetooth , LAN connection on single chip, so we can use variety of programming languages to build the project. based on that we use Raspberry pi with python programming language to build temperature and humidity indicator project. Because of raspberry pi we can monitor temperature and Humidity data remotely there is no need to go and checked physically. Programming part is also easy only 75 lines of code require for this project.

As compare to Arduino base project and Raspberry pi base project , the Raspberry pi base project is easy and highly reliable.

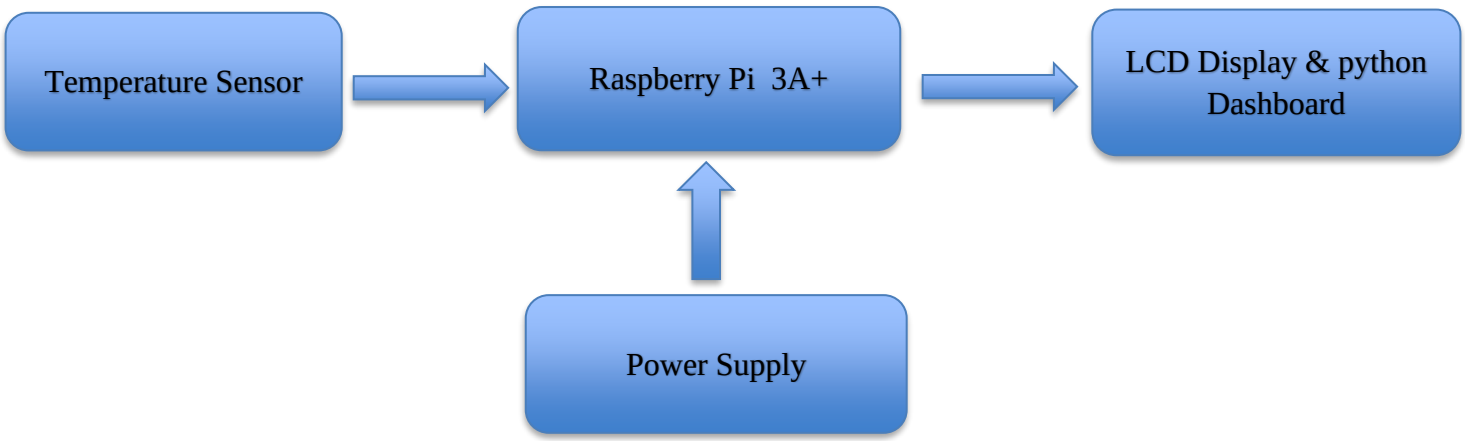
3.PROBLEM STATEMENT

In the food processing industries .The presence of water vapor also influences various physical, chemical, and biological food processes. ¬Its measurement in industries is critical because it may affect the business cost of the product, the health and safety of the personnel. ¬Humidity sensing is very important, especially in the control systems for industrial food processes. Classification of Humidity Sensors • Humidity measurement determines the amount of water vapor present in a gas, • That can be a mixture such as air or a pure gas, such as nitrogen or argon.

In the manufacturing Industries have lots of costly machines and equipment, they run for 24 hrs to produce require amount of production, that machines parts like drives and controllers are very costly, temperature and humidity are main factor they affect to electronics components and equipments.in machine electrical panel there is panel cooling system is available but suppose because of some technical issue that cooling system stop functioning and because of this reason panel temperature and humidity increases , this will damage that costly Drives and controllers.so for eliminate this situation we need Real time continuous monitoring system base on IOT, so person can monitor panel temperature and humidity on remote location.so person can take immediate action on it and increase the life of electronics equipment and by default save the cost of industries.

4.Mini project design (principle and working)

4.1Block Diagram:-



4.2 Block Diagram Description :-

1.Temperature and Humidity sensor DHT11 Interface with Raspberry pi 3A+ , sensor sense temperature And Humidity from environment and convert into electrical form and sed that data to Raspberry pi.

2.Raspberry pi is controller plus PC , the output of DHT11 sensor fed to Raspberry pi as input and Raspberry pi process on that data using that python code and send that data to LCD display.

3.LCD display take data from Raspberry pi and Display that data on screen so human can read that data, Python dashboard is also show same data but it can access remotely on desktop screen.

4.3 Circuit diagram and working:

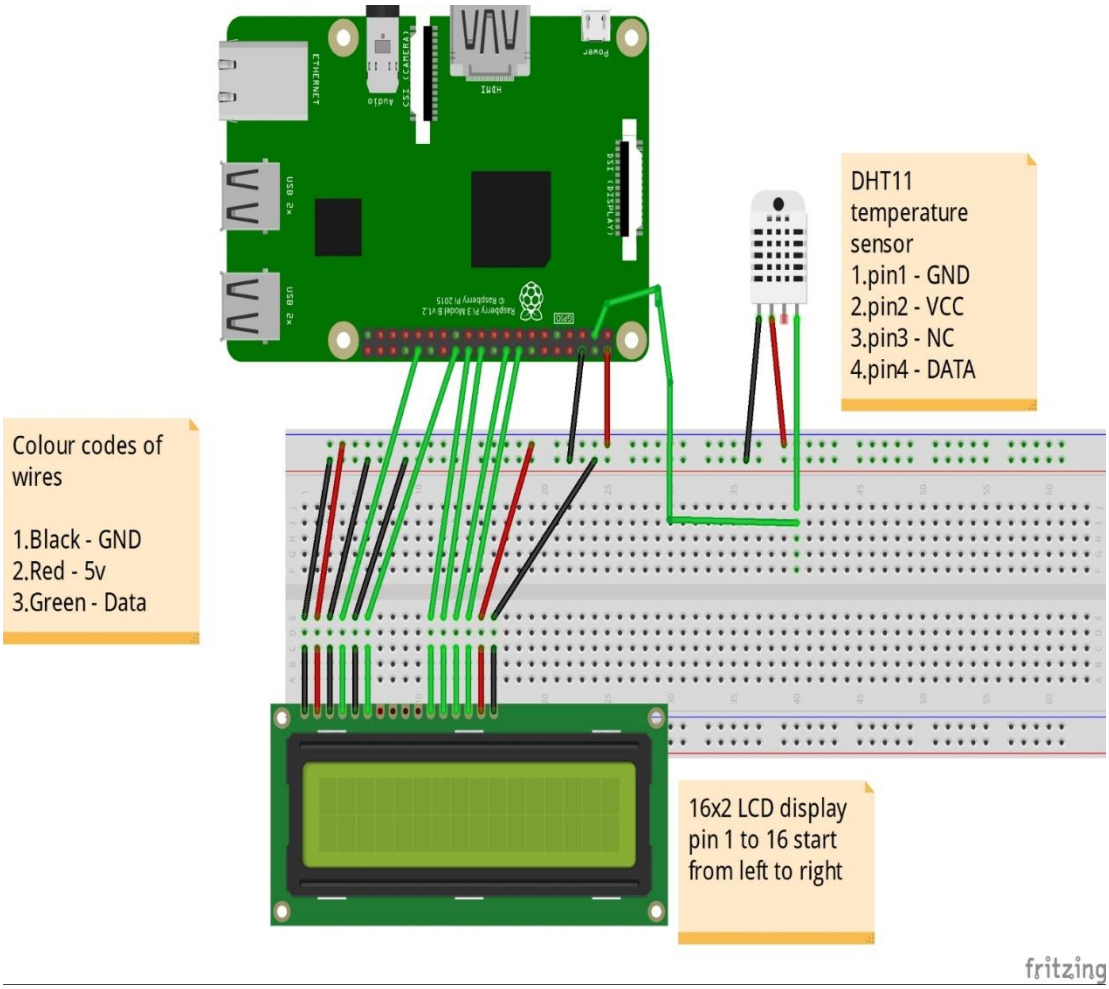


Fig.(a) Circuit Diagram

Explanation:

- In this project we used Following Components:-
  1.Raspberry pi 3A+
  2.LCD
  3.Temperature Sensor (DHT11)
  4.Bread board
  5.Micro USB cable
  6. Jumper wires
- Raspberry pi is heart of the project, its process the Data and control the Input / Outputs through it GPIO pins, all peripheral connected to GPIO of raspberry pi.
- 16x2 LCD Display connected to GPIO of Raspberry pi, the pins 1-16 of LCD display start from left to right
  1.Pin 1 – GND
  2.Pin 2 – 5V
  3.Pin 3 – GND
  4.Pin 4 – GPIO12

5.Pin 5 – GND
6.Pin 6 – GPIO7
7.Pin 7 to 10 – NC
8.Pin 11 – GPIO8
9.Pin 12 – GPIO25
10.Pin 13 – GPIO24
11.Pin 14 – GPIO23
12.Pin 15 – 5v
13.Pin 16 – GND

- Temperature Sensor (DHT11) is also connected to GPIO of Raspberry pi
  1.Pin 1 – 5V
  2.Pin 2 – GPIO2
  3.Pin 3 – GND
  4. Pin 4 – NC

Working:

1. Main principle:

- The Raspberry pi is heart of project which contain python source code , in that code include the library of LCD Display and Temperature sensor. This help to interface LCD Display and Temperature sensor with Raspberry pi.
- Temperature Sensor sense environment temperature and Humidity and give the digital output , its send that Temperature and Humidity data to Raspberry pi Serially.
- As written in the code Raspberry pi convert that serial data into string format and sed that data to 16x2 LCD Display , so Display show the real-time value Temperature and Humidity.
- In the Python code we used Tkinter Module so that they show the Temperature and Humidity Data on Dashboard of computer screen.

2.Scope of improvement:

- In tkinter Module we can further modify our dashboard as more attractive , we can create Gauge for display our Temperature and Humidity
- By using third party server we can access that dashboard by using other networks also, so we don’t need same wi-fi network to access Temperature and Humidity dashboard.

Advantage :-

- Low Power Consumption
- Simple Circuit
- Easy to Implement
- Easy to handle

Disadvantages :-

- High cost
- Require Technical knowledge

Application:-

1. Use in Manufacturing industries for Condition monitoring of CNC Machine's electrical Panel.
2. Use in Food Processing Industries
3. Use in Greenhouses
4. HVAC system monitoring
5. Server room.

5. Components and tools which are used in project:

5.1 Component used:-

- Raspberry pi3 A+ :-

The Raspberry Pi is a low cost, credit-card sized computer which plugs into a computer monitor or TV, and requires a standard keyboard and mouse. **Raspberry Pi** is a dynamic microcontroller and runs with the **Python** programming language. **Raspberry Pi3 A+** includes a quad-core Cortex A7 processor CPU running at t1.4 GHz, dual-band 2.4 GHz and 512 MB RAM, Integrated Video core 4 Graphics Processing Constituent (GPU) capable of frolicking Maximum 1080p Elevated Meaning Blu-Ray Quality Video,512Mb SDRAM, The free, flexible and exceedingly builder approachable Debian GNU/Linux(RASPBIAN)Operating System, 1 x USB Ports, HDMI Video Output, RCA Video Output,3.5mm Audio Output Jack,10/100Mb Ethernet Port for Internet Access, 5V Micro USB Domination Input Jack, Micro SDHC card, MMC,40 gpio pins[2]. It has capability of a little device that allows people of all ages to explore computing. It's capable of doing everything you would expect a desktop/computer to do, from browsing the internet and playing high-definition video to making spreadsheets, word processing, and playing games . The Raspberry Pi has the ability to interact with the outside world, and has been used in a wide array projects like smart home monitoring system, wireless motion sensor activated light and many more.

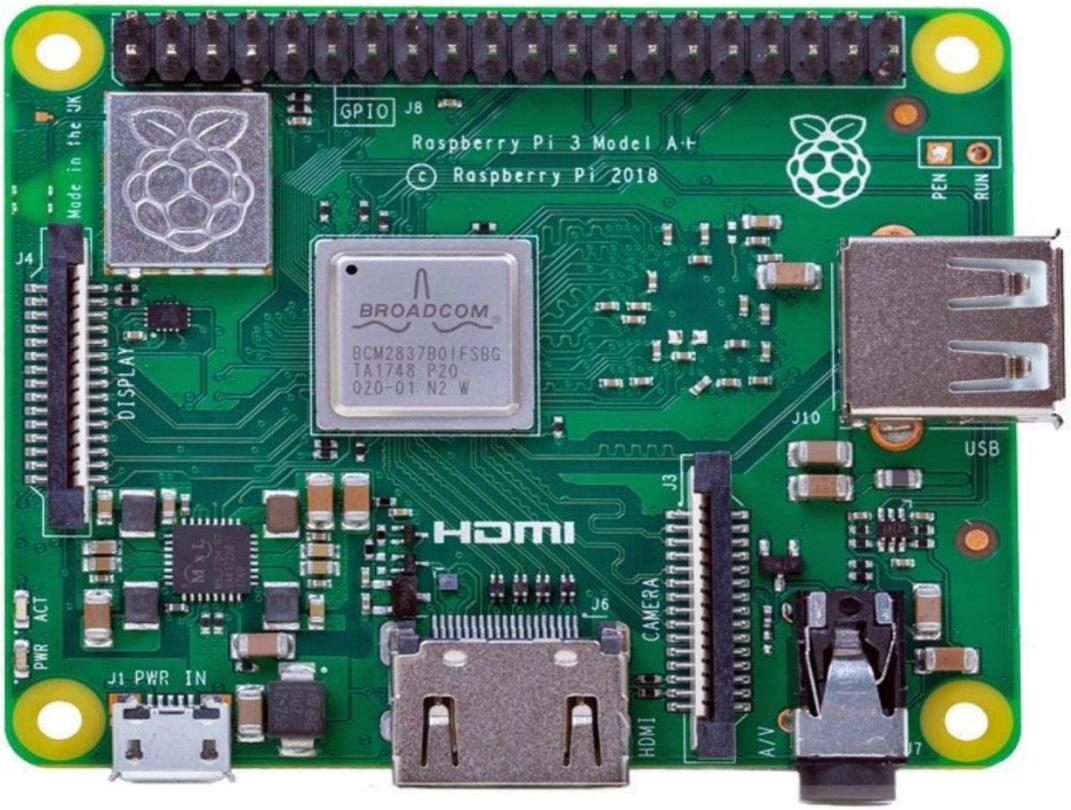


Fig.(b) Raspberry Pi 3 Model A+

- Temperature and Humidity Sensor DHT11:-

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc… to measure humidity and temperature instantaneously.

DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form.
For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers. The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz .i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.

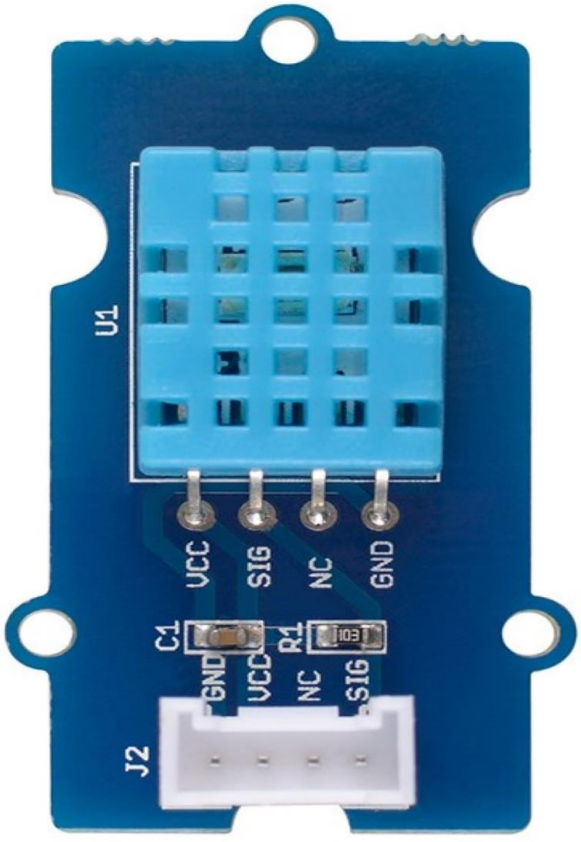


Fig.(c) DHT11 sensor

- 16x2 LCD Display:-

Nowadays, we always use the devices which are made up of LCDs such as CD players, DVD players, digital watches, computers, etc. These are commonly used in

the screen industries to replace the utilization of CRTs. Cathode Ray Tubes use huge power when compared with LCDs, and CRTs heavier as well as bigger. These devices are thinner as well power consumption is extremely less. The LCD 16×2 working principle is, it blocks the light rather than dissipate

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

Features of LCD16x2:-

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters

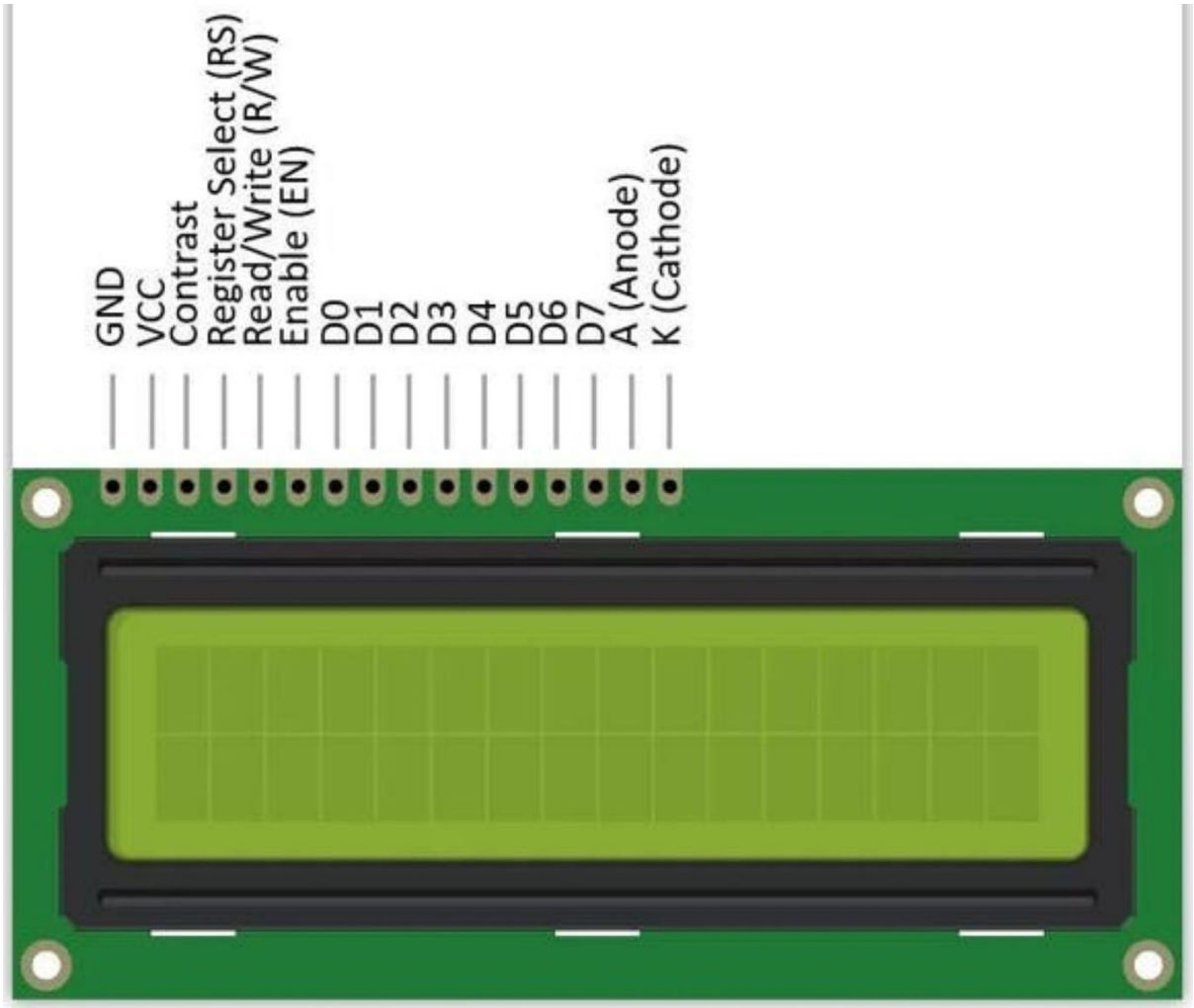


Fig.(d) LCD Display 16x2

Tools used:

- Soldering iron
- Multimeter
- Wire stripper
- Bread Board

- SD card with NOOBS :-

  SD card require for Operating system of raspberry pi, First of all Raspberry pi has to be prepared and for that we require NOOBS. NOOBS, short for New Out of the Box Software. It's an operating system manager that makes it easy to download, install, and set up your Raspberry Pi. When you first boot up NOOBS, you'll get a selection of OSes to choose from. NOOBS makes getting started with Pi easy, and includes a bunch of different operating systems to choose from. The Raspberry Pi itself doesn't come with an operating system, we need to select it while booting of NOOBS. Raspbian is the "official" operating system of the Raspberry Pi. Raspbian has been the standard Raspberry Pi operating system. Raspbian is a version of Linux built specifically for the Raspberry Pi.

  NOOBS installation:-

  1. Insert an SD card that is 4GB or greater in size into your computer.
  2. Format the SD card using the platform-specific instructions below:
  a. Windows
  i. Download the SD Association's Formatting Tool from https://www.sdcard.org/downloads/formatter_4/eula_windows/
  ii. Install and run the Formatting Tool on your machine
  iii. Set "FORMAT SIZE ADJUSTMENT" option to "ON" in the "Options" menu
  iv. Check that the SD card you inserted matches the one selected by the Tool
  v. Click the "Format" button
  3. Extract the files contained in this NOOBS zip file.
  4. Copy the extracted files onto the SD card that you just formatted so that this file is at the root directory of the SD card. Please note that in some cases it may extract the files into a folder, if this is the case then please copy across the files from inside the folder rather than the folder itself.
  5. Insert the SD card into raspberry Pi and connect the power supply.
  Raspberry Pi will now boot into NOOBS and should display a list of operating systems that you can choose to install.
  If your display remains blank, you should select the correct output mode for your display by pressing one of the following number keys on your keyboard:
  1. HDMI mode - this is the default display mode.
  2. HDMI safe mode - select this mode if you are using the HDMI connector and cannot see anything on screen when the Pi has booted.

- Python IDE:-

  Also other languages like C language,C++,JAVA can be used but python is used for current application as it has following advantages.

Python programs are typically 3-5 times shorter than equivalent Java programs. This difference can be attributed to Python's built-in high-level data types and its dynamic typing.Python is designed to be highly readable . Python is a simplest, dynamic, interpreted, object oriented language[4]. Python interpreters allowing Python code to run on a wide variety of systems.

For Install Python IDLE Follow following Steps:-

1. Open terminal Window and give the command “sudo apt-get upgrade”, “sudo apt full-upgrade”
2. after successfully upgradation give the command “sudo apt-get install idle3”

- LCD Display and DHT11 Sensor Library:-

Need to install LCD and DHT11 sensor library in Python , for interfacing purpose.
1. Command for LCD Display to install library:-
https://github.com/dhylands/python_lcd.git

2.Command for DHT11 sensor to install library:-
https://github.com/adafruit/Adafruit_Python_DHT.git

5.1 Software :-

In this Project we Used Python program and to run this program we used Python 3 IDE

Code for Temperature Humidity Project :-

```
# Import Some Important library That require for Interfacing of components
import tkinter as tk
import numpy as np
import random
import time
import datetime
import threading
import Adafruit_DHT
import Adafruit_CharLCD as LCD
import RPi.GPIO as GPIO

# Defined GPIO pin in variable
pin = 2
sensor = Adafruit_DHT.DHT11
GPIO.setmode(GPIO.BCM)

# Defined GPIO pin in Variable for LCD Interfacing
lcd1 = 12
lcd2 = 7
lcd3 = 8
lcd4 = 25
lcd5 = 24
lcd6 = 23
```

```
lcd = LCD.Adafruit_CharLCD(lcd1,lcd2,lcd3,lcd4,lcd5,lcd6,0,16,2)

# Defined Tkinter function for clock
def tick():

    time3=time.strftime('%H:%M:%S')
    clock.config(text=time3)
    clock.after(200,tick)

# Defined get data function to read Temp. and Humidity data every 5 second
def get_data():

    threading.Timer(5, get_data).start()
    humidity, temperature = Adafruit_DHT.read_retry(sensor, pin)

# If else Statement for Fault signal

    if humidity is not None and temperature is not None:
        print('Temp={0:0.1f}*C  Humidity={1:0.1f}%'.format(temperature, humidity))
        l_display.config(text = temperature)
        l_display1.config(text = humidity)
        l_t2=tk.Label(mainwindow, text="OK",font=("Arial",25),bg="green")
        l_t2.grid(row=3,column=1, padx=10, pady=0, sticky="nsew")

        lcd.clear()
        lcd.message('Temp={0:0.1f}*C  \nHumidity={1:0.1f}%'.format(temperature, humidity))
        time.sleep(1)

    else:
      print('Failed to get reading. Try again!')
      l_t2=tk.Label(mainwindow, text="Fault",font=("Arial",25),bg="red")
      l_t2.grid(row=3,column=1, padx=10, pady=0, sticky="nsew")

      lcd.clear()
      lcd.message("Fault")
      time.sleep(1)



    return temperature
    return humidity


# Create Dashboard for Temperature and Humidity Indicator Using Tkinter Module
functions
mainwindow = tk.Tk()
mainwindow.geometry('640x340')
mainwindow.title("Sensor Data Live Feed ")

clock=tk.Label(mainwindow,font=("Arial",30), bg='azure',fg="black")
clock.grid(row=0, column=0, padx=10, pady=10, sticky="nsew")

l_m=tk.Label(mainwindow,text="Sensor Data ",font=("Arial",30),fg="Black")
l_m.grid(row=0,column=1, padx=10, pady=10, sticky="nsew")
```

```
l_t=tk.Label(mainwindow, text="Temperature C",font=("Arial",25),bg='honeydew3')
l_t.grid(row=1,column=0, padx=10, pady=0, sticky="nsew")


l_display=tk.Label(mainwindow,font=("Arial",25),fg="red")
l_display.grid(row=1,column=1, padx=10, pady=10, sticky="nsew")

l_t1=tk.Label(mainwindow, text="Humidity",font=("Arial",25))
l_t1.grid(row=2,column=0, padx=10, pady=10, sticky="nsew")

l_display1=tk.Label(mainwindow,font=("Arial",25),fg="green")
l_display1.grid(row=2,column=1, padx=10, pady=10, sticky="nsew")


Status=tk.Label(mainwindow, text="Status",font=("Arial",25),bg='honeydew3')
Status.grid(row=3,column=0, padx=10, pady=0, sticky="nsew")


tick()
get_data()

mainwindow.mainloop()
```

6. Proposed executions steps:

6.1 Implemented Steps for PCB:-

i. Drawn one circuit diagram for components Location on Bread Board
ii. Soldered wire to DHT11 sensor.
iii. Connected all connection As per circuit Diagram.

6.2 PCB layout and soldering (actual photos of project from front and back view)

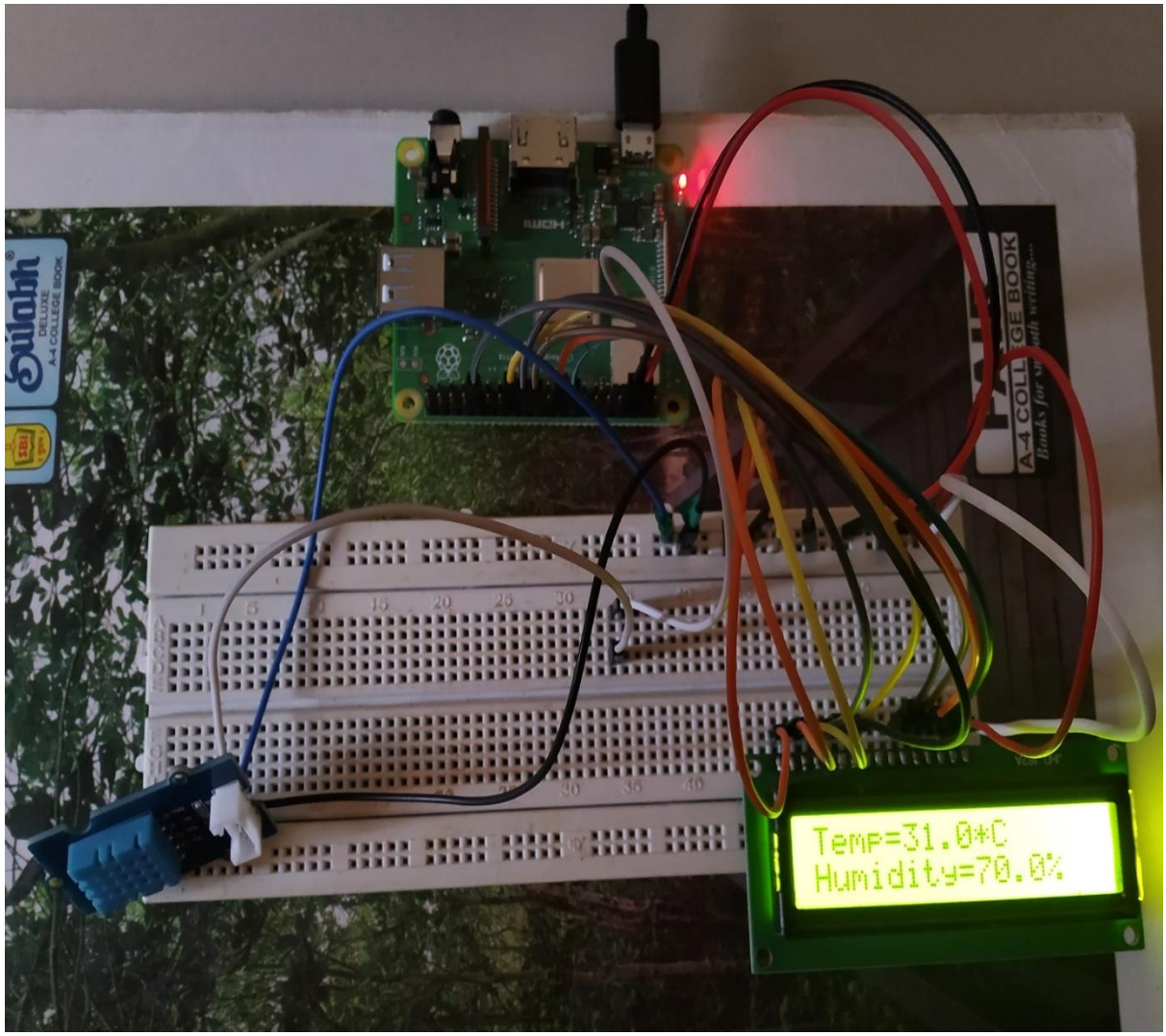


Fig.(e) Practical Implemented Circuit

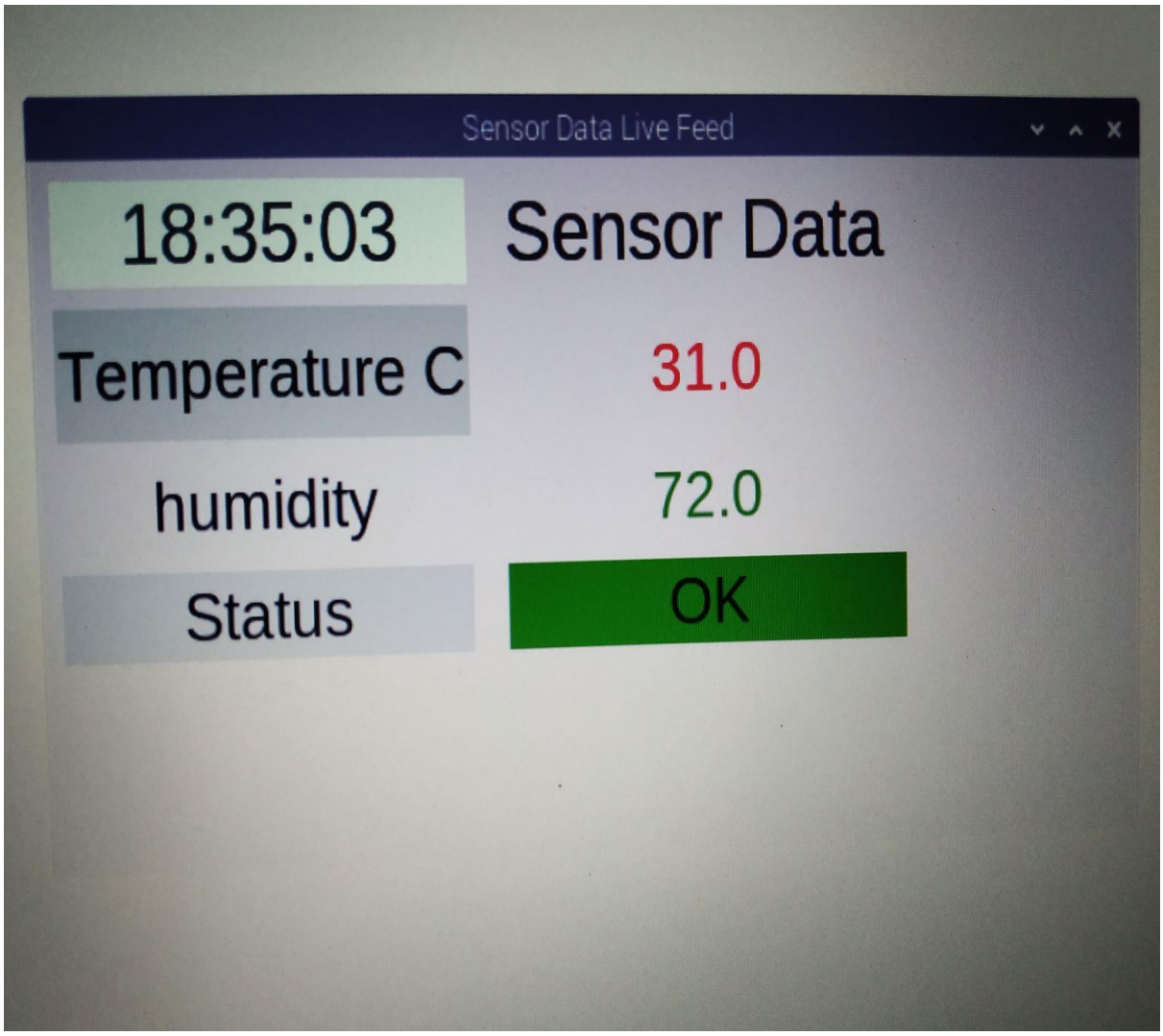


Fig.(f) Temperature & Humidity Dashboard

7. Troubleshooting:

7.1 Problems/Faults in project:- Message was not showing on LCD Display

7.2 Steps to solve problems/faults in project :-

1. tried to find out any loose connection in circuit , but that connection found okay
2. For Checked GPIO pin's of Raspberry pi , we wrote one code for IR sensor and Checked GPIO pin's , whether it's receiving and sending data or not. That was also Working fine.
3. Checked the Jumper wires with Multimeter , resistance of some jumper wires found High it was in range 200 ohm – 250 ohms, replaced that wires with new wires , then Message started showing on LCD display. The resistance of that new wires is 5 ohm to 10 ohm.

References:

1. https://youtu.be/tICT98WwYxI
2. https://youtu.be/aNVjEmg85E0
3. https://www.raspberrypi.org/
4. https://github.com/dhylands/python_lcd
5. https://github.com/adafruit/Adafruit_Python_DHT#

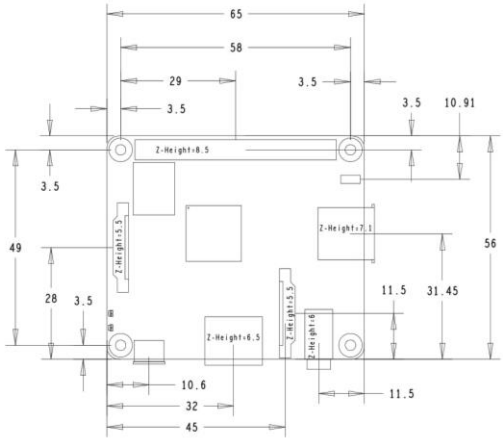
Appendix: Data sheets of components

- Raspberry pi 3A+ :-

Specification

Processor:	Broadcom BCM2837B0, Cortex-A53 64-bit SoC @ 1.4 GHz
Memory:	512MB LPDDR2 SDRAM
Connectivity:	2.4 GHz and 5 GHz IEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2/BLE
Access:	Extended 40-pin GPIO header
Video & sound:	1 × full size HDMI MIPI DSI display port MIPI CSI camera port 4 pole stereo output and composite video port
Multimedia:	H.264, MPEG-4 decode (1080p30); H.264 encode (1080p30); OpenGL ES 1.1, 2.0 graphics
SD card support:	Micro SD format for loading operating system and data storage
Input power:	5 V/2.5 A DC via micro USB connector 5 V DC via GPIO header
Environment:	Operating temperature, 0–50°C
Compliance:	For a full list of local and regional product approvals, please visit: www.raspberrypi.org/products/raspberry-pi-3-model-a-plus
Production lifetime:	The Raspberry Pi 3 Model A+ will remain in production until at least January 2023

Physical specifications



all dimensions in mm

WARNINGS

- This product should only be connected to an external power supply rated at 5 V/2.5 A DC. Any external power supply used with the Raspberry Pi 3 Model A+ shall comply with relevant regulations and standards applicable in the country of intended use.
- This product should be operated in a well-ventilated environment and, if used inside a case, the case should not be covered.
- While in use, this product should be placed on a stable, flat, non-conductive surface and should not be contacted by conductive items.
- The connection of incompatible devices to the GPIO connection may affect compliance, result in damage to the unit, and invalidate the warranty.
- All peripherals used with this product should comply with relevant standards for the country of use and be marked accordingly to ensure that safety and performance requirements are met. These articles include but are not limited to keyboards, monitors, and mice when used in conjunction with the Raspberry Pi.
- The cables and connectors of all peripherals used with this product must have adequate insulation so that relevant safety requirements are met.

SAFETY INSTRUCTIONS

To avoid malfunction or damage to this product, please observe the following:

- Do not expose to water or moisture, or place on a conductive surface while in operation.
- Do not expose to heat from any source; the Raspberry Pi 3 Model A+ is designed for reliable operation at normal ambient temperatures.
- Take care while handling to avoid mechanical or electrical damage to the printed circuit board and connectors.
- While it is powered, avoid handling the printed circuit board, or only handle it by the edges to minimise the risk of electrostatic discharge damage.

Technical & Physical Specification of Raspberry pi 3 A+

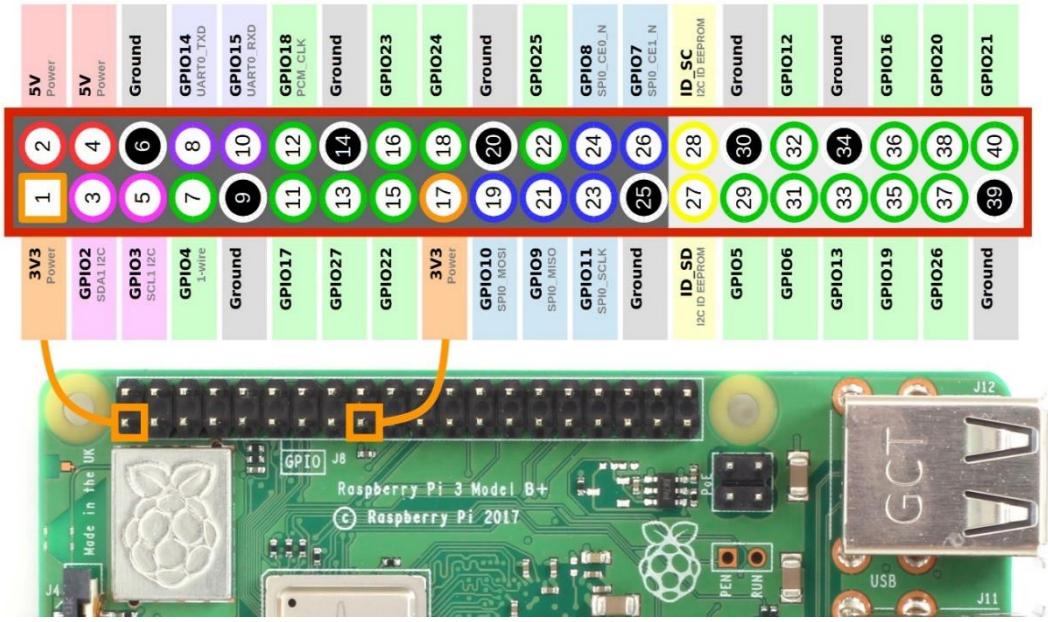
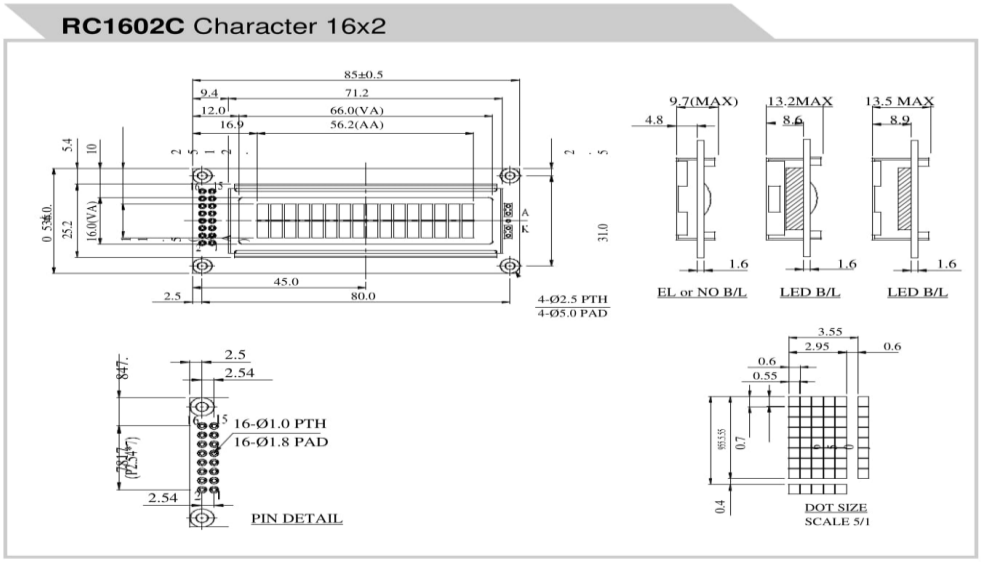


Fig.(g) Raspberry Pi GPIO Pin Configuration

- LCD Display 16x2 :-



Feature

1. 5x8 dots includes cursor
2. Bulit-in controller ST7066 or Equivalent
3. 5V power supply (Also available for 3V)
4. N.V, optional for 3V power supply
5. 1/16 duty cycle
6. LED can be driven by PIN1, PIN2, PIN15, PIN16 or A and K
7. Interface : 6800, option SPI/I2C (RW1063 IC)

Pin No.	Symbol	Description
1	Vss	Ground
2	VDD	Power supply for logic
3	Vo	Contrast Adjustment
4	RS	Data/ Instruction select signal
5	R/W	Read/Write select signal
6	E	Enable signal
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
15	APower supply for B/L +	
16	KPower supply for B/L -	

Mechanical Data

Item	Standard Value	Unit
Module Dimension	85.0 x 36.0	mm
Viewing Area	66.0 x 16.0	mm
Mounting Hole	80.0 x 31.0	mm
Character Size	2.95 x 5.55	mm

Electrical Characteristics

Item	Symbol	Standard Value typ.	Unit
Input Voltage	VDD	3/5	V
Recommended LCD Driving Voltage for Normal Temp. Version module @25ºC	VDD-VO	3.70	V

Display Character Address Code

Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DD RAM Address	00	01														0F
DD RAM Address	40	41														4F

Fig.(h) Specification & Pinout of LCD Display

➢ DHT11 Sensor :-

1. Technical Specifications:

Overview:

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 ℃	±5%RH	±2℃	1	4 Pin Single Row

Detailed Specifications:

Parameters	**Conditions**	**Minimum**	**Typical**	**Maximum**
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25℃		±4%RH	
	0-50℃			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0℃	30%RH		90%RH
	25℃	20%RH		90%RH
	50℃	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25℃, 1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long-Term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1℃	1℃	1℃
		8 Bit	8 Bit	8 Bit
Repeatability			±1℃	
Accuracy		±1℃		±2℃
Measurement Range		0℃		50℃
Response Time (Seconds)	1/e(63%)	6 S		30 S

2. Electrical Characteristics

VDD=5V, T = 25℃ (unless otherwise stated)

	Conditions	Minimum	Typical	Maximum
Power Supply	DC	3V	5V	5.5V
Current Supply	Measuring	0.5mA		2.5mA
	Average	0.2mA		1mA
	Standby	100uA		150uA
Sampling period	Second	1		

Note: Sampling period at intervals should be no less than 1 second.

Technical Specification & Electrical Characteristics of DHT11 Sensor