City, University of London

Department of Electrical and Electronic Engineering

LAB - MANUAL

EE3600 / EE3700 Design - III

Simple Weather Station

T1 LAB - 2

Version: 2020/2021

1.0 Introduction

In this project we will make a simple weather station that will measure the humidity and temperature and will show it on the LCD attached to the Arduino.

We will build a small circuit to interface Arduino with DHT11 temperature and humidity sensor. The main part of this design is connecting the DHT11 sensor with Arduino to monitor temperature and humidity.

2.0 Required Components

- Arduino UNO
- DHT11 Temperature and Humidity Sensor
- Breadboard
- 20 x 4 LCD Display
- Connecting wires

3.0 Component Description

3.1 DHT11 Temperature and Humidity Sensor

DHT11 is a part of DHTXX series of Humidity sensors. DHT11 humidity sensors are cheap, and they are immensely popular among hobbyists and beginners.

The DHT11 humidity and temperature sensor consists of 3 main components. A resistive type humidity sensor, an NTC (negative temperature coefficient) thermistor (to measure the temperature) and an 8-bit microcontroller, which converts the analog signals from both the sensors and sends out single digital signal. This digital signal can be read by any microcontroller or microprocessor for further analysis.

The DHT11 detects water vapor by measuring the electrical resistance between two electrodes. The humidity sensing component is a moisture holding substrate with electrodes applied to the surface. When water vapor is absorbed by the substrate, ions are released by the substrate which increases the conductivity between the

electrodes. The change in resistance between the two electrodes is proportional to the relative humidity. Higher relative humidity decreases the resistance between the electrodes, while lower relative humidity increases the resistance between the electrodes.

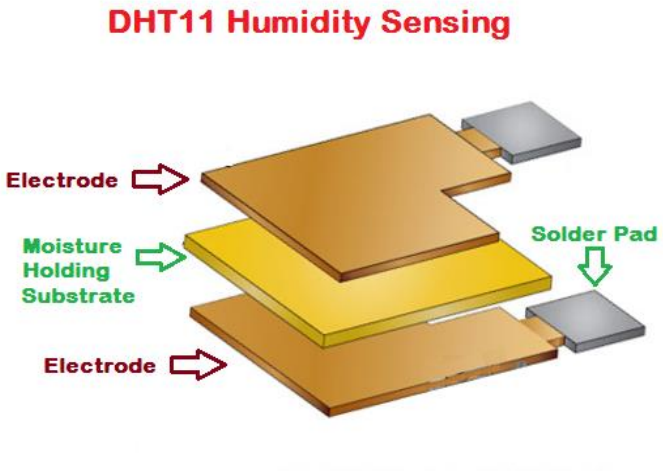

Figure1: Humidity sensing technique

The DHT11 measures temperature with a surface mounted NTC temperature sensor (thermistor) built into the unit.

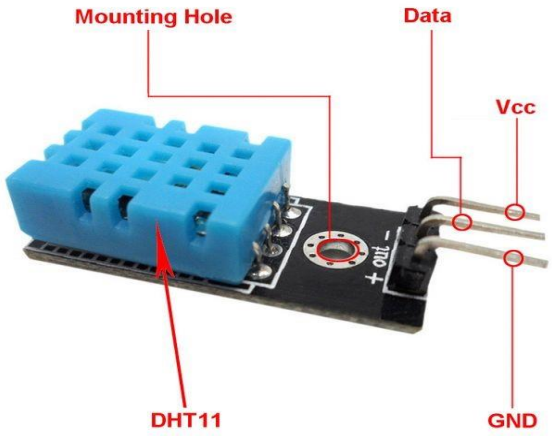

Figure2: DHT11 module

DHT11 Humidity Sensor consists of 3 pins: VCC, Data Out, and GND. The range of voltage for VCC pin is 3.5V to 5.5V. A 5V supply would be sufficient. The data from the Data Out pin is a serial digital data.

The data from the DHT11 sensor consists of 40 – bits and the format are as follows:

8 – Bit humidity integer value,

8 – Bit humidity decimal value,

8 – Bit temperature value,

8– Bit data for fractional temperature value and

8– Bit data for checksum (parity).

Example:

Consider the data received from the DHT11 Sensor is

00100101 00000000 00011001 00000000 00111110

This data can be separated based on the above-mentioned structure (40 – bits) as follows:

In order to check whether the received data is correct or not, we need to perform a small calculation. Add all the integral and decimals values of relative humidity (RH) and Temperature and check whether the sum is equal to the checksum value i.e. the last 8 – bit data.

00100101	00000000	00011001	00000000	00111110
Humidity (Integer)	Humidity (Decimal)	Temperature (Integer)	Temperature (Decimal)	Checksum (Parity)

00100101 + 00000000 + 00011001 + 00000000 = 00111110

This value is same as checksum and hence the received data is valid. Now to get the RH and Temperature values, just convert the binary data to decimal data.

RH = Decimal of 00100101 = 37%

Temperature = Decimal of 00011001 = 25^0

3.1.1 Technical Specification for DHT11:

- Humidity Range: 20-90% RH
- Humidity Accuracy: ±5% RH
- Temperature Range: 0-50 °C
- Temperature Accuracy: ±2% °C
- Operating Voltage: 3V to 5.5V
- Formula for calculate the humidity:

$$RH = \frac{PW}{PS}\ x\ 100\ \%$$

RH = Relative Humidity
PW = Density of water vapor
PS = Density of water vapor at saturation

3.1.2 Applications

DHT11 Relative Humidity and Temperature Sensor can be used in many applications like:

- HVAC (Heating, Ventilation and Air Conditioning) Systems
- Weather Stations
- Medical Equipment for measuring humidity
- Home Automation Systems
- Automotive and other weather control applications

3.2 20 x 4 LCD Display

ERM2004SYG-2 is 20 characters wide, 4 rows character LCD module, SPLC780C controller (Industry-standard HD44780 compatible controller), 6800 4/8-bit parallel interface, single led backlight with yellow green colour included can be dimmed easily with a variable resistor.

Figure 3: Front view of the LCD

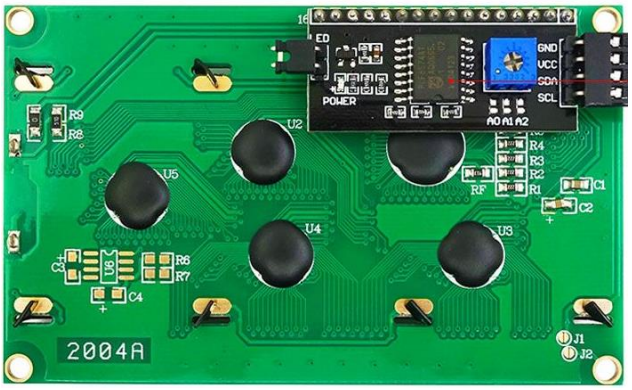

Figure 4: Rear view of the LCD

3.2.1 Technical specification of LCD

Backlight Colour	Yellow Green Colour
Backlight Current (Typ)	75mA
Power Supply(Typ)	5V
Supply Current (Max)	2000uA
Operating Temperature	-20℃~70℃
Storage Temperature	-30℃~80℃

4.0 Working of the Project

The project is built using Arduino UNO and DHT11 humidity and temperature sensor, where the humidity and temperature of the surroundings are displayed on an LCD display.

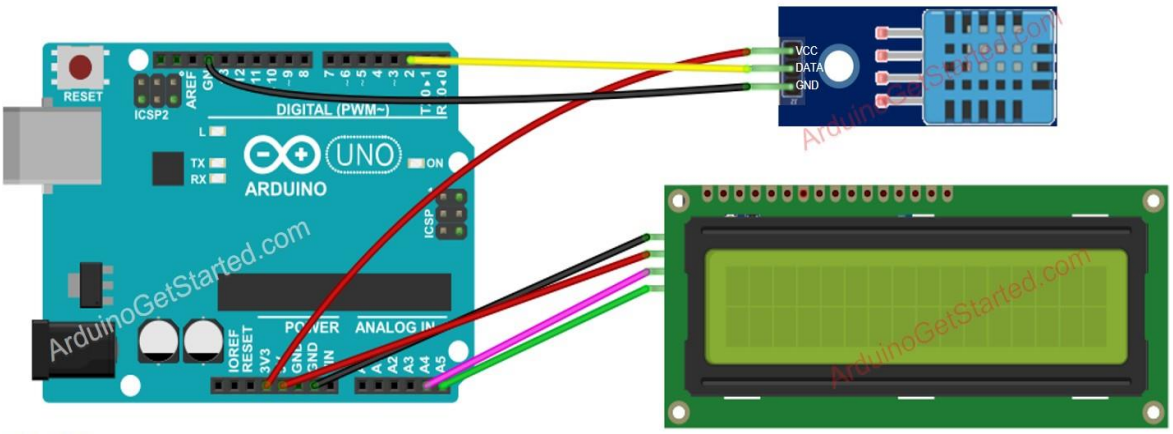

Figure 5: Circuit diagram for weather station

DHT11 is a humidity and temperature sensor, which generates calibrated digital output. DHT11 can be interfaced with any microcontroller platform like Arduino, Raspberry Pi, etc. and get instantaneous results.

We will see the circuit design of DHT11 interfacing with Arduino. The DHT11 Humidity and Temperature sensor comes in two variants: just the sensor or a module.

Coming to the pin configuration, the pins of the DHT11 sensor configuration are as follows:

No	DHT 11 Pins	Connection to Arduino Pins
1	**GND**	**GND**
2	**VCC**	**5V**
3	**DATA**	**7**

LCD 2004A display is used to display the results. The control pins of LCD:

No	LCD 2004A Pins	Connection to Arduino Pins
1	**GND**	**GND**
2	**VCC**	**5V**
3	**SDA**	**SDA**
4	**SCL**	**SCL**

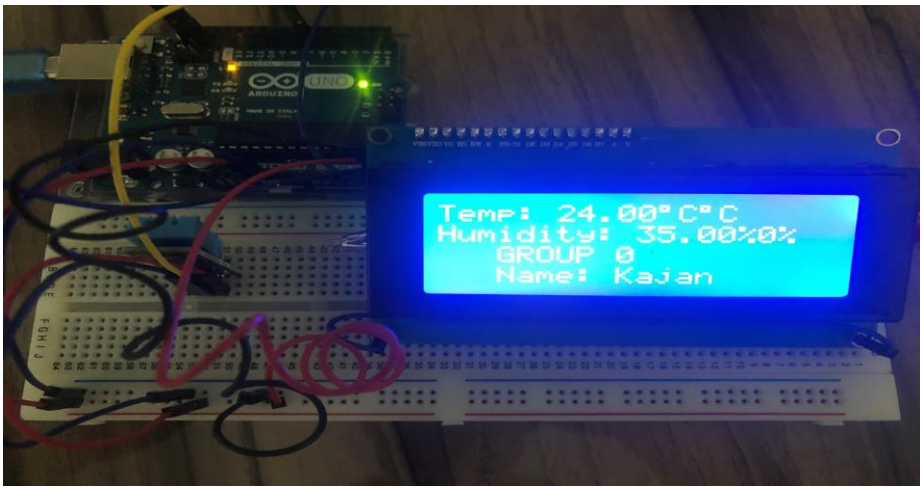

Figure 6: Buit circuit

5.0 Code

After creating the circuit, we need to write a program that can functionalise the circuit. In this design we can use the special library available for the DHT11 module called "**dht**".

If you want to use this library, you need to download this library separately and add it to the existing libraries of Arduino IDE. The program will make the Arduino to automatically read the data from the sensor and display it as humidity and temperature on the LCD Display.

6.0 Tasks

1. Understand the overall concept of this design,
2. Familiarise yourself with the hardware setup,
3. Understand the given sketch (i.e. Arduino Code) for this design,
4. Modify the sketch to display your **group number** and **date** in different lines on the LCD in addition to temperature and humidity display,
5. Identify how this design can be extended further and where /how we can implement this design in the real world.

7.0 Marking Scheme

Description	Marks
Total marks for this mini project	**10**
Hardware Design	**04**
Oral (each member of the group will be accessed)	**06**

8.0 Sample MCQs for Quiz

8.1) What is the pin number assigned for the DHT11 sensor in the given sketch?

1) Eleven
2) Nine
3) Seven
4) Fourteen

8.2) What is the outcome of the **lcd.print("Humidity: ");** command?

1) Display the value of the humidity
2) Display the word *Humidity* and : symbol
3) Display the word *Humidity*
4) All the above

8.3) How many maximum lines we can display on the LCD which we used for the Lab-2?

1) 2
2) 6
3) 4
4) None of the above

8.4) Why we have include the **lcd.init()** command in the Lab-2 sketch (original sketch given by us)?

1) To switch off the LCD
2) To clean the dust on the LCD
3) To Initialize the LCD
4) To define the data pin connection from LCD to Arduino

End of Lab - 2