Low Cost Arduino Controlled Humidity Meter

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Abstract- *This paper proposes a cost -friendly and efficient, humidity and temperature monitoring system, which can be easily used in industrial and agronomic sector. Our system measures room temperature and humidity using an Arduino board, based on Atmega 328P using the sensor HDC1080 from Texas Instrument*

Key Words: Humidity Meter, Arduino, sensors, HDC1080, DHT22, DHT 11, Relative Humidity

1. INTRODUCTION

The measurement of Humidity, is an integral part of manufacturing industries, like semiconductor manufacturing, power distribution and power generation. In such sectors, moisture is unwanted. Moisture can degrade product quality, damage machines, thus increasing the overall cost involved in production. Thus, the monitoring is the vital part for industries.

Humidity is measured as the amount of water in a sample of air. There are two types of humidity measurement.

- Absolute Humidity

- Relative Humidity

1.1 Absolute humidity

Absolute humidity is the total mass of water vapor present in a given volume or mass of air:

$$R_{ABS} = \frac{m_h}{v_h}$$

where , R_{Abs} is the absolute humidity, m_H is Mass of water in the sample of air and v_H is Volume of water and air.

1.2 Relative humidity

Relative humidity (RH) is the ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at a given temperature. Relative humidity depends on temperature and the pressure of the system of interest.

$$R_{rel} = \frac{P_{h20}}{P_{*h20}}$$

Where R_{rel} = Relative Humidity, P_{h20} = partial pressure of water vapor in the mixture and P_{*h20} = equilibrium vapor pressure of water over a flat surface of pure water

Absolute humidity is rarely used to express the moisture content of the air. Instead, we use relative humidity as it is strongly proportional to temperature and highly sensitive to temperature changes. This means that with stable temperature in a system, corresponding relative humidity will also be stable. As well as temperature, relative humidity also depends on the pressure of the system in concern.

2. LITERATURE REVIEW

In [1] using the sensor DHT 11, an efficient system has been proposed. The DHT 11 sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit micro controller. The Accuracy of the sensor as specified in the data sheet is ±5% which is only good for small projects.

The authors in [2] uses DHT22 sensor which includes a capacitive sensor wet component and a high-precision temperature measurement device, and connected with a high-performance 8-bit micro controller. The Sensor is better than the previous version of DHT11 as it uses a capacitive sensor rather than a restive one. The Accuracy ranges from ±2% to ±5% but again due to the low resolution of 8 bit, it can detect micro changes to the humidity in the system.

In the present paper, the objective was to develop an Arduino based Humidity meter which will be simple, cost effective so that it can be utilized and commercialized in different industrial applications with higher degree of accuracy.

The paper has been organized in following sections. In the next section, terminologies used in humidity sensor have been discussed. In section 4 and 5, circuit diagram and experimentation setup have been explained.

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3. OUR SYSTEM

Our System consists of an Arduino Board with a HDC1080 sensor along with and 0.96" OLED Display to measure and display the humidity. We are using an Arduino Board due to following reasons

- It is open source

- It is easy to program and implement

- It is cost effective

Arduino can be easily programmed by the java base Arduino IDE (Integrated Development Environment) or Micro-Python. There are several Arduino boards with different configuration i.e. controller architecture, chip size and USB to serial converters.
As the Sensor, we are using the HDC1080

3. 1 Sensor Description

We are using the HDC1080 Sensor which is a digital humidity sensor with integrated temperature sensor that provides excellent measurement accuracy at very low power. The HDC1080 operates over a wide supply range, and is a low cost, low power alternative to competitive solutions in a wide range of common applications. [5]

We are selecting this sensor for the following feature

- Relative Humidity Accuracy ±2% (typical)

- Temperature Accuracy ±0.2°C (typical)

- 14 Bit Measurement Resolution

- 100 µA Sleep Mode Current

- I^{2}C Interface

- Supply Voltage 2.7 V to 5.5 V

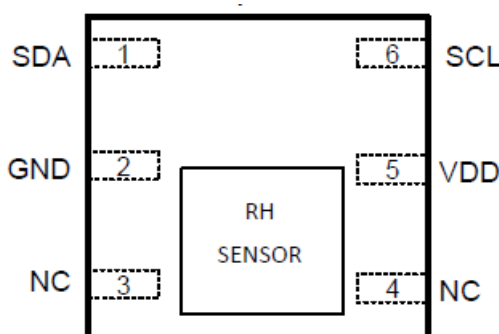### 3.1.1 Pin Configuration and Functions

Fig -1: Pin Diagram of HDC1080

Table -1: Description of different pins of RH Sensor

Pin Name	Pin No	I/O Types	Description
SDA	1	I/O	Serial data line for I2C, open-drain; requires a pull-up resistor to VDD
GND	2	G	Ground
NC	3,4	-	These pins may be left floating, or connected to GND
VDD	5	P	Supply Voltage
SCL	6	I	Serial clock line for I2C, open-drain; requires a pull-up resistor to VDD
DAP	DAP	| - |	Serial clock line for I2C, open-drain; requires a pull-up resistor to VDD

3.1.2. Typical Characteristic

The relative humidity has an accuracy of 3% when the Relative humidity is below 10%, the accuracy increases to 2% and remains steady from 20% to 60% Relative Humidity. The Accuracy again drop to 4% from 70% onward.
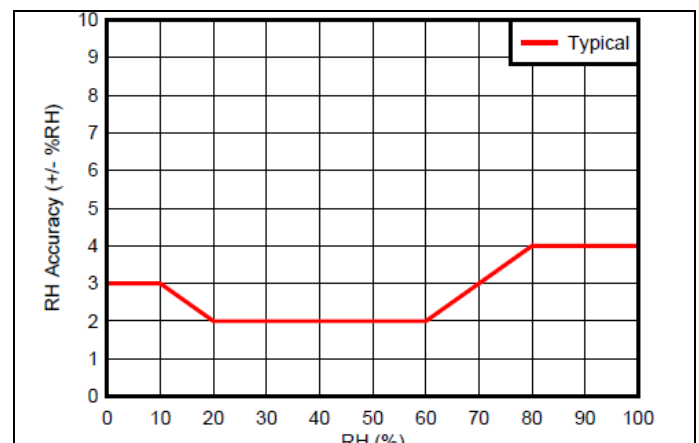

Chart -1: RH Accuracy vs RH

3.1.3. Modes

The HDC has two modes, the sleep mode and measurement mode. It waits in the sleep mode till it fetches the command to measure using the I2C Bus. Once it receives the command it goes to measurement mode and then takes the reading and switches back again to sleep mode [5]
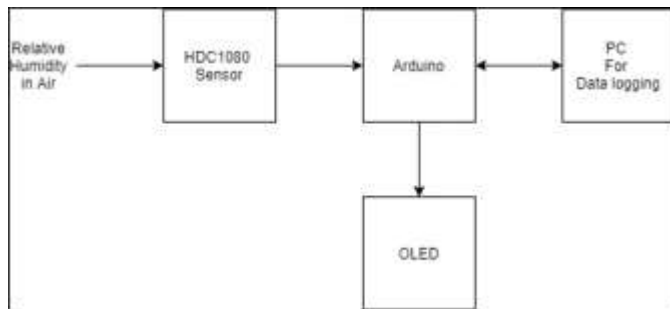
4. BLOCK DIAGRAM

Fig -2: Block diagram of the System

The HDC1080 Senses the ambient humidity and transmit the data to the Arduino using the I2C Bus the Arduino then reads the data, updates the oled buffer, which in turns changes the display. The Arduino can be connected the to the PC Via the USB Cord and can be used for data Serial Monitoring.

5. CIRCUIT DIAGRAM

The Arduino is connected to the HDC1080 sensor and OLED display with the I2C port. The I2C port consist of Vcc, GND, SDA, SLA pins. For Arduino the SDA and SLA are the A4 and A5 pins respectively. The I2C Address needs to be changed for each device as the address can vary.
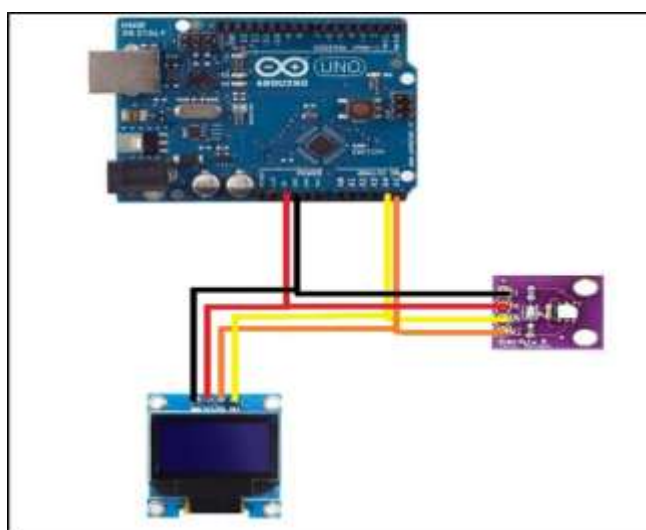

Fig -3: Connection with Arduino

6. EXPERIMENTATION SETUP

The experimental setup has been shown in Figure 4. A program is coded in Processing Environment, which is open source software to collect the data using from the serial monitor and save it into the .CSV file which can be plotted later. The data has been collected from 9:30 AM to 3:00 PM for consecutive three days. The collected data have been stored in an Excel file.
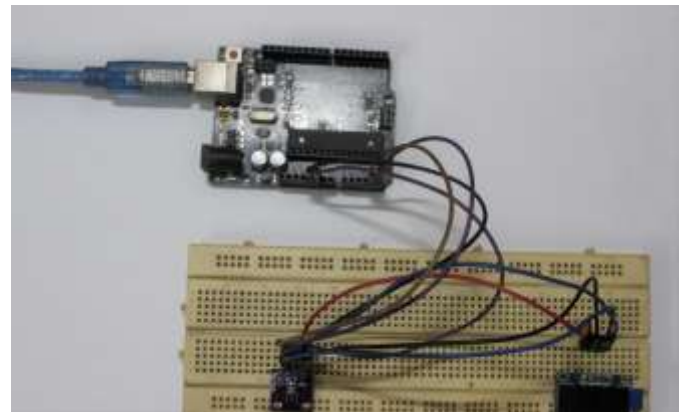

Fig -4: Actual Experimental Setup of the Proposed System
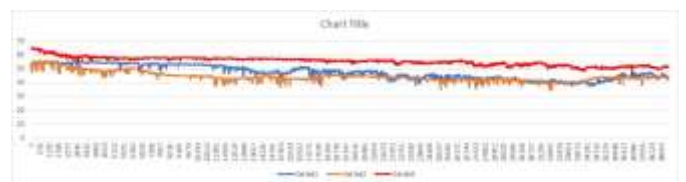
7. RESULTS AND DISCUSSIONS

Chart -2: RH Time

As the data has been plotted, we can observe that there is a slight variation that can be detected, which can be removed by applying a filter. The 3 Plots series 1, series 2 and series 3 represent the data collected on 12th ,13th,14th Of January 2020.

8. CONCLUSIONS

From the results obtained from the proposed setup, it has been observed that the current hardware has the ability to measure data up to 3-digit decimal place, which definitely enhance more accurate reading. Considering the cost and size of individual parts, the system can be easily converted into portable solution.

To enhance the accuracy of the obtained data from the sensor, the sensor limitation incorporated while measuring data, can be filtered out by applying different filtering algorithm available in literature.

Moreover, the total cost of this experimental setup would be around Rs.1000/–, and resolution of 14 bit with an accuracy

of ±2% makes it cheap but efficient to detect slight change in humidity.

Market survey states that an industrial humidity sensor price will be starting somewhere around Rs.9000/– Offering accuracy of ±3%. Mass production of the instrument as well as by fabricating the system into SMD package, the cost will decrease 5 times. An external case can be easily designed and manufactured using 3D Printing technologies. making the meter economical and efficient as proposed.

The total cost of the meter summarizes as follow:

- OLED display cost: Rs.150/–

- Arduino cost: Rs.250 to Rs.350/–

- HDC cost Rs.500 to Rs.600/–

ACKNOWLEDGEMENT

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BIOGRAPHIES

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