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Low Cost Temperature and Humidity Estimator with Atmega8 Microcontroller

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ABSTRACT

This paper presents a efficient but also cost effective system to determine two parameters of the atmosphere, which are the temperature and humidity. The Digital Temperature and Humidity Sensor 22 (DHT 22) is used to measure the temperature and humidity. The temperature measured is the ambient temperature of the atmosphere and humidity is the relative humidity of the atmosphere. The system is constructed with AVR atmega8 as a controller and a LCD (liquid crystal display) 16x2 display as a means to display the temperature and humidity. Through the Arduino IDE (Integrated Development Environment) code Is uploaded to the ATmega8. Also as the display is operated in 4 bit mode thus there are many pins of the ATmega8 which are available for other purposes and the system becomes compact. Thus the small device can be adjusted in different places for use. As it is using a ATmega8 it can be used to command various devices as temperature and humidity varies.

KEYWORDS: *DHT22, ATmega8 and LCD display*

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INTRODUCTION

Having an ideal temperature and humidity of the atmosphere is very important. As maintaining temperature is needed different kinds of operations, such as the using of Cold Storage, the using Air Conditioner etc. also different devices which has metal gets corroded slowly for high humidity in the atmosphere.

The controller in this system is the ATmega8 microcontroller. Which will take the data from the DHT22 sensor and then show the values of the data in the LCD 16x2 display. The process is really simple as the experiment.

Characters in binary code are of 8 bits thus the controller send the the 8 bits of each word to the LCD. As LCD will be used in 4 bit operation mode, so the characters first 4 bits will go from then controller to the lcd then the other 4 will go from the controller to the LCD. It is a bit slower then 8 bit operation mood but it saves pins which can be used in other purposes, such as taking inputs from other sensors or devices or giving output to other devices.

For uploading the code Arduino IDE will be used. There are different processes to upload code to ATmega8 microcontroller but in this case a simple way was used. That is the ATmega8 microcontroller was inserted on a Arduino Uno then plugged into a computer. Then Arduino IDE was used to upload code to the Atmega8.

Now inserting the ATmega8 in the system will run the system efficiently and show the values of temperature and humidity in the LCD display as programmed.

HARDWARES

Hardware is an electronic device which can be physically touched. A combination of different hardwares are needed to create a complete working system. The hardwares that are needed to create the system of ***Temperature and Humidity Estimator*** are listed below:

1. ATmega8 microcontroller
2. Crystal oscillator
3. 22 micro farad capacitor x2
4. DHT22
5. LCD 16x2
6. 10k ohm potentiometer
7. Breadboard
8. Jumper wires
9. 10k ohm resistance
10. Power supply 5V

These are also a few things that are not the hardware of the system but are required. These are listed below :

1. Computer/Laptop
2. Arduino Uno
3. Cable for Arduino Uno

ATMEGA8 MICROCONTROLLER

ATMEGA8 is a 28 pin AVR microcontroller. Although we have many similar microcontrollers, ATMEGA8 is popular because it is one of the cheapest microcontroller and provides many features in lesser pins. With program memory of 8Kbytes, ATMEGA8 application is very versatile. With various POWER SAVING modes it can work on MOBILE EMBEDDED SYSTEMS. With its compact size it can be put in many small boards. With Watchdog timer to reset under error it can be used on systems with minimal human interference. These features added together in one controller make the ATMEGA8 very useful.[1]

TABLE 1: ATMEGA8 –Simplified Features[1].

CPU	8-bit AVR
Number of Pins	28
Operating Voltage (V)	+4.5 V TO +5.5 V (ATmega8) (+5.5V being absolute maximum)
Number of I/O pins	23
Communication Interface	Master/Slave SPI Serial Interface(16, 17, 18, 19 PINS) [Can be used for programming this controller] Programmable Serial USART(2, 3 PINS) [Can be used for programming this controller] Two-wire Serial Interface(27, 28 PINS)[Can be used to connect peripheral devices like sensors and LCDs]
ADC Module	6 channels, 10-bit resolution ADC
Timer Module	Two 8-bit counters, One 16-bit counter [Total three]
PWM channels	3
External Oscillator	0-8MHz for ATMEGA8L 0-16MHz for ATMEGA8
Internal Oscillator	0-8MHz Calibrated Internal Oscillator
Program Memory Type	Flash
Program Memory or Flash memory	8Kbytes[10000 write/erase cycles]
CPU Speed (MIPS)	16 MIPS
RAM	1KBytes
EEPROM	512
Watchdog Timer	Programmable Watchdog Timer with Separate On-chip Oscillator
Operating Temperature	-55°C to +125°C(+125 being absolute maximum, -55 being absolute minimum)

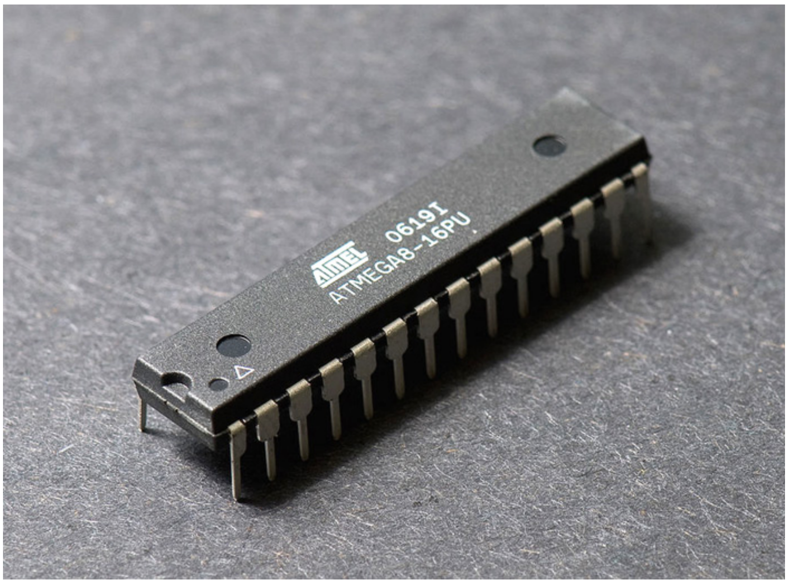


Figure 1: ATMEGA8-16PU[1]

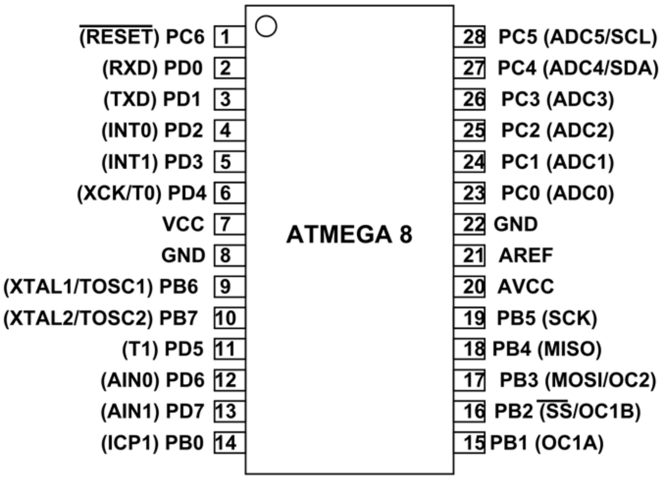


Figure 2: ATMEGA 8 pins.[1]

CRYSTAL OSCILLATOR

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency. This frequency is often used to keep track of time to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators.[2]

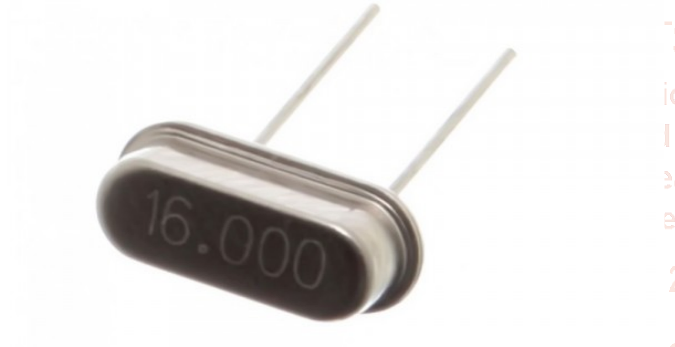


Figure 3: Crystal oscillator 16MHz.

CAPACITOR

A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals. The main cause of using the capacitor in the system is to ensure proper flow of electricity. In the experiment ceramic capacitor of 22micro farad was used in this system.

Figure 4: 22 micro farad capacitor.

DHT22

The DHT-22 (also named as AM2302) is a digital-output relative humidity and temperature sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and gives a digital signal on the data pin.

The specification of DHT22 is given below:

1. Operating Voltage: 3.5V to 5.5V
2. Operating current: 0.3mA (measuring) 60uA (standby)
3. Output: Serial data
4. Temperature Range: -40°C to 80°C
5. Humidity Range: 0% to 100%
6. Resolution: Temperature and Humidity both are 16-bit
7. Accuracy: ±0.5°C and ±1% [3]

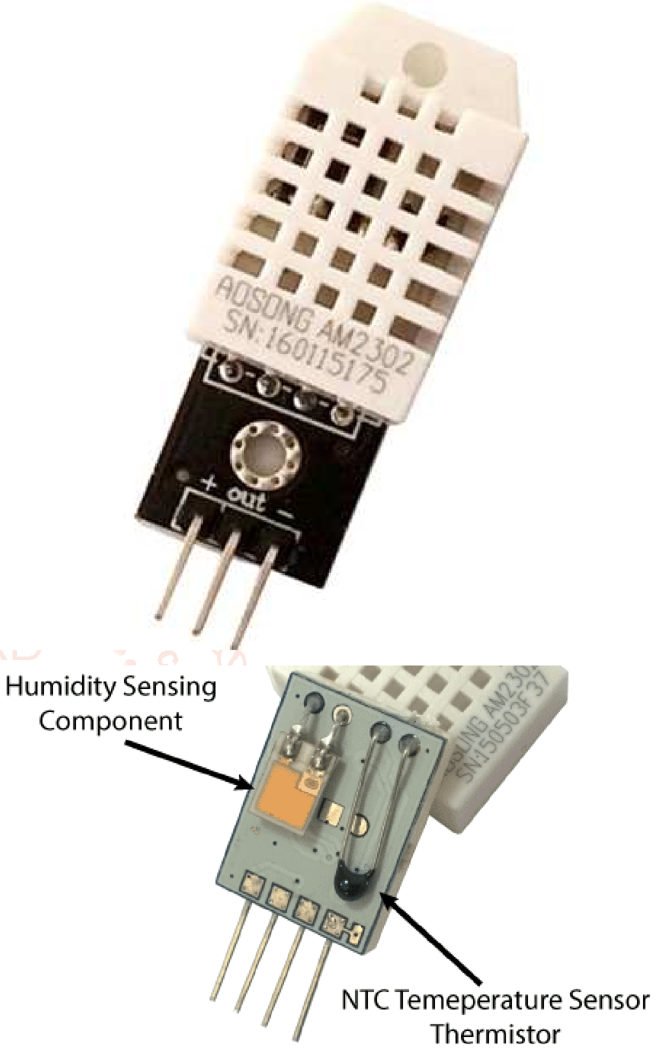

AOSONG AM2302
SN:160115175
+ out -
Humidity Sensing Component
NTC Temeperature Sensor Thermistor

Figure 5: (a) DHT22, (b) DHT22 internal component.

LCD 16x 2 DISPLAYS

An LCD16x2 display is an electronic display module and has a wide range of applications.16x2 stands for 16 words in a single line and there are 2 lines of the display.

The specification of LCD 16x2 display is given below:

1. Operating Voltage is 4.7V to 5.3V
2. Current consumption is 1mA without backlight
3. Alphanumeric LCD display module, meaning can display alphabets and numbers
4. Each character is build by a 5×8 pixel box
5. Can work on both 8-bit and 4-bit mode
6. It can also display any custom generated characters [4]

In 8 bit mode all 8 of the data pins are connected to the controller and the controller sends 8 bits to the LCD display. But in 4 bit mode the higher 4 data pins are connected to the controller and the controller sends 4 bits of the 8 bits to the LCD then again sends the other 4 bits of the 8 bits of the LCD thus creating a character. 4 bit mode may be slower then 8 bit mode but it is able to efficiently display the output. Thus 4 bit mode was used in this system.

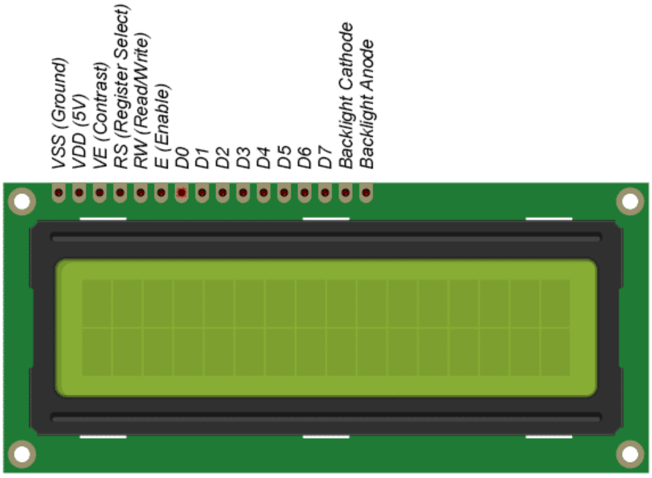


Figure 6: LCD 16x2 display pins.

POTENTIOMETER

A potentiometer is one type of variable resistance with 3 terminals. If the first and last pins of the potentiometer are VCC and GND respectively the middle pin would act as a variable resistance. The rotary type potentiometer of 10k ohm was used in this system to adjust the LCD display contrast.

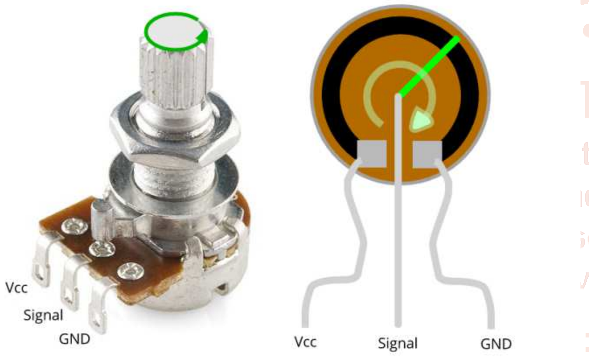


Figure 7: Rotary potentiometer and Internal structure of potentiometer.[5]

BREADBOARD

A breadboard is a platform used to build and test electronic circuits, usually without having to do any soldering.The Whole system is setup upon the Breadboard to test, demonstrate and to solve errors.

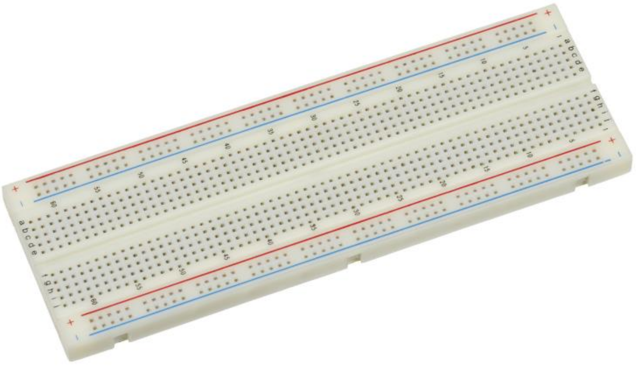


Figure 8: Breadboard.

JUMPERS WIRES

Jumper wires are used to connect different components/hardware of the system together as these are very easy to insert and remove unlike soldering.

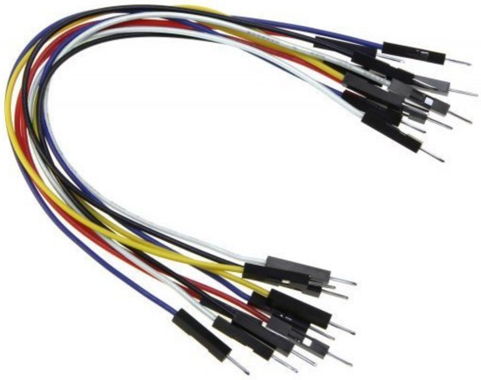


Figure 9: Male to male jumper wires.

RESISTOR

A 10k ohm resistor is use to connect the 5Volt terminal to the DHT22 data pin as to keep the pin high.

POWER SUPPLY

To run this system we would need a 5Volt power supply. There are many ways to supply power, such as adaptors, battery, breadboard power supply etc, but alternatively the output 5Volt of Arduino Uno was used to power this system.

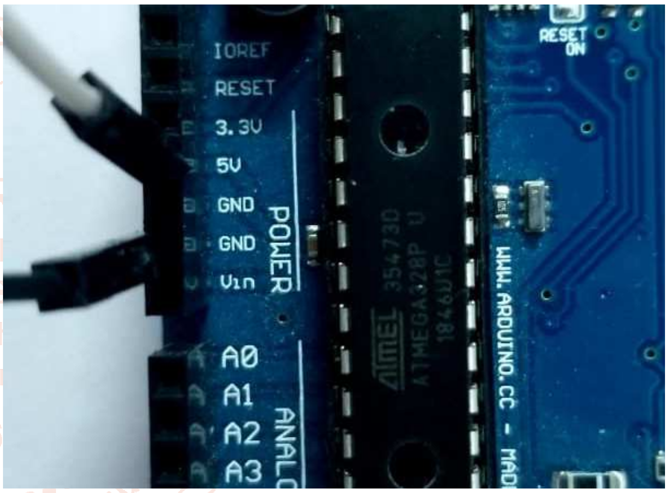
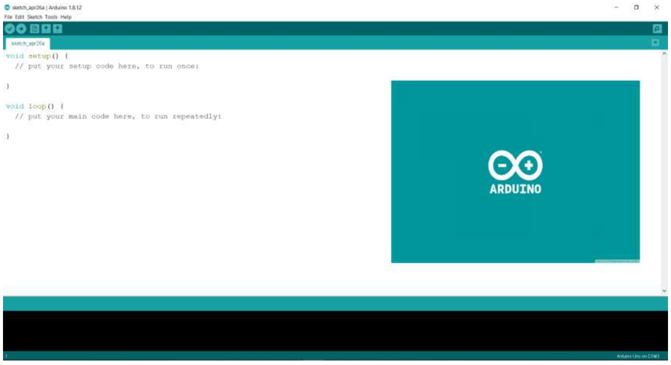


Figure 10: Arduino Uno as a power supply.

SOFTWARE

The software used here is the Arduino Integrated Development Environment (IDE). Arduino IDE is a cross-platform application that is written in functions from C and C++ [6]. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards [7].



```
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}
```

Figure 11: Arduino IDE interface with Arduino logo.

CODE

#include <LiquidCrystal.h> //add build in arduino liquid crystal library

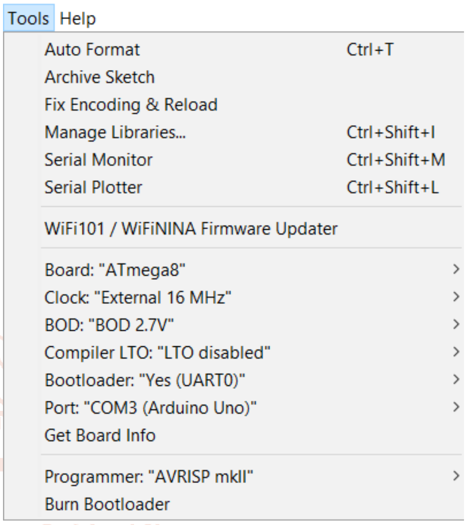
```
#include <DHT.h> //https://github.com/adafruit/DHT-sensor-library

#define DHTPIN 8

#define DHTTYPE DHT22 // DHT 22 (AM2302), AM2321

DHT dht(DHTPIN, DHTTYPE);

LiquidCrystal lcd(1, 2, 4, 5, 6, 7);

// Creates an LCD object. Parameters: (rs, enable, d4, d5, d6, d7)

void setup()

{

 Serial.begin(9600); // ***This is the 13th line

 lcd.begin(16, 2);

 // Initializes the interface to the LCD screen, and specifies the dimensions (width and height) of the display

 dht.begin();

}

void loop() {

 float h = dht.readHumidity();

 float t = dht.readTemperature();

 // Printing the results on the LCD display

 lcd.setCursor(0, 0);

 // Sets the location at which subsequent text written to the LCD will be displayed

 lcd.print("Temp.: ");

 // Prints string "Temp." on the LCD

 lcd.print(t);

 // Prints the temperature value from the sensor

 lcd.print(" C");

 // Prints string " C" on the LCD

 lcd.setCursor(0, 1);

 lcd.print("Humi.: ");

 lcd.print(h);

 lcd.print(" %");

 // Printing the results on the serial monitor

 Serial.print("Temperature = ");

 Serial.print(t);

 Serial.print(" *C ");

 Serial.print(" Humidity = ");

 Serial.print(h);

 Serial.println(" % ");

 delay(2000);

}
```

CODE UPLOAD PROCEDURE

The ATMEGA8 is firstly inserted on a Arduino Uno board. Next the Arduino Uno was connected to the laptop. From there the arudino IDE was used to select the Board of ATMEGA8 of minicore [8]. Also the Port and Programmer was selected from there as shown in figure 12.

Setting all the specified requirements the code was successfully uploaded to the ATMEGA8. To see if the code works and to check the values of temperature and humidity are being correctly recieved by the ATMEGA8, the arduino uno with ATMEGA8 microcontroller was set up as shown in figure 13 and then the output was taken from the serial monitor as shown in figure 14.

In few cases the LCD shows error for having the 13th line of the code, thus after conducting this small test the 13th line was removed and the code was uploaded again.



Tools Help

Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L

WiFi101 / WiFiNINA Firmware Updater

Board: "ATmega8"
Clock: "External 16 MHz"
BOD: "BOD 2.7V"
Compiler LTO: "LTO disabled"
Bootloader: "Yes (UART0)"
Port: "COM3 (Arduino Uno)"
Get Board Info

Programmer: "AVRISP mkII"
Burn Bootloader

Figure 12: Tool Specifications.

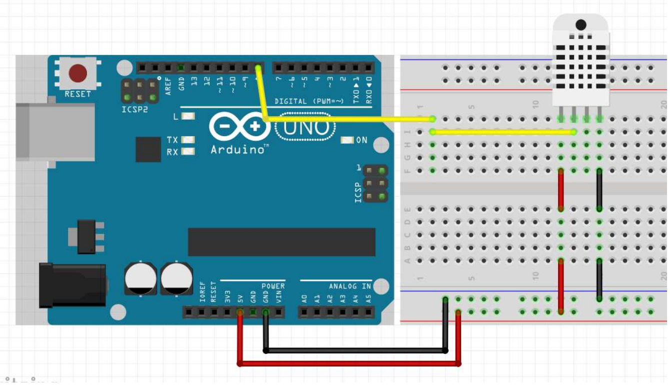
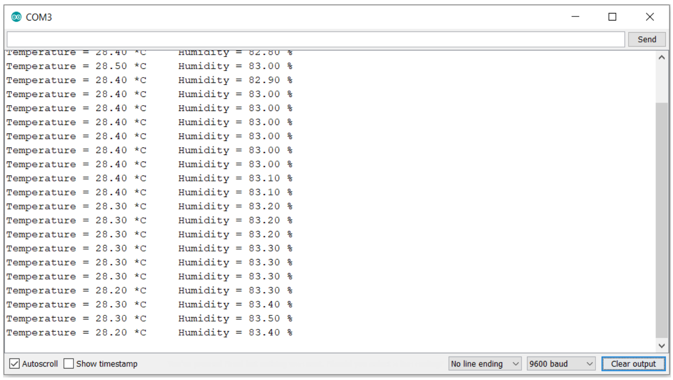


Figure 13: Test Circuit Setup.



COM3

Send

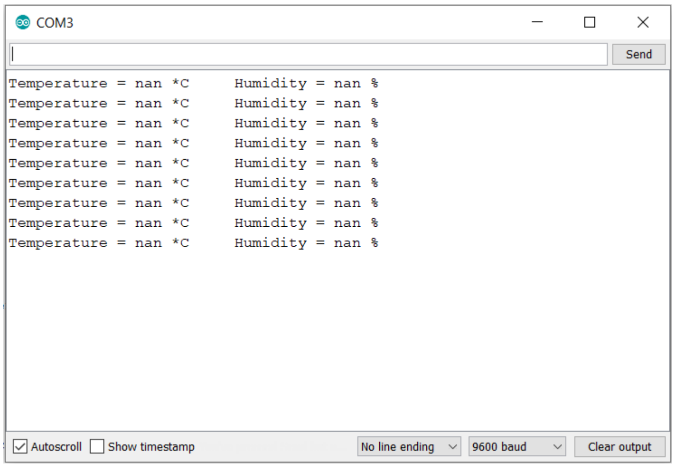
```
Temperature = 28.40 *C     Humidity = 82.80 %
Temperature = 28.50 *C     Humidity = 83.00 %
Temperature = 28.40 *C     Humidity = 82.90 %
Temperature = 28.40 *C     Humidity = 83.00 %
Temperature = 28.40 *C     Humidity = 83.00 %
Temperature = 28.40 *C     Humidity = 83.00 %
Temperature = 28.40 *C     Humidity = 83.00 %
Temperature = 28.40 *C     Humidity = 83.00 %
Temperature = 28.40 *C     Humidity = 83.00 %
Temperature = 28.40 *C     Humidity = 83.10 %
Temperature = 28.40 *C     Humidity = 83.10 %
Temperature = 28.30 *C     Humidity = 83.20 %
Temperature = 28.30 *C     Humidity = 83.20 %
Temperature = 28.30 *C     Humidity = 83.20 %
Temperature = 28.30 *C     Humidity = 83.30 %
Temperature = 28.30 *C     Humidity = 83.30 %
Temperature = 28.30 *C     Humidity = 83.30 %
Temperature = 28.20 *C     Humidity = 83.30 %
Temperature = 28.30 *C     Humidity = 83.40 %
Temperature = 28.30 *C     Humidity = 83.50 %
Temperature = 28.20 *C     Humidity = 83.40 %
```

☑ Autoscroll □ Show timestamp No line ending 9600 baud Clear output

Figure 14: Output of the test.

As seen from the serial monitors output the ATMEGA 8 is giving data of the temperature and humidity. The data refreshes after 2 second interval as given the delay and also as this DHT22 sensor gives new data after 2 seconds.

If the dht is not connected the output would be as in **figure** 15.



```
Temperature = nan *C     Humidity = nan %
Temperature = nan *C     Humidity = nan %
Temperature = nan *C     Humidity = nan %
Temperature = nan *C     Humidity = nan %
Temperature = nan *C     Humidity = nan %
Temperature = nan *C     Humidity = nan %
Temperature = nan *C     Humidity = nan %
Temperature = nan *C     Humidity = nan %
Temperature = nan *C     Humidity = nan %
```

Figure 15: Error if dht is not connected.

CONSTRUCTION OF THE SYSTEM

The whole system is constructed as in the Circuit diagram of figure 16.

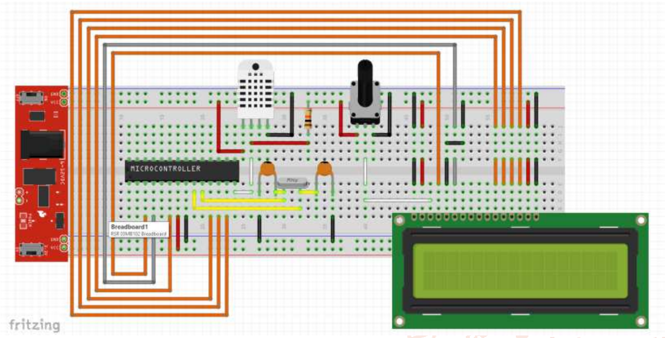


Figure 16: Circuit diagram of the system.

In the diagram power is supplied from a breadboard power supply.

The microcontrollers 9 and 10 pin is connected to a crystal oscillator of 16MHz. Both ends of the crystal is connected to a 22 microfarad capacitors one end and the other end of the capacitors are connected to GND. Next the microcontroller is powered on by connecting pin 7 to positive rail of the board and pin 8 to negative rail of the board.

The DHT22 is powered by connecting the pin 1 to the positive rail and the pin 4 to the negative rail. The data pin or pin 2 which gives the data is connected to the pin 14 of the ATMEGA8.

The LCD display is powered by connecting the pins VDD, LED+ to positive rail and the pins VSS, R/W, LED- to negative rail. The data pins of the LCD D4, D5, D6, D7 are connected to pins 6, 11, 12, 13 of the ATMEGA8 respectively. The pin VE of the LCD is connected to the potentiometer. The rs pin and the e pin is connected to the microcontrollers pin 3 and pin 4.

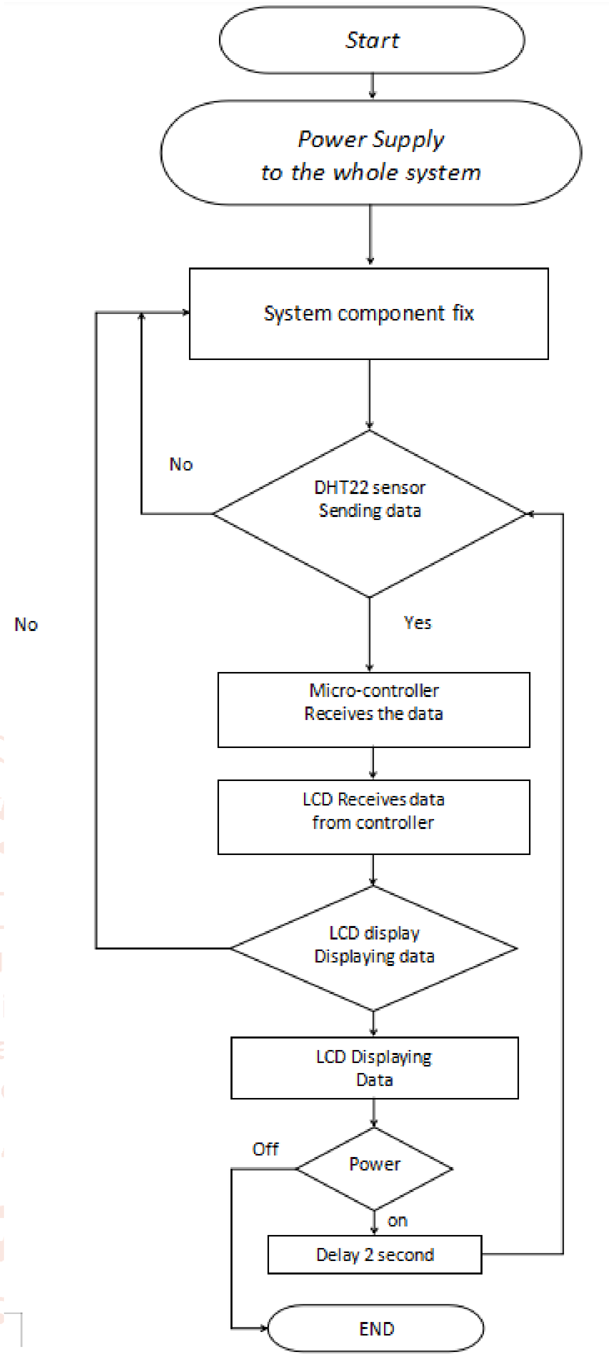


Figure 17: Flow chart of the system

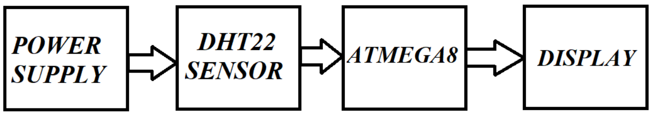


Figure 18: Block diagram of the system.

COST ANALYSIS

Table 2: Cost of the system with arduino uno

No.	NAME	COST (in BDT)
1.	Arduino Uno	450
2.	DHT22	360
3.	LCD 16x2	160
4.	10k ohm potentiometer	25
5.	Breadboard	100
6.	Jumper wires x40	2.5 x40
7.	10k ohm resistance	4
8.	Battery with connecting cable	400
	TOTAL	1599

Table 3: Cost of the system with ATMEGA8

No.	NAME	COST (in BDT)
1.	ATMEGA8	95
2.	Crystal oscillator	10
3.	22 micro farad capacitor x2	2 x2
4.	DHT22	360
5.	LCD 16x2	160
6.	10k ohm potentiometer	25
7.	Breadboard	100
8.	Jumper wires x40	2.5 x30
9.	10k ohm resistance	4
10.	Battery	350
	TOTAL	1183

Values of items where taken at 4/27/2020.

SYSTEM ANALYSIS AND OUTPUT

The system with ATMEGA8 is given in figures 19, 20, 21, 22, 23, 24.

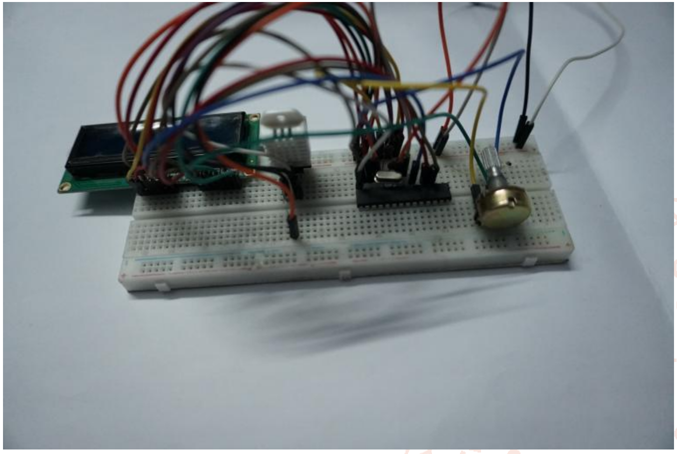


Figure 19: Whole system setup.

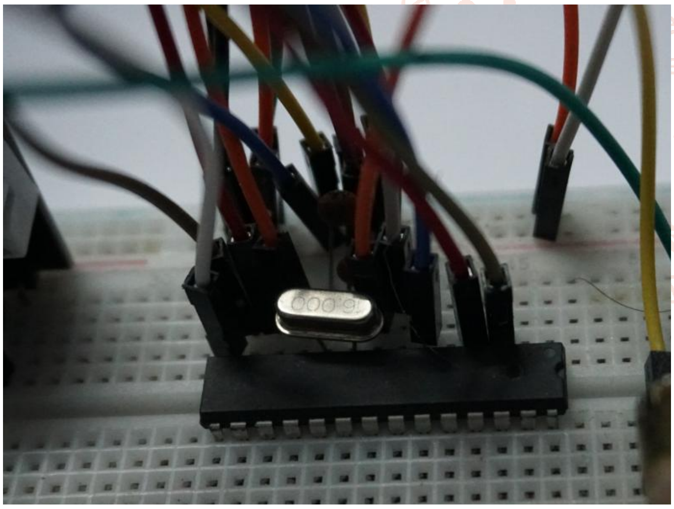


Figure 20: ATMEG8 and Crystal oscillator

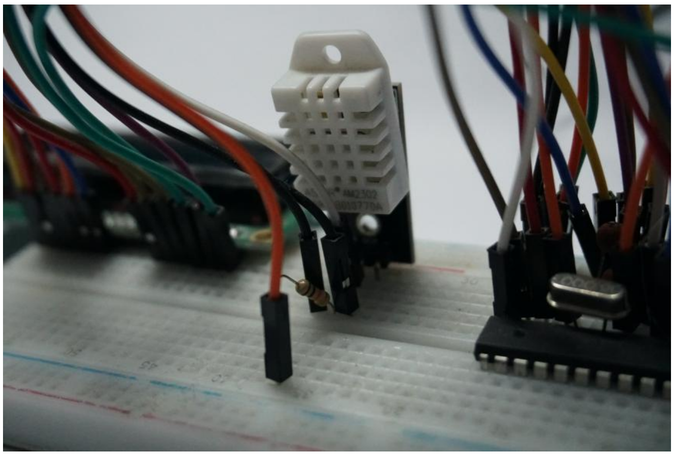


Figure 21: DHT 22 Sensor.

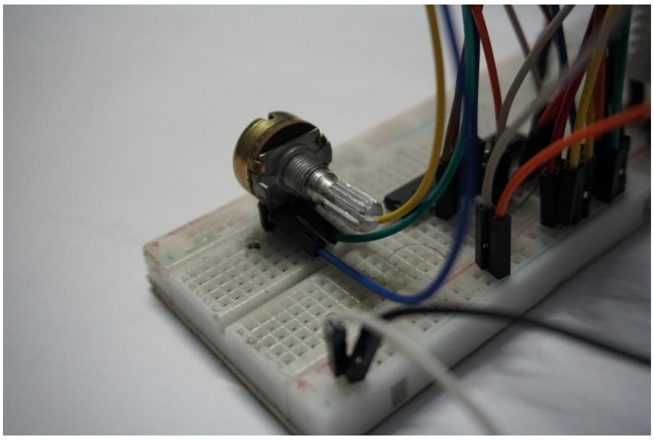


Figure 22: Potentiometer.

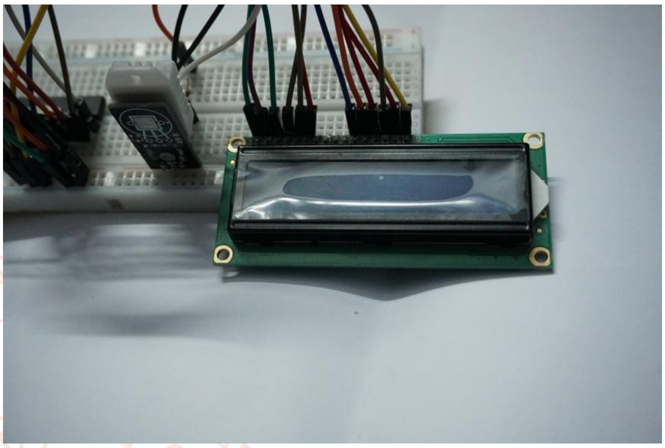


Figure 23: LCD display module.

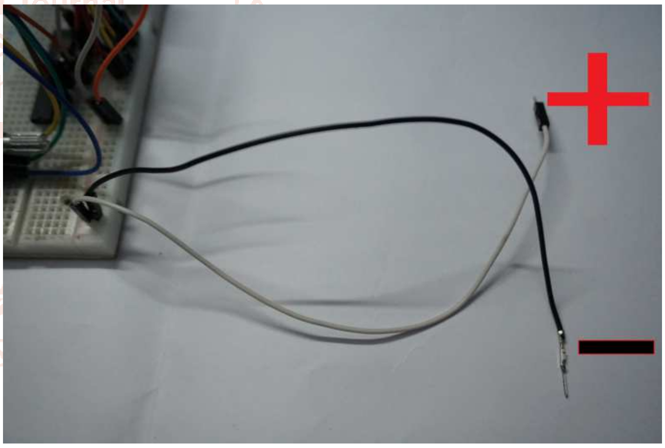


Figure 24: Power supply wires.

Giving power to the system the output is given in the LCD 16x2 display module which is shown in figure 25.

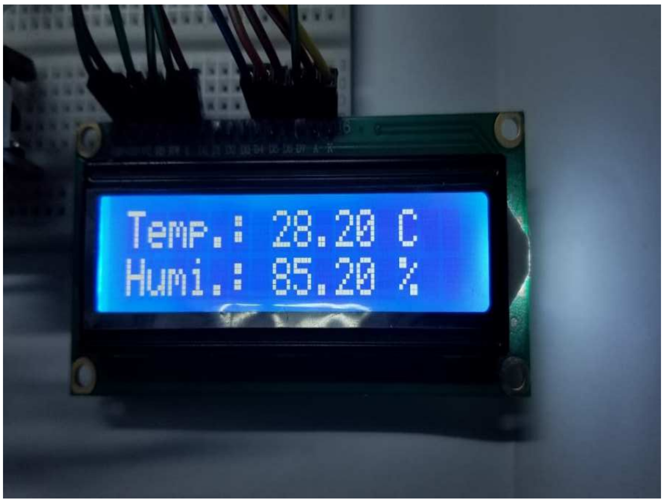


Figure 25: LCD Output.

CONCLUSION

This system with ATMEGA8 is not only very cheap and easy to built, but also very efficient. The Sketch/code uses 5730 bytes (74%) of program storage space. Maximum storage space is 7680 bytes. Global variables uses 311 bytes (30%) of dynamic memory, leaves 713 bytes for local variables. As this dht sensor is able to read data of temperature from -40°C to 80°C and Relative humidity from 0% to 100% the application field of this system get extended. The DHT22 mainly read the temperature and humidity of a rooms atmosphere, it will not give correct reading if the sensor is under any liquid or in contact with any solid object. Also as there is storage and data pins available in the ATMEGA8 those can be used for other purposes such as controlling a device.

REFERENCES

[1] www.components101.com, ATMega8 - 8bit AVR Microcontroller, https://components101.com/microcontrollers/atmega8-avr

[2] The term crystal oscillator refers to the circuit, not the resonator: Graf, Rudolf F. (1999). Modern Dictionary of Electronics, 7th Ed. US: Newnes. pp. 162, 163. ISBN 978-0750698665.

[3] www.components101.com, DHT22 – Temperature and Humidity Sensor. https://components101.com/sensors/dht22-pinout-specs-datasheet

[4] www.components101.com, 16x2 LCD Module https://components101.com/16x2-lcd-pinout-datasheet

[5] Core Electronics | Electronics Australia, Potentiometer and the Arduino Unohttps://core-electronics.com.au/tutorials/potentiometers-and-the-arduino-uno.html

[6] "Arduino Software Release Notes". Arduino Project. Retrieved September 25, 2019. https://www.arduino.cc/en/Main/ReleaseNotes

[7] Arduino, FAQ, https://www.arduino.cc/en/main/FAQ#toc13

[8] Github, MCUdude/MiniCore https://github.com/MCUdude/MiniCore