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Design and Development of Microcontroller Based Wireless Humidity Monitor

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Abstract: *The wireless humidity monitor is widely used in several research laboratories, hospital's store, industries for research, treatment and diagnosis of the patients, production, storing food and beverage etc. The aim of this research work is to design and development of a low cost, portable microcontroller based wireless humidity monitor. The humidity monitor has been designed using the sensor module DHT22. The sensor operates in capacitive principle i.e. changes in relative humidity (RH) of the surrounding air cause a change in dielectric constant of the polymer film leading to a change of sensor capacitance. The module converts this capacitance change into analog voltage. The DHT22 sensor provides analog voltage for both temperature and humidity. The sensor is connected with Arduino-UNO and a RF 433MHz transmitter is also connected with the Arduino-UNO. The microcontroller of Arduino-UNO converts the analog voltage into digital and the transmitter send the digital data to the receiver. There is a RF 433MHz receiver and a 16x1 Liquid Crystal Display (LCD) is also connected with another Arduino-UNO. The receiver receives the digital data and sends it to the microcontroller of Arduino-UNO and the microcontroller converts the digital data into analog data and displays the data in 16x1 LCD. The program is written in Arduino software (IDE). The accuracy, in measuring humidity, of our designed meter has been found satisfactory.*

Keywords*: Humidity monitor, microcontroller, DHT22 sensor, Arduino-UNO, RF 433MHz transmitter and Arduino software.*

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I. Introduction

Weather monitoring has a great importance nowadays. In early age weather monitoring has great importance only in agricultural purpose. But in modern age its value increased a lot in different field mostly in industrial condition monitoring. Weather monitoring helps us to explain different climatic behaviors including temperature, humidity and light intensity. In our country weather monitoring or the measurement of humidity and temperature specially used in some research laboratories, hospitals store and industries for research, treatment and diagnosis of the patients, production, storing food and beverage etc. Using weather monitoring system we can explain humidity and temperature of air. Weather monitoring system can be either wired or wireless one. Wireless communication is more convenient and user friendly then wired communication and it is not need to require the physical presence of person at the location that's why importance of wireless communication is increased nowadays [1-4].

Wireless communication is transfer of information over a distance without wires. The distance means it can be short (a few meters as in television remote control) or long (thousands or millions of kilometers for radio communications). There are different technologies which are used in wireless communication the cheapest one is GSM technology. Wireless weather monitoring system basically requires few basic modules like Microcontroller module, Sensor module, Display module, RF module, GSM module etc. [5-7].

Humidity monitor is an electronic device and it can be called in different names like hygrometer or humidity meter. The first crude hygrometer was invented by Leonardo da Vinci in 1480 and a more modern version was created by Polymath Johan Heinrich Lambert in 1755. To make user friendly, wireless communication is used in making of humidity monitor nowadays. Wireless humidity monitor can be made using more modern short range wireless technology like GSM, Wi-Fi, Bluetooth, ZigBee**,** 6loWPAN etc. [8-12]. Ingale and Kasat [13] were designed and developed microcontroller-based drip irrigation system and they

monitored the changing conditions of humidity levels by weather patterns and soil types and scheduled irrigation activity and proper timing for water supply. Microcomputer based humidity monitor was designed and developed by Kabir *et al.* [14] to measure the relative humidity of the air continuously. The operating range of this monitor is 0%-100% and the humidity accuracy is ±2.4 between 0 to 39 %, ±1.25 between 40 to 70%, +2%, -0.9% between 71 to 100%. Hedley *et al.* [15] were designed and developed a wireless soil moisture sensor networks for irrigation scheduling. Nutrient management system was additionally incorporated within the design system to optimize plant nutrient as well as to minimize detrimental environmental effects. The management zones are derived from data layers found from electromagnetic (EM) surveys and yield maps and thereafter wireless soil moisture sensor networks were positioned into the zones to monitor wetting and drying events for precision irrigation scheduling. A microcontroller based portable and digital thermo hygrometer was designed and developed by Mashud *et al.* [16] to measure the value of temperature and humidity at any place. A microcontroller PIC16F877A was used to control the developed system's function and the system was measure the temperature from 0°c to 100°c while humidity % RH from 0 to 100. Wireless sensor node for wireless sensor network to monitor several industrial parameters were designed and developed by Mane *et al.* [17]. Nath and Baruah designed a microcontroller based wireless measurement and monitoring of temperature and relative humidity using Zigbee. The system can measure the ambient temperature and relative humidity, using temperature and humidity sensor DHT11 and also able to send measured data wirelessly to remote location using Zigbee based wireless sensor network and can also displayed on LCD. Kim and Evans [12] designed and developed decision support software and its integration with an in-field wireless sensor network (WSN) to implement site specific sprinkler irrigation control via Bluetooth wireless communication.
The objective of this project is to design and develop a wireless humidity monitor using Arduino-UNO which is a microcontroller based board. Transmission section has been designed using sensor, transmitter and Arduino-UNO while receiving section by using receiver, LCD and Arduino-UNO.

II. Methodology

The first attempt has been taken to design a system, is to design the block diagram of the desired system which may be composed of several units. The entire block diagram of the designed microcontroller based wireless humidity monitor is illustrated in **Fig. 1**. The system is spitted up into two major parts, namely transmission section and receiving section. The transmission section consists of an Arduino-UNO, a DHT22 humidity and temperature sensor and a RF 433MHz transmitter, where as the receiving section contains an Arduino-UNO, a RF 433MHz reciver and a 16x1 LCD.

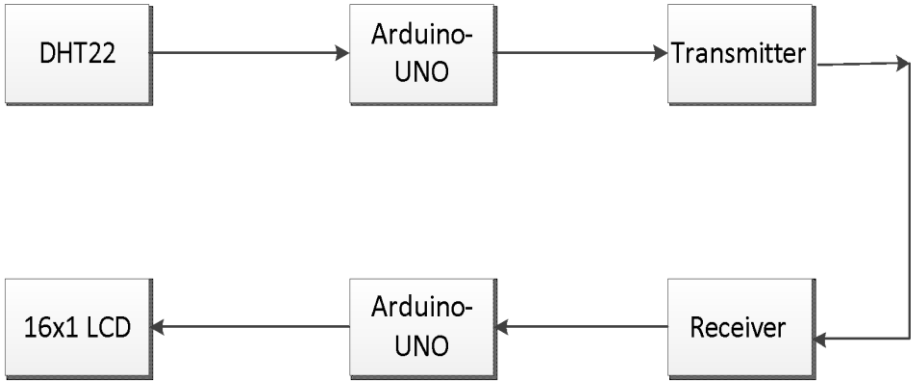

Fig. 1: Block diagram of the developed microcontroller based wireless humidity monitor.

2.1 Sensor

In this research work, a DHT22 temperature and humidity sensor (Model: SEN-00077) was used. DHT22 humidity and temperature sensors are capacitive type sensors and operate in capacitive principle. DHT22 sensor consists of a capacitive moisture sensor and a high-precision temperature measurement device which is connected to a high-performance 8-bit microcontroller. In DHT22 sensor the calibration-coefficient is saved in type of program in OTP memory and at the time of detection it will excerpt coefficient from memory. DHT22 sensor is temperature compensated and it calibrated in accurate calibration chamber [18]. There are some DHT22 sensors which have 4 pin but one pin among them have no use which is known as null pin. In this work, the DHT22 sensor has 3 pins, namely VDD, GND and data pin and the null pin is grounded inside the sensor. The electrical connection diagram of DHT22 sensor is shown in Fig-2.

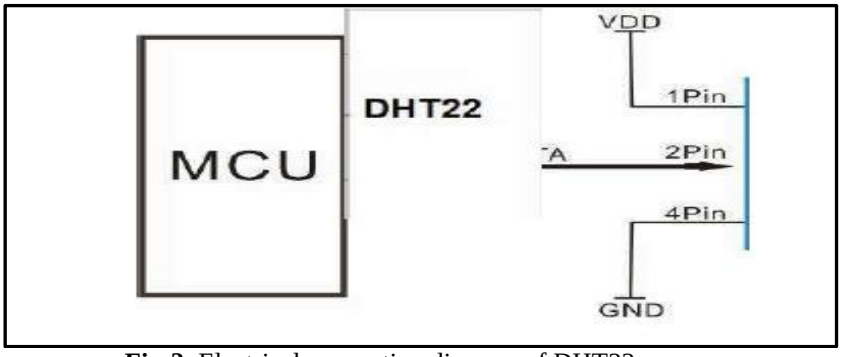

Fig-2: Electrical connection diagram of DHT22 sensor.

2.2 Transmitter and Receiver Unit

A transmitter and receiver module, known as radio frequency (RF) module, was used to design the system. RF module is a small electronic device which can transmit and receive radio signal and mostly used in wireless projects. There are several frequencies which are used in RF module including 315 MHz, 433.92 MHz, 868 MHz, 915 MHz, and 2400 MHz. A 433MHz RF module was used in our design purpose [19].

2.2.1 Transmission Unit

In transmission section, the DHT22 humidity and temperature sensor is first connected with the Arduino. The power supply pin (+5V) of DHT22 sensor is connected with the Arduino power supply pin (+5V) indicated by red lines, the ground (GND) pin of DHT22 sensor is connected with the ground pin of the Arduino (Black lines). The data pin of DHT22 sensor is connected in the pin number 4 of Arduino (Green lines). The circuit connection of the transmission section is shown in **Fig. 3**.]

2.2.2 Receiving Unit

The circuit connection of receiving section incorporating with an Arduino-UNO, a RF 433MHz reciver and a 16x1 LCD (Liquid Crystal Display) are represented in **Fig. 4**. In **Fig. 4**, the red lines are indicating that they are connected with the power supply pins (+5V) and the black lines are indicating that they are connected with the ground (GND) pins and the green lines are indicating that they are connected with the data pins.

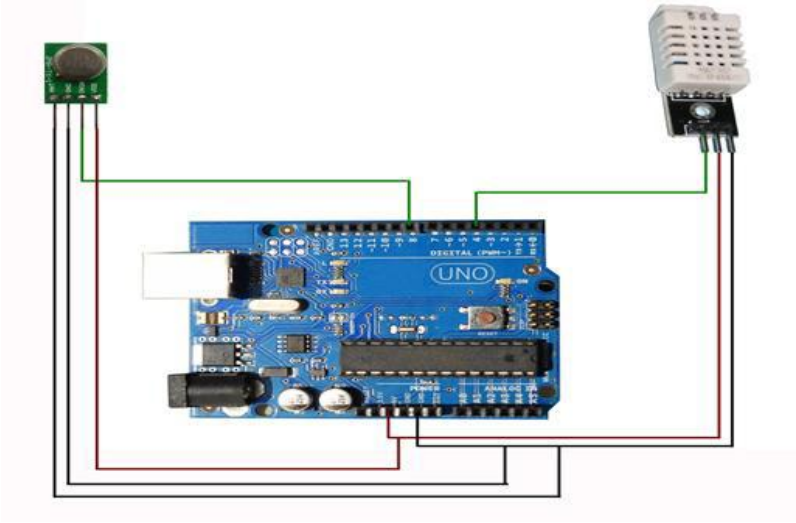

Fig-3: Circuit connections of transmission section.

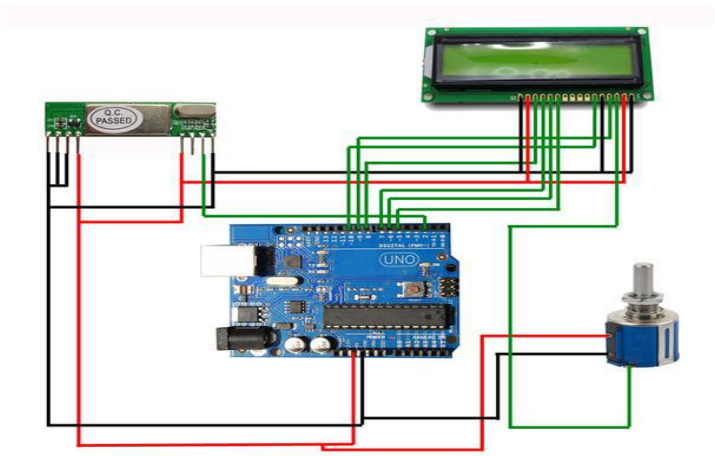

Fig-4: Circuit connections of receiving section.

2.2 Liquid Crystal Display

LCD is an electronic visual display that uses the light-modulating properties of liquid crystals. It is a an electronically modulated optical device made up of any number of segments controlling a layer of liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome. There are many LCDs like 16 x 1, 16 x 2 and 20 x 4 etc. In this work, a 16 x 1 alphanumeric liquid crystal display with model JHD161A has been used.

2.4 Programs and Flowcharts

As the designing of the system is divided into two sections including transmission and receiving section, so there are two programs as well as two flowcharts in total, has been developed to operate the developed system properly. The flowchart of the program used in transmission unit as well as in receiving unit is shown in **Fig. 5** and **Fig. 6**, respectively.

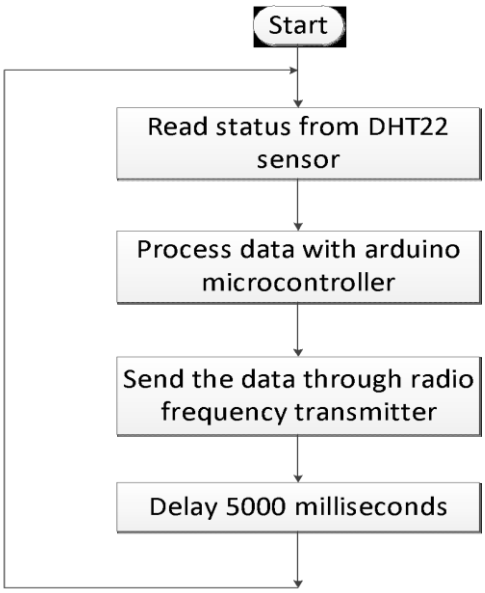

Fig-5: Flowchart of the program used in transmission unit.

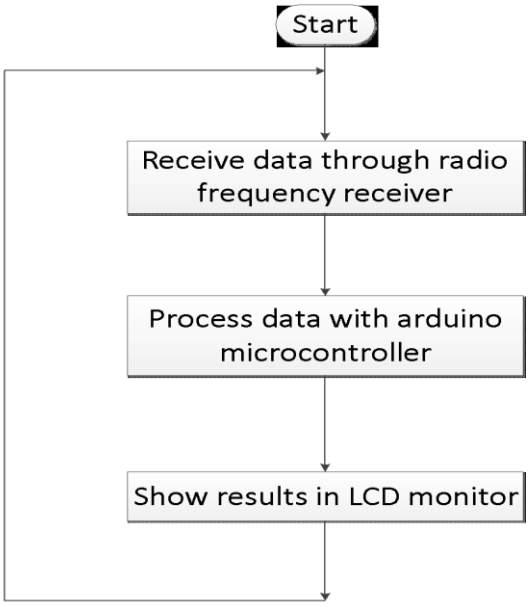

Fig-6: Flowchart of the program used in receiving unit.

III. Results and discussion

The design of this research work was planned in step-by-step and systematic way. At first the whole system was outlined in a block diagram and then the different parts of the circuits of the block was designed and tested. Finally the whole system of the designed microcontroller based wireless humidity monitor was developed and the accuracy of the developed system has been tested through a digital standard humidity meter. The data obtained from developed system and standard. Several graphs were plotted with the help of recorded data and are presented in Fig. 7-9. From the Fig. 7-9, it can be observed that the humidity data obtained from the

developed system shows a very good accuracy with a mean error of approximately 2% which is mainly due to the hysteresis effects of the sensor. The cost of the system which is significantly lower compared to other systems with similar features is another advantage of this system.

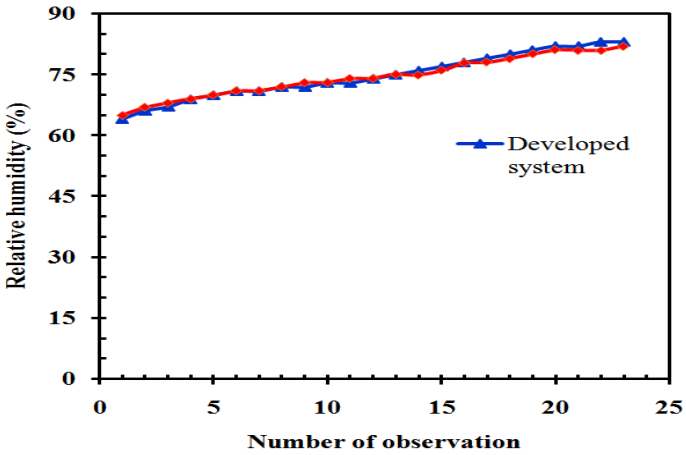

Fig. 7: Comparison of experimental relative humidity with standard relative humidity (Day one).

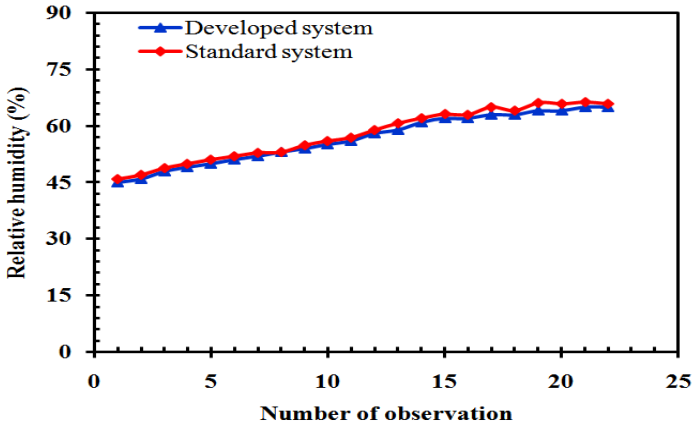

Fig. 8: Comparison of experimental relative humidity with standard relative humidity (Day two).

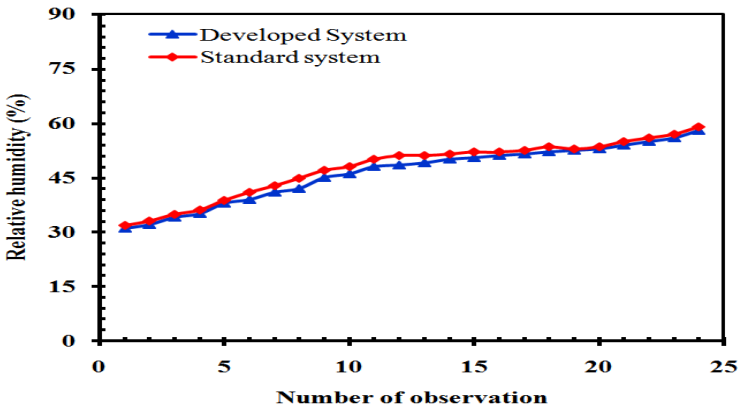

Fig. 9: Comparison of experimental relative humidity with standard relative humidity (Day three).

IV. Conclusions

Emphasizing the measurement of relative humidity, microcontroller based wireless humidity monitor has been successfully designed and implemented for the purpose for which it has been designed. On investigation of the performance, it can be concluded that the developed system is `and precisely provide the data. The system is fully functional with the advantage of being possible monitoring from remote without

carrying the whole setup to the field as well as inexpensive. The system can find its potential applications in the agricultural as well as industrial areas.

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