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IoT based Greenhouse Irrigation System

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***Abstract:** Scarcity of water is one of the major problems in the current development of the agriculture sector and due to increase in jobs in cities there is less labor for the management of crops. The proposed system provides improvement in agriculture by using automation and modernization of traditional agricultural systems. The solution proposed is a smart irrigation system which can control and regulate water usage with the help of less labor. The features of this system are monitoring of humidity, soil moisture, and temperature through DHT sensors. The data is tracked in real time through the sensors, Xbee modules and Arduino Uno.*
***Keywords:** DHT sensor, Xbee, Arduino Uno, Soil moisture sensor.*

I. INTRODUCTION

Agriculture plays a crucial role for the development of our country with more than 70% of our population depending on agriculture as a source of income. Growth and improvements are required in the agricultural sector as a necessity for the development of our country. Scarcity of water is one of the major problems faced by our farmers today. The farmers are tapping into the groundwater supply for their crops. This might pose a problem for the future generations due to less availability of surface water.

Every year there is more consumption of water for irrigation than the supply present and it has become crucial that water is preserved and hence it is necessary to apply strategies such that the water is only used as per requirement and stop the wastage of water.

The proposed system enables us to adopt the necessary precaution to monitor and use water resources in the agricultural fields through sensors, Arduino and XBee all of which are relatively cheap. The temperature and humidity sensor is placed with the crops to check the moisture content of the soil and send the necessary signals to the Arduino. The Arduino makes the decision to switch the motor on/off, the XBee uploads the data to a platform where the data can be monitored in real time. Using this system usage of water in agriculture can be monitored.

II. LITERATURE SURVEY

Agriculture sector plays an important role in the economy of a developing country. [1] The agriculture sector as a backbone of an economy provides basic ingredients for mankind and raw materials for industrialization. [2], [3] Internet of things (IoT) along with cloud computing plays an important role in increasing crop yield and reducing burden on a farmer. In the existing method of agriculture, the farmers themselves verify all the parameters and calculate the readings. [4] It focuses on developing devices and tools to manage, display and alert the users using a wireless sensor network system.

[5] It aims in increasing the efficiency of the system by using two soil moisture sensors. They are placed at different locations for better monitoring of the moisture content. [6] It demonstrates the use of smart GPS based remote controlled robot to perform tasks like weeding, spraying, moisture sensing, human detection and keeping vigilance. It also contains a warehouse unit with motion detector, light sensor, humidity sensor, temperature sensor, room heater, cooling fan. [7] It proposes a methodology for smart farming by linking a sensing system and control system through wireless communication technology. [8] It proposes an idea to use water level and pH sensor along with moisture and temperature sensor and also indicates the use of mobile applications for weather forecasting. [9] It proposes a low-cost wireless sensor network technique by using a Bluetooth as the mode of communication. [10] Greenhouse is a building in which plants are grown in a closed environment. In this paper, the problems related to the management of a farm made up of several greenhouses are discussed.

III. PROPOSED SYSTEM

This project is based on realizing IoT based greenhouse farming where the temperature, humidity and soil moisture is monitored to help the crops/plants grow in an ideal environment. DHT11 sensor is used to monitor temperature and humidity. A DC operated fan is used to bring the temperature of the surroundings to a desired value and soil moisture is used to balance the moisture content in the soil using a motor pump. Arduino UNO acts as the processing unit to collect the sensor output and to control the conditions. The data from the Arduino is presented on the LCD display.

For remote reception of data and to realize IoT we have interfaced a Xbee module both in the transmitting and receiving side. Through the Xbee module, relevant status of the farm's environment is monitored. Finally, an RTC timer circuit is connected to Arduino UNO to get the time. Fig. 1. shows the block diagram of the proposed system.

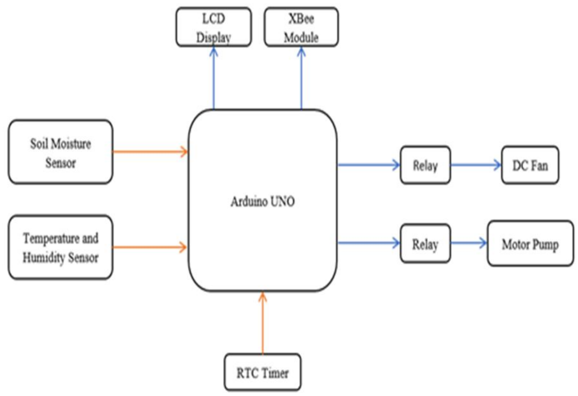

Fig. 1. Block diagram of the proposed system.

A. Algorithm

This is the path followed by the system:

1) *Step 1:* Start
2) *Step 2:* humidity and temperature values are sensed by the DHT11 sensor. Soil moisture sensor senses the moisture content of the soil.
3) *Step 3:* If soil moisture value is above the threshold value (>30%) then the motor pump will continue to be in OFF state. If the temperature of the surroundings is below the threshold value (<28 °C) DC fan will continue to be in OFF state.
4) *Step 4:* If soil moisture value is below the threshold value (<30%) then the motor pump will switch to ON state automatically. If the temperature of the surroundings is above the threshold value (>28 °C) DC fan will switch to ON state automatically.
5) *Step 5:* Once moisture level and temperature level become equal to the threshold value (>70% and <22 °C) then both motor pump and DC motor will switch back to OFF state.
6) *Step 6:* If the humidity of the surroundings is greater than 60%, then it is treated as a humid condition and the motor switches to OFF state for soil moisture level greater than 50%.
7) *Step 7:* End

IV. DEVICE SPECIFICATIONS

A. Arduino Uno

Arduino Uno is one of the most popular and easy to use microcontroller. It is a microcontroller based on ATmega328P. It uses C++ programming language with an addition of special methods and functions. The written code can be uploaded to the Arduino Uno board using Arduino IDE software.

B. Temperature and Humidity Sensor

DHT11 is used to sense temperature and humidity. It is a 3-pin ultra-low-cost device. A Single-bus data format is used for communication and synchronization between microcontroller and DHT11 sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding conditions, and gives a digital signal on the data pin. The temperature range of DHT11 is from 0 ℃ to 50 ℃ with 2-degree accuracy and the Humidity range of this sensor is from 20 %RH to 90 %RH with 5% accuracy.

C. Soil Moisture Sensor

Soil moisture sensor (FC28) measures the volumetric water content in soil. It is a 4-pin device, made up of two electrodes and can provide both analog and digital output. It uses capacitance to measure dielectric permittivity of the surrounding medium. A current is passed across the electrodes through the soil and the resistance to the current in the soil determines the soil moisture. If the soil has more water then resistance will be low and thus more current will pass through. Similarly, when the soil moisture is low then the sensor module outputs a high level of resistance.

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D. Xbee Module

Digi XBee module is an embedded solution providing wireless end-point connectivity to devices. These modules use the IEEE 802.15.4 networking protocol for fast point-to-multipoint or peer-to-peer networking. They are designed for high-throughput applications requiring low latency and predictable communication timing.

E. Real Time Clock

The DS1307 is an 8-pin, low power, Full Binary Real Time Clock (RTC) IC that communicates through I2C Protocol. The RTC can provide seconds, minutes, hours, day, date, month, and year information. This IC can work from direct supply on Vcc and switch to an inbuilt 3V Battery automatically when required.

F. Proteus

Proteus 8 is one of the best and user-friendly tool to simulate circuit designs. It has a wide range of electronic devices readily available for use. It can be used to simulate complex circuits before actual hardware testing, so that it can avoid the risk of damaging the hardware.

G. Arduino Ide

It is an open source user-friendly software used to write code and upload it to the Arduino board. This software can be used with any Arduino board. It can run on multiple platforms like windows, mac os x, Linux.

H. Virtual Serial Port Driver

Virtual COM Port Driver is a powerful technology designed specifically for those who develop, test, or debug serial port software and hardware. Various applications can exchange data using virtual serial ports connected with a virtual null-modem cable. Serial data sent from one port to another will be received momentarily. The Two Xbee's in this project are virtually connected using a virtual serial port driver tool.

V. METHODOLOGY

The soil moisture sensor's anode and cathode pin was connected to the sensor board and the power supply was given. The test pin was connected to a potentiometer whose resistance variations were considered as the moisture variations of the soil in the simulation. The analog output pin was connected to the analog input of Arduino via a LC filter. The LC filter was only used in the proteus simulation as the peak to peak output that was generated was not conducive and it had to be converted to RMS value before feeding it to the Arduino and also to stop the high frequency signals from entering the Arduino. The DHT 11 humidity and temperature sensor was connected with the source and output was serially interfaced with the analog input of the Arduino. The set-up was not a real-time one but only a software simulation hence the temperature and humidity was varied manually to verify different cases. The RTC timer DS 1307 was connected to a suitable source and the serial clock and data pins were interfaced with the analog input pins of the Arduino in order to display time during any change in output condition. The Arduino UNO board was interfaced with all the sensors to the analog pins and LCD pins were connected to the digital ports. The Xbee serial transmitter and receiver pins were connected to that of Arduino's to facilitate serial data communication. The LCD display was powered with suitable power supply and the digital pins were connected to the Arduino serial communication ports. The control pin was connected to a 10K POT in order to vary the colour contrast of the display. The register select pin was connected to Arduino to differentiate the instruction from the Arduino to be a displayable statement or a command. Two Xbee modules were connected one to the Arduino as the transmitter and another as receiver to the virtual terminal that displays information. The data is serially communicated between the Xbee and Arduino. The output of Arduino was connected to a motor and a fan through a relay that was mainly used as an AC switch. The motor was connected with an external battery as the output of the Arduino solely could not drive the latter and the fan was connected to an external AC source to serve the same purpose as the external battery. The below Fig.2. Shows the organization of the components in the circuit.

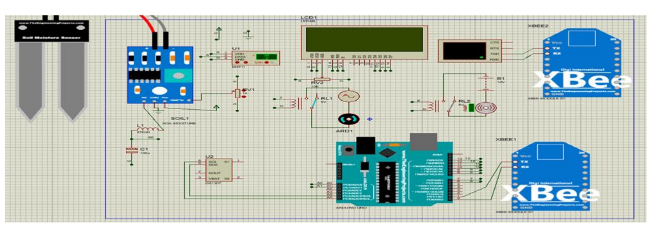

Fig. 2. Simulation Setup

VI. DISCUSSION AND RESULTS

This project is run under the input of all the sensors as mentioned above which up next is processed by Arduino Uno. Firstly, the moisture sensor senses the moisture in the soil and this value is compared in the Arduino with the preset threshold value, this output is given to the motor of the sprinklers in the farm. Hence the working condition of the motor is determined by the moisture content in the soil. The above information of the motor state along with the time specified by the RTC timer at that instant is updated in the LCD display that is in the farm and also communicated wirelessly to remote places through the Xbee modules connected.

Secondly, DHT 11 sensor senses the humidity and temperature and these values are given to the Arduino. Based on the humidity conditions the motor state is varied and to regulate the temperature the fan is connected. Hence the working condition of the fan is determined by the temperature in the soil. The above information of the fan state, temperature along with time is updated in the Xbee module at the receiver.

The data in the LCD display and the receiver Xbee is updated only when there is a change of state in the motor state or fan state.

The following trials were carried out on the simulation and the results obtained were as follows: -

1) *Case 1:* Wet surface with low temperature surroundings is shown in Fig. 3. Moisture content is 70%, temperature is 20 °C, humidity is 43%, both motor and fan are in OFF state.

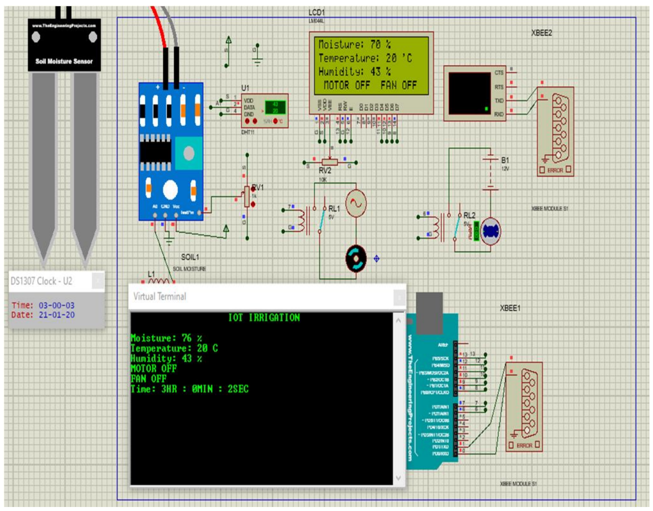

Fig. 3. Wet surface with low temperature surroundings

2) *Case 2:* Dry surface with low temperature surroundings is shown in Fig. 4. Moisture content is 20%, temperature is 20 °C, humidity is 43%, fan is in OFF state and motor is in ON state.

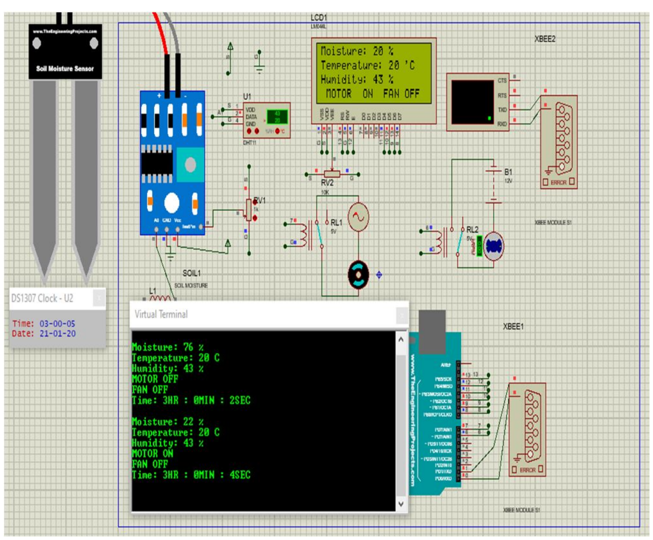

Fig. 4. Dry surface with low temperature surroundings

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3) *Case 3:* Dry surface with high temperature surroundings is shown in Fig. 5. Moisture content is 40%, temperature is 31 °C, humidity is 43%, both motor and fan are in ON state.

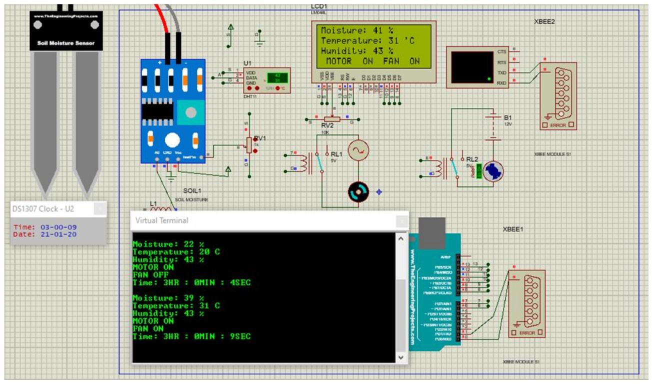

Fig. 5. Dry surface with high temperature surroundings

4) *Case 4:* Wet surface with high temperature surroundings is shown in Fig. 6. Moisture content is 80%, temperature is 31 °C, humidity is 43%, fan is in ON state and motor is in OFF state.

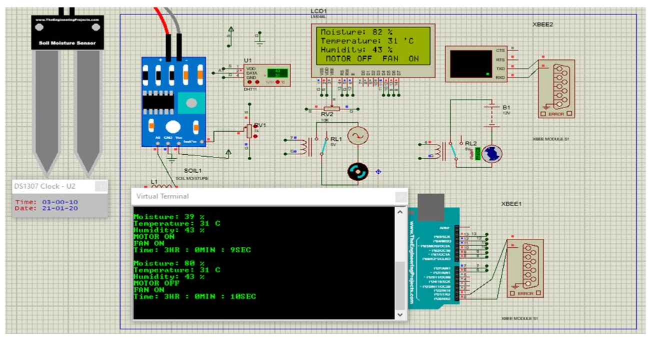

Fig. 6. Wet surface with high temperature surroundings

5) *Case 5:* Highly humid conditions are shown in Fig. 7. Moisture content is 60%, temperature is 31 °C, humidity is 70% (Humid Condition), fan is in ON state and motor is in OFF state.

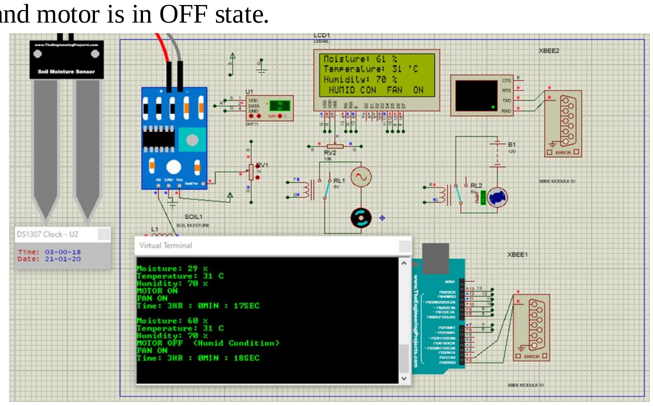

Fig. 7. Highly humid conditions

VI. CONCLUSION AND FURTHER SCOPE

This automated greenhouse irrigation system is found to be effective in preserving water resources and providing the required amount of water to the crop. This system is found to be cost effective and requires less maintenance thereby reducing burden on the farmer. The use of a DC fan to cool the environment provides better grip on the climatic changes.

As per future perspective, the system can be enhanced by developing and implementing it in large scale areas. A PIR sensor can be interfaced to monitor movement of humans and animals in restricted areas. The system can also be enhanced using Machine learning and Artificial intelligence which can predict nutrition level required for crops, calculate the correct time for harvesting, etc.

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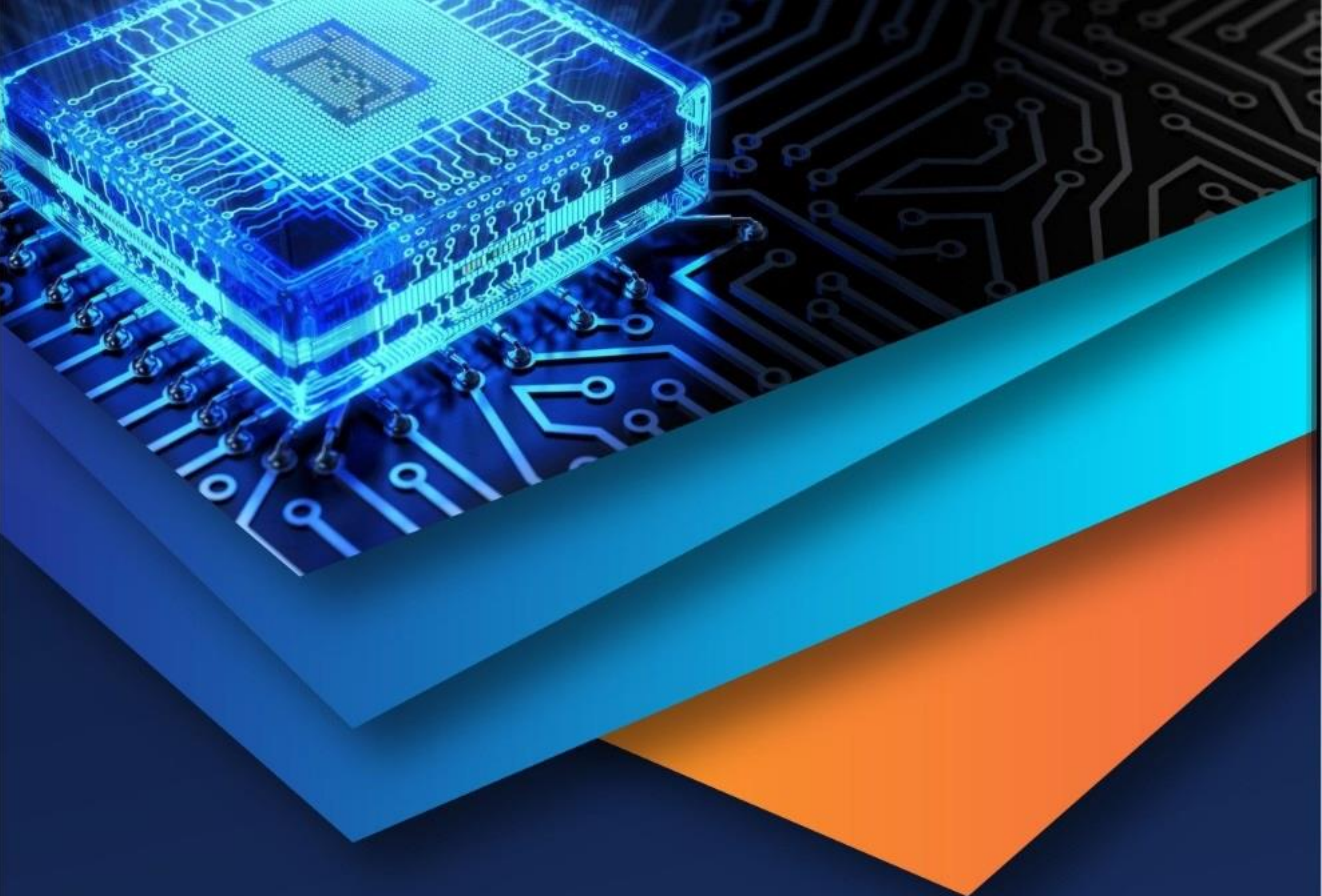

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