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A Wireless Sensor Network Based Smart Farming Using Internet Of Things Approach To Modernise Agribusiness Framework

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ABSTRACT

Internet of Things (IoT) is transforming the agricultural field and proving to be a boon to farmers by helping them in solving various issues by combining their practices with advanced technologies and equipment. Simplifying complex issues, sensors can be placed across farm locality and farming machineries in order to enable farmers to gain an abundance of insightful data, such as the soil temperature and health, the amount of fertilizer used, the water holding capacity of the soil based on which a graph can be plotted, the pH of the soil which will further help us analyse many factors influencing behaviour of the soil and which in-turn will help us conclude the status of the soil. Our work here aims to achieve the result by placing remotely monitored sensor station at the farm. This station measures various soil and weather parameters from its sensors and sends this data through RF module to a central hub station. At central hub, the data received is uploaded to the cloud through internet. Through this smart farming system, agriculturist can keep a track on accurate real-time field data and form valid decisions regarding appropriate use of pesticides and fertilizers, measure crop health and other analytic informative to increase gross yield. A questionnaire is prepared with an aim of collecting prerequisite data so that it further helps us to give precise output of the procedure and to put up a detailed summary. We hope that the entire series of observations can help us find apt solutions which can make difference and take us towards increase in productivity in a sustainable manner.

Keywords. Wireless Sensor Network, Internet of Things, Cloud.

I. INTRODUCTION

Agriculture is the backbone of many countries. If proper agricultural method is not followed then it impacts the economy of the nation. Increased supply of food by agriculture sector is important for the growth of our country. The agriculturists are sometimes unaware of the new advanced technologies that exist to increase their crop production. The major concern of our project is to increase the yield both quantitatively and qualitatively and also to preserve the water which is a major issue in recent days. Hence we came up with the idea of using Internet of Things approach in agriculture. Internet of Things technology is a boon to agriculturists. By using IOT approach sensors can be placed wherever you want on the ground, so that it collects the data like the soil moisture and the health of the crop and sends it to the target. If this technology is used there will be increase in the quantity, quality and the sustainability of the agriculture products. Our project mainly focuses on the issues put forth above. Our project aims at helping farmers get better yield both qualitatively and quantitatively and to preserve the water. For this to be achieved, we use sensors like DHT11 (temperature and humidity sensor) connected to multiple hubs, and the data from these hubs are sent to a RF hub after which it is pushed to cloud and stored in a Dropbox account. Primarily, the sensors will be placed at different locations in the farm which will be connected to Arduino. The sensed data from the sensor DHT11 is collected by the end nodes. All the sensed data from the Arduino are sent to the Raspberry Pi. There is no physical connection between the Arduino and the Raspberry Pi. For the establishment of the connection, a transceiver module, NRF24L01, is used. The transceiver connected to Arduino acts like a transmitter and the transceiver connected to Raspberry Pi acts like a receiver. Hence, the transceiver connected to Arduino sends the sensed data and the transceiver connected to Raspberry Pi receives this data. This data which is received in Raspberry Pi is then set to a Dropbox, where the information is stored in a text format. This stored information can be accessed by any user who has access to their respective Dropbox account. It helps the agriculturists to be more precise about the soil to be used or the irrigation method to be practiced and about the kind of crops to be used in their farm land. The main objective of this system is to consider different environmental factors,like moisture of the soil, temperature and so on, so that they can take up a better and precise decision in farming that result in increase in their yield. If this system is in place,it will be helpful for the farmers to take up informed and precise decisions like which crop grows well in which kind of soil or the irrigation method to be used etc.

II. DESIGN

In the agricultural farm, we position multiple end nodes (Arduino) which are equipped with various sensors and a battery to power up the Arduino. The data collected by these sensors attached to each end node is sent to Raspberry Pi (gateway that connects Arduino and cloud). An intranet network is built using NRF24L01 Wi-Fi module also used as a transceiver module i.e. It is used in Arduino as transmitter and in Raspberry Pi as receiver. After the Raspberry Pi receives sensor data from the multiple end nodes, the data are pushed to cloud (here, Dropbox) so that the farm holder can do live monitoring of his/her farm.

A. Architectural Design

We have listed below all the hardware equipment that was required in order to design a working module.

1) DHT11 Sensor.The DHT11 sensor is a basic, cost effective digital temperature and humidity sensor. It consists of a thermistor and a capacitive humidity sensor that measures the temperature and humidity respectively of the air surrounding it, and spits out digital output on the data pin to which it is connected.

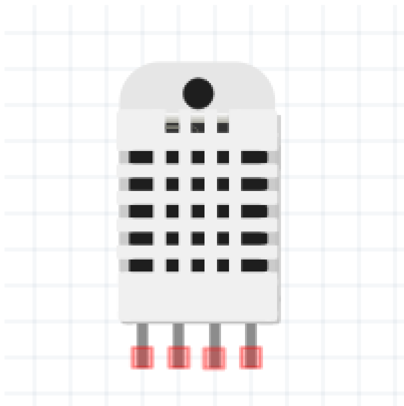

Figure 1.DHT11 Sensor

2) NRF24L01 (Wi-Fi Module).An effective communication between Arduino and Raspberry Pi requires the installation of this transceiver module on the sender and receiver side. This module works as transmitter for Arduino and receiver for Raspberry Pi.

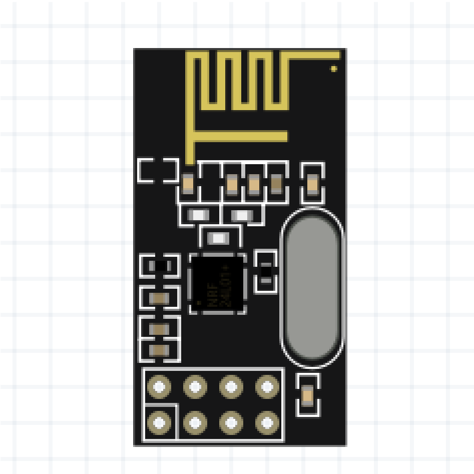

Figure 2.NRF24L01 Wi-Fi module

3) Arduino Uno.Arduino Uno is a microcontroller board based on the ATmega328P (datasheet) and equipped with 14 digital input/output pins, 6 analog inputs and a 16 MHz quartz crystal. It is programmable with Arduino IDE via USB cable. It can be powered by an external 5V battery or a USB cable.

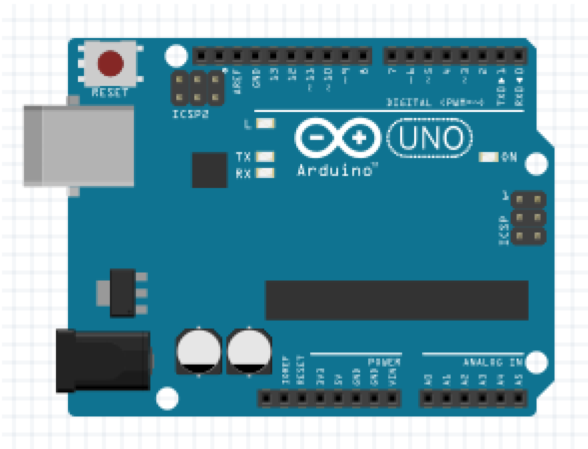

Figure 3. Arduino Uno

4) Raspberry Pi:The base station is set up using a low power credit-card-sized single-board computer Raspberry Pi Model B. The board is equipped with a combination of interfacingperipherals, including USB port, SD Card storage, 512 MB RAM, HDMI port. We can connect monitor, keyboard and mouse to it and using a HDMI cable, we can create a desktop terminal. The Raspberry Pi can be connected to a local area network through Ethernetcable or USB Wi-Fi adapter, and then it can be accessed through SSH remote login.

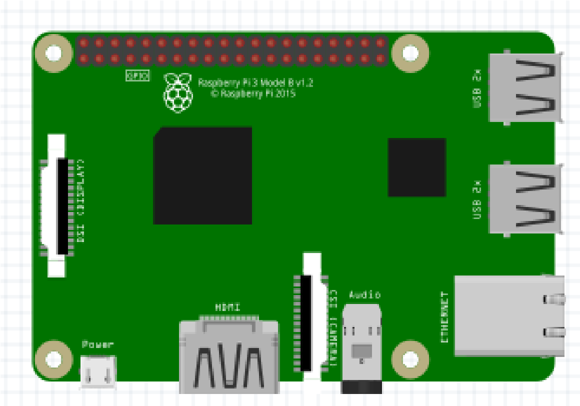

Figure 4. Raspberry Pi

B. System Design

The outline design of the system is shown in figure 5.Many Arduino Uno boards equipped with NRF24L01 (Wi-Fi module) and DHT11 sensor are connected to a gateway i.e. Raspberry Pi connected with NRF24L01. This gateway acts a base station, from which the data sensed by the sensor are stored in a text file and then uploaded to a cloud storage platform. At the time of configuration of Dropbox, the users can feed their respective credentials. In order to know the status of the farm, the owner or the user can log on to their respective Dropbox account and access the data stored in the text file. This is the overall procedure to be followed in order to access the data from the cloud.

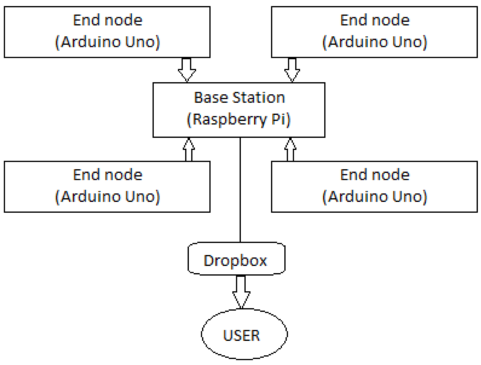

Figure 5. System Design outline

1) Connecting NRF24L01 Wi-Fi module and DHT11 sensor to Arduino board.Figure 6 shows the connections of DHT11 sensor and NRF24L01 module to Arduino Uno board.

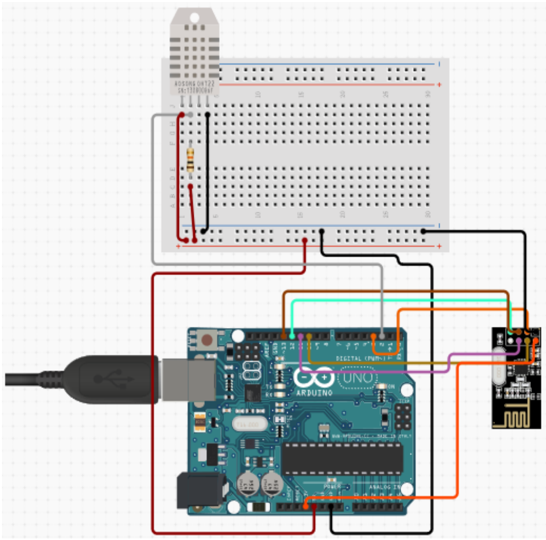

Figure 6. Arduino connection with NRF24L01 and DHT11

2) Connecting NRF24L01 Wi-Fi module to Raspberry Pi.Figure 7 shows the connections of NRF24L01 module to Raspberry Pi Model B.

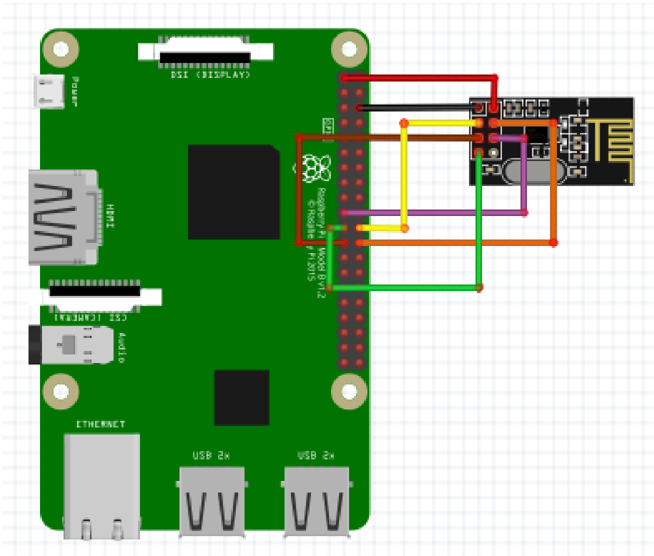

Figure 7. Raspberry Pi connection with NRF24L01

II. IMPLEMENTATION

The experimental agricultural farm can be spread across a large area, due to which the temperature and humidity values of the surrounding air at different areas can vary.The end nodes which are placed in different locations get the values read from the sensors. To collect the values read from the end nodes, there will be a base station (Raspberry pi). The base station collects the readings from multiple end nodes (Arduino), stores it in the form of text and sends it to the Dropbox. It should be noted that there is no physical connection between the end nodes and the base station. They communicate among themselves by the transceiver module that is used. A transceiver module, NRF24L01, which is a Wi-Fi module, is used for communication between Arduino and Raspberry Pi. In our experimental analysis, we have used an Arduino Uno, to which the DHT11 sensor is connected using jumper wires and a breadboard. The sensor gets the values of both temperature and humidity from the field. The transceiver which acts as a transmitter when connected to the end node will send the sensed values from the Arduino to the Raspberry Pi. The transceiver which acts as receiver when connected to the Raspberry will receive the data from the end nodes and sends it to the Pi. The Pi is programmed in such a way that it collects the data and stores it in a sheet. After a definite period of time the Dropbox uploader script running on the background will upload the data from the Pi to the Dropbox which can then be accessed from any platform at any time.

A. Sender Side Algorithm. There are mainly two functions in the sender's side algorithm i) loop function and ii) setup function. We define the pin configuration of the DHT11 temperature and humidity sensor and NRF24L01 Wi-Fi modules. The serial monitoring of Arduino ide begins with the execution of setup function. In the loop function,, Variable t.h is initialised for temperature and humidity respectively. The temperature and humidity values obtained by the sensor are read and stored in a character array. An inbuilt function (radio.send()) is executed to transfer the data to the base station.

B. Receiver Side Algorithm.A file descriptor is created for creating or opening a text file. By using the available function, we check whether the radio is available or unavailable. Until the radio is available and responding, we receive the data in the buffer and write this buffered data in the file descriptor.

IV. TESTING AND COMPARISON

1)MODULE-1 (Sending sensor values from Arduino to Raspberry pi).When the sender algorithm is run to test this module and the component receives values through sensors. The sensed temperature and humidity readings (from several Arduino Uno- end nodes) are received at the Raspberry Pi end.

2)MODULE-2 (Receiving data from Raspberry pi).We run the receiver end set of codes to test this module and observe results displayed on the screen. The sensed temperature and humidity values from the end nodes are received in Raspberry Pi in parallel and in real time. This base station receives the data and stores it in a text file.

3)MODULE-3 (Uploading data to and accessing data from cloud platform-Dropbox).A shell script is run to upload the text file to the Dropbox. Then this uploaded file can be accessed where we get the name of text file in the website and they are further opened through click operation to obtain the data.

V. RESULTS

The following results are obtained after testing the modules:

1) Displaying the sensor values on the Arduino IDE.Figure 8 shows the values of temperature and humidity as sensed by the end nodes placed at different locations. The values of temperature and humidity sensed by one node (Arduino) may or may not be different from the values sensed by another node (Arduino). Nevertheless, these ranges of values are sent to Raspberry Pi which is the base station.

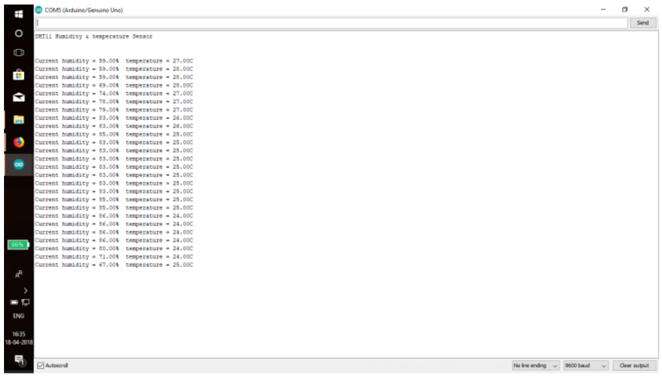

Figure 8. Displaying sensed values in Arduino IDE

2) Receiving data from Raspberry pi.The Raspberry Pi receives the data sent by the end nodes and displays it on its terminal. These values are then later pushed to cloud storage where the user can access by entering their details.

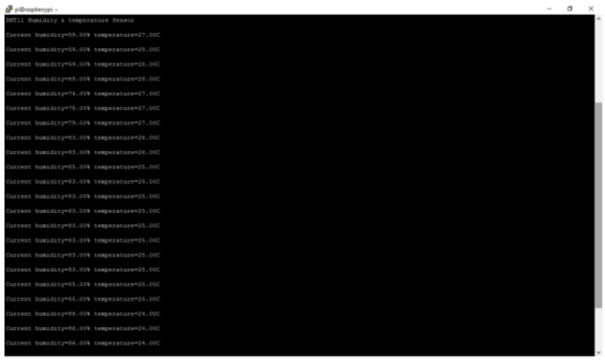

Figure 9. Displaying the sensed values in Raspberry Pi

3) Uploading data to and accessing data from cloud platform-Dropbox:A user needs to enter his/her credentials and create a Dropbox account (here, an alternative option is Google Drive). The data stored in the text file can be uploaded and stored in the account; the user needs to be signed in for this task. Next, the user can access this valuable data at any time, from anywhere.

VI. SCOPE AND FUTURE ENHANCEMENT

Many agricultural hurdles can be brought down on successful implementing the full version of the designed system. Then agricultural standards can be up scaled by many levels definitely facilitating the agriculturalists and easing the entire procedure of farming. We are aware that very module has a stipulated range in which it can act. We can use more components with better range capabilities to observe the entire farm land. It can be used for various research and scientific systems also. We can also have a system which balances excess moisture by sucking away water till the moisture has reached the required range.

Also, there are other several ways through which sustainable moisture maintenance can be observed. We can have a system which is fed with the range in which the moisture content can vary between and this can operate both ways, one during the increase in the moisture level and two during the fall in the moisture level. This shall pass signals to the sprinklers to operate accordingly. Certainly, we shall appreciate upgradation in technology as well as simplifying the process to attain similar implementations advancements.

VII. CONCLUSION

Smart farming through scientific methods is the main aim behind designing the entire system with the intentions to better the existing systems. Agriculture is a traditional occupation of a huge part of a population. Instead of following the traditional methods blindly, one should first do the thorough check of the soil condition and then grow different products according to the type of soil. That shall also influence their choices of crop rotation in a large range. For this purpose, this system can play a major role, as it helps in collecting the soil information (temperature and humidity values) which are required to check the fertility of the soil and henceforth can be used for further researches on the soil and examining of soil for agricultural purposes. This examination of soil can help us find out the fertility of soil more precisely in the use of pesticides and fertilizers, irrigation techniques and harvesting decisions to maximize the yield of the agricultural field. Thus, overall the system contributes to the smart agriculture by applying modern agricultural techniques by using the principles of IoT.

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VIII. REFERENCES

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