

Weather Station Automation in Agriculture Zone Using Zigbee

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Abstract— This paper presents the checking and monitoring of weather parameters in agriculture zone by the system of automation of weather station in agriculture zone using Zigbee. In the system architecture the wireless sensors network devices are used to check and monitor different weather parameters in agriculture zone to avoid or to solve the difficulty of checking and monitoring different weather parameters in agriculture zone using wires and different analog devices during some weather or environmental hazards. The monitoring different weather parameters are always plays very important role in the process of the farming production. To send the weather related information or guidelines using GSM SMS technique to the farmers to plan their farm in a better way, the Zigbee/IEEE802.15.4 based wireless sensor network is utilized in the system architecture. The weather parameters like humidity in the soil, temperature, and wind speed and wind direction in the agriculture zone are measured by the system. For the secure data communication through Zigbee in the WSN (Wireless Sensor Network), the mesh topology is used through which the signals can send over the far distances and it also consumes low power of the system. The system can be installed in the areas or locations easily where it is very difficult hardwire or do not have the electricity.

Keywords—Zigbee, IEEE 802.15.4, Wireless Sensor Network (WSN), Wireless Personal Area Networking (WPAN), GSM SMS technique.

I. Introduction

The system architecture of the automation of weather station in agriculture zone using Zigbee is used to check and monitor the three different weather parameters which are temperature, wind speed and humidity in the soil.

The checked and monitored values of the different weather parameters by using the system architecture of automation of weather station in agriculture zone using Zigbee, used to prevent the enormous damage or hazards from natural disaster in agriculture zone [5], [11], [12]. The weather station system architecture provides the facility to check, monitor and observe the weather conditions. The observed and monitored different weather parameters information is very useful to study the weather and climate and also to make weather forecast reports with the help of the system architecture of the automation of the weather station in agriculture zone. Temperature measurements are taken free from direct solar radiation or insulation while wind measurements are measure as free of other obstructions as possible, and humidity measurements are directly taken from the soil in the agriculture zone. These measurements are taken through the different weather sensors for different parameters with respect to the equipment placed in the agriculture zone. The system architecture is design and develops as a embedded system for the Automation of Wireless Weather Monitoring System, which enables to monitor and check the different weather parameter in an agriculture zone using Zigbee technology and the system also generates the guideline data or information sends to the farmers using GSM SMS technique [8], so that farmers get the guideline data or information directly on their cell phones.

II. Zigbee/ IEEE802.15.4

In the system architecture the Zigbee/IEEE 802.15.4 is used for the secure communication in the wireless sensor network for transferring the weather information from different weather sensors in the network. The Zigbee/IEEE802.15.4 supports the communication protocol for the transferring the data in the network between every Zigbee modules present in the wireless sensor network. The advantages to the automation of weather station in agriculture zone using Zigbee are from the advantages of the wireless sensor network using Zigbee technology. The communication between the Zigbee devices could not possible if there is no pairing or proper authorization key of 128 bit between the Zigbee communication devices, so every Zigbee device should be paired with each other in the WSN by proper authorization key for the communication, therefore Zigbee technology is very secure. It is a cost effective, low power consumption, standards based wireless networking solution that supports low data rates, reliability, and security for fulfilling all the required market needs [1], [3], [5], so that it is very beneficial in the system. The Zigbee

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technology specification is intended to be simpler and less expensive than other Wireless Personal Area Networks (WPANs). Zigbee uses the MAC and PHY layers defined by the IEEE 802.15.4 standard for wireless communications of the short distance. The Zigbee operates at 2.4GHz which is in the Industrial, Scientific, and Medical (ISM) frequency band at the data rate of 250kbps, 915 MHz North American Band at the data rate of 40kbps and 868 MHz European Band at the data rate of 20kbps [1], [3], [12].

III. Review of the Weather Station Automation

The Zigbee (IEEE 802.15.4) is a new technology that allows the implementation of Wireless Personal Area Networks (WPAN) [1], [3]. Zigbee is used in the WSN for emergency response notification for weather station automation. The one of the researched system is used to measure parameters such as sample temperature, vibration, air pressure etc. On the requirement of the surveillance system, these different parameters will vary depending [1]. In another system, the entire network using the Zigbee technology monitor, control and check by a single person. The Zigbee technology is also used as an emerging technology for the building automation. The Zigbee protocol can manage the data messages routing, acknowledgments and retries within the radios [1], [3]. In the different weather parameter monitoring applications works for different weather parameters like temperature, solar radiations, light, lightning, humidity, rain, wind speed, wind direction, gas and vibration [2], [4], [5], [7], [15],[16] and provides the accuracy at center level and sector level [6].The one of the system works on to monitor, check and control the greenhouse effect in agriculture zone with respect to temperature, humidity and light parameters and also record weather statistics for planning and development using the Zigbee/IEEE802.15.4 technology of with wireless sensor networks and Arduino microcontroller [5]. In the research the one of the new method for measuring overhead conductor temperature and sag factors using GSM SMS and Zigbee technology [7]. The weather station automation system will overcome the drawback of the existence of a single point of failure during the communication between Zigbee/IEEE 802.15.4 present in the WSN and low transmission speed, and also emergency service could not respond to false emergencies so their time can be better utilized to manage real emergencies or fight [10]-[13].

IV. System Design

The system of Weather Station Automation in Agriculture Zone Using Zigbee having two different and important parts that are software part and other one is the hardware part. Software part is design to easily interact with the system equipment to get the proper and accurate real time different weather parameters values.

A. Hardware Setup

There are two sides in the hardware part one is transceiver side and another is receiver side. The transmitter part consist of the different weather sensors, Atmega microcontroller, ATMEL89C51 microcontroller, transmitter side Zigbee module and power supply. On the transceiver side, the three different sensors are used to sense the real time values of the different weather parameters which are temperature, wind speed and humidity which will be placed in the agriculture zone. The temperature is measured via component DS18B20 (Dallas Semiconductor 18820) which is very small component and directly detects the temperature via air medium. It is located at a height of 2 meters (approx. 6 feet) to avoid temperature extremes found near ground level. The one Atmega Micro Controller and 16X2 LED display is used on the transceiver side to set the maximum temperature value through microcontroller programming in the LED display with facility of setting the temperature value. If the temperature value cross the limit then only the real time values of temperature is send to the receiver side through WSN using Zigbee.

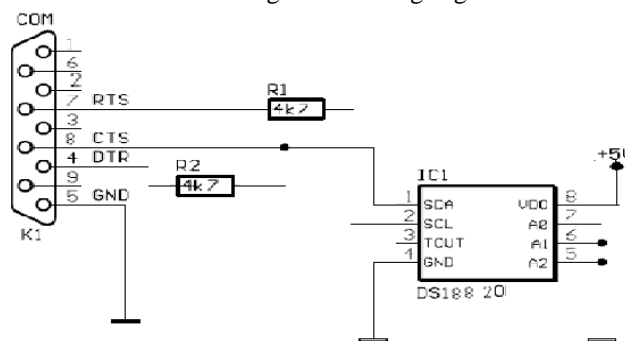


Figure 1. Circuit diagram of Temperature Sensor

The humidity in the soil calculated by the component LM324N which having five different probes in the soil in the agriculture zone, one main probe is placed at the center in the field area and other four are placed in the four different corners of the field in the agriculture zone to measure the humidity or percentage of water level in the soil of the field area and send the values of the water level present in the soil to the receiver side through WSN using Zigbee.

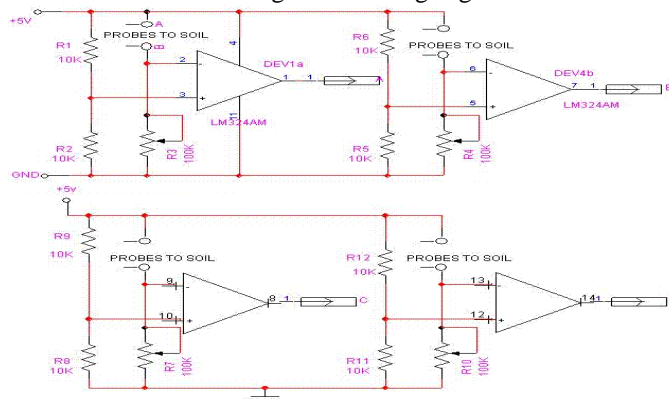


Figure 2. Circuit diagram of Humidity Sensor

The wind speed is measured by the IR Transmitter, IR Receiver sensors and TSOP sensor. To measure the wind speed the conical flask like structure is created on the tower in the field area and the component of IR transmitter placed on the top of the tower and IR receiver in the bottom of the tower with setting the line of site between both the sensors, so that it is easy to calculate wind speed whenever the wind cuts the line of site between the sensors. The component at the top of the tower, with 3 spinning cups, records wind speed. It has a low starting threshold (< 1 MPH), and records wind speeds ranging from 0-125 MPH. The calculated or measured wind speed is transferred to the receiver side through WSN using Zigbee. The ATMELEL 89C51 microcontroller is used to collect the data from the different weather sensors in the transmitter part and send the data to the computer of the receiver part through WSN using the Zigbee modules of both transmitter and receiver part. The ATMELEL 89C51 microcontroller implements a separate memory space for code and data [17].

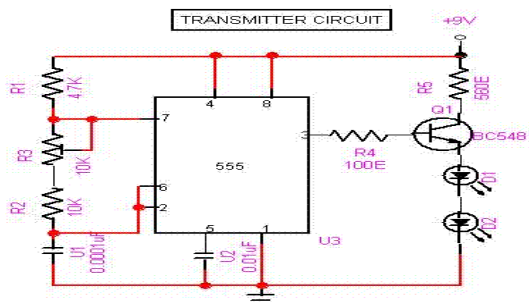


Figure 3. Circuit diagram of IR Transmitter

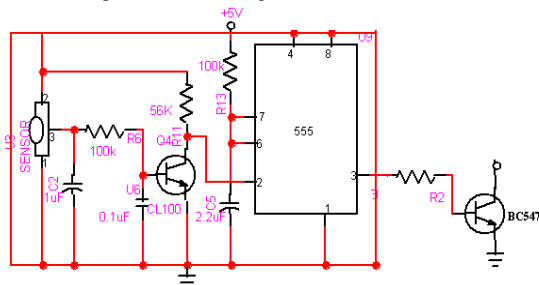


Figure 4. Circuit diagram of IR Receiver

The receiver part of the system consists of power supply, a PC interfaced with Zigbee through PC serial port and GSM modem. In the receiver section whatever data is come from the Zigbee module of transmitter section, that data is captured by the Zigbee module of the receiver section. The new real time data from the different weather sensors compares with the previously researched data and create the guideline notification for the farmers to take precautions about their farm. The comparison process of the new real time data value of the different weather sensors with the previously stored historical or old data from the database is done through using the Data Matching algorithm [18] on the PC of the receiver side by the researchers from the research center. After the comparison of the real time data value the different weather parameters with the old historical data from the database the best and proper concluded information will send to the

farmer’s cell phones by executing the Advance Technology (AT) commands on the PC at the research center by the researchers. The AT commands are used to convert any device into GSM modem so that the concluded information can be easily send to the farmers mobile devices via SMS whose mobile numbers are previously stored in the database [8].

B. Algorithm Used

The process of the fetching the data of the different weather parameters from the different weather sensors on the agriculture field to the microcontroller cyclically and send every cycle to the receiver side is by using the Re-Linking Algorithm on the transmitter side. By use of the Re-linking Algorithm execution for the microcontroller is to maintain the every new and old data transmission successfully and efficiently.

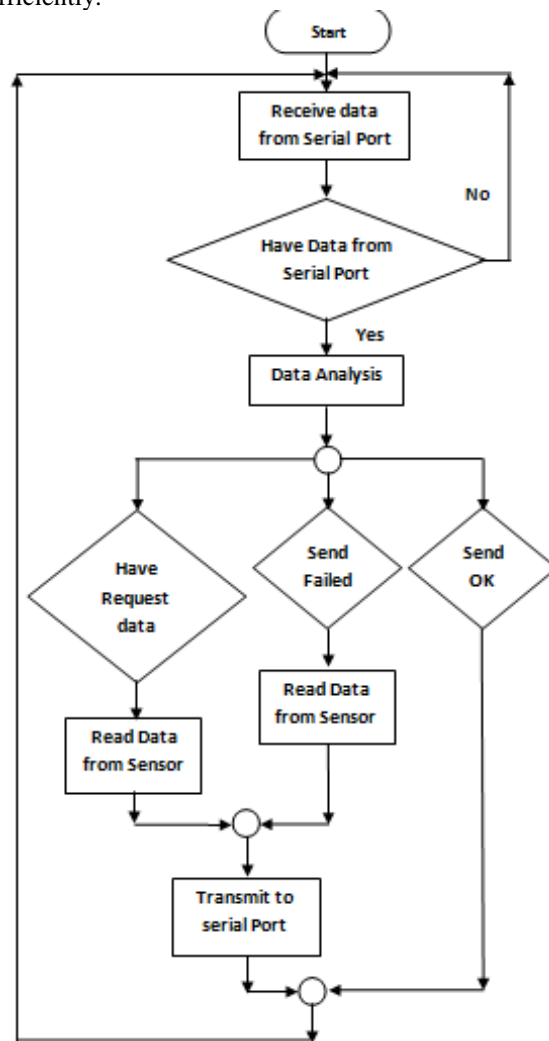


Figure 5. Flow Chart of Re-Linking Algorithm

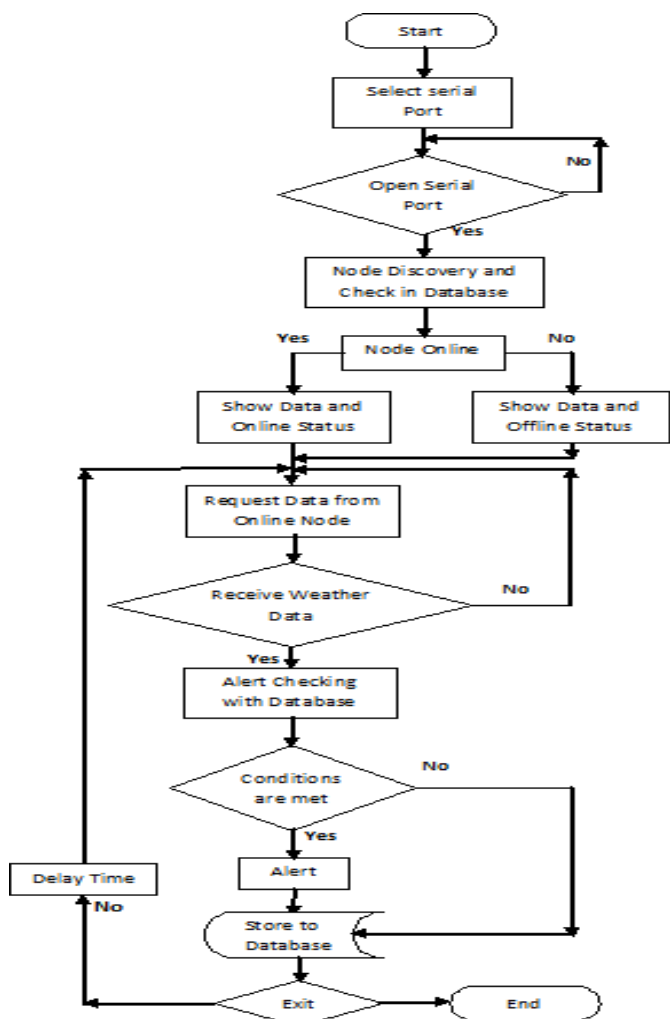


Figure 6. Flow chart of Data Matching Algorithm

The Data Matching algorithm is used to execute on the receiver side of the proposed system [18]. The receiver side of the system of the automation of the weather station is used to collect the real time data of the different weather parameter from the transmitter side of the system. Whatever the real time weather data is received from the transmitter side that data will compares with the historical or previously stored weather data in the database for checking and generating the current weather conditions instructions or guidelines and the alert of the weather conditions instructions to the farmers on their fingertips. After all this process the data aggregation is done, the data aggregation is the process of aggregation the sensor data using the aggregation approaches. It aims to eliminating redundant data transmission and thus improves the lifetime of the energy constrained of WSN.

C. Software Setup

To setup the software for the system of weather station automation in agriculture zone using Zigbee is through the Visual Basic.Net 2010. The software is used because it is very user friendly and it having the menu driven options, high security options, vast database, and also available the online help. The software is used to develop the code for receiving

the different weather parameters values from the transmitter side on the receiver side PC. The real time data is received from the serial port before that the communication configuration should be set by the help of communication parameters like baud rate, data bit, parity bit and stop bit for the real time data [10] is also done by the port level coding using the software for both the transmitter and receiver side of the system on the receiver sides PC. By executing the software code, it is possible to directly interact with the different weather parameter values from the agriculture field to the receivers PC through the main Form of the software. Whatever the values get from the transmitter side can be stored in the in the database of the system through the database form of the software. After that if the situation is critical or need to send the proper guideline to the farmers from the different weather parameters reading by the researchers, and then sending the guidelines to the farmers at their fingertips from the instruction set form via GSM SMS technology by executing AT (advance Technology) commands on the system.

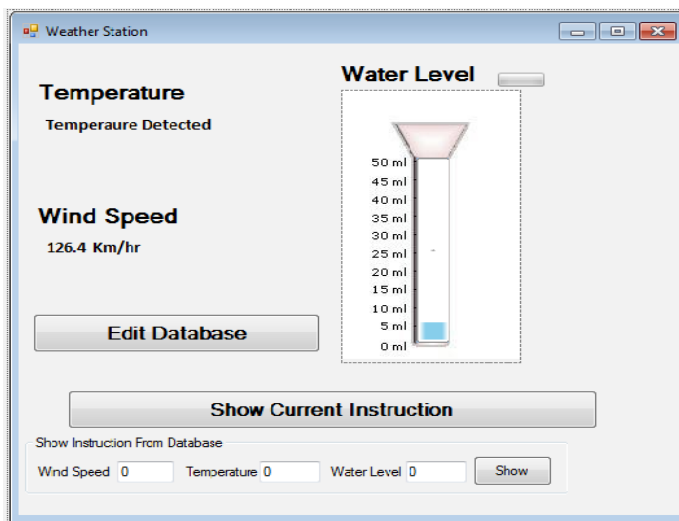


Figure 7. Main Form for Weather Parameter Readings

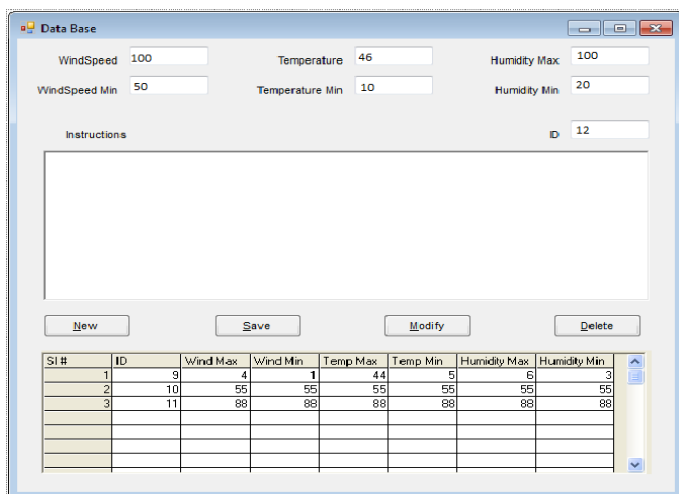


Fig 8. Database Form

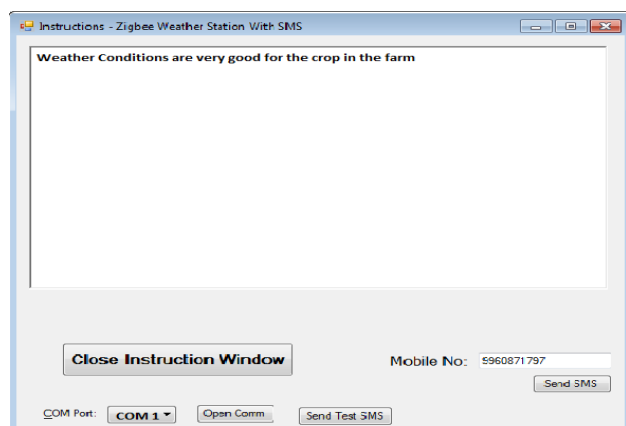


Figure 9. Instruction Form with Message Sending Option

v. Conclusion

The System design is used to construct the weather station automation in the agriculture zone using Zigbee for providing the best guideline or instruction to the farmers to plan their farm for best crop growth production. The proposed system include WSN using Zigbee of weather station automation overcome the problem that inherited from IEEE 802.15.4 having low transmission speed. Zigbee supports the mesh, tree & clusters topology in the wireless sensor network. The existence of single point or node of sensor failure is removed by the system of weather station automation. The system is very cost effective. The system can help to decrease the false services. The system of the weather station automation focuses on the checking and monitoring the different weather parameters through the different used weather sensors in the equipment and provides the proper guideline for planning their farms to the farmers according to the weather conditions using Zigbee/IEEE802.15.4 and GSM SMS technology.

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