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Intelligent System for Monitoring of Agricultural Parameters

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ABSTRACT:

Agriculture is the field which assumes a significant part in improving our nation's economy. Agriculture is the one which brought forth progress. India is an agrarian country and its economy to a great extent dependent on crop profitability. Monitoring of various agricultural parameters is complex task owing to its dependence on various factors. This paper presents a low-cost solution for monitoring of various agricultural parameters. The Integrated system measures agriculture parameters like temperature, humidity, soil moisture etc. and sends these parameters to the user system using an ultra-low powered LoRa module. Hardware modules are designed to monitor. Sensor's data is read by a low power consumed controller, ESP8266. The controller is programmed using Arduino IDE. The parameters that are read from the sensors and the data packets are transmitted using the LoRa transmitter, and received by the LoRa receiver. The data is then transmitted to the cloud using WiFi technology. We have used Things Board to configure IoT dashboard and visualise the data using different IoT devices. In this system all modules include sensors, controlling device and communication devices that work with less power consumption. The developed system was tested the hardware in the laboratory as well as field. The humidity, temperature and soil moisture slightly differed in both the cases. In future the system can be developed for irrigation systems by connecting motors and controlling it using web applications, at that time LoRa module works as bi-directional device.

Keywords: Monitoring, Agricultural Parameters, Temperature, Humidity, Soil Moisture, Lora Module.

I. INTRODUCTION

With the advent of the Internet of Things (IoT), agriculture has witnessed significant development over the years. Despite stupendous advancement in technology, in the field of agronomy, farmers still use orthodox methods for monitoring crop health due to cost and reliability issues associated with technology. Soil and environmental parameters affect the growth of the crops. Hence monitoring field parameters is necessary as it helps the farmer to increase the crop yield.

IoT reduces labor and promotes remote monitoring of field parameters, which is cost-effective and helps the farmers to monitor plants and use optimal inputs for better yield.

LoRaWAN connectivity means farmers can know the weather across their farms in a highly granular way and have full traceability over time. Wirelessly-connected soil moisture sensors enable farmers to make better irrigation decisions for increased yield, with smart soil moisture measurements. LoRa-based wireless sensors detect nitrogen, phosphate and potassium levels in soil to help farmers reduce waste and improve crop yields. LoRa Technology streamlines and improves daily operations in each smart agriculture application. The system which utilizes LoRa module to develop a smart agriculture control and monitor has been designed.

II. SMART AGRICULTURE & RELATED WORKS

A variety of methods have been proposed in the literature to monitor the parameters using sensors and IoT network. Measurement of humidity, temperature, and soil moisture content using various sensors integrated with RFID technology is proposed in [3]. Authors in [4] proposed a smart crop monitoring system in which sensor nodes use the ZigBee protocol to communicate the data collected and uploads to the cloud using an ESP8266 Wi-Fi module. ZigBee protocol offers a short range of communication, which is not suitable for large agricultural fields. Authors in [5] proposed a paper where parameters are monitored and measured with the help of Arduino based Microcontroller through Internet of Things (IoT) or Cloud based automation through GPS and the output is observed through Mobile Phone or Laptop or Tablets. Authors in [6] proposed a paper smart IOT based approach consisting of pH, water monitoring, soil moisture sensors, a WiFi module and a dc motor, to measure and display the different parameters for the crop. GSM modem receives the data values from the controller and sends notification to registered mobile number. In [7] authors have proposed a low power IoT network based on the IITH mote in which the sensor nodes are solar powered, which makes them self-sustaining by using an ambient energy source.

III. PROPOSED LOW POWER LONG RANGE IOT PLATFORM

A. Components

The components used in the system are as follows:

1. Temperature and Humidity Sensor (DTH-11):

DHT11 sensor features a temperature & humidity sensor complex with a calibrated digital signal output. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. It has a supply voltage of +5V, operating current of 0.3mA, temperature range -0-50 °C error of ± 2 °C and humidity range 20-90% RH ± 5% RH error.

2. Soil Moisture Sensor (FC-28):

Soil moisture sensors measure the volumetric water content in soil. This works on the principle of open and short circuit. The output is high or low indicated by the LED. When the soil is dry, the current will not pass through it and so it will act as open circuit. Hence the output is said to be maximum. The input voltage is 3.3-5V, output voltage is 0-4.2v, output current is 35mA.

3. ESP8266:

ESP8266 is capable of functioning consistently in industrial environments, due to its wide operating temperature range. It has a programmable Wi-Fi module. It provides 3 configurable sleep modes for low power consumption. The 3 sleep modes are: Modem-sleep, Light-sleep, Deep-sleep.

4. LoRa Module:

LoRa is the physical layer or the wireless modulation utilized to create the long-range communication link. LoRa is based on chirp spread spectrum modulation, which maintains the same low power characteristics as FSK modulation but significantly increases the communication range. LoRa parameters set to frequency 868MHz, bandwidth 125 KHz, spread factor is 6 raw bits, coding rate is 4/5, preamble length is 8 bits, transmission power 17 dBm and implicit header mode. The parameters measured at the receiver end are RSSI, SNR and packet size.

5. Liquid Crystal Display (LCD):

It is a display module. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc. It is used at the transmitter section to visualize the transmitted packets.

6. Arduino IDE:

The open-source Arduino Software (IDE) makes it easy to write code and upload it on to the board.

6. ThingsBoard:

Things Board is used to configure IoT dashboard and visualise the data using different IoT devices. We used digital gauges for visualisation. Each IoT Dashboard may contain multiple dashboard widgets that visualize data from multiple IoT devices. Once the IoT Dashboard is created, we may assign it to our IoT project.

B. Block Diagram & Working:

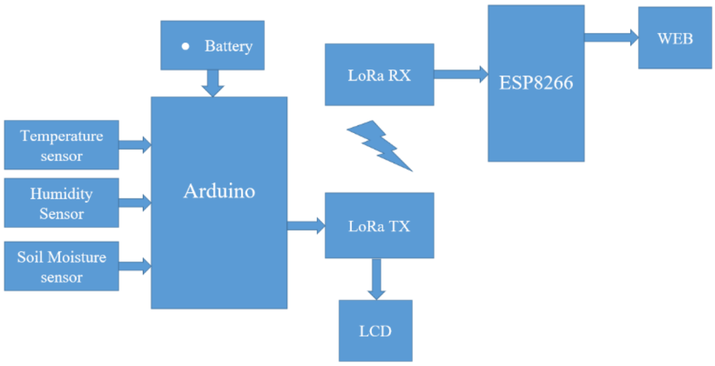

Figure 1 Block Diagram

The Arduino board is connected with the sensors i.e., soil moisture (FC-28) sensor, humidity and temperature sensor (DHT-11). Readings from these sensors are sent to the LoRa transmitter module. Data received from the transmitter is sent to the user using the LoRa receiver module. The data is interfaced with the ESP866 board and the readings are sent to the web. The readings can be operated by the user through the web using ThingsBoard.

IV. RESULTS & DISCUSSION

We have monitored the parameters in both lab and field. The parameters slightly differed in both the cases. We have used digital gauges for visualization. The temperature and humidity are in the similar trend and hence it shows that our sensors are accurate. The soil moisture sensor is left free in the lab and hence it showed negative value, while it is inserted in moist soil in the field and hence it showed some positive value.

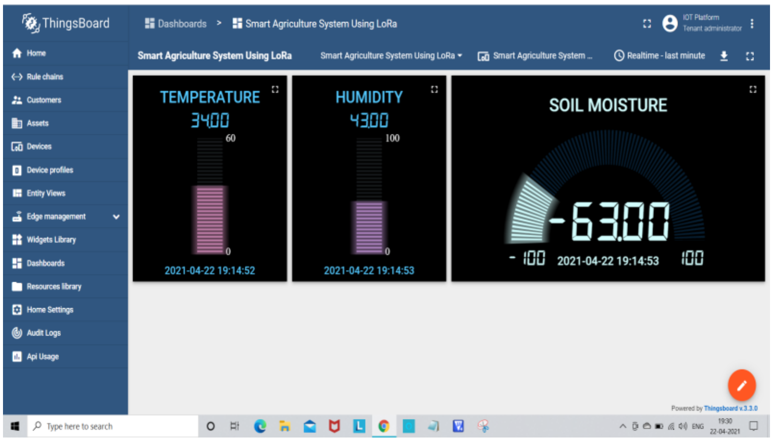

Figure 2 Lab Result

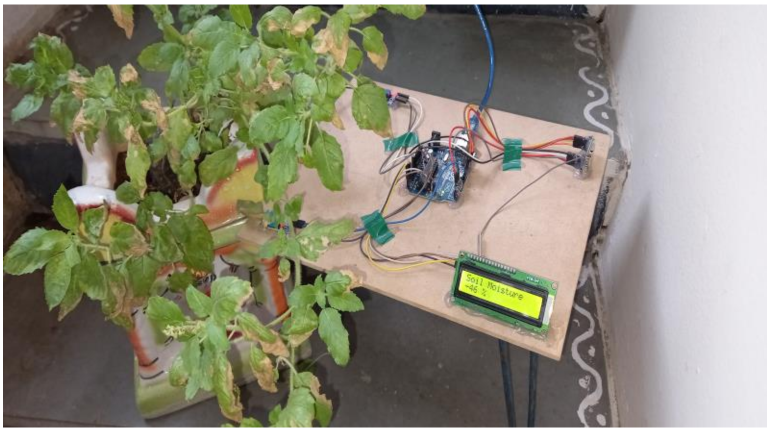

Figure 3 Field Setup

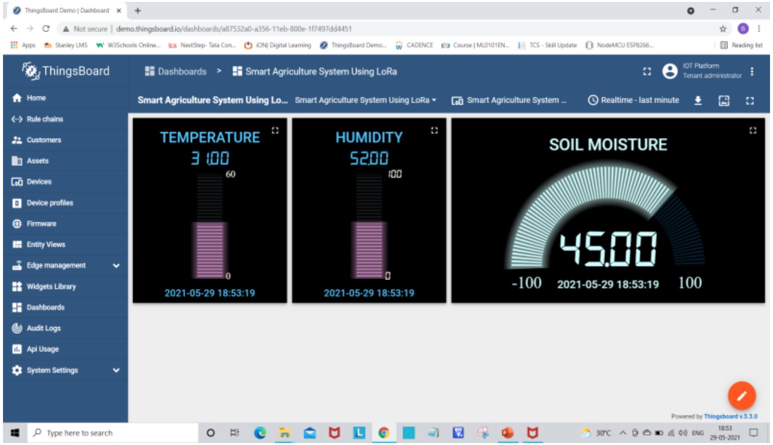

Figure 4 Field Result

V. CONCLUSION

We have proposed and implemented a low-power IoT network for smart agriculture. We have used soil moisture to measure soil parameter. The humidity and temperature are used to measure environmental parameters. We have proposed a LoRa based gateway to solve power line problem and to cover large area in agriculture field. In future, we can design total agriculture system as energy efficient system using low powered sensors and controller device along with low power communication module and user can control motor in the field using bidirectional communication of LoRa.

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