Design and Development of Soil Moisture Sensor

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Abstract: Water is a very valuable and stimulating force for irrigation. The Optimum usage of water is an hourly requirement. Efficient irrigation helps to conserve water, increase plant yields, reduce fertilizer reliance, and improve the quality of crops. Various techniques are available to measure soil moisture content, both laboratory and field, including remote sensing, but the fastest and better one is with the use of soil moisture sensor electronic devices. The range of soil moisture sensors has its own benefits and drawbacks.The goal of this work is to design and develop a module for the measurement of soil moisture and temperature levels, as well as ambient temperature and humidity by using frequency concepts. The sensor is made of a corrosion resistant element and it is rugged, battery operated, low power and long range sensor using IoT. A "GND BLE Mobile Application (gSense100)" has been developed, which includes everything related to the BLE technology and soil moisture sensor, where the app uses BLE technology to transmit all sensor values to the consumer.

Index Terms: BLE, BLE technology, gSense100

I. INTRODUCTION

Capacitivesensors, as a means of measuring changes near the surface of the sensor, have many distinct advantages over other techniques.Capacitive sensor tests, for instance, do not have the inherent health effects of radiation-based techniques. By using frequency domain principles, gSense100 allows measurement of soil moisture levels. The sensor consists of an element that is resistant to corrosion and gives it a long service life. The gSense100 is a robust, battery-operated, low power and long-range IoT network sensor. In various areas of fields, gSense100 can provide a better understanding of how quickly soil water is depleted, helping to control the effectiveness of rain water and irrigation water.gSense100 is water and weather proof. Three elements, such as hardware, web and mobile applications, are used in [1]. The goal of this paper is to monitor the watering of crops by means of a mobile smartphone application. In [2], the emphasis ison exploringthe progress and potential problems in the current application ofobservations of satellite soil moisture in hydrological modeling. Three different microwave soil moisture sensors were presented by scholars in[3], which demonstrate the potential of microwave technology in this area. In [4], the paper presents design and development of a soil moisture sensor and a framework for monitoring the response.The probes used in this sensor are made of nickel, which is an anti-corrosion anddurable material for applicationsrelated to agriculture.In [5], a prototype was built to demonstrate that soil probes can be used to measure the amount of soil moisture and decide if the soil needs watering or not.

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It needs a reliable circuit for sensing moisture and a simple circuit is not sufficiently accurate. In [6], the work presents a new multi-sensor system with wireless connectivity taking advantages of three different sensing techniques for automatic measurement of Soil Moisture in the field. In [7], Dual Probe Heal Pulse (DPHP), a capacitive and resistive soil moisture sensor, is developed by the developed multi-sensor device. The paper describes an integrated framework for the efficient use of water supplies for agriculture and the monitoring of crop growth using GSM. This work [8], presents a newparadigm for a smart wireless web-based sensor technology for optimum of surface-to-depth measurements of soil moisture profiles using in-situ sensors. The main objective of the paper [9] is to create, along with other factors,a smart wireless sensor network (WSN) for the agricultural environment basedonvarious factors,such as soil moisture, temperature and humidity.Using Zigbee, it explores a remote monitoring device.The aim of the work in [10] is to establish an automated irrigation mechanism that turns the pumping motor ON and OFF to detect the earth's moisture content. Reducing human intervention is a benefit of these strategies. "GND BLE Mobile application (gSense100)" contains everything relevant to the BLE technology and soil moisture sensor, where, using BLE technology, the app transmits all sensor values to the user and shows the live status of the sensor to the user and provides the device's update status and also allows the user to adjust the values for the device accordingly and to predefine the values and save as file for each device using Network Settings and Device Settings and also to configure the different devices.

II. PROBLEM STATEMENT

Water consumption is very high in advanced agriculture. As a result of technological advances, efforts are being channeled into the automation of irrigation systems to enable remote irrigation control in order to improve crop production and cost efficiency. A soil moisture sensor is thus developed, where it allows soil moisture levels to be measured by using the frequency domain definition.The moisture content is measured in two layers: the top and bottom layer. This sensor can interact in two modes as compared to the existing sensors-LoRaWAN or Sigfox. The sensor consists of an element that is resistant to corrosion and gives it a long service life. It helps to track the efficiency of rain water and water for irrigation. It also contains an application for Android. The definition of the issue is generated to increase productivity and make the job simpler for the consumer. The main objective of the project is to provide the user with an overall understanding of the BLE system and broadcast the sensor data. The BLE technology enables the devices to link the mobile application and read and write the data from the device, which improves the speed and accuracy of business processing and efficiently provides accurate information.

III. METHODOLOGY

By using frequency domain principles, the soil moisture sensor allows the measurement of soil moisture levels. The sensor consists of an element that is resistant to corrosion and gives it a long service life. This sensor uses the Iot network as a rugged, battery-operated, low-power and long-range sensor. A fast response time is provided by the sensor. This sensor can provide a better understanding of how fast the soil water is being depleted in different areas of field which helps in tracking effectiveness of Rain water and Irrigation water. The sensor is evidence of water and temperature. The simplified diagram of the proposed system is demonstrated in Fig.1.

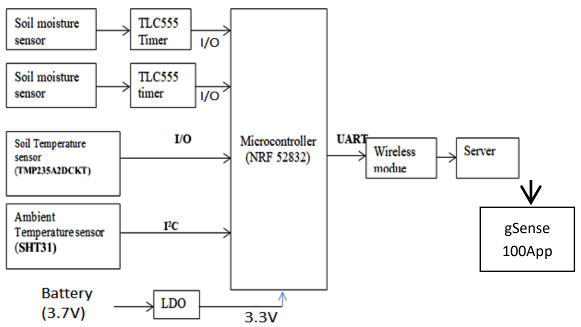

Fig.1. The block diagram of soil moisture sensor system.

Using a capacitive soil moisture sensor, the moisture content in the soil is sensed. The sensed value is in analog form and is fed to the timer TLC555 and is further fed via I/O to the microcontroller NRF52832. Using a TMP235A2DCKT temperature sensor, the temperature value is sensed and the sensed value is fed to the microcontroller. Using SHT31, the ambient temperature value is sensed and given to the microcontroller using I2C. All the values fed to the microcontroller are processed and communicated via UART through the wireless module. Furthermore, these values are published in the form of periodic messages to the server and also to the GND BLE Mobile Application. The packet formats can be classified widely into downlink and uplink messages of two kinds. Uplink messages are those sent to the server by the soil moisture sensor (gSense100), and downlink messages are those sent to the soil moisture sensor by the server (gSense100).

A. UpLink Messages

The general format of all the uplink messages will be as follows.

Message Type (1 byte)	Payload (n bytes)
0xA1/0xC1 – 0xAn/0xCn	0x01 0x02 0x03…

All the UpLink Messages will have message type of 0xAn followed varying payload based on the type of message.

- Health Message(0xA1/0xC1)
- Alert Message(0xA3/0xC3)
- Periodic Message(0xA4/0xC4)
- Battery calibration Acknowledgement (0xA5)

B. DownLink Messages

The general format of all the downlink messages will be as follows

Message Type (1 byte)	Payload (n bytes)
0xB1 – 0xBn	0x01 0x02 0x03…

All the Downlink Messages will have message type as 0xBn followed by varying payload based on the type of message.

- Configuration Settings(0xB1)
  - Health check request (0xB2)
  - Battery calibration request (0xB3)
  - Alert Acknowledgement (0xB4)

C. Dataflow diagram

The dataflow diagram of analyzing and designing program in various fields is shown in Fig.2 and Fig.3

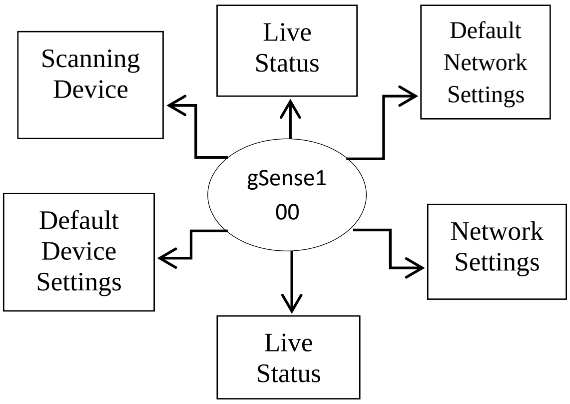

Fig.2: Level one: DFD Diagram

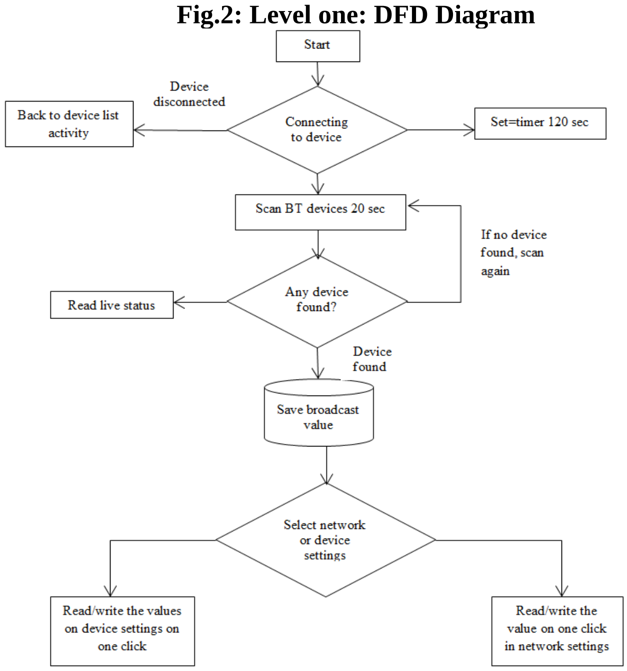

Fig.3: Level two: DFD Diagram

IV. RESULTS AND DISCUSSION

In the proposed work, to optimize and enhance the experience of companies and user using the soil moisture sensors such as farmers, we proposed the following system use, such as the BLE technology and mobile application on the android platform. This work aims to improve the soil moisture sensor efficiency andreduce user's workload. User phones and sensors must have contact in order to be able to do so.

The BLE devices that will be used by users will have this interaction. Mobile apps are designed to interpret this interaction to transfer the user's sensor data and handle all the changes made by the user with one click. For fast communication and less power consumption, low-energy Bluetooth is used. In order to interpret the data and communicate with sensor, the mobile application is used to transmit and broadcast the sensor data to the user. The framework is proposed for mobile devices on an Android platform consisting of an operating system and a Software Development Kit (SDK). Most people understand the actions of regular Android apps. The app has a menu, for instance, which has to be accessible from the menu button. And this allows the user to use the application to access all the operations on the computer. In Fig.4, the selected device is LoRaWAN device. Then the user gets this value from the device after connecting to the device in Network Settings.

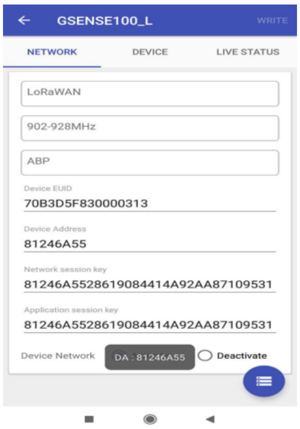

Fig.4: Characteristics when connected to LoRaWANdevice

If it is a Sigfox device, the user can view these settings of the device which consists of select band and network as shown in Fig.5.

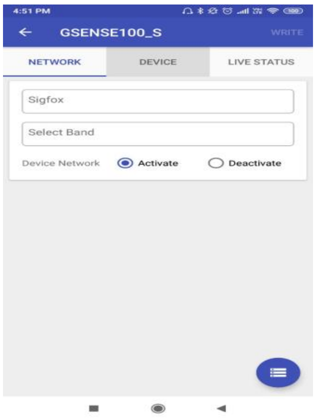

Fig.5: Characteristics when connected to Sigfox device

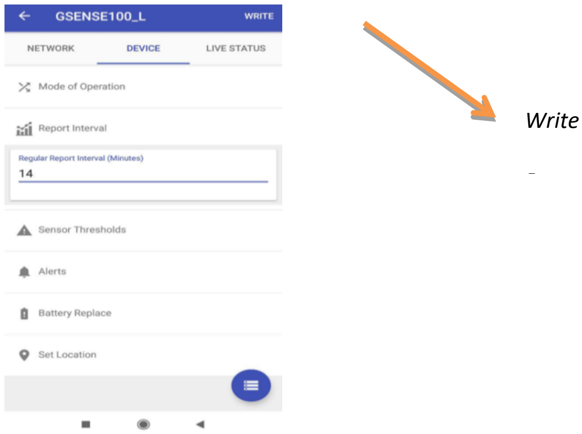

Fig.6: Setting report interval timings

Device settings consist of report interval, battery replacement and location which can be modified and read from the deviceas shown in Fig.6.

Fig.7 shows the current location of the device which is read from the device. This location can be changed accordingly by the user.

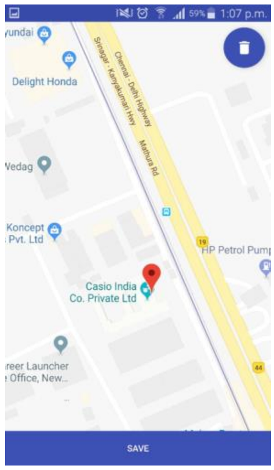

Fig.7: GPS Location Indication

Fig.8Displays the Live status of the device for certain characteristics.

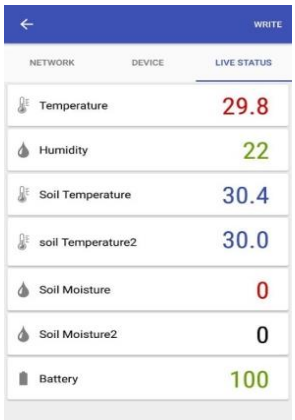

Fig.8: Display of humidity, moisture and temperature values

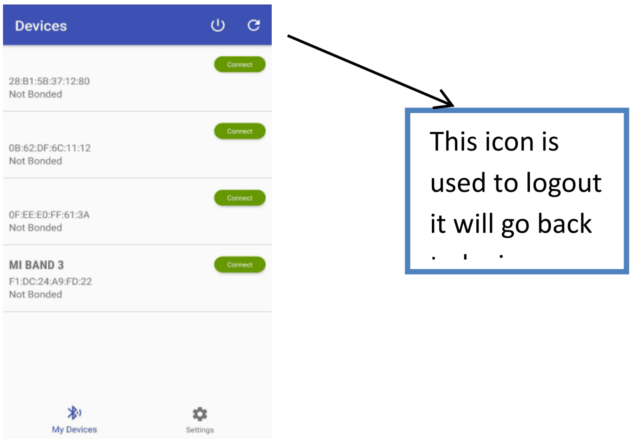

Fig.9: Logout Action

Fig.10: gSense100 Soil Moisture sensor

Table.1: Comparison Table

	Soil Moisture Sensor LM393	gSense100 -314	gSense100 -315	gSense100 -316
Ambient Temperature (°C)	29.1	28.3	28.4	29.7
Humidity (%)	61	59	62	62
Soil Upper Temperature (°C)	22	22	21	19
Soil Bottom Temperature (°C)	22	20.8	24	20
Top Left Moisture (%)	57	59	62	50
Top Right Moisture (%)	57	59	62	50
Bottom Left Moisture (%)	81	77	74	61
Bottom Right Moisture (%)	81	83	87	58

Table.1 gives the comparison between the proposed work and existing work with respect to various characteristics such as temperature and humidity at different levels. Fig.12 shows the graphical representation of the comparison table.

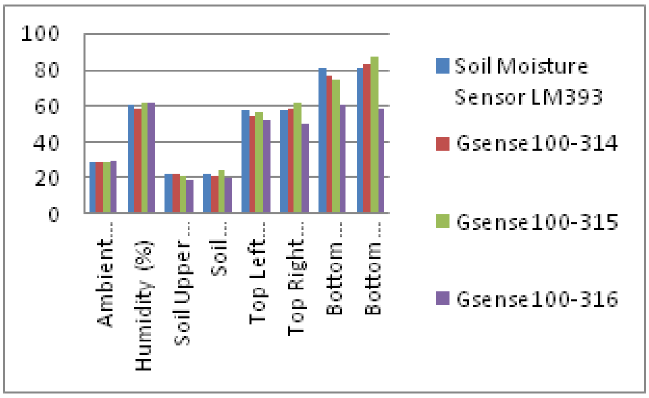

Fig.12: Comparison Graph

V. NOVELTY

- It is a capacitive soil moisture sensor.
- It offers wireless communication with long range connectivity and low power consumption.
- It provides multi wireless communication such as, LoRaWAN, Sigfox and BLE.
- Measurement is done in two layers, top layer and bottom layer.
- Due to two layer of measurement, it gives better idea of how fast the rain water is being depleted in different areas.
- It provides ambient temperature measurement too.
- Generates alert message when the temperature exceeds threshold.
- Time intervals of measurement can be set as per the requirement.
- Includes remote configuration settings, such as activation and deactivation using switch.
- There are two modes of operation, standard mode and alert mode.
- Packets format can be broadly categorized into two types, downlink and uplink messages.

VI. CONCLUSION AND FUTURESCOPE

The proposed system shows the flow, structure and functioning of the Soil Moisture Sensor and GND BLE Mobile Application (gSense100). This mobile application is simple to use and user-friendly. It is cost-free on the Android store. Thus, it is both a time-saving and cost-effective application. So, we can infer that the proposed framework can be used to minimize human efforts and luxurious human lives, hand in hand, with the new technology. This program is used by the soil moisture sensor user, who can use the data that can be transmitted and interpreted by the user, who can also make adjustments to the device settings by connecting to the device. The Internet seems to be the cornerstone of all technology. A revolutionary phase in the field of BLE technology is the GND BLE Mobile application (gSense100).

To locate and interact with the BLE Sensors, any user can make use of such an app. Any smartphones user of Android can use the proposed framework.

The purpose of this work is to produce an interactive and user-friendly application for the Android marketplace. The GND BLE Mobile framework consists of two key components: a client-side application that runs on Android phones and a sensor-side application that supports and communicates with different features on the client side.The dive is designed to provide characteristics of the soil moisture sensor as a whole. Considering the available technology resources, the above suggested model is easy to implement. The model is simple, secure and scalable. The proposed model is based on serial communication between the soil moisture sensors. But for future scope in enlarging the system we can use, connectionless system. We can even start online transmitting and communication through the server based system which can be connected to the server and display for the user.

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Dr. U B Mahadevaswamy has completed his B.E Degree in Electronics and communication in the year 1988 from the university of Mysore, M.Tech in industrial Electronics in the year 1995 from Mangalore University, and obtained PhD in Electronics from University of Mysore in the year 2013.He is presently working as Professor in the Department of Electronics and Communication at Sri Jayachamarajendra College of Engineering, JSS Science and Technology University, Mysuru, Karnataka, India. He has authored several textbooks and published many technical and research papers in international Journals and Conferences. His research interest includes the topics: Wireless Sensors Networks, VLSI Design, Embedded Systems, and Digital Signal Processing.

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