Long range based effective field monitoring system

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ABSTRACT

Adoption of the internet of things (IoT) is moving forward quickly because of the developments in communication protocols and technology involving sensors. The IoT is promoting real-time agricultural field monitoring from any distant place. For the IoT to be implemented effectively there are a number of agricultural issues related to less power usage and long-distance transfer of data are to be addressed. By using LoRa, which is a wireless communication system for IoT applications, these difficulties can be avoided when sending information from fields of crops to a web server. Acustomized sensor node and LoRa are used in this work to transmit continuously updated information to a remote server. Monitoring the quality of water, and reducing wasteful use of water are the main goals.

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1. INTRODUCTION

A vital part of national economies and a source of existence is agriculture. Therefore, it may be claimed that a country's agricultural growth speaks for the country [1], [2]. Improvements to agricultural operations also help the nation's workforce. Farmers that practice ecological farming must check farms to assess crop status. Furthermore, knowing farm status and farm management take about 70% of farmers' time [3]. Current advances in internet of things (IoT), communication and sensor technologies enable distant agricultural field observation from any place [4]. As the end gadgets are energy-constrained, the IoT requires minimal energy usage and far-reaching transmission-based wireless communication methods [5]. The requirements of the IoT are being met by long range (LoRa) which stands for long range that provide reliable and improved connectivity for sending information from field to a remote server without paying any fees [6], [7]. The IoT will be able to connect to a huge number of end nodes spread across a vast geographic area with LoRa technology, an advanced agriculture support tool [8].

Most prevalent protocol for communication employed by IoT is LoRa [9]. It uses chirp spread spectrum [10]. It consumes less power, covers long distance which makes it suitable for remote monitoring of fields [11]. It can be operated by battery. LoRa can communicate with the devices with in a range of 2 to 5 kilometers [12]. The most crucial element in IoT applications is the communication range. As with IoT, the majority of Wi-Fi-based devices require several access points to serve a sizable region. Consequently, the cost of integrating the system has increased [13]. The system may be extended to long-range by the addition of LoRa unit, because LoRa is able to handle several nodes. LoRa's principal objective is to improve twoway communication. The information is stored on the gateway and sent to a remote server, where we can view the information from anywhere using any smartphone, personal computer (PC), or other device by downloading the necessary app on the device [14]. With more efficiency, longrange wide area network (LoRaWAN) can get around obstacles that stand between the transmitter and receiver. Gateways and servers are connected to one another using internet protocol (IP) connections in a star architecture. Data from radio frequency (RF) packets are translated into IP packets in this instance, and vice versa. By using a hop link, the configuration might be one too many, many to one, and many to many [15]. The information transmission and reception functions are shared by all nodes in this network. The battery-powered nodes feature long-lasting batteries and extensive connectivity [16]. LoRa is better suited for applications run remotely with deployed equipment or nodes of sensors that are far away. In recent years, both entrepreneurs and academics have noticed the effects of low power wide area network (LPWAN) [17]. The sector is increasingly committed to promoting LoRa-based solutions that could be better for human civilization [18]‒[26]. The LoRa-based IoT ecosystem offers a multifaceted applicability across several industries [27]. A sensor node, which is referred to as an end device, and a gateway, which creates communication linkages between end devices and servers, make up the LoRa architecture. Servers locally store all data that may subsequently be shifted to the cloud. This technology can influence society as a whole set’s various standard of expectation.

Nowadays, there are several communication protocols in use. Compared to Wi-Fi, LoRa technology is more frequently used and more popular due to its sophisticated characteristics. However, there are several restrictions on LoRa's data transfer rate. LoRa's bit rate is lower than Wi-Fi's, which ranges from 20 to 30 Kbps [28]. Table 1 compares the most common communication protocols in use today. In terms of distance and minimal power usage, LoRa holds its position. Nearly all products, such as mobile devices, headphones, and speakers, include blue tooth low energy (BLE) [29]. Similarly, Wi-Fi exists but LoRa prevails.

Table 1. Overview of commonly employed protocols for communication

	Features							
	Standard	Frequency	Topology	Range	Battery life time	Cost	Power consumption	Modulation
WiFi	IEEE 802.15.1	2.4 GHz	Tree	35-70 for indoor 100-250 for outdoor	0.1-5 days	Average	Low-high	QPSK
Zig bee	IEEE 802.15.4	2.4 GHz, 868,915 MHz	Mesh	1-75 m and more	100-7,000 days	Low	Low	DSSS
Bluetooth	IEEE802.11	2.4 GHz	Tree	>1-10 m	1-7 days	Low	Very low	FHSS
LoRa	IEEE802.15.4 g	ISM868/915 MHz	Star	2-5 km in urban 5 km in rural	Extended battery life	Low	Low	Chirp spread spectrum

This article presents a prototype specifically created for agricultural use which uses LoRa SX1278 that offers notable benefits in blocking and selectivity, resolving the age-old compromise between distance covered, interference immunity, and consumption of electricity. End nodes are set up in the field to gather additional data for the use of predictive modeling in precision agriculture. Precision farming makes it possible to produce agricultural products of very high quality.

The following structure is being used to organise the paper. The introduction is in section 1. Description of hardware and software used in the proposed method is then provided in section 2. The experiment's methodology and findings are presented in section 3. Section 4 presents the conclusion.

2. DESCRIPTION OF HARDWARE AND SOFTWARE USED IN THE PROPOSED METHOD

2.1. Hardware

In order to monitor irrigation water quality, soil moisture, and humidity for precision agriculture, we have presented a system. It is built using sensor nodes that track water quality to decide whether the water requires treatment. It also uses sensors to measure moisture of the soil in the field, and humidity. Figures 1 and 2 shows the proposed system’s block diagram of transmitter and receiver. It consists of Arduino Uno, LoRa module, Wi-Fi module, sensors, LCD display and motor. Arduino Uno features a total of 14 digital input/output (I/O) pins, six of them are pulse width modulation (PWM) outputs and six are analogue inputs. It consists of a crystal oscillator at 16 MHz, a USB connection, a power jack, an in-circuit serial programming (ICSP) header, and are setbutton. The SX1278 LoRa module version contains two extra antenna pins in addition to the 12 pins for microcontroller interface. The development of end-point IoT apps makes up the majority of Wi-Fi module usage. A TDS sensor is used to detect total dissolved solids (TDS), which is frequently used as a water quality indicator. The total volume of water of the earth's surface is calculated using soil moisture sensors. Humidity sensors measure the quantity of moisture in the air. The light dependent resistor (LDR) is a unique form of resistor that, as its name implies changes resistance in response to light intensity. It operates on the photoconductivity concept. With an increase in light intensity, its resistance falls.

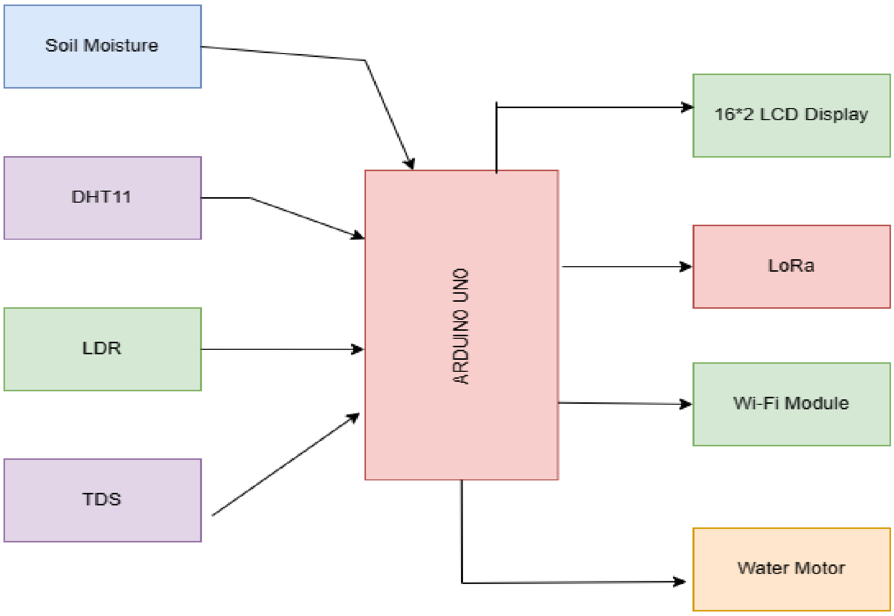


Figure 1. Diagram of a transmitter block

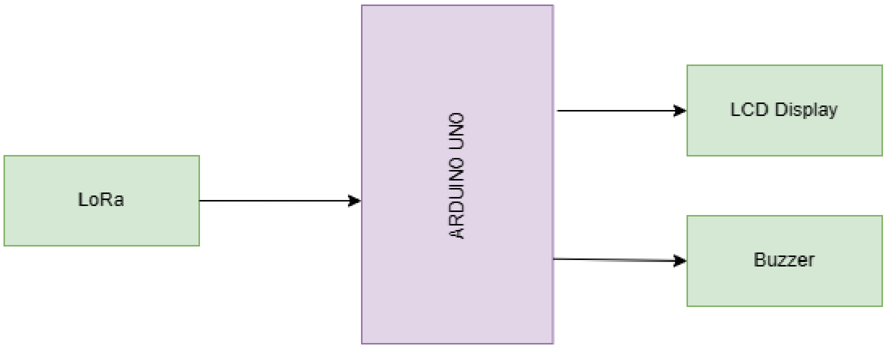


Figure 2. Diagram of a receiver block

2.2. Software
2.2.1. Arduino IDE

The Arduino software (IDE), has an editing interface for coding, a notification box, a writing terminal, a panel of tools with tabs for basic actions, and a variety of menus for the purpose of uploading programs and interacting with them. Programmes made with the Arduino software (IDE) are referred to as "sketches". They link genuine hardware and Arduino. Changing the code allows monitoring of all sensors.

2.2.2. Thing speak cloud platform

An "Internet of Things" platform called thing speak allows users to keep and get information from objects via internet using HTTP. The Arduino Uno microcontroller will send the sensor data to the thing-speak IoT API. The information collected by the thing-speak IoT API may be exported in ".xml" format. This can be further processed if required. From their own devices, a farmer may transmit data to thing-speak to take the appropriate actions, visualize live data instantly, and set off bells. The thing-speak IoT API is chosen because it is considerably more user-friendly than other programs.

3. EXPERIMENTAL DESIGN AND OUTCOMES

The testing environment suggested for agricultural surveillance model is depicted in Figures 3 and 4. One SX1278 LoRa module, coupled to the sensors, is used in the transmitter nodes, which are positioned in the farm to measure temperature, humidity, total dissolved solids in water, and soil moisture in the field. At the reception node, a liquid crystal display shows the information from the sensors that were relayed. The transmitter nodes provide information to the reception node and the cloud server using the LoRa modulation technique.

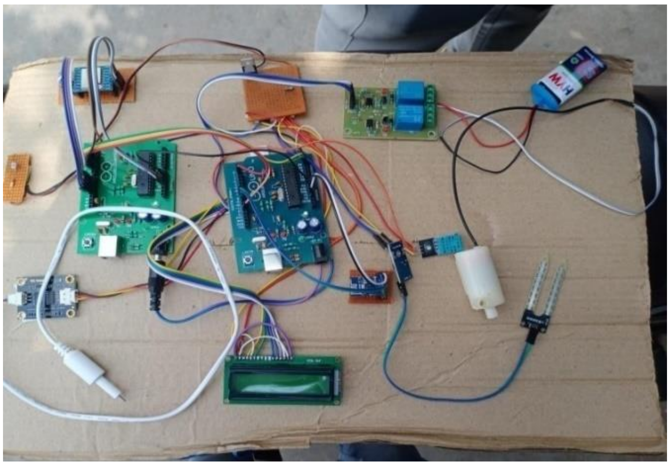
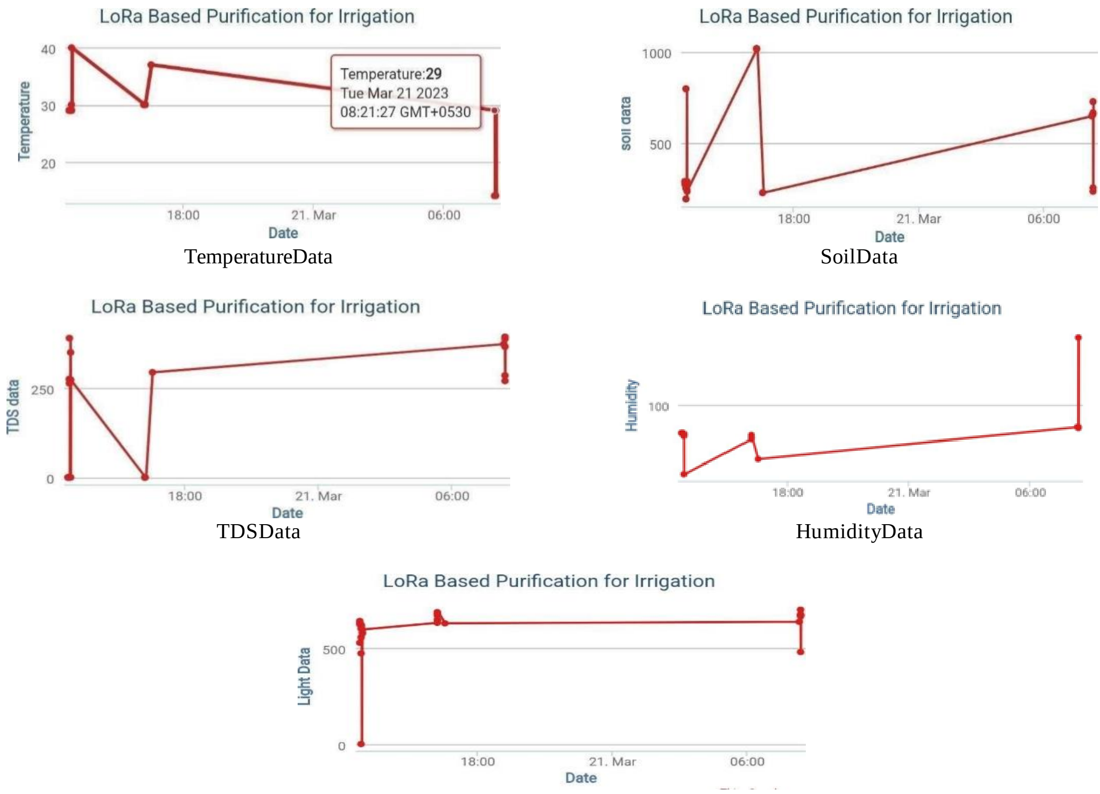


Figure 3. Experimental design for LoRa transmitter

Figure 4. Experimental design for LoRa receiver

The sample field's measuring process will start as soon as the sensors are switched on. The Arduino Uno can analyse data and transform it into the required parameters for sending upon getting observations from the field. Arduino Uno then tell LoRa module to send information to thing-speak. The data is stored in memory and converted to a graphic representation by thing-speak when it gets the data. Customers may view real-time data by logging onto the thing-speak website. The temperature, humidity, soil moisture, TDS data are measured and displayed in Figure 5.



TemperatureData SoilData

TDSData HumidityData

LightData

Figure 5. A graphic representation of the thing-speak cloud server's sensor readings

4. CONCLUSION

LoRa is an attractive technology to use since it can increase the scalability of installing IoT devices in agricultural areas. LoRa works well in many locations, such as rural regions, where applied precision agriculture (PA) requires internet access. These LoRa-based endpoints overcome bandwidth limitations while being economical, energy-efficient, and cost-effective. In this article, a LoRa-based effective field monitoring system is suggested. The sensor-enabled end nodes can be placed in the farm field. To the recipient node, these nodes send data. The received data is displayed on LCD. And also, on the thing speak platform, the humidity, temperature, and soil moisture of the received data are tracked. It is an autonomous wireless transceiver and is relatively inexpensive.

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