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LoRa Based Framework for Smart Greenhouse Monitoring Systems

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Abstract: Agriculture being the largest profession in India depends on various factors like temperature, humidity, soil moisture, and others. LoRa is a long-range, low-power wireless platform framework developed for smart greenhouse monitoring to gain accurate values for dependent factors like temperature, humidity, soil moisture. LoRa is based on chirp spread spectrum modulation, which has low power characteristics like FSK modulation but can be used for long-range communications. LoRa can be used to connect sensors, gateways, machines, devices, animals, people, etc. wirelessly to the cloud. The purpose involves eliminating the traditional methods of the agriculture system and enhancing the crop yield and quality. Automated tools utilization is also being implemented, thereby improving the agricultural conditions, and reducing the human intervention.
Keywords: Internet of Things (IoT), LoRa Technology, Smart Greenhouse Monitoring Systems, Dht11 Sensors, ESP32 Development Boards, and LoRa Chips.

I. INTRODUCTION

Greenhouse technology may be a a part of agriculture, providing promising environmental situations to the plants. to shield plants from harmful atmospheric condition like wind, cold, extreme temperature, and disease, assembling a greenhouse will protect the plants by providing suitable environmental conditions. Greenhouses have their own place within the agriculture sector and the awareness to stay the sustainability of the greenhouse is vital. Crop production could be a challenging business, with the crops being constantly exposed to unfavorable climate. Weather and climate conditions play a crucial role in determining the pace of crop production. However, during times when global food security strongly depends on crop production, there's no place for any limitations. Therefore, the search for solutions resulted in farm management practices that involve farming during a controlled environment. Greenhouse Farming is one of the basic variations of farming in a controlled environment.

II. LITERATURE SURVEY

This is the survey carried on various journal or reference papers to undertake the existing system to explore the drawbacks in the existing technology for the Greenhouse Monitoring system using Lo-Ra. George Princess T and Poovammal E explored that integrating IOT in greenhouse farming helps in monitoring the pesticides and storage facilities, tracking the required products of farm and also prevents the farmers from illegal logging. It becomes more effective by reducing the cost of production, connecting the greenhouses, stabling and monitoring the livestock. They gave a comprehensive analysis on smart agriculture and greenhouse farming using the current trends of IoT. It discusses the several distinct types of sensors for monitoring the consumption of power, energy and water. It also aims in assisting the researchers and helps farmers to accumulate the knowledge of the innovative IOT technology in the smart greenhouse cultivation.

KHH Priyadarshana et. al. identified that with the degradation of the environment due to soil erosion and the mass developments and the mechanical revolutions, the agriculture becomes a challenge with unfavorable environmental conditions.

Rakia Rayhana et. al. suggested that the evolving Internet of Things (IoT) technologies, which encompass the smart sensors, devices, network topologies, big data analytics, and intelligent decision is believed to be the solution in addressing the key challenges facing the greenhouse farming, such as greenhouse local climate control, crop growth monitoring, crop harvesting and etc.,

Mohamed M. Abbassy and Waleed M. Ead explored that in Egypt, Agriculture assumes a huge role within the improvement in food protection. Moreover, there is a faster progression in the innovation of monitoring the agricultural conditions to increase the quality of production in the field. Various cultivating conditions like light, soil moisture, temperature, humidity, and so forth are viewed and restricted via checking and controlling devices. Heri Andrianto et. al. studied that food availability is a very important problem to be resolved due to the growing world population. The problem faced is how to increase agricultural production and how to reduce the use of pesticides so that they are not harmful to humans.

One solution to overcome this problem is to create a smart greenhouse system. Farming in this smart greenhouse system does not use pesticides. This study aims to develop smart greenhouses for hydroponic farming based on the Internet of Thing (IoT). In this study, they also measured the chlorophyll content of mustard leaves grown hydroponically in a greenhouse system to determine the nitrogen status of the mustard plant. The controller unit of this system is the Arduino Mega2560. Data on temperature, humidity, TDS, PH, light, and actuator conditions (pumps, lights, fans, sprayers, and valves) are stored on the real-time database firebase. Environmental conditions in the greenhouse can be monitored via an application on a smartphone and all actuators can be controlled via an application on a smartphone.

T C Jermin Jeaunita et. al. proposed that Greenhouse deployment of farms gives hope for the farmers on higher crop yield, through lowering risks against pests, insects and adverse climatic conditions. Automation of greenhouse benefits the farmers in various ways by detection of soil and water quality and automatic irrigation. Involving scientific process in this automation boosts the benefits on agricultural activities. The current status of the greenhouse can be collected and sent to the cloud infrastructure for further decision making. This paper deals with the design and implementation of a model for IoT based agricultural greenhouse system for better crop yield. The system uses light-weight MQTT protocol for device-to-device communication.

III. METHODOLOGY

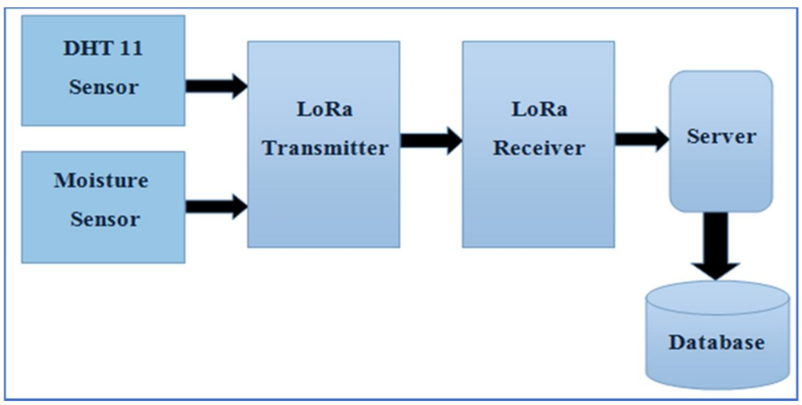

Fig. 1: Methodology Diagram

The above figure shows the methodology being adopted, Dht11 sensor fetches the temperature and humidity values, soil moisture sensor gives the moisture value of soil, LRD sensor helps to fetch light intensity, these are given to the LoRa sender. This in turn sends the data to LoRa receiver without the help of any network. LoRa devices create a wireless data communication network. Further, a server can be used to dump the data into the database.

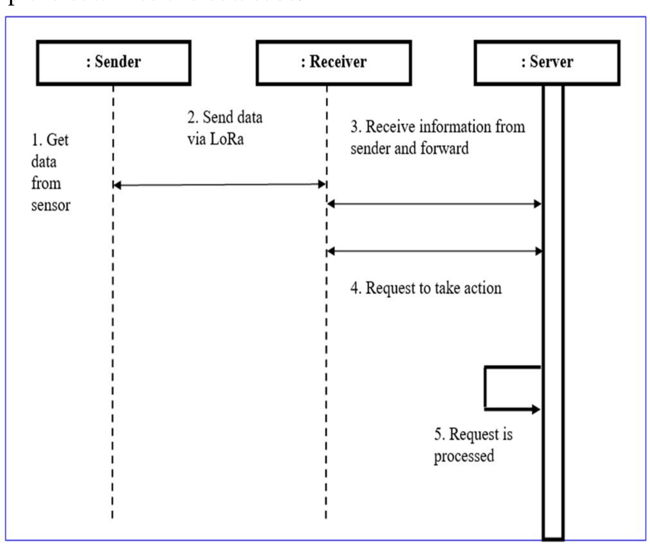

Fig. 2: Flow Diagram

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The above figure shows the sequence of interactions. The series of messages are shown and labelled to guide through the LoRa framework for the smart greenhouse monitoring system. The interaction between the sender and receiver allows to get the data from the sensor and send data via LoRa. The receiver can receive the information from sender and forward it to the server. A request can be made to take the appropriate action. Later on the request can be processed.

IV. MODEL DESIGN

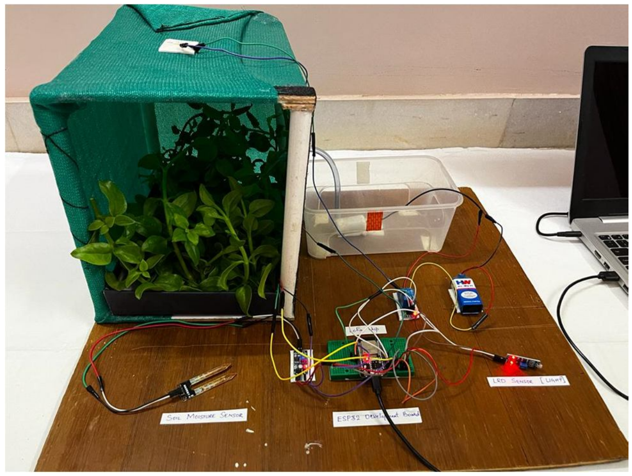

Fig. 3: Model Design

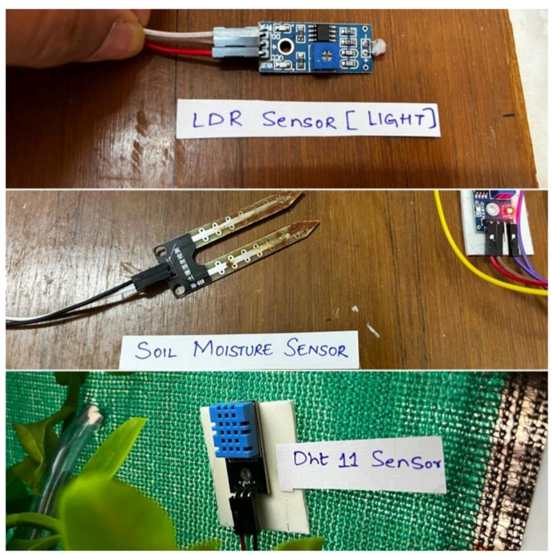

Fig. 4: Sensors

1) *Soil Moisture Sensor:* Soil moisture sensors measure the water content in the soil and can be used to estimate the amount of stored water in the soil horizon. Soil moisture sensors do not measure water in the soil directly. Instead, they measure changes in some other soil property that is related to water content in a predictable way.
2) *Dht 11 Sensor*: The DHT-11 Digital Temperature And Humidity Sensor is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin.
3) *LDR Sensor:* An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits. Light Dependent Resistors (LDR) are also called photoresistors.

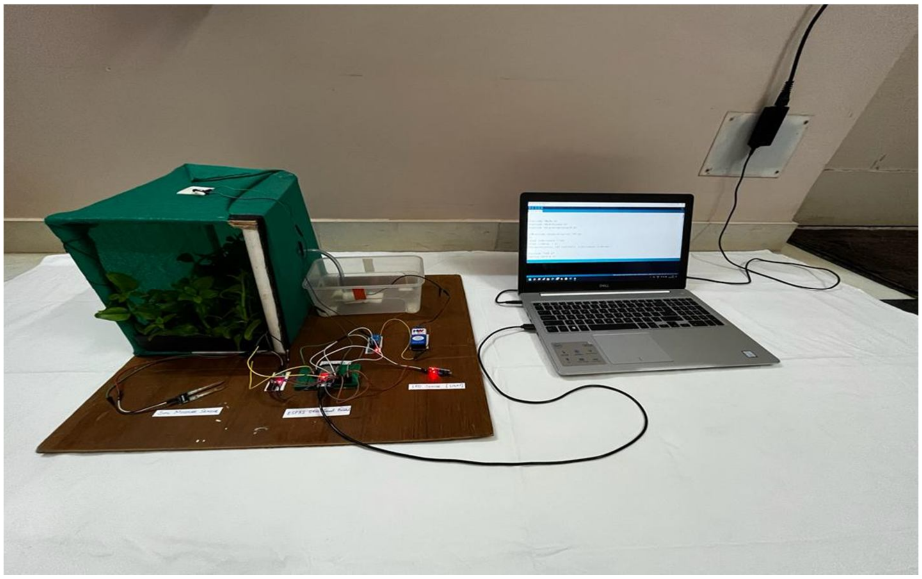

Fig. 5: Model Setup

4) *Thingspeak Cloud:* ThingSpeak is an IoT analytics platform service that allows you to aggregate, visualize and analyse live data streams in the cloud. ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak.

The analysed live data is then presented to the mobile interface.

V. RESULTS

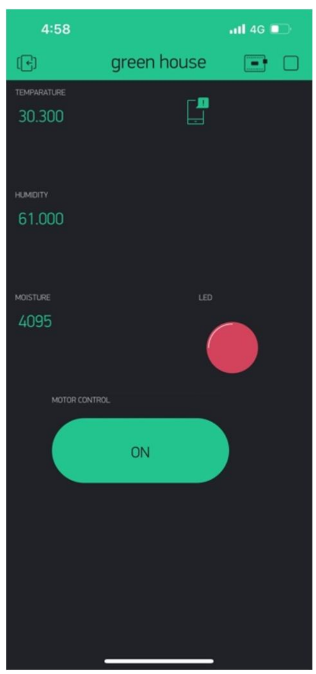

Fig. 6: Blynk IoT Mobile Interface

The user can launch the Blynk application, monitor various parameters and get the notifications about the parameters. At the later stage, necessary actions can be taken according to the data notified to the user.

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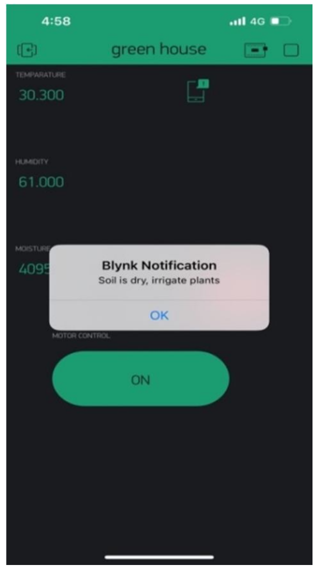

Fig. 7: Blynk Notifications Triggered

The user will receive the notification through the Blynk application when the moisture hits a certain threshold i.e., here stating as the "Soil is dry, Irrigate plants". Once this notification is triggered, the user can click on the "ON" buttonin the application to irrigate the plants, which will initiate to start the motor and plants will be irrigated.

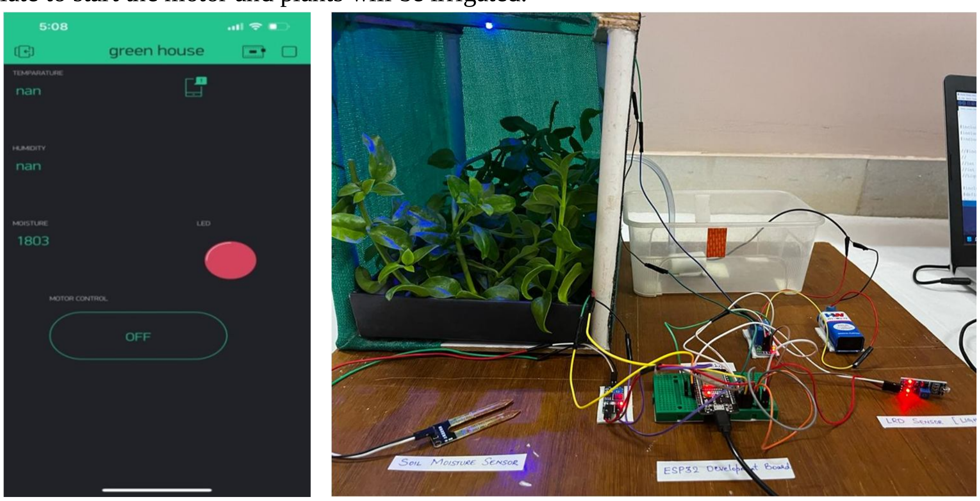

Fig. 8: LDR Sensor activating the light inside the Greenhouse

When is no sufficient light inside the greenhouse, the LDR sensor tracks the light intensity and senses that there is not sufficient light and the light will automatically be turned on inside the greenhouse and vice versa.

VI. CONCLUSION

The designed model is a scalable system to monitor and control greenhouse sensors, temperature, humidity, and moisture sensors of LoRa based framework for Smart greenhouse monitoring system. Based on the problems identified, the tentative objectives have been framed. We examined the methodology diagram and explored the advanced facility available in which we can control the climate to increase plant growth and avoid the effect of seasonal changes on the plants. The tools and technologies have been identified in order to implement the proposed system. The designed backend system can be easily integrated with other IoT applications, so, can the system contribute not only as a greenhouse's monitoring and control system but also as an initial step for future smart city development. The proposed system offers the users to get easily choose the period that they want to check the sensors readings on ThingSpeak website and allows the users to self-retrieve past data, and additional sensor nodes and gateways to be integrated to extend the coverage.

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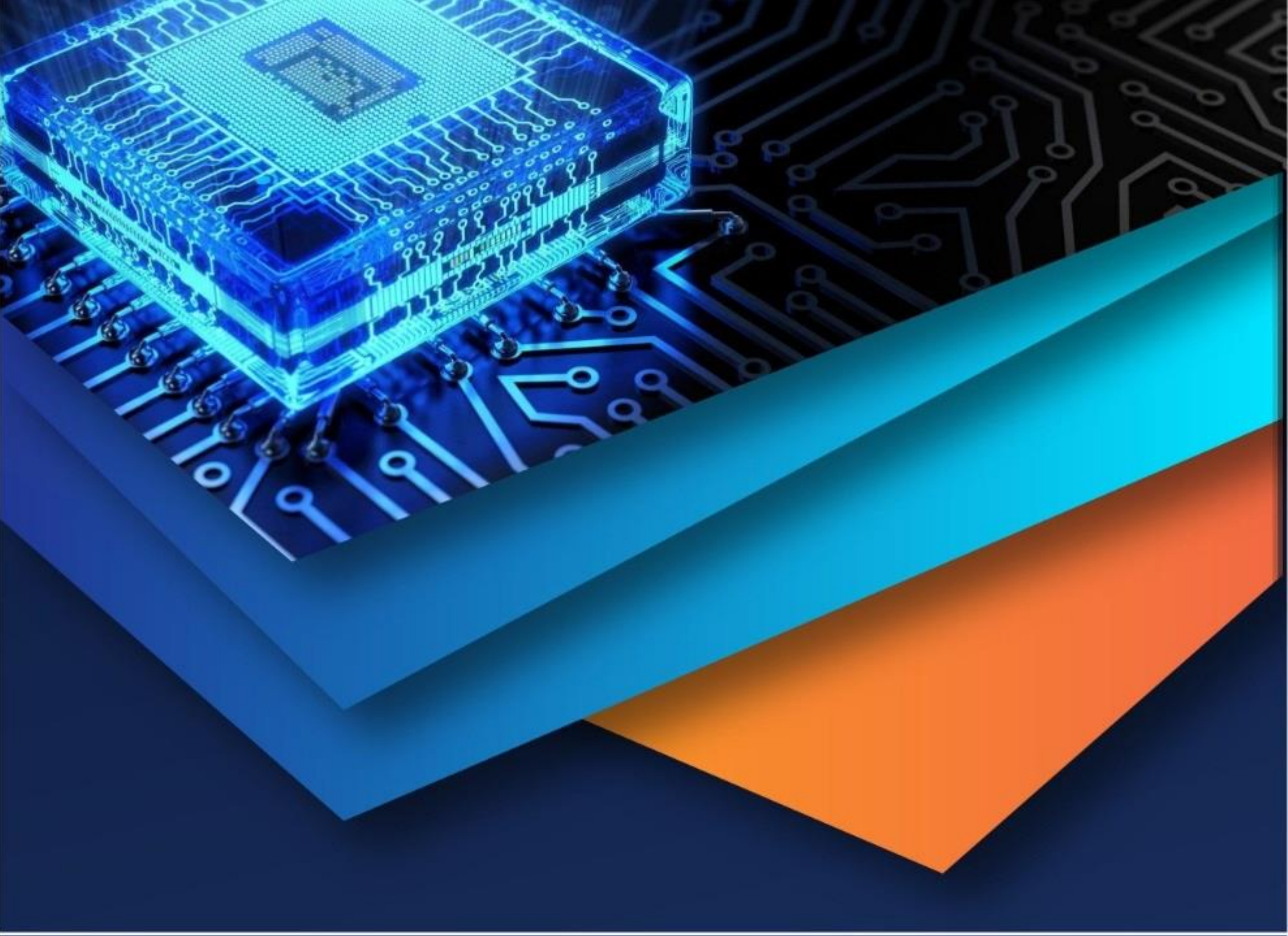

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