"Smart Agriculture Solution using LoRa and IoT"

Shamali K.Makode[1], Radhika R. Harne[2]

[1](P.G. Scholar), Electronics System and Communication Engineering GCOEA, Amravati Maharashtra, India.
[2](Assistant Professor), Electronics System and Communication Engineering GCOEA, Amravati Maharashtra, India.

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Abstract- *Traditional agriculture is converting into smart agriculture due to the bulge of the IoT (Internet of things). An agriculture service platform is developed to support environmental monitoring and to improve the efficiency of agricultural management. In agricultural field like Greenhouses, various Climatic Condition Parameters are essential to monitored for regulation of crop production, and climate change has already shown its negative impact that has on agriculture and food production, particularly because of rainfall deficit or excess of temperature changes and other associated environmental variations. Wireless sensor networks are gaining greater attention from the research community and industrial professionals. LoRa is a low power and enables very long range transmission (upto 15km) with low power consumption (in terms of mili-watt) as compare to Wi-Fi module, mobile communication, Bluetooth an other wireless techniques. In this work, the technical differences of Wifi, LoRa, Bluetooth and mobile communication are present and compared in terms of physical or communication features. And finally explain LoRa is the best technology in all wireless sensor network. This system is based on a high-performance micro-controller, integrated temperature and humidity sensor on real-time data analysis. In our approach K-means unsupervised clustering algorithm used for data mining and IoT for real time data analysis. Also find the fault of the particular sensor. The use of Data collection, pattern classification and apply strategic analysis then control execution for the final result.*

Keywords: Agriculture, LoRa techniques, IoTs (Internet of Things), Wireless Sensor Network, k-means clustering algorithm.

I. INTRODUCTION

The rapid development of the Internet and the Internet of Things (IoTs), various convenient service applications are being used in various fields. In recent years, a new agricultural information and communication technology, called smart agriculture, which meets the needs of farmers for information collection, signal processing, data analysis and equipment control, has been developed. This work proposes an agricultural service platform that is based on a wireless sensor network and LoRa communication technology. Work uses LoRa as a network transmission interface to solve problem of communication failure and save energy. An smart agriculture service platform is developed to support environmental monitoring and to improve the efficiency of agricultural management.

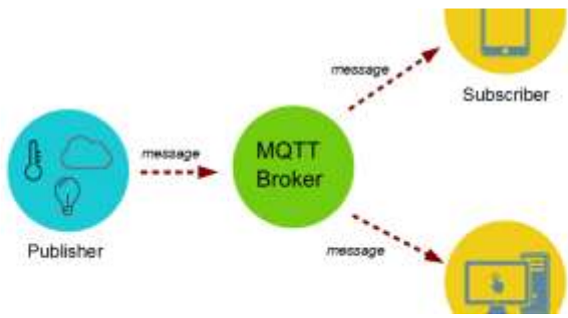
The goal of this work is to integrate IoTs awareness and communication technology into an smart agriculture platform. The accuracies of sensors of various types are measured and these sensors are integrated into multi-function sensor component. Then, multi-functional sensor components are integrated with LoRa wireless network components. In this work, an smart sensor network platform for agricultural applications is designed and constructed.

Environment Sensors - Natural changes in temperature, humidity, Soil moisture, and direction may cause poor crop growth or disease, reducing crop yields. Therefore, in this work, an environmental sensor is used to reminds changes in the physical atmosphere. The information is collected and sent to an ESP32 controller platform for preprocessing. ESP32 controller uses a LoRa communication component to send data to a server for analysis [6] Humidity and Temperature Sensor.- The temperature sensor uses Thermally Sensitive Resistance (TSR). TSR is very sensitive to temperature changes, and obtained changes in resistance values can be converted into temperature values. The humidity sensor is used to define the quantity of water vapours in the atmosphere [4,5]. The Soil moisture sensor measures the water level of the environment. It helps for the growth of plants in agriculture [3]. The light sensor measures the brightness of the environment using a camera IC. It the light value from a voltage and directly outputs a digital signal [9].Temperature Control- To ensure the +accuracy of sensed data, the sensor must be placed in a suitable environment. The inaccuracy of measurement as a result of long-term operation is eliminated by using a temperature controlled fan to ensure that the sensor is properly ventilated.

Internet of Things -

For the connection with remote location MQTT protocol is used. MQTT is a machine-to-machine, Internet of Things connectivity system development protocol. MQTT is a telemetry protocol based on the publish-subscribe communication model. MQTT is based on publisher, server and clients. Likewise, the server is the guy who is responsible for handling the client's requests of receiving or sending data between each other.

MQTT server is called a broker and the clients are simply the connected devices. When a device (a client) wants to send data to the broker, this operation is called a "publisher". When a device (a client) wants to receive data from the broker, this operation is called a "subscriber" So in this system, node MCU esp32 is the publisher which will publish the acquired data of sensors GSM and GPS module. It is further sent to the MQTT broker. And those whoever are subscribed on that channel will get that data on their device. So this is how caregiver will acquire obtained data.



II. LITERATURE SURVEY

Yi-Wei Ma1 and Jiann-Liang in 2018 which represents proposed architecture of agriculture With the rapid development of the Internet and the Internet of Things (IoTs), various convenient service applications are being used in various fields. In recent years, a new agricultural information and communication technology (ICT), called intelligent agriculture, which meets the needs of farmers for information collection, signal processing, data analysis and equipment control, has been developed. This work proposes an intelligent agricultural service platform that is based on a wireless sensor network and LoRa communication technology [1]. A multi-sensor component and an integrated communications network are established. Wireless sensor networks and network communication technology are used to support intelligent agricultural data collection and equipment control [1].

Vaibhavraj S. Roham Kopargaon, Ganesh A. Pawar Kopargaon, Abhijeet S. Patil Kopargaon, Prasad R. Rupnar in 2015, that In farming Temperature, Humidity and CO2 are the most essential parameters. The growth of crops is mainly depending on these three parameters. Currently farmers don't have any system which will show real-time levels of these parameters. Even farmer don't know when humidity is increased or CO2 level increased in his green house, because of it crop production gets affected. The proposed system is going to monitor these changes periodically and take an action automatically or pretend the required action to the farmer. System will have a provision to visualize the graphical representation of all the streaming data from the green house. Later on farmer can operate the devices from remote location by using its smart phone.

The author Manikandan .S.V1, Jayapriya represented that the Wireless Sensor Networks (WSNs) have concerned much attention in recent years. In 2016, Deployment of sensor networks still is a problem and subject of wide range researches and developments. Prototype of WSN built in framework of current research shows that small networks are more or less functional while large scale WSNs with long range nodes are issue. Despite of problems our WSN prototypes gave possibility to gather valuable data for field weather monitoring. The sensor network technology will help the farmers to know the exact values of the requirements that they need to improve the crop productivity. It will help them in taking better decisions at the right time. This will save their time and labour also. The basic aim here is to transport the Indian farmer from prediction to the exact values which are beneficial for their farms[11].

Authors Aloÿs Augustin1, Jiazi Yi 1,*, Thomas Clausen 1 and William Mark Townsley 2 explained In this techniques to LoRa is a long-range and low-power telecommunication systems for the "Internet of Things". The physical layer uses the LoRa modulation, a proprietary technology with a MAC protocol. LoRaWAN is an open standard with the specification available free of charge [23]. This paper gives a comprehensive analysis of the LoRa modulation, including the data rate, frame format, spreading factor, receiver sensitivity, etc. A testbed has been built, to experimentally study the network performance, documented in this paper . The results show that LoRa modulation, thanks to the chirp spread spectrum modulation and high receiver sensitivity, offers good resistance to interference. Field tests show that LoRa can offer satisfactory network coverage up to 3 km in a suburban area with dense residential dwellings. The spreading factor has significant impact on the network coverage, as does the data rate. LoRa is thus well suited to low-power, low-throughput and long-range networks. This paper has also shown that LoRaWAN is an LPWAN protocol very similar to ALOHA. Its performance thus degrades quickly when the load on the link increases [13].

Author Orestis Georgiou and Usman Raza described that Low Power Wide Area (LPWA) networks. We have investigated the effects of interference in a single gateway LoRa network, a LPWA technology with promising IoT applications. Unlike other wireless networks, LoRa employs an adaptive CSS modulation scheme, thus extending the communication range in the absence of any interference. Interference is however present when signals simultaneously collide in time, frequency, and spreading factor. Leveraging tools from stochastic geometry, we have formulated and solved two link-outage conditions, one based on SNR, and the other on co-spreading sequence interference. Each displays interesting behaviours, unique to LoRa, with the latter causing performance to decay exponentially with the number of end-devices, despite various interference mitigation measures available to LoRa, thus limiting its scalability. It is interesting that LoRa networks appear to be impervious to cumulative interference effects (typically modelled as shot-noise [8]). If this assumption is invalid, then our qualitative results are simply optimistic upper bounds towards network scalability. Going beyond this first foray into the modelling of LoRa, it would be interesting to understand the effets of multiple gateways [6], and spatially inhomogeneous deployments. Finally, we point towards recently developed packet-level simulators [13] which can further shed light into the performance of LoRa networks.

In 2016 designed by R. Fatchurrahman, H. Putra, I. Joyokusumo, M. H. Habib, I. Imawati, S. P. Hadi,paper presents a technique for selecting the light sensor candidates according to its effectivity and sensitivity criteria. the light sensor candidates, such as light dependent resistor, photodiode, and photo transistor, is taken due to its good performance in daylight sensing. Analytic Hierarchy Process (AHP) which provides a structured technique for organizing and analyzing complex decisions based on mathematics was chosen. It offers simple ways in matrix based-operations to rank the best light sensor candidates over those criteria. In expecting the best work of Wi-MoLS for controlling building illuminance by adjusting the incoming natural light coming to the building, the best light sensors must be selected over expected criteria. The effectivity and sensitivity test had been performed to evaluate the light sensors characteristic. AHP is used to select the best light sensor candidates. The result shows that light dependent resistor is the most effective and sensitive light sensor by 62.16 \% in score instead of phototransistor (19.72\%) and photodiode (18.12\%)[3].

III. METHODOLOGY-

Currently, various types of sensors are used to collect agricultural information, such as the moisture of soil, light intensity and temperature and humidity in air. However, such sensors can only perform environmental monitoring and data collection; they lack an integrated computing platform, so obtained data cannot be effectively used or analyzed. To solve this problem, an agricultural intelligence platform is researched and developed here. This work develops an smart agricultural platform that integrates communication and multi-functional sensing components. The intelligent agriculture platform can be used to collect environmental information in agricultural areas and transmit that data to remote computers through the LoRa and in another approach used of IoTs i.e. sends over the internet. for analysis, to make decisions concerning equipment control. For example, ambient temperature sensing can yield information about the current temperature and changes in humidity in the field. If the temperature is too high, a fan is turned ON and if the moisture level is less then DC pump turns ON. The sensor is placed outside of sensor platform so that sensor probe is in direct contact with the environment for sensing. The light sensor horizontally on the upper of a sensor platform. The placement of air temperature, air humidity under eaves. And soil moisture sensor deep at agricultural platform. The wind speed and direction sensors outside.

Block Diagram:

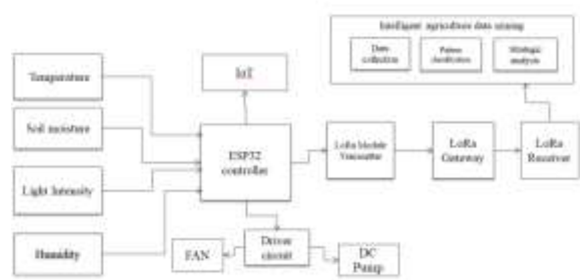


Fig 1. Methodology in Smart Agriculture Platform

Reference [1]

Finally, LoRa is placed in the sensor house and transmitting antenna are located on its roof, as Collected data are transmitted to the LoRa base station; instantly uploaded to a server, and presented on a web page for analysis. This work is carried out by using k-means unsupervised clustering algorithm for data analysis.

IV. RESULT AND DISCUSSION

Another approach is based to compare differences and conditions between a single sensor and a calibration sensor. A curve that reveals a linear correlation indicates that the former sensor has a small deviation and is suitable for use. In our dissertations work, several readings has been taken for 'n' number of days. We had taken readings of 28 days for analysis. To avoid complexity we consider

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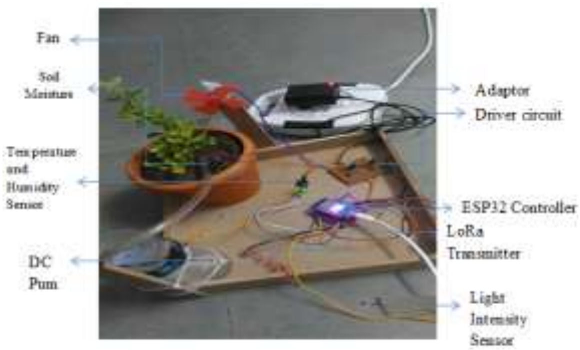
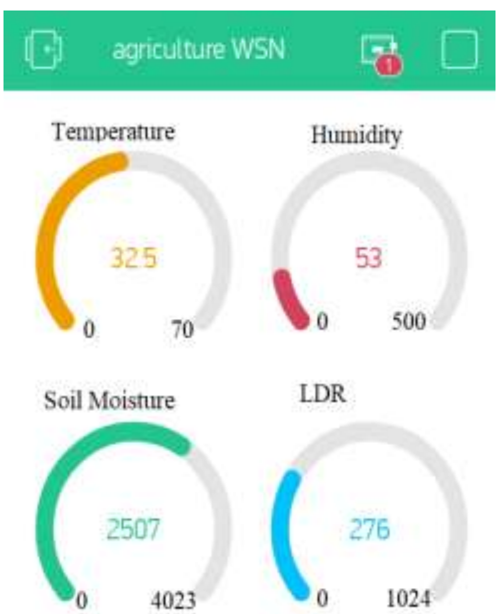
reading of five days are taken for plotting the accurate graphs. Below figure shows that readings of five days at different environmental conditions over surrounding. Similarly the graph of humidity, soil moisture, and light intensity etc.

EXPERIMENTAL SETUP –



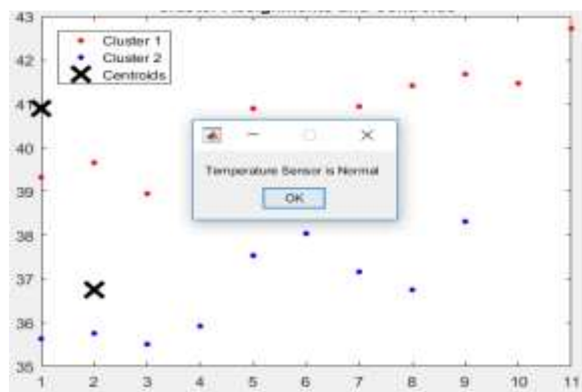
(a) Setup of Smart Agriculture Platform

(b) LoRa Receiver



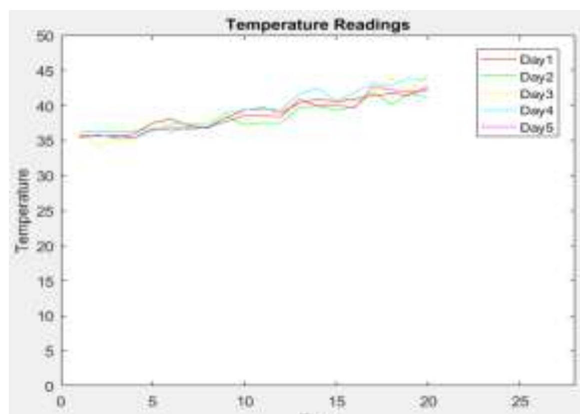
(c) Output on blynk app

It concludes, whether the sensors working or not. And it contains all non-zero readings i.e., the temperature sensor works continuously. According to expert readings the equivalent reading of evaluated individual sensor, now sensor is compared with centroid value and then compare faulty and normal readings. Below figures shows graph of measurement of sensors. The Y-axis show the different values of temperature and X-axis show different readings with respect to time in seconds at different days. The different colors indicates that the different readings for each day. Graph is non-linear according to time variation due to temperature in day scenario. Similarly the graph of humidity, soil moisture, and light intensity etc.



(a)

(a)Temperature Dependence Coefficient of Sensor.

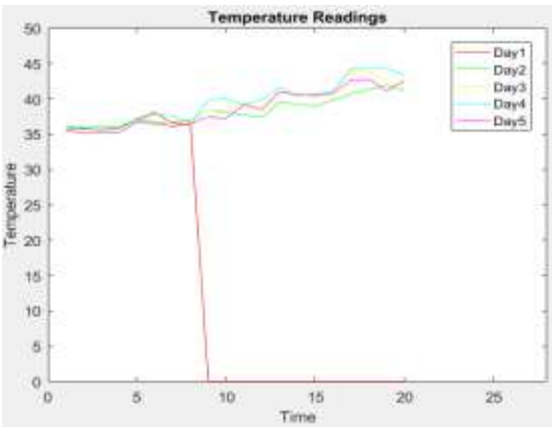


(A)

(A) Graph of Temperature Measurement Sensor.

In this case the reading of sensors contains zero values so there is some fault in that sensor. After that find the fault of particular sensor and then gives the linear or Non-linear graph between all individual sensor. The faulty sensor indicates on X-axis as shown in graphs. And the figure shows the Faulty temperature dependence coefficient comparison.

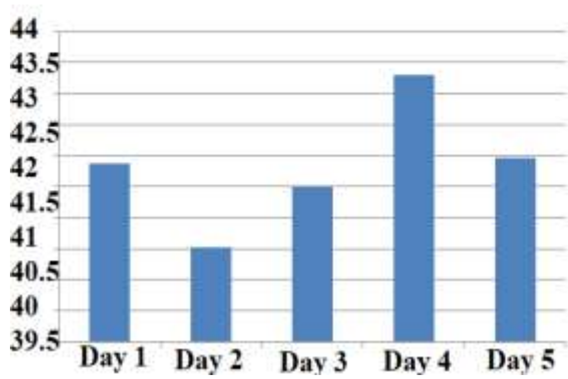
In our dissertations work, several readings has been taken for 'n' number of days. To avoid complexity we consider reading of five days are taken for plotting the accurate graphs. The five days analysis at different environmental conditions over surrounding. If it contains zero readings then it concludes that there is some fault in sensors. Figures show that days has the faulty sensors. Similarly the graph of humidity, soil moisture, and light intensity etc.



(1)

(1)Graph of Faulty Coefficient of Temperature Sensor.

The below figures represent the mean error of sensors which indicates the smallest error. And it shows that the mean error comparison of sensors. The results show that day has smallest mean error in sensors. The Y-axis shows the different values of sensor and X-axis shows different readings with respect to different days. Similarly the graph of humidity, soil moisture, and light intensity etc.



(2)

(2)Graph of Mean Error Graph of Temperature.

V. CONCLUSION AND FUTURE WORK

Wireless sensor networks have a huge potential for smart monitoring systems. The ability to develop low cost and simple end devices for quickly deploying in the field makes WSNs very attractive for smart agricultural systems. There is a gap in the literature about the engineering design and application of such systems for a real-world application. Moreover, most of the work focuses on LoRa-WAN as the networking protocol of choice for deploying LoRa based sensor networks, specifically for the applications. Dissertation work focused on design, development, and application of LoRa and IoT technology using low-cost solution available for agriculture platform. The experiment measures to determine sensor accuracy, select sensor and design a long-range (up to 500m) low power (66 mW per hour) communication platform. To reduce communication failure and save energy to enhance the efficiency of agricultural management by designing the LoRa network transmission interface. Experimental work aids remote monitoring of fields to farmers as well as assists to increase in yield. In another approach use of IoTs for data analysis of the sensor network is recommended with the help of a smartphone. In our approach K-means unsupervised clustering algorithm used for data analysis and also we can find the fault of a particular sensor network.

LoRa module has further increases range by improving antenna design. The customize web-page design for real time data analysis for the specific wireless sensor network design. In another approach the number of parameter with n number of sensors extends so get real time data with high accuracy.

In future this work can be extended as large number of data collected then gives more accurate and precise results by the use of algorithm.

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