WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Regulation of Multi-Featured Sensory System for Remote Lab Management

Ashley Anisha T*, Bhargavi J K*, Jog Sai Vaibhav*,Mahima P*, Usha Rani J#

*B.E. Students *, Assistant Professor#*
Department of Computer Science and Engineering, GSSS Institute of Engineering and Technology for Women, Mysuru-570016

A B S T R A C T

This paper illustratesthe remote monitoring of a variety of parameters and application control in a laboratory environment. The main concentration of this paper is to focus on performing the above stated using LoRa along with Arduino. The paper also shows the results of application control using esp8266 board. The monitoring features includes detecting the temperature and humidity of the environment. It includes a flame detection system. This flame detection system extends to accommodate a sprinkler system that extinguishes the flame. In order to monitor the various parameters that are being detected we connect to a cloud environment that is Thingspeak. Over here we visualize the collected data. This project also pings the user with an email notification through Thingspeak-MATLAB. The data transmitted to Thingspeak is read through an API and stored in a MySQL database which is displayed on a self-created webpage. Similar application control is also performed using an esp8266 module. Here, we achieve light and fan control of the laboratory using an intermediatory Blynk application. Transmission and displaying of a message on an LCD screen are also done using the same.

Keywords: LoRa, Remote management, ESP8266, Arduino, ThingSpeak

1. INTRODUCTION

LoRaWAN is a networking protocol which is built on top of the LoRa radio modulation. It is low power consuming and can be used for wide area. WSN refers to dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. LoRa is being used in our project as it uses 868 MHz/ 915 MHz ISM bands. It has a wide coverage range. It consumes less power and many to one connection features. E-commerce giants like Amazon using robots and IoT sensors for smart warehouse management. It can also be used in home automation systems, where you can use it to control appliances like lights, fans, TV's and other devices. It can also be used for fire detection and for monitoring the temperature for air conditioning. . This can be achieved using low power wireless networks like LoRa.

Our aim is to create a remote laboratory management system pertaining to features such as temperature, humidity and flame detection and control with LoRa, Remote Application monitoring system, communication system with ESP8266 based Wi-fi module NodeMCU. It is our aim to accomplish an in-house two-way communication system in our project.

After high-speed internet has become popular, a lot people can be interconnected over the world. This is not limited to only human beings conversing with each other, but includes all electronic devices sending information amongst themselves and being connected. As internet became popular, the prices and cost of using WiFi- wireless fidelity became cheaper. So, one might ask what internet of things is and how it works. It basically connects electronic devices called sensors (or nodes) at any place to other sensors or to the network. The network might consist of the cloud storage or even for processing purposes, leading to analyzing the data. The storage on the cloud lets the users use the data stored there however they want, mainly to send notifications and alerts based on some criteria. The IOT also includes the interaction between the humans and these devices- sensors. This interaction is highly beneficial in developing new technologies which will reduce the amount of only human interaction. It can be used in developing smart cities, weather

* *Corresponding author.* Tel. : 9900211003;
E-mail address: ashleyinweb@gmail.com

monitoring, healthcare, security systems, etc. For example, it can be used in smart cities with smart transportation, security systems, automated parking systems, etc.

Nomenclature

API – Application Programming Interface
DHT11 – Digital Temperature and Humidity – 11
LoRa – Long Range
LCD – Liquid Crystal Display

2. LITERATURE SURVEY

2.1.Smart Home Prototype- Sarah OpipahHusnul; Qodim; Deni Miharja- 03 November 2020- IEEE Xplore-

This paper implements smart home technology system using LoRa. Here, LoRa Dragino 915 MHz module has been used.Using this module communication is made possible between the LoRa client and the server. Over the past few years, many devices are able to connect to the internet. These technologies have taken modern smart home designs to the next level. These electrical devices enable a comfortable automated environment which is entertaining as well as safe to be in. However, this leads to increased energy consumption day by day. Hence smart homes offer variety of safety protocols and reduced energy consumptions methods and other features too. These systems are not able to cover all the possible areas of a home automation system. Multiple sensors are attached to the system to include facilities like home environment adjustment, monitoring and controlling the home from any place and at any given time [1].

2.2. Wireless network mesh-Kai-Hsiang Ke; Qi-Wen Liang; Guan-Jie Zeng -12 June 2017-

The paper examines LoRa, which is a wireless communication technology that can be used over a long distance. This technology works efficiently to transmit data over long distances in countryside but interference can be caused due to any obstacles like buildings, trees etc. in its signals.It is this interference that generates the necessity to use multiple LoRa gateways in Urban areas so that indoor devices can also transfer data to remote. Mesh networking can helpto increase the range of communication and packet delivery without installing too many LoRa gateways. This paper presents study of LoRa mesh-networking for Internet of Things applications [2].

2.3. Forest fire detection -Adnan; A. EjahUmraeni Salam; Arham Arifin- 24 October 2019 –

When it comes to forest fires, timing is a very critical aspect. Delays could lead to unwanted complications and loss. To overcome the problem, we conduct research so that forest fires can be quickly detected.This paper focuses on using mesh networks to reduce the delays caused in the receival of the alarm information when fire is detected. Forest areas generally do not have any network communication facilities available due to which the chances of delays in case of forest fires are high. We have hence designed forest fire detectorsthat work through mesh network using LoRa. It also uses Google maps to send the exact location of the fire. It utilizes the following components:Arduino Uno, DHT 11 humidity and temperature sensor, MQ2 sensorand LoRa modules. Several gateways can be installed in the forest area. BW 250 CR 4/5 SF 10 are the best configurations that can be used for fire detection. As a result,we are able to achieve sending data to the LoRa gateway over 500 meters away from the sensors [3].

2.4. Design and application of smart home using lora-03 November 2020-F.A.R. Mu'amarWildan; Eki Ahmad Zaki Hamidi

This paper discusses controlling of home applications using Lora. Here, a LoRa Dragino Gateway acts as a client and a NodeMCU modules helps transfer data between user and the server. The purpose of NodeMCU(ESP8266) is to allow us to connect to different Servers using Wi-Fi technology. It is a small module which also provides mobility. The aim of this is to design a GUI for smart homes in order to control the various electronic devices and everything done with the help of LoRa. Th findings could help implement LoRa based interfaces and home automation systems in real life. The web-based application is compatible with various Android versions like Android 6, 7.1.2, 9, 10, and iOS 9.3.5, and browsers such as Google Chrome,Mozilla Firefox and Internet Explorer. Each of the interface designs have been tested 10 times and produced 0% errors. Hence it is safe to say that all the features are implemented precisely [4].

2.5. Lora in sensor network for indoor application - Raihan ZakyThamrin; Octarina Nur Samijayani - 25 January 2021-

In the LoRa design, the last nodeworkslike a end node that is connected to sensors and other allies which then send data togateway, and to send to amain Server. This paper talks about LoRa on network, showcasing its advantages, has long range distance of 1 km, low energy usage, and data received

in json string. This was conducted to testperformance and working of single LoRa node in sending the data sensor for monitoring. The testing is done in a closed environment, with 3-meter distance between end device node and gateway. The test is done using twotypes of data string. The size of data collected depends on the number of data strings that has been sent. More the number of data strings sent will increase the capacity of data and increases the power usage. Data sensed is successfully sent by LoRa transceiver to the gateway, There is a data transmission error of about 14%. Some parameters that can be adjusted to increase the performance include the channel frequency, number of data string bits, and also interval time of data transmission, which can be changed following to the properties of the sensing parameters.[5]

2.6. Long range alarm system- Weifeng Wu; Fengying Huang - 19 November 2021-
This paper talks about the design of a wireless long range alarm system. There are two types of long range wireless network for different situations and then it shows the hardware design of the system. Espressif ESP32-WROOM-32 microcontroller and Ai-Thinker Ra-02 LoRa module based on Semtech SX127 is used to design the system. It is separate on the sender side and reciever side. On the sender side, a TOF Lidar distance sensor is used for calculating the real time distance which is taking place at a high speed. If the distance calculated by the TOF Lidar is below the alarm threshold then the sender side distributes a particular LoRa packet, and the reciever identifies the LoRa packet to trigger the alarm[6].

3.PROPOSED METHOD

Automations were introduced in the past few years so that it makes the human life easy. The existing systems are heavily concentrated on home automation, irrigation system,industry automations using robots, etc. In this project, we are trying to implement a multi-featured sensory system in the laboratory. This system is mainly directed to solve a few of the shortcomings of a laboratory when it comes to remote monitoring. We use IOT concepts, specifically LoRa technology and ESP8266 based Wi-fi module NodeMCU. This project mainly focuses on the following features of a real time laboratory:

- Temperature and humidity control with LoRa:
  Humidity plays an important part in maintaining good condition of a system. Too much humidity might cause corrosion or similar faults in the device. Thus, it is a good practice to monitor humidity in a laboratory.
- Automatic fire detection and water sprinkler system:
  We designed an IoT based LoRa module which is used for forest fire detection systems to detect fire in the laboratory as soon as possible, before the fire spreads and ruins the components. The system will be integrated with several sensors to detect fire and automatically turns on the sprinkler system.
- Remote Application monitoring system:
  The Remote Power Switch can be used to remotely control the power of external devices or appliances. Appliances include the control of general devices, lighting, remote servers, towers, enabling and disabling security systems, access control of gates and doors. The control can be done using an app called Blynk.
- In-house Communication system:
  Primarily, the proposed system has been divided into two parts, the sender end, where the system interconnects users' mobile phone and the receiver end which is a monitor to display the information.
- Database and webpage:
  The temperature, humidity and flame values collected from the sensors will all be safely stored in the database, for future references, and has the additional feature of them being displayed on an exclusive webpage.

3. SYSTEM DESIGN

The different design diagrams for each of the modules of the project are shown below with explanation:

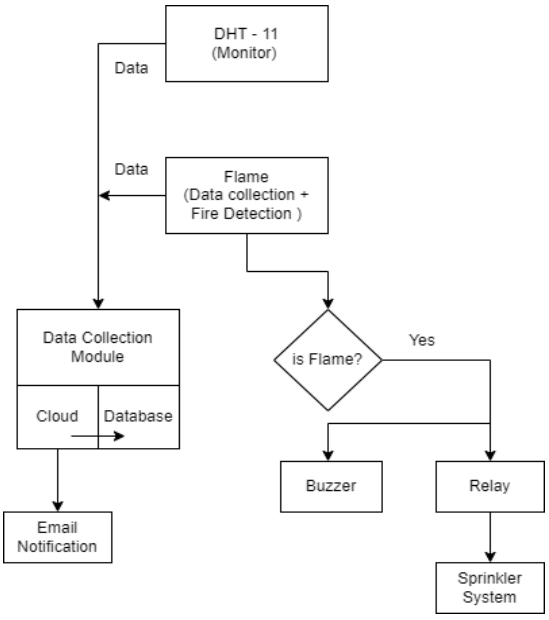


Fig. 1 - Dataflow diagram for data collection, fire detection and sprinkler system.

Fig. 2–Static diagram for application control and communication.

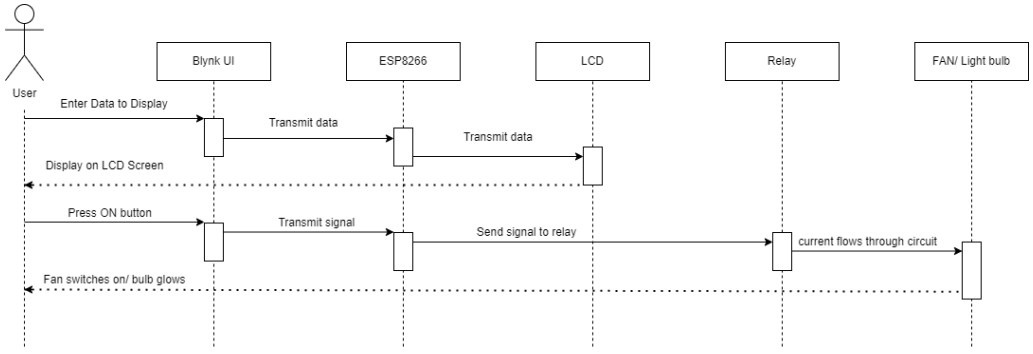


Fig. 3 – Schema diagram for Application control and communication.

5. DESIGN METHODOLOGY

5.1 Humidity and Temperature monitoring:

This module utilizes a sensor called DHT11 in order to sense the humidity and temperature of the environment. The sensor is mounted on an Arduino board where the code is fed. This code also consists of the client code that will help transmit data to the gateway. The gateway in turn has a server code running on it that then transmits the data over to Thingspeak cloud platform. We make used of graphs and displays to display the current temperature and humidity of the environment. This data is then collected using the read API keys and then stored in a local MySQL database from where, with the help of queries, it is displayed on a webpage.

5.2 Flame Detection:

This module uses a flame sensor in order to detect fire. This sensor is built such that it receives electromagnetic radiation using an electric circuit. The sensor is connected to LoRa Shield mounted on the top of Arduino board where the code is fed. It has a similar client server process running as seen previously in the "Humidity and Temperature Monitoring" module. Hence the data generated by the flame sensor is sent to ThingSpeak where it is displayed as high if there is fire and a digital red button glows and low for no fire where a digital green button glows. This data is also red by an ajax code using ThingSpeak API and store in a MySQL database from where it is fetched to be displayed on the database.

5.3 Alarm System:

In case there is a fire in the laboratory environment then there must be various ways to alert the user about it to take quick and proper measures. This project demonstrates a few ways to do so. There is a buzzer connected to the flame detection circuit. If flame is detected then the buzzer is programmed to ring. Alongside, there are also LEDs that glow in case there is a fire to provide visual cue to anyone present in the laboratory at the time of fire. The cloud platform ThingSpeak that displays the data from the flame sensor shows a digital red button glowing indicating fire. It is also programmed using MATLAB to send email alerts to the user to alert them regarding the fire. Hence using these methods, the alarm system is constructed.

5.4 Cloud and Database:

This project makes use of the cloud platform called ThingSpeak. The data is sent to this platform using the LoRa Shield and the Dragino Gateway over the LoRaWAN. There is a client code running on the Arduino and a server code running on the gateway. By making use of the write API keys of ThingSpeak the data from the sensors is sent to the cloud platform.ThingSpeak is a cloud platform that servers a variety of purposes to help analyse data and act upon the data to gain results. You can send data to ThingSpeak from your devices, create instant visualization of live data, and send alerts. Hence utilising the services of ThingSpeak we are able to display the data from the sensors in terms of graphs and charts. More over ThingSPeak can utilise MATLAB programming and using this we are able to send email notifications to the user.

The database we use in the project is a MySQL database run on XXAMP server. The data from ThingSpeak is read through an Ajax code using read API keys of the ThingSpeak platform and then it is stored in the MySQL database in table format. A webpage is created using HTML and PHP that uses SQL queries to access this data and display it to the user viewing the webpage.

5.5 Sprinkler System:

The project contains an automated sprinkler system that is triggered in case of fire. This system uses an AC/DC adapter to power up a 5V DC motor. It makes use of a relay to switch the motor ON and OFF. The code written makes sure that once flame is detected by the sensor, after a delay of a few seconds, a signal is sent to the relay which switches on the motor and this motor pumps water through sprinklers to extinguish the fire. This motor doesn't run indefinitely. When the fire is extinguished, the flame sensor detects no fire and send a signal to the relay to turn the motor OFF and hence the motor stops pumping the water.

5.6 Application Control:

The project includes an application control where a user is able to control light bulbs and fan using an Interface called Blynk. The user uses ON/OFF buttons on the Blynk interface. These signals are sent over Wi-Fi to ESP8266 board which then signals the relay and controls the devices by turning them on and off based on the command given.

5.7 Communication System:

The project is able to achieve communication by send a message using Blynk application to the laboratory on a small LCD display. This message is transmitted over Wi-Fi to the ESP8266 module which then passes the data on to the LCD screen and it is displayed on it. This LCD display is programmed to refresh itself every time a new message is sent. Hence, small snippets of code can be transmitted to this module and communication is achieved.

6.RESULTS

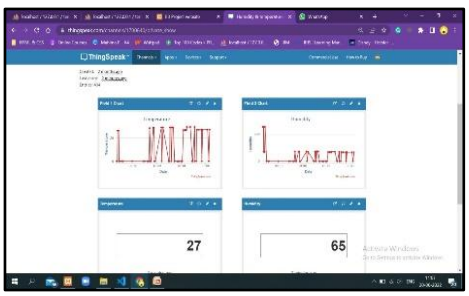


Fig. 4 – Output on thingspeak for temperature and humidity.

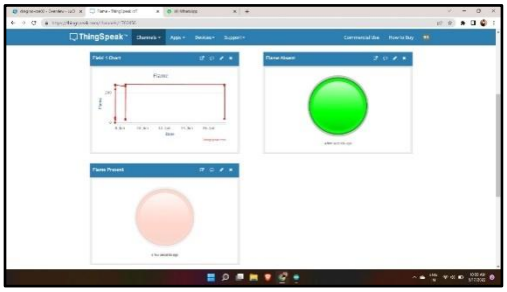


Fig. 5 – Output for flame detection on Thingspeak-green refers to no flame.

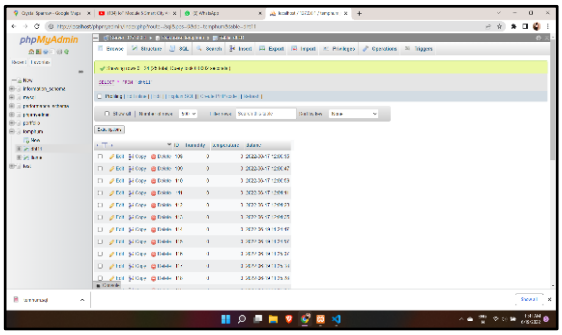


Fig. 6 – Database to store information collected.

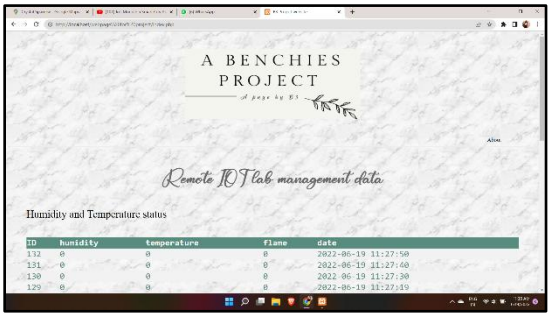
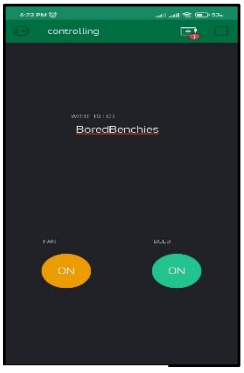


Fig 7- A webpage to display the data collected from the sensors



abbbbbbb b

Fig. 8 – (a)(b) Application control and communication system using NodeMCU.

7.CONCLUSION AND FUTUREWORK

From the project, it is clear that using LoRa technology, it is truly possible to transmit data over a long range. Since it uses very little power and is cost effective, it is useful in the Internet of things domain where sensors are required in all kinds of places and conditions. For example, the laboratory environment that we have used. As the applications of Internet of things are wide-ranged, we have also demonstrated the ESP8266 board to perform various functions over a Wifi network. Hence based on the needs of the user or the application, a choice can be made between both the technologies by surveying and weighing the odds when using either one of them. While we have achieved sending data over these networks, we have also demonstrated a variety of ways to use this data and various ways to display it through certain User Interfaces. We have successfully achieved a working model of sprinkler system, transmitting, receiving, storing and displaying of data through different platforms. This project gave us an opportunity to work with new and upcoming technologies in the vast and prospectus domain of Internet of Things. The experience was absolutely rewarding. While it was challenging to work with new technology and we confronted many hurdles. Paving our way through numerous trial and error processes helped us learn a lot and the outcome was more fruitful than ever. We gained many skills like programming with Arduino and ESP8266, using electronic devices and circuit connections, understanding LoRa network, working with ThingSpeak etc. We were also able to experience working in a team, discussing and taking important decisions and going through the multiple phases of software engineering. This will definitely help us in our future academic and career life. Lastly, the domain of IOT is full of new and creative opportunities for anyone who wishes to take a dive. We conclude that this project provides a new direction in achieving progress in the various IOT networking technologies and achieving the dream of living in a smart world.

This project is implemented on a small-scale basis in the model of a laboratory environment. It can be used in an actual laboratory to monitor the surroundings and control the equipment in real time. Just like the automated sprinkler system there are a variety of automation possibilities in using these technologies. There are many more sensors that can be connected and integrated in the environment to achieve more communication amongst things and create a smart environment that is not only limited to the scope of laboratories but can be used in any kind of indoor and outdoor environment. Since the technologies used in this project are constantly upgrading the working models need to be constantly updated so that they work more efficiently and are also able to run in sync with any other technologies that are used. LoRa – Long Range is capable of transferring data over 3 miles range and hence the project can be made to scale up and work over this kind of range, all with low cost and less power utilization.

Acknowledgements

This paper and the research behind it along with the satisfaction that accompany the successful completion of the project would have not been possible without the supervision and guidance of the following people. Predominantly, the authors are very much obliged to Smt. Vanaja B Pandit, Honorary

Secretary, GSSS(R) and the Management of GSSSIETW, Mysuru for providing help and support to carry out the project.The authors are grateful to our Principal, Dr. Shivakumar M, for providing us a productive environment for engineering studies and also for giving the freedom of applying the theoretical knowledge that we have gained.The authors regard it is a privilege to express sincere thanks to Dr. S.MeenakshiSundaram, Professor and Head, Department of Computer Science & Engineering, for his support and extremely useful guidance throughout the working process of this project. The authors would like to appreciate our Guide Mrs. Usha Rani J, Assistant Professor, Department of Computer Science & Engineering for her consistent support, pointing us to the right direction, suggestions, immeasurable motivation and encouragement for the successful completion of this project. The authors would like to extend the thanks to the Project coordinators Smt. Madhu M Nayak, Assistant Professor & Smt. Usha Rani J, Assistant Professor, Department of Computer Science & Engineering for their constant monitoring, guidance & motivation throughout the tenure of this project. The authors appreciate all the help given by the teaching and non-teaching staffs of our Computer Science & Engineering department. Finally, the authors would like to warmly thank their parents and friends who gave them unwavering motivation to complete this work successfully.

REFERENCES

[1] S. Opipah, H. Qodim, D. Miharja, Sarbini, E. A. Z. Hamidi and T. Juhana, "Prototype Design of Smart Home System Base on LoRa," 2020 6th International Conference on Wireless and Telematics (ICWT), 2020, pp. 1-5, doi: 10.1109/ICWT50448.2020.9243643.

[2] K. Ke, Q. Liang, G. Zeng, J. Lin and H. Lee, "Demo Abstract: A LoRa Wireless Mesh Networking Module for Campus-Scale Monitoring," 2017 16th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN), 2017, pp. 259-260.

[3] Adnan, A. E. U. Salam, A. Arifin and M. Rizal, "Forest Fire Detection using LoRa Wireless Mesh Topology," 2018 2nd East Indonesia Conference on Computer and Information Technology (EIConCIT), 2018, pp. 184-187, doi: 10.1109/EIConCIT.2018.8878488.

[4] F. A. R. Mu'amar Wildan, E. A. Z. Hamidi and T. Juhana, "The Design of Application for Smart Home Base on LoRa," 2020 6th International Conference on Wireless and Telematics (ICWT), 2020, pp. 1-6, doi: 10.1109/ICWT50448.2020.9243648.

[6] W. Wu and F. Huang, "Long Range Wireless Alarm System Based on LoRa and TOF LiDAR," 2021 International Symposium on Computer Technology and Information Science (ISCTIS), 2021, pp. 55-58, doi: 10.1109/ISCTIS51085.2021.00020.

Websites and manuals:

• LG01_LoRa_Gateway_User_Manual

• http://matternett.blogspot.com/2016/09/fetching-data-from-thingspeak-iot-cloud.html

• LoRaWAN Tutorial | Dragino Gateway Setup with TheThingsNetwork | LG01-P LoRa TTN -https://www.youtube.com/watch?v=VldgrTKdAqo&feature=youtu.b