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LORA BASED DATA ACQUISITION SYSTEM

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Abstract - *Since the current and future trend in building and industrial automation sees an increasing demand of Internet of Things (IOT) technologies, that allows us to implement networks of low power sensors and actuators, and, at the same time, it enables advanced services and applications. So, in this project we propose the use of a common protocol in the IoT domain, the REST API (Application programming interface) over a LoRa physical communication link, to jointly use the lightweight features offered by the long range, low power wireless capabilities offered by LoRa, to deliver high end data acquisition system. We decided to make a Data Acquisition System while using LoRa and IoT mainly for application related to Automobiles. It will have sensors that monitor the status of different parameters such as fuel percentage, temperature, smoke detector, GPS with precise location, humidity, vibration in a vehicle and report it to the user on his mobile , laptop or any device . We have installed VS code, Python IDLE, Arduino IDE in laptop to run the code . We have designed a virtual circuit of our hardware through fritzing and after verifying it we implemented it physically. We have used Embedded C language to write Arduino code and used python for Graphical User Interface.*

Key Words: **LoRa, SX1278, ESP32, NodeMCU, IoT, ThingSpeak , Dashboard**

1. INTRODUCTION

The LoRaWAN identification stands for Low Power , Wide Area networking protocol that is specifically designed for battery to connect wirelessly and may be used for battery operated things for the web in regional similarly as international networks so that it works on certain vital and key IOT needs like Bi-directional communication ,end-to-end security , etc. The proprietary LoRa wireless frequency technology stands for the physical layer protocol meantime LoRaWAN, developed by the LoRa alliance , stands for the media access management layer protocol each LoRa and LoRaWAN along permits IOT applications that solve a number of the largest challenges facing by our planet : energy management , natural resources reduction , pollution management , disaster interference , etc .

2. LITERATURE SURVEY

The wide preparation of Wireless sensor Network has created huge contribution to create positive that the healthy and orderly operation of DC device. setting attached info similar as temperature, humidity, smoke concentration, CO2 (CO2) concentration may be keep and be studied with the assistance of WSNs (5-6). Among them, the temperature distribution of the DC has continuously been associate degree crucial index, as a result of it mostly affects the performance of the system and its trustability on that and at a similar time it can even provide bound steering on system operation (7). With the ever- stern and growing in size of DCs and also the adding range of outfit that must be coated and managed, most short- vary Wireless sensing element Network technologies similar as Zigbee or Bluetooth aren't any longer practicable in DC. Li etal. (1) designed LEMoNet, a Bluetooth- based mostly low- energy WSN, for DC watching. The core of the LEMoNet node is that the HY-40R201PC module. so as to expand the watching vary of Bluetooth from 18m × 10m to 38m × 20m, the authors exaggerated the amount of entranceways from three to eight and adjusted the position of the gateway within the rack. Experimental results showed that the position and range of gateways affected the PLR. Jiang (4) used the Zigbee technology to create a tree topology so as to gather the DC environmental info and expand the communication vary. The routing node will establish a subnet freelance of the equivalent and is to blame for encouraging info. All the below work that used Zigbee or Bluetooth amplified the communication vary by adding the amount of routing nodes or gateways. however these approaches additionally exaggerated money prices and energy consumption. LoRa may be a low- power wide space network (LPWAN) that exhibits benefits ofultra-long-distance transmission and low power consumption as a result of it's Combines unfold Communication (CSC) (8). it's been with success positioned in varied large-scale operations. For illustration, Petajajarvi etal. (9) had stationed an outsized range of LoRa detector nodes at the University of Oulu, Republic of Finland on the 868 megacycle unaccredited oftenness band and achieved full content of the complete lot; Guang etal. (10) assembled a LoRa wireless network within the island agriculture space to hide the hydrogen ion concentration, water temperature. The take a look at results show that the tip device and also the LoRa entranceway can do electronic communication within the entire space (900 × 800m) with low power consumption and have sensible communication trustability. Lately, LoRa attracts amenities from information center masterminds to create wireless watching systems grounded on commercially on the market LoRa finish node (11). This paper, on the opposite hand we tend to style an extra provident and energy- saving hardware board of the tip device..

3.LoRa

LoRa acronym for Long Range is a vast modulation of spread spectrum technique which has been discovered from CSS technology also known as chirp spread spectrum technology. Devices grounded on LoRa and other technologies similar as wireless radio frequency are all wireless platform with low power with long range that's one of the useful wireless side of IOT platform. These devices have revolutionized IOT by enabling data communication over a long range while using little power. When connected to a non cellular LoRaWan network, Lora devices hold a vast range of IOT operations by transmitting packets with important information.

Fig -1: Applications of LoRa

4.OBJECTIVES

Data acquisition starts with the physical phenomenon or property that needs to be measured . It can be included for example temperature, light intensity, gas pressure, fluid flow, and force, etc. Regardless of the type of physical property that mainly needs to be measured , the physical state measurement is the priority and first it must be transformed into a single form that can be sampled further by a particular data acquisition system. Such event or a task that performs these processes or operations that leads to its transformation are all devices also known as sensors . A data acquisition system is a collection of both hardware & software that allows to measure or take charge in any physical characteristic of something in the reality . A total data acquisition system consists of DAQ hardware, sensors and actuators, signal conditioning hardware, and a computer which mainly runs on DAQ software. The main objectives of the Data Acquisition System is it must monitor the complete operation to maintain online optimum and safe operations. It must provide an effective communication system which will be able to identify problem areas targeting mainly on minimizing the unit availability and increasing the unit through point at low cost . It must collect, conclude and store the data required for diagnosis of the process and record the requirement. It must be able to analyze unified performance indices using online, real time data. It must be dependable, and not have a lesser down time.

5. CIRCUIT DIAGRAM

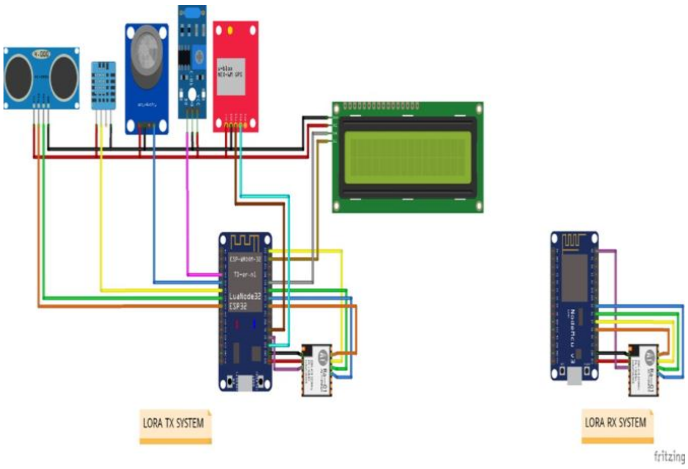


Fig -2: Final Circuit Diagram

Red wire in the circuit is the VCC wire and VCC stands for Voltage Common Collector it has voltage which is higher with relevancy to GND that is Ground . Black wire is the ground wire . Grounding gives electricity the most effective way to return to the ground via our electrical panel. For LCD then we have used I2C LCD for displaying the collected data which has 2 pins SDA and SCL. SDA stands for Serial Data and it works as the master and slave to send and receive data while SCL full form for Serial Clock does the work of carrying the clock signal. Next is GPS sensor it will detect the location of the car in which our device is fitted and will share real time precise location of the vehicle and also alert about any accident. GPS sensor has 2 pins RX and TX and they represent the receiving vehicle and the transmitting GPS satellite, respectively. Next important part is the ultrasonic sensor for fuel level of the vehicle which has 2 pins trig and echo Trig (Trigger) pin is used to trigger the ultrasonic sound pulses. Echo pin produces a pulse once the mirrored signal is received . Next is smoke sensor which has 1 pin . That will basically detect any smoke incase of fire and alert the system about it. And it will trigger the water pump to start water shower in the vehicle to extinguish fire. The 5 pins on the Lora is used for SPI communication , i.e. Serial Peripheral Interface. Vibration sensor has 1 pin that will sense any sudden vibration and then we can match data with accelerometer to verify if there is an accident or a small bump on the road..

6. BLOCK DIAGRAM

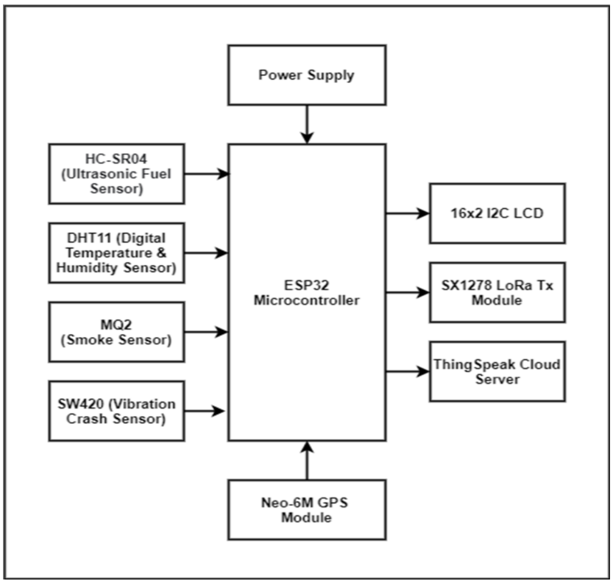


Fig -3: LORA TX SYSTEM

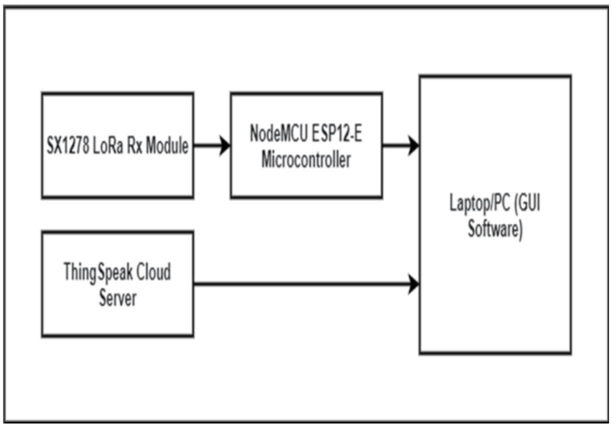


Fig -4: LORA RX SYSTEM

Description:

In block diagram of our project we have two systems one is LoRa transmitter system i.e LoRa TX SYSTEM and other is LoRa receiver system i.e LoRa RX SYSTEM. In LoRa transmitter system we have ESP32 microcontroller to which the particular sensors that we have chosen are connected as shown in the above figure of TX system and also GPS for live location tracking and its details. LoRa works in a specific range and to collect the data if the system is out of distance or its range then the Thingspeak cloud server is used which specifically transmits the data using Wifi. We also have LoRa TX module attached to the microcontroller which transmits the data forward. Now as you can see the figure of the LoRa receiver system . We have NodeMCU to which LoRa receiver module is attached this forwards the data to the PC which further displays the data.

7. METHODOLOGY

Sender device comprises of NodeMCU and a LoRa Module along with sensors such as HC-SR04 (ultrasonic sensor for monitoring fuel level), DHT11(for monitoring temperature and humidity), MQ2(for detecting smoke) and SW420(vibration sensor for crash alert). Neo-6M GPS module will be used for location alerts. Sensors sense data and report it to NodeMCU. Data is then sent over LoRa Communication Link. Receiver device comprises of Node MCU and LoRa Module. Receiver LoRa collects data through LoRa communication link and passes it to NodeMCU. The data received by NodeMCU is then passed to Python based GUI for Data Acquisition System. Here data collected can be displayed or saved for future use. The device can work as an IoT Device (over internet) when LoRa cannot establish link with other LoRa.

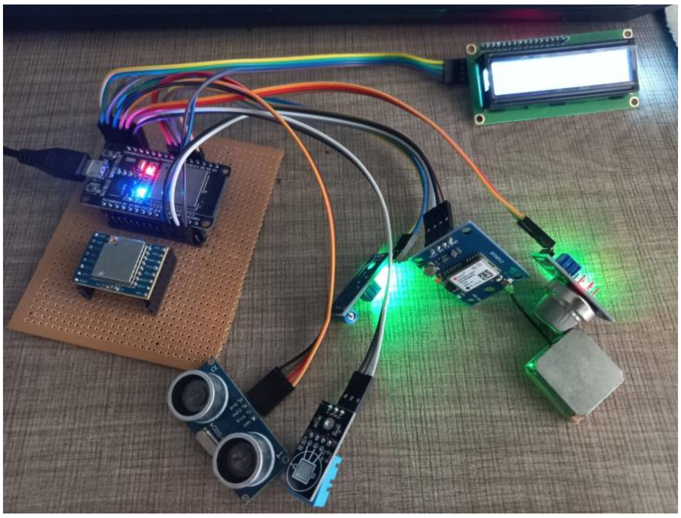


Fig -5: TRANSMITTER DEVICE

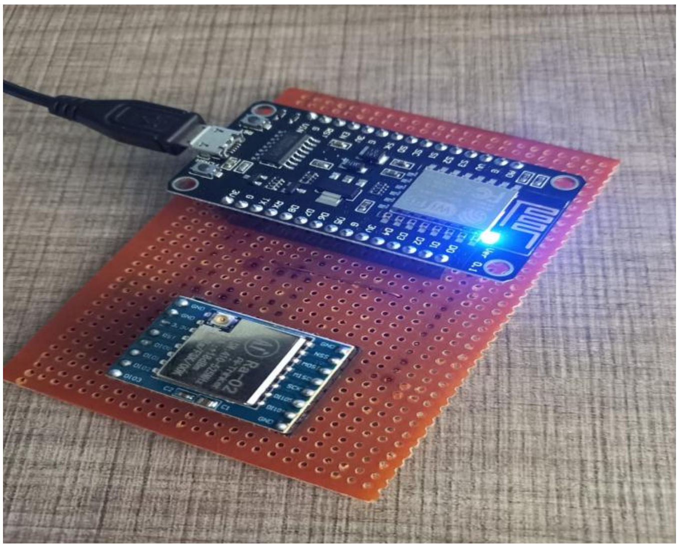


Fig -6: RECEIVER DEVICE

8. IMPLEMENTATION

Major components used in hardware were ESP32 Microcontroller, NodeMCU, ESP12-E Microcontroller , HC-SR04 Ultrasonic Sensor , DHT11 Digital Temperature & Humidity Sensor, MQ2 Smoke Sensor , SW420 Vibration Sensor , Neo-6M GPS Module , SX1278 LoRa Modules , 16x2 I2C LCD , Connecting Wires , Zero PCB , Male Headers, Female Headers , Jumper Wires, USB Cable, Power Supply.

And this is the circuit we implemented as shown in the picture below with different sensors by giving them the power supply.

As we can see after connecting all the sensors including GPS module as well as the LoRa device and the ESP32 microcontroller with the I2C LCD display on the transmitter device or the sender device at the same time on the receiver device another LoRa and Esp32 microcontroller .

After all the data that the sensors and the GPS module collects it gets processed into the microcontroller which displays the data on the LCD display and at the same time it sends the data to Lora device which then will be nominated as a packet .

The data which is sent by the microcontroller to the Lora is possible with the help of Serial Peripheral Interface i.e SPI.

The LoRa device which is called as the packet then sends the packet to the other packet i.e. Lora device of the receiver circuit and that communication process is called Lora to Lora communication.

After that data is transferred on the receiver circuit Lora again through SPI it gets processed to the microcontroller device on the receiver .

That microcontroller then posts the data on the Internet where with the help of Thingspeak we can monitor and save the data as many times as we want which will be our data acquisition of our project.

And finally the data or the results is also displayed on the Graphic User Interface as you can see in the below picture which we have created using Python.

Components for Software were Arduino IDE , Python IDLE , ThingSpeak , Fritzing , VS Code .

The Arduino integrated (IDE) was a cross-platform application for Windows, macOS, Linux that was used for writing the programming language and for our project we used Embedded C . It was used to write and upload programs to basically integrate to our circuit and we modified the code for our sensors accordingly.

Python is an interpreted high-level general-purpose programming language. It allowed us programmers to easily write Python code for the Graphic User Interface .

ThingSpeak was an open-source software which basically allowed us to communicate with internet enabled devices. It provided data access, retrieval and logging in and out of data by providing an API to both the devices and social network websites.

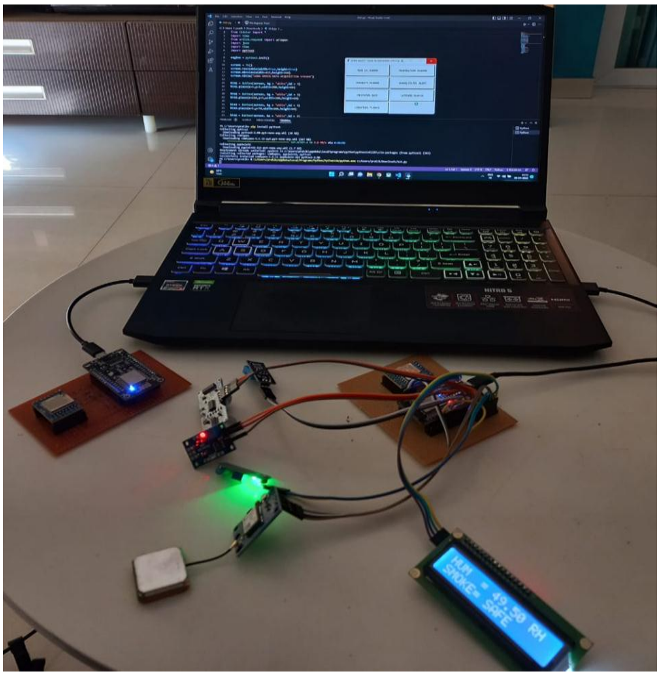


Fig -7: LORA BASED DATA ACQUISITON SYSTEM

RESULTS

1)Some of the Outputs that were collected by the sensors according to the surrounding that are displayed on the I2C LCD Display .

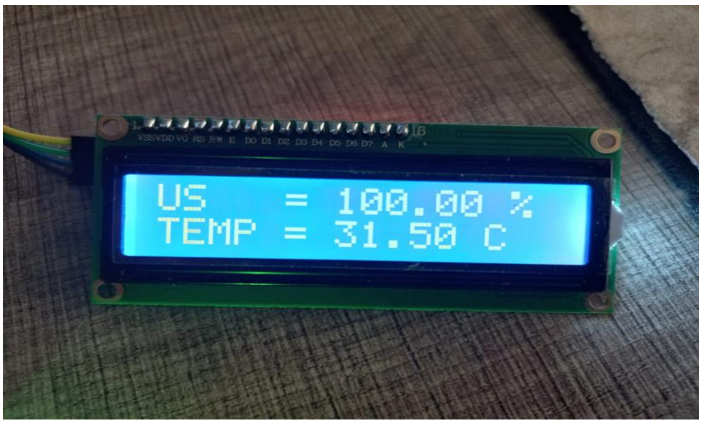


Fig -8: TEMPERATURE AND ULTRASONIC SENSOR OUTPUT

2) LATTITUDE AND LONGITUDE readings from GPS MODULE with respect to the precise location where the module is .

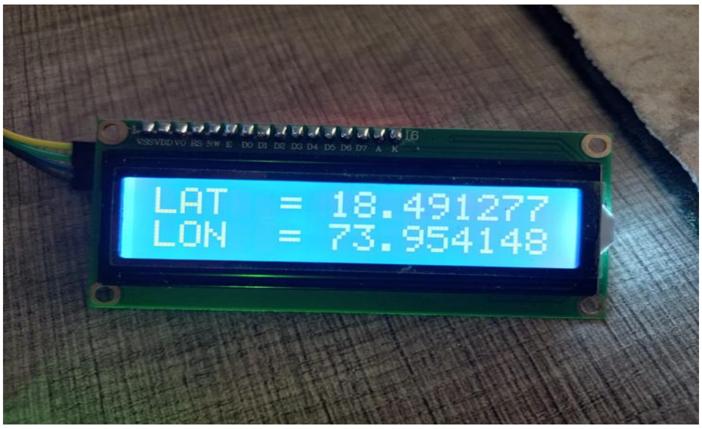


Fig -9: LATTITUDE AND LONGITUDE FROM GPS MODULE

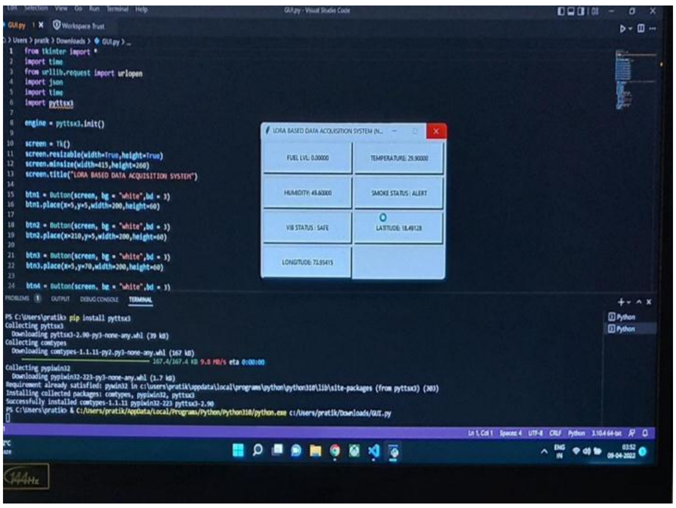
3) Different readings from Humidity sensors that changes according to the current location and smoke detector after detecting the smoke showing ALERT or else giving the signal that its SAFE.

Fig -10: HUMIDITY AND SMOKE SENSOR

4) Vibration sensor sensing whether its ALERT or SAFE

Fig -11: VIBRATION SENSOR OUTPUT

5) Outputs displayed on the GUI



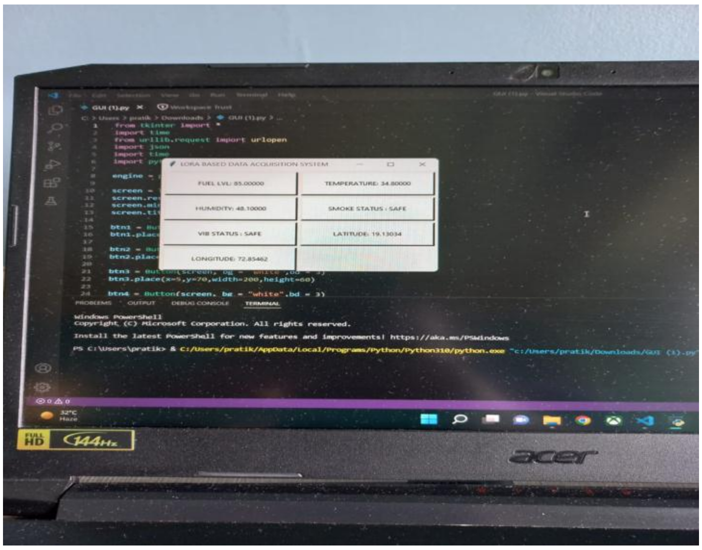


Fig -12: OUTPUT ON GUI

6) Also various entries and outputs recorded in the Thingspeak since the channel was created which helps us to monitor the data of the particular surrounding the sensors are placed at .

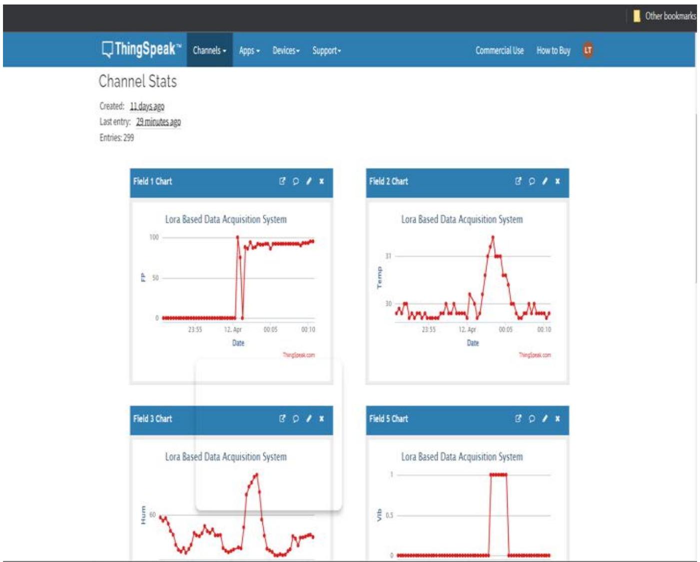


Fig -13: THINGSPEAK

FUTURE SCOPE

Camera can be installed for live monitoring. Android app can be developed which will be more convenient for an user instead of the GUI . Modify the code according to the results we want for more convenience. More sensors can be installed with respect to the application which can have more features. As said earlier since LoRa has many applications so could be used in various fields since the basic communication protocol is same .

CONCLUSION

This paper presented a system with hybrid communication focused on monitoring and controlling in data acquisition. Hybrid communication provides versatility to the system, allowing the addition of sensors or actuators and allowing remote monitoring through LoRa modules. Therefore, the Data Acquisition System can be deployed also without access to the Internet or mobile network coverage.

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REFERENCES

[1] C. Li, J. Li, M. Jafarizadeh, G. Badawy and R. Zheng, "LEMoNet: low energy wireless sensor network design for data center monitoring," 2019 IFIP Networking Conference (IFIP Networking), Warsaw, Poland, 2019, pp. 1-9.

[2] S. K. Vuppala, A. Ghosh, K. A. Patil and K. Padmanabh, "A Scalable WSN Based Data Center Monitoring Solution with Probabilistic Event Prediction," 2012 IEEE 26th International Conference on Advanced Information Networking and Applications, Fukuoka, 2012, pp. 446-453.

[3] S. Saha and A. Majumdar, "Data centre temperature monitoring with ESP8266 based Wireless Sensor Network and cloud based dashboard with real time alert system," 2017 Devices for Integrated Circuit (DevIC), Kalyani, 2017, pp. 307-310.

[4] C. Jiang, Y. Qiu, H. Gao, T. Fan, K. Li and J. Wan, "An Edge Computing Platform for Intelligent Operational Monitoring in Internet Data Centers," in IEEE Access, vol. 7, pp. 133375 -133387, 2019.

[5] W. Z. Khan, M. Y. Aalsalem, H. M. Zangoti, M. Zahid and M. K. Afzal, "Internet of Things based Physical and Environmental Monitoring System for Data Centers," 2018 International Conference on Radar, Antenna, Microwave, Electronics, and Telecommunications (ICRAMET), Serpong, Indonesia, 2018, pp. 41-44.

[6] M. G. Rodriguez, L. E. O. Uriarte, Y. Jia, K. Yoshii, R. Ross, and P. H. Beckman, “Wireless sensor network for data-center environmental monitoring,” in Sensing Technology (ICST), 2011 Fifth International Conference on. IEEE, 2011, pp. 533– 537.

[7] J. Moore, J. Chase, P. Ranganathan, and R. Sharma, "Making scheduling cool: Temperature-aware workload placement in data centers," in Proceedings of the annual conference on USENIX Annual Technical Conference. USENIX Association, 2005, p. 5.

[8] P. Edward, E. Tarek, M. El-Aasser, M. Ashour and T. Elshabrawy, "Further LoRa Capacity Enhancement through Interleaved Chirp Spreading LoRa Expansion," 2019 International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob), Barcelona, Spain, 2019, pp. 1-6.

[9] Petajajarvi J, Mikhaylov K, Roivainen A, et al. On the coverage of LPWANs: Range evaluation and channel attenuation model for LoRa technology[C]//IEEE International Conference on ITS Telecommunications (ICITST), 2015: 55圻59.

[10] Jin Guang, Gao Zihang, Jiang Xianliang, Zhu Jiahua. Development of island aquaculture environment monitoring system based on low-power wide area networks [J]. Transactions of the Chinese Society of Agricultural Engineering (Transactions of the CSAE), 2018, 34 (24): 184圻191. (In Chinese with English abstract)

[11] Diogo Santos, Bruno Mataloto, and Joao C. Ferreira. 2019. Data Center Environment Monitoring System. In Proceedings of the 2019 4th International Conference on Cloud Computing and Internet of Things (CCIOT 2019). Association for Computing Machinery, New York, NY, USA, 75–81.

[12] H. W. Chen and F. J. Lin, "Converging MQTT Resources in ETSI Standards Based M2M Platform," 2014 IEEE International Conference on Internet of Things (iThings), and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom), Taipei, 2014, pp. 292-295.

[13] R. Sharma, C. Bash, and C. Patel, ''Dimensionless parameters for evaluation of thermal design and performance of large-scale data centers,'' in Proc. 8th AIAA/ASME Joint Thermophys. Heat Transf. Conf., Fluid Dyn.Co-Located Conf., 2002, p. 3091.

[14] C.D.Patel, C.E.Bash, R.Sharma, et al.Smart chip, system and data center enabled by advanced flexible cooling resources[C]. Twenty First Annual IEEE. Semiconductor Thermal Measurement and Management Symposium. 2005:1-7.