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 technologies, that allows 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 , over a LoRa physical communication link, to jointly use the lightweight features offered by both and also the long range, low power wireless capabilities offered by LoRa, to deliver high end data acquisition system. We plan to implement a Data Acquisition System based on LoRa and IoT for Automobiles. It will have sensors that monitor status of different parameters in a vehicle and report it to the user.

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

1. INTRODUCTION

The LoRaWAN specification is a Low Power , Wide Area (LPWA) networking protocol designed to wirelessly connect battery operated things to the internet in regional or global networks and targets key IOT requirements such as Bi-directional communication ,end-to-end security , etc. The patented LoRa wireless radio frequency technology stands for the physical layer protocol meanwhile LoRaWAN, developed by the LoRa alliance , stands for the media access control layer protocol Both LoRa and LoRaWAN together enables IOT applications that solve some of the biggest challenges facing by our planet : energy management , natural resource reduction , pollution control , disaster prevention etc .

2. LITERATURE REVIEW

The widespread deployment of WSN has made important contribution to ensure the healthy and orderly operation of DC device. Environmental information such as temperature, humidity, smoke concentration, Carbon dioxide (CO_2) concentration can be collected with the help of WSNs [5-6]. Among them, the temperature distribution of the DC has always been an important indicator, because it remarkably affects the system performance and reliability, and can provide guidance on system management [7]. With the ever-growing size of DCs and the surging number of equipment that needs to be monitored and managed, most short-range WSN technologies such as Zigbee or Bluetooth are no longer applicable in DC. Li et al. [1] designed LEMoNet, a Bluetooth-based low-energy WSN, for DC monitoring. The core of the LEMoNet node is the HY-40R201PC module. In order to expand the monitoring range of Bluetooth from 18m×10m to 38m×20m, the authors increased the number of gateways from 3 to 8 and changed the location of the gateway in the rack. Experimental results showed that the location and number of gateways affected the PLR. Jiang [4] used the Zigbee technology to form a tree topology in order to collect the DC environmental information and expand the communication range. The routing node can establish a subnet independent of the coordinator and is responsible for forwarding information. All the above work that used Zigbee or Bluetooth expanded the communication range by increasing the number of routing nodes or gateways. But these methods also increased monetary costs and energy consumption. LoRa is a low-power wide area network (LPWAN) that exhibits advantages of ultra-long-distance transmission and low power consumption because it has Combines Spread Communication (CSC) [8]. It has been successfully deployed in many large-scale applications. For example, Petajajarvi et al. [9] had deployed a large number of LoRa sensor nodes at the University of Oulu, Finland on the 868 MHz unlicensed frequency band and achieved full coverage of the entire campus; Guang et al. [10] built a LoRa wireless network in the island aquaculture area to monitor the pH, water temperature. The test results show that the end device and the LoRa gateway can achieve data communication in the entire area (900×800m) with low power consumption and have good communication reliability. Recently, LoRa draws attentions from data center engineers to build wireless monitoring systems based on commercially available LoRa end node [11]. This paper, on the other hand we design a more economical and energy-saving hardware circuit board of the end device.

Chenhe Li (2019) developed LEMoNet, a novel low-energy battery operated wireless sensor network design for monitoring DCs. It assigns a two-tier network architecture and a data exchange protocol working multi-mode to balance the exchanges between high data reliability and low power consumption . They evaluated the performance of LEMoNet by deploying custom-designed sensor and gateway nodes in a production DC as well as through extensive simulation studies in networks of various sizes. They showed experimentally that LEMoNet achieves an average data yield over 98 % in the production DC. With one temperature and one humidity reading under normal working every thirty seconds, the battery life of LEMoNet sensor nodes is approximated up to 14.9 years on a single lithium coin battery.

Sunil Kumar Vuppala (2012) suggested considering the energy efficiency as key factor in data center design and they developed a WSN based data center monitoring (DCM) solution which includes the hardware system and an enterprise application. In the paper, he described the system architecture and analysed data that was captured for nine months which was one of the largest real life WSN deployment and based on the result they argued that the manual monitoring cost of data centers is reduced by 80%. This also resulted in avoiding a vast amount of emission of carbon.

Saraswati Saha (2017) proposed in the paper that The Internet of Things (IoT) system is an advanced solution for monitoring the temperature at different points of location in a data centre, with the help of internet through cloud based dashboard and also sending SMS and alerts via various platforms to the recipients making this temperature data visible over internet to particular recipients when temperature rises above when it is safe zone . This helped the datacenter management team to take immediate action to rectify this temperature deviation. Also it could be monitored from anywhere anytime over online dashboard by the senior level professionals who are not present in the data centre at any point in time.

Congfeng Jiang (2019) since he witnessed there is increase in demand for cloud-based services, such as big data analytics and online e-commerce, causing a rapid growth of large-scale internet data centers. In order to provide highly reliable, cost effective, and high quality cloud services in the paper they proposed an edge computing platform for intelligent operational monitoring in data centers. The platform integrated wireless sensors and on-board built-in sensors to collect data during the operation and maintenance of data centers. In addition, he proposed the platform also provides predictions of resource utilization, workload characteristics, and hardware health trends in data centers.

Wazir Zada Khan (2018) As we know the most valuable and critical asset in any organization is its data and the data center is the custodian of this data. The failure of detection of any such tragic events like fire break or any other physical breach may lead to total shutdown and destruction of the data center. Since smooth and protected functioning of data center is a challenging task and to bring these objectives in reality, Internet of Things (IoTs) was among the best option. So in this project they have proposed an internet of things based smart physical and environmental monitoring system for data centers. The proposed system generates security alarms and notifications and responds to situations when a threat occurs, and the smart object takes some task independently with human supervision.

Michael G. Rodriguez (2011) developed a wireless sensor network in her project for data-center environmental monitoring to improve energy efficiency and to optimize data-center performance. The sensor network consisted of a suite of sensor nodes for data sensing, a router node to relay sensed data, and a coordinator node to establish a network, receive the data, and process the data. The prototype sensor network was builded on Arduino open source hardware with a seamlessly integrated XBee RF module which configured to operate within the ZigBee mesh network standard. A 24-hour test run at Argonne's data center demonstrated the wireless networked environmental monitoring solution which was easy to integrate and manage with the existing IT infrastructure, while it delivered better visibility into the data center's 3D temperature and humidity distribution and substantial improvements in energy efficiency.

Justin Moore (2005) In contrast to the approaches towards trends like consolidation and higher-density computing configurations making the problem of heat management one of the critical challenges in emerging data centers their paper explored an alternate dimension to address this problem and a systems-level solution to control the heat generation through temperature aware workload placement. He examined a theoretic thermodynamic formulation that uses information about steady state hot spots and cold spots in the data center and developed realworld scheduling algorithms. Based on the insights from the results overall they demonstrated up to a factor of two reduction in annual data center cooling which costs over location-agnostic workload distribution, with minimal investment in terms of capital through solely software optimizations .

Juha Petajajarvi (2015) in the project she studied the coverage of the recently developed LoRa LPWAN technology via real-life measurements. They conducted the experiments in the city of Oulu, Finland, using the commercially available equipment. The measurements were concluded for scenarios when a node located on ground (attached on the roof rack of a car) or on water (attached to the radio mast of a boat) resulted their data to a base station. For a node operating in the 868 MHz ISM band using 14 dBm transmit power and the maximum spreading factor, they observed the maximum communication range of over close to 30 km on water to 15 km on ground . Besides the actual measurements, in the paper they presented a channel attenuation model derived from the measurement data. The model could be used to estimate the path loss in 868 MHz ISM band in an area similar to Oulu, Finland.

Hsiang Wen Chen (2014) since one of the key challenges of the Internet of Things (IoT) is the integration of heterogeneous technologies and communications solutions so in the paper he proposed a method to integrate Message Queuing Telemetry Transport (MQTT) protocol with the

ETSI M2M architecture via a new network function called MQTT proxy. The MQTT proxy, on the one side, acts as an MQTT broker to the MQTT clients. While on the other side, it served as a Gateway Application (GA) for interfacing with the ETSI M2M-compliant architecture, specifically OpenMTC developed by Fraunhofer FOKUS. By the MQTT

Proxy, MQTT resources now can be converged in the ETSI M2M architecture. Then they compared the MQTT Proxy with our previous HTTP Proxy.

P. Edward (2019) In this paper, he proposed more ICSLoRa designs in order to further enhance the LoRa capacity. The LoRa chirp signal is sub-divided into 4 or 8 subintervals and various interleaving patterns are designed with the objective to increase the number of bits per symbol by 2, 3 or 4 bits. The interleaving patterns were designed such that the cross-correlation among all the interleaved chirp signals were minimized. As a result, the data rate was enhanced by up to 57% for spreading factor 7 compared to only 14% in case of the original ICS-LoRa. This increase in data rate was at the expense of a BER degradation of only 0.95 dB. The results also showed that the proposed ICSLoRa system with 4 additional bits increased the cumulative capacity of ED by 50.61% compared to the nominal LoRa.

DETAILED INFORMATION

2.1 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 based on LoRa and other technologies such as wireless radio frequency are all wireless platform with low power with long range that is 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 accommodate a vast range of IOT applications by transmitting packets with important information .

3. OBJECTIVE

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 are as follows:

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 reliable, and not have a greater down time.

4. 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.

ACKNOWLEDGEMENT

I would like to express my special thanks of gratitude to our guide Mohan Kumar sir as well as our HOD Mahalaxmi Palinje mam who gave us the golden opportunity to work on this wonderful project on the topic of LoRa BASED DATA ACQUISITION SYSTEM which also helped us in doing a lot of research and we came to know about so many new things.

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