Advanced Journal of Technical and Vocational Education, 2 (3): 49-53, 2018
e-ISSN: 2550-2174

DOI: 10.26666/rmp.ajtve.2018.3.9

Design and Development of Gunung Lang Temperature and Humidity Monitoring System using LoRA Technology

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Abstract: The Internet of Things (IoT) can provide services to many areas including the environment monitoring. This paper explores the use of the LoRa Technology for environment monitoring, specifically temperature and humidity at Gunung Lang recreational park at Ipoh Perak Malaysia. The Lora Technology is been chosen because it can provide distance and remote monitoring using Long Range radio frequency before connecting to the Internet through Internet Gateway. The system consist of end node temperature and humidity sensor, Lora Gateway and using The Things Network (TTN) as a cloud services for logging and viewing data. The system has been implemented at Gunung Lang recreational park and was successful. The test of the distance also been done to have understanding of the approximation and the worakable range of the system.

Key words: LoRa Technology, IoT, environment monitoring

INTRODUCTION

Nowadays, the wireless technology is rapidly growth in the world. All of the information that we got are from the Internet. The important of wireless technology is to communicate between two different devices. The usage of the technology also across other areas like tourism and enviromental.

Main factors affecting tourism activities in Malaysia are physical factors, Malaysia having beautiful maritime islands and marine parks to attract tourists to the country. Malaysia can also attract tourists through the forest attraction of various types of fauna and flora and comfortable and fresh air. Various types of tourism activities that can be run in areas such as jungle forest lovers and camping.

Tourism in Malaysia is also influenced by the hot and humid climate conditions throughout the year. This situation has encouraged the influx of European tourists such as from Germany, United Kingdom, and Canada to Malaysia. The tourists who come from these countries love to enjoy sunbathing and environment exploration and jungle tracking activities due to the temperature of 27 C or more throughout the year. In addition, the availability of adequate facilities provided more advantages in tourism sector.

Gunung Lang recreational park which is located only five kilometers from Ipoh town is one of the many limestone mountains in the state of Perak. The park covering area of 30.35 hectares out of which 14.16 hectares consists of lakes. The problem encountered is not able to transmit the data due to the absence of an internet signal located. The Problem occurs because this area is located in the hillside and outback areas.

Implementing the LoRa technology [1] brings advantages in tourism. It helps lots in sector taking care and protecting flora and fauna in the forest. It keeps all information and statistics recorded and stored in cloud server of LoRa monitoring system. This is a safer and quicker way to achieve the monitoring project's objectives which is creating a temperature and humidity monitoring system.

Gunung Lang is chosen because of its unique geographical location which is rich of ecology diversity [2]. LoRa system is used since there do not have any Wi-Fi antenna or spot around Gunung Lang. LoRa system solves the problems related to location, distances and costs as expected [3]. It sends the records or data to administrators or administration department for investigation use. The data will be sent over the LoRa network into data storage that is hosted by a cloud service. The user or administrator can read the data using an application. Data in the application will be retrieved by an API that has to be created. Because the

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project will be open source, other people can help with the project and a community can be built around it.

We can connecting to the internet connection using long range radio frequency no matter where we are to monitor and collect data. LoRaWAN [4][5][6][7] is a Long Range, Low Power Wide Area Network (LPWAN) specification designed for the Internet of Things [8]. It emphasizes secure bi-directional communication, mobility, and localization services to provide simple, seamless interoperability among smart Things.

LoRa spreads communication between end-devices and gateways across multiple frequency channels and data rates. The spread spectrum technology uses data rates ranging from 0.3 kbps to 50 kbps to prevent communications from interfering with each other, and creates a set of "virtual" channels that increase the capacity of the gateway. To maximize both the battery life of the end-device and the end-devices and the overall network capacity, the LoRa network server manages the data rate and RF output for each end-device individually through an adaptive data rate (ADR) scheme. LoRa also addresses the need for security by providing encryption at the network level, application level, and device level through the use oa a unique network key, a unique application key, and a device specific key.

LoRaWAN networks typically are laid out in a star-of-stars topology in which gateways relay messages between end-devices and a central network server at the back end. Gateways are connected to the network server via standard IP connections while end-devices use single-hop LoRa™ or FSK communication to one or many gateways. All communication is generally bi-directional, although uplink communication from an end-device to the network server is expected to be the predominant traffic. Communication between end-devices and gateways is spread out on different frequency channels and data rates. The selection of the data rate is a trade-off between communication range and message duration, communications with different data rates do not interfere with each other. LoRa data rates range from 0.3 kbps to 50 kbps. To maximize both battery life of the end-devices and overall network capacity, the LoRa network infrastructure can manage the data rate and RF output for each end-device individually by means of an adaptive data rate (ADR) scheme. End-devices may transmit on any channel available at any time, using any available data rate, as long as the following rules are respected:

The end-device changes channel in a pseudo-random fashion for every transmission. The device respects the maximum transmit duty resulting frequency diversity makes the system more robust to interferences. The end cycle relative to the sub-band used and local regulations.

SYSTEM DESIGN

Before the development of the system is done, sketch of system design should be done in order to develop the system a more systematic and seamlessly.

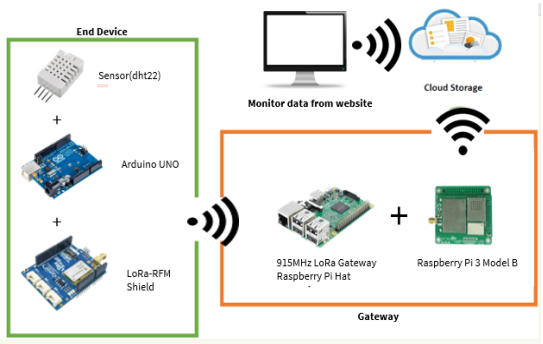

Figure 1 : System Design

The system design is divided into 3 parts,

End Nodes

Consistes of Humidity and temperature sensor which will received and send the data from arduino UNO to the LoRa shield. The data then been transmit using long range radio frequency.

LoRA Gateway

This part of the system will receive the data and connecting the data to the Internet.

Cloud

The data will be stored and keep well in cloud storage. In this setup, we are using TTN (The Things Network). The data will be log into the cloud storage and the user will be able to access and view the data stored in the cloud.

SYSTEM DEVELOPMENT

Software

A suitable software must be used in implement this system to develop the best system. Selection depends on the suitability of software and system requirements.
The software used are Arduino IDE, NOOBS (for Raspberry Pi installation), Putty and the Things Networks.

Hardware

Computer hardware requirement are essential to ensure the minimum requirement for development accordance with the specified time and meet the user requirements. The hardware used are DHT22 temperature and humidity sensor, Arduino UNO, LoRa Shield (Cytron LoRa RFM shield), LoRa Gatewaty 915MHz and Raspberry Pi 3 model B.

End Nodes

The end nodes consist of DHT22 temperature and humidity sensor, Arduino UNO and LoRa shield was been setup at Gunung Lang recreational park.

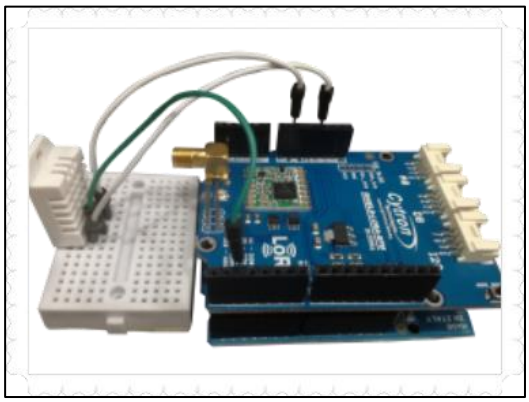

Figure 2: End Nodes

LoRA Gateway

LoRa Gateway consist of Raspberry Pi and the HAT-LRGW-915 (Cytron 915MHz 8 Channel LoRa Gateway HAT). This part will connect the data received to the Internet.

Figure 3: LoRa gateway

Putty software is used as interface of lora gateway. It helps to monitor Lora signals/packets from LoRa end devices at Raspberry Pi 3. There are 2 ways for RPI connection, serial or SSH. In this case, serial port was used. Port is check and speed was set to 115200 so the program runs smoothly. Then, the log in interface appeared as figure 5.8. Password was entered and privileges was granted for users. Putty is now available to be used to set to function as needed: Connect to TTN network.

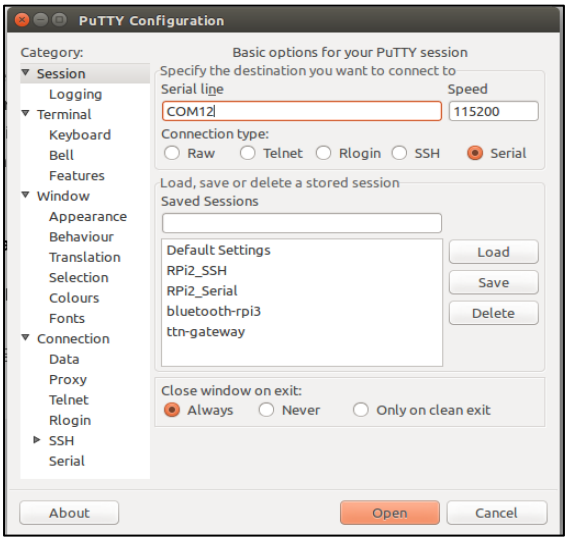

Figure 4: Putty Configuration

Cloud

The account is registered using username and password on TheThingsNetwork. The Things Network acts as a website platform for Lora technology. The Things Network is building a network by creating abundant data connectivity. The technology we use is called LoRaWAN and it allows for things to talk to the internet without 3G or WiFi. So, no WiFi codes and no mobile subscriptions. It features low battery usage, long range and low bandwidth.

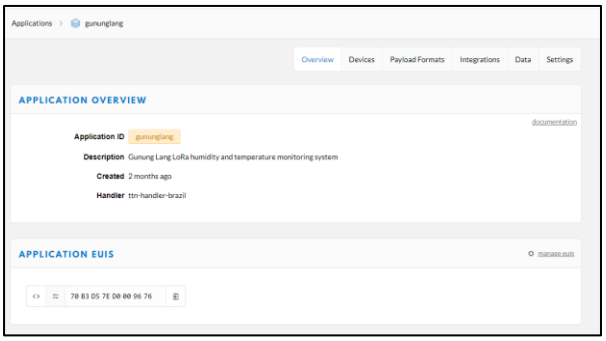

Figure 5: TheThingsNetwork Device Page

Figure 6 Device Details

Each LoRa node will use "session keys". In Figure 7, there are 2 session keys generated for the device. These keys will be used in arduino coding.

All data send from transceiver to TTN through compatible Lora gateway. To send data from lora node, the following information are needed and can be retrieved from TTN account page.

A Network Session Key (NWKSKEY). Press <> to show the msb hex decimal value. Copy and paste for arduino code use.
B App Session Key (APPSKEY). Press <> to show the msb hex decimal value. Copy and paste for arduino code use.
C Device Address (DEVADDR). Copy and paste for arduino code use.

The NWKSKEY, APPSKEY, and DEVADDR are paste into Arduino to connect the lora node to TTN using Lora gateway.

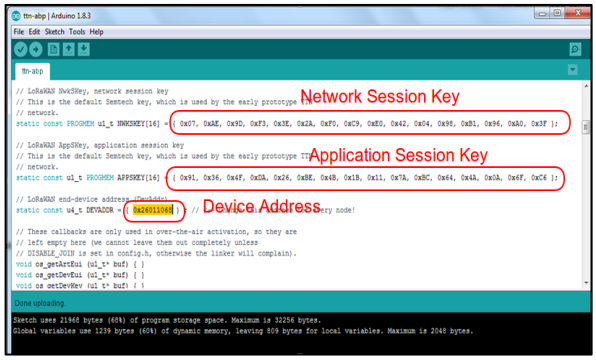

Figure 7: Session key

The data log into TTN can be viewed using TTN services. An URL can be obtain to view the temperature and humidity each day. The logging data can be viewed by manually created graph from raw data or in real time. In manually graphs, we have to get the raw data in TTN or cloud storage in .csv file before create the graphs.

IMPLEMENTATION AND RESULT

The end nodes which consist of DHT22 temperature and humidity sensor was been put in together with arduino and LoRa Shield in open area at an island of the Gunung Lang. The transmission testing is carried out in Gunung Lang recreational park where the LoRa Gateway station located approximately 1 km from the End Nodes. The Gateway operates at frequency band of 915Mhz. The data was successfully been log into TTN.

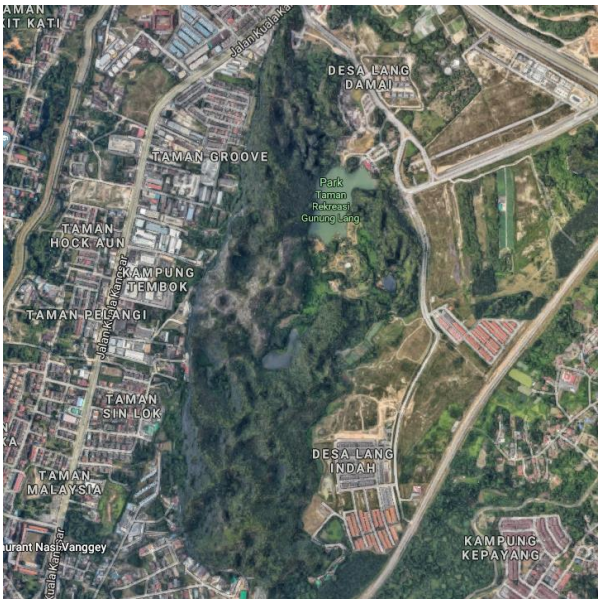

Figure 8: Gunung Lang Recreational park

The end node was set up at Gunung Lang recreation park for a week and the temperature are ranging from 20ºC to 33ºC and the relative humidity ranging from 4% to 7%.

The Lora gateway was relocated into another distance approximately 2 km and 6 km and still successful in logging the data to TTN. The uplink RF signal quality including RSSI and SNR are measured at 1 km, 2 km and 6 km and give average of RSSI to -93 dBm and the average of SNR to 8 dBm. An effort to locate it more than 6 km was not successful because of the nature of sorounding hill in the area.

CONCLUSION

This main purpose of this paper is to show the setup of temperature and humidity mesasurement using LoRa technology. Therefore, the main focus of this paper is one of the setup of LoRa technology and not the result. In the setup to explore the LoRa technology, end node consist of DHT22 temperature and humidity sensor, LoRa shield and arduino Uno was used. And at the

receiving side is LoRa Gateway 915 MHz, Raspberry pi and TTN (The Things Network). The setup was successful and achieved it purpose to explore LoRa technology.

LoRa technology and Internet of Thing(IoT) can offer services to monitor data for environment. The Gunung Lang temperature and humidity monitoring system was build for this purpose. It was develop for temperature measurement and can be use for others environment monitoring such as in the area of climate change, pollution control and early warning of natural disaster.

ACKNOWLEDGMENTS

The authors acknowledge the financial support from Ungku Omar Polytechnic, Ipoh Perak, Malaysia.

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