LoRa based Renewable Energy Monitoring System with Open IoT Platform

Chang-Sic Choi, Jin-Doo Jeong, Il-Woo Lee, Wan-Ki Park
IoT Research Division, ETRI
cschoi@etri.re.kr, {jdjeong, ilwoo, wkpark}@etri.re.kr

Abstract

The use of various renewable energy sources is increasing with the 2015 United Nations Climate Change Conference (Conference Of the Parties 21). In case of unstable wind power and photovoltaic power generation, analysis and optimal maintenance of operation status through remote monitoring system are required. In this paper, we describe the implementation of monitoring system for renewable energy generation facilities with the system architecture, implementation method, and analysis program. We use various open IoT platform such as Arduino, Raspberry Pi and low-cost LoRa network. In the future, we will carry out research result on the performance analysis and improvement solutions after operating on the testbed site for a long time.

Keywords: Energy IoT, Energy Monitoring System, LoRa, Raspberry Pi, Arduino

1. Introduction

As a result of the response to the COP21, various renewable energy plants have been globally developed from conventional fossil fuel-based power generation plants. However, such renewable energy sources are difficult to operate in a planned schedule and have unstable output due to unpredictable environmental conditions such as the weather.

It is possible to manage the power generation system more stably by collecting, analyzing and responding to the information of continuous power generation status, and the accumulated data provides an advantage of predicting future power generation and optimal maintenance. These improved stability is also contributed to the grid reliability and flexibility.

In this paper, we propose implementation methods to effectively construct energy monitoring system which is based on open IoT hardware and software platforms for economical system construction. And LoRa supporting low power long distance network is applied through low cost solution without base station of Telco's[1].

This work was supported by the Korea Institute of Energy Technology Evaluation and Planning(KETEP) and the Ministry of Trade, Industry & Energy(MOTIE) of the Republic of Korea (No. 20172410100040).

The monitoring system proposed in this paper can be applied to the future energy IoT system because of the ease of implementation, reduced development cost and variety of applications.

The detailed configuration architecture of the energy monitoring system is described in the following section 2. In section 3 shows the detailed the functional implementation of the energy IoT node. And the energy IoT gateway's implementation is also explained at section 4. In section 5, future projects are introduced.

2. LoRa based Energy IoT Monitoring System with Open Hardware Platform

Energy IoT monitoring system consists of three parts. The First is an energy IoT node that collects power generation status data from energy device, second is IoT gateway that receives and stores data from nodes at remote site, and the last is the low cost LoRa network which is support wide area networking and low costed wireless solution.

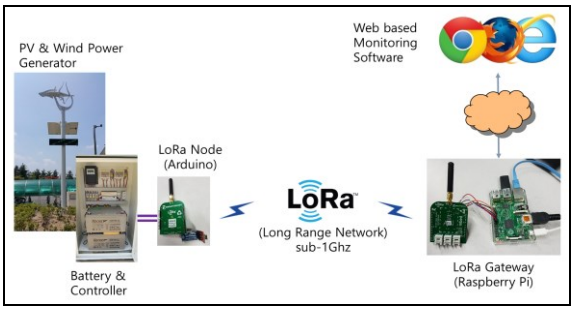

Figure 1. Energy monitoring system architecture

Figure 1 shows the overall configuration and architecture of the implemented energy IoT monitoring system. In order to implement this system under the requirement of low-cost and quick-construction, we apply the open IoT hardware such as Arduino and Raspberry Pi. And a LoRa network using sub-1Ghz frequency, which is a license-exempt band, is used for low-power long distance wireless transmission. In particular, the low-costed low-

powered LoRa network is implemented by applying a end-to-end modems without using base station.

3. Arduino based Energy IoT Sensor Platform

In the following Figure 2, the Arduino based IoT node is connected to energy device's controller with serial interface, and collects the current status information of the voltage, current, temperature and battery. In addition, the LoRa modem also connected to Arduino with serial interface, and the embedded application simply calls the send api function from the LoRa protocol stack.

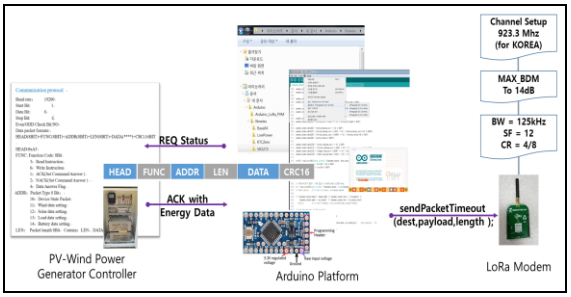

Figure 2. Arduino based IoT sensor platform

To support a low-power mode, IoT node uses the power level sleep function, and it is configured to periodically wake up. We also setup some LoRa parameters such as government defined channel center frequency, maximum output power, channel bandwidth, spreading factor and coding rate[2][3].

4. Open IoT based LoRa Gateway with Web Energy Monitoring Service

The Raspberry Pi based energy IoT gateway operates as a monitoring system server, and it can be accessed by web protocol.

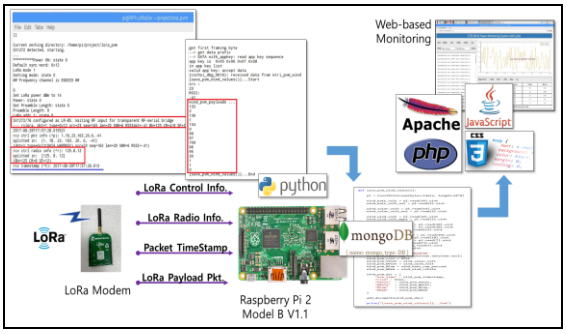

Figure 3. Raspberry Pi base monitoring system

In figure 3, the LoRa modem send the received energy data to Raspberry Pi through serial interface, and it also carries control, radio and timestamp information. The data received through the LoRa modem are stored at the MongoDB which works with NoSQL method and supports the structure suitable for large-capacity big data[4].

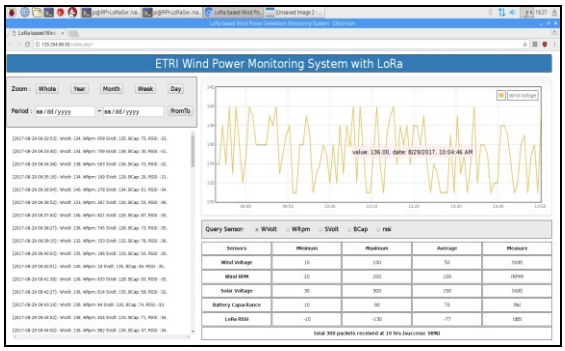

Figure 4. Web based energy monitoring system

Figure 4 shows the monitoring system's GUI for the photovoltaic and wind turbine based power generation facility. This web server is implemented with well-known web technologies such as apache, PHP, JavaScript and CSS. In figure 4, the trend graph can be selected by the energy, and statistical results are also displayed at table with the min/max/avg values. The reception ratio information is provided with the RSSI value to analyze the wireless network environment.

5. Summary

In this paper, we introduce a low-cost and efficient renewable energy monitoring system using open IoT platform such as Arduino, Raspberry Pi. And our system implements the low-powered low-cost LoRa network without base station. We collect energy status data from solar and wind power generation facilities, and various analysis services are provided with web based protocols. In the future, we are expanding our study on the performance and optimization method.

References

[1] Prof. Congduc Pham, "A Low-Cost LoRa Gateway with QoS Features", *http://www.univ-pau.fr/~cpham*, Université de Pau, France, May 2016.

[2] Semtech Corporation, "SX1272/73 - 860 MHz to 1020 MHz Low Power Long Range Transceiver", *www.semtech.com*, March 2015.

[3] LoRa Alliance Technical committee, "LoRaWAN™ Regional Parameters", LoRa™ Alliance, July 2016.

[4] Hong Sun Hag, Cho Kyung Soon, "Full Stack Platform Design with MongoDB", *Journal of the Institute of Electronics and Information Engineers*, THE INSTITUTE OF ELECTRONICS ENGINEERS OF KOREA, pp.152-158. Dec 2016.