International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST

LoRa-based Renewable Energy Monitoring System on Lcd Display and IOT Platform

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ARTICLEINFO

Article History:

Accepted: 05 March 2023
Published: 24 March 2023

Publication Issue

Volume 10, Issue 2
March-April-2023

Page Number

448-453

ABSTRACT

The use of renewable resources is rapidly rising, and many applications are being deployed with considerable cost savings and a green go manner by decreasing energy waste. Therefore, we execute the operation of monitoring renewable energy use using the implementation approach and analysis in this project. In the case of unsteady solar voltage and current generation, a thorough investigation and optimal operating status maintenance via a remote monitoring system are being made in this work. To validate the results, we employ several open IoT platforms such as Arduino and the low-cost LoRa Network. Together with the monitoring system, an energy management system is being built to make use of the monitored renewable energy resources stored in batteries, which is a very important and complicated issue. From the monitored renewable energy, current and voltage are calculated and produced from the solar panel in proportion to the loads. Because of its ease of implementation, low development costs, and wide range of applications, the monitoring system presented in this study may be desirable even in future instances.

Keywords: Renewable resources, monitoring system, LoRa, IoT, and Arduino.

I. INTRODUCTION

Renewable energy sources for power generation are gaining popularity due to environmental benefits such as lower greenhouse gas emissions and reduced reliance on fossil fuels for power generation [1]. By the end of 2019, the world's renewable energy generation installation capacity was 2,351GW [2]. This implies a greater use of sources of renewable energy for power generation, with potentially extremely high penetration in the coming years at the macro, mini, and micro generation levels.

The most promising aspects of the paradigm transition towards Industry 4.0 is[3] none other than IoT-Internet of Things [4]. The Internet of Things (IoT) is a network architecture that was first driven by wireless connection for data sharing and has minimal power consumption during data transfer [3]. IoT has advanced sufficiently in recent years to allow data transfer from the field to the server [5-7].

IoT may be used to monitor dispersed devices in a renewable energy producing system. More components are required when installed power capacity from renewable energy sources increases [1].

As a consequence of the COP21 reaction, numerous renewable energy facilities have been constructed across the world to replace traditional fossil fuel-based power producing plants. Nevertheless, such renewable energy sources are difficult to run on a regular basis and have inconsistent production owing to uncontrollable environmental circumstances such as weather. It is feasible to operate the power production system more reliably by collecting, evaluating, and responding to continuous power generation status information, and the gathered data offers the benefit of anticipating future power generation and optimal maintenance. Its increased stability benefits grid dependability and flexibility. As a result, many researchers have started using methods for efficiently building an energy monitoring system based on open IoT hardware and software platforms for economic system creation. And LoRa, which supports low power long distance networks, is used in a low-cost solution that does not require a telecommunications network base station.

Because of its ease of implementation, low development cost, and wide range of applications, the similar monitoring system could be developed and utilized to the future energy IoT system.

II. LITERATURE REVIEW

[8] carried out a research study in which the renewable energy system was continually inspected and a list of LoRa applications was provided without any particular real-world use being mentioned. It offers generic implications but no actual solutions to the problem.

In order to offer security for the system, [9] have designed their idea in such a way that wind turbines are monitored extremely well. Nonetheless, the system's cost-inefficient use of the IoT as a transmission medium is a downside.

The "Transient studies of power system" have been introduced by [10], in which the power system was fully stable but solely uses nonrenewable sources of energy, which causes a great deal of trouble.

[11] created a prototype for a smart hybrid renewable energy harvesting system using a water flow and storage system in conjunction with an IoT-based energy monitoring system. Low-voltage applications might be powered by the energy that was captured from the water flow and stored in an energy storage device. About 100Wh of energy may be obtained daily at the most from this prototype. The quantity of energy that was gathered and consumed in real time and remotely were both monitored using an IoT-based energy monitoring system.

For any climatic situations, [12] constructed a cost effective, dependable, and implementable weather monitoring system which was powered by the solar energy. The Bluetooth-enabled online monitoring system collects weather data using sensors and transmits it to the system. By utilizing a DC supply or battery, it really was simple to oversee the gadget and track real-time changes in the weather conditions via the Bluetooth system. In the suggested concept, the solar system automatically keeps track of the weather, and Arduino receives the information.

Implementation of the Internet of Things (IoT), requires monitoring, conservation of green energy, conservation of green energy, and microgrids, [13] introduced a FF-SHMS (i.e., Fuzzy Framework for Smart Home Monitoring Systems) that was efficient in energy use. The design of smart microgrids with storing systems, sustainability, and resource-controlled loads was optimized using the fuzzy framework that was suggested. Using renewable energy sources, the fuzzy framework enhances electricity and storage while maximizing the microgrid's financial return.

[14] suggested a method to track consumption and management of energy using the IoT. The research project planned and created an IoT-based energy administration system in which data was gathered from smart energy meters through GPRS network and displayed on a website. In the Internet of Things context, the suggested solution was suited for data collecting and load management. In the Internet of Things context, the suggested solution was suited for data collecting and load management.

[15] investigated the many AE concepts in RE systems in order to provide a thorough summary and to clearly illustrate the cutting-edge approaches and difficulties. Also considered and put forth were future directions for research, application, and standards.

The design and development of particular IoT applications for electric motors and wind energy generators were given by [16]. Improvements in performance monitoring and management, as well as potential energy savings, are made feasible by IoT technologies used in the control systems of electric machines, particularly in applications of motor drives and wind energy producing systems. Engineering education is given new teaching and research perspectives thanks to the experimental arrangements, which also improve laboratory infrastructure.

The monitoring of a hybrid system made up of solar, wind, and battery energy storage devices was a novel application for the SCADA (i.e., Supervisory Control and Data Acquisition) system [17]. The ThingSpeak website allows users to monitor electrical metrics including voltage, current, and power in real-time.

III. EXISTING WORKS

The energy IoT monitoring system is made up of three pieces. The first is an energy IoT node, which gathers power generation status data from energy devices, the second is an IoT gateway, which receives and saves data from nodes at remote sites, and the third is a low-cost LoRa network, which supports wide area networking and low-cost wireless solutions. Consequently, we could use open IoT hardware like Arduino and Raspberry Pi to create any system concerned with the configuration and architecture of the implemented energy IoT monitoring system while meeting the need of low-cost and quick construction. A LoRa network, which uses a license-free sub-1GHz frequency spectrum, is utilized for low-power long-distance wireless communication. The low-cost, low-power LoRa network is accomplished by employing end-to-end modems rather than base stations. Based on these very conceptions, many works like [18-22] have started contributing to our environment in possible means.

IV. PROPOSED IOT-BASED RENEWABLE ENERGY MONITORING SYSTEM

As far as our LoRa-based Renewable Energy Monitoring System is concerned, we have built the transmitter and receiver ends as follows found in the following figures 1 and 2.

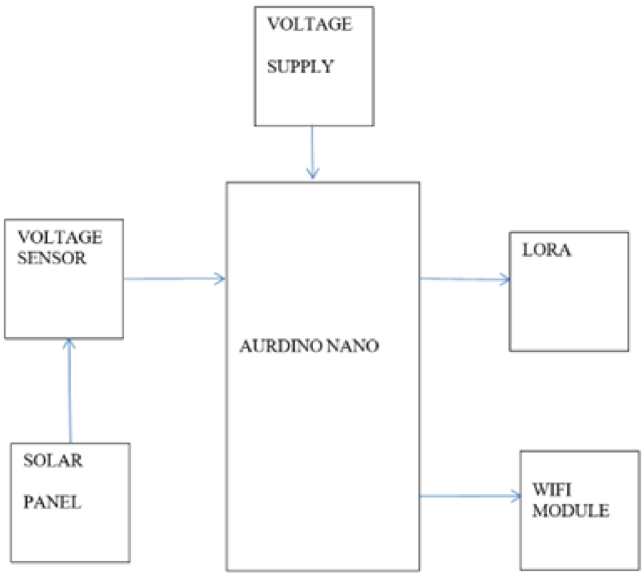

Figure 1 Block Diagram of the Transmitter end in our LoRa-based Renewable Energy Monitoring System using IoT

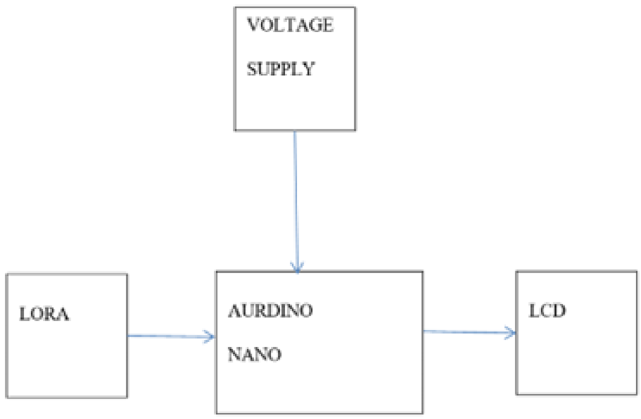

Figure 2 Block Diagram of the Receiver end in our LoRa-based Renewable Energy Monitoring System using IoT

The Arduino-based IoT node is connected to the controller of an energy device through a serial interface and gathers current voltage, current, temperature, and battery condition information. Moreover, the LoRa modem is serially linked to the Arduino, and the embedded program simply calls the transmit API function from the LoRa protocol stack.

The power level sleep function is used by the IoT node to enable a low-power mode, and it is programmed to wake up on a regular basis. We also configured various LoRa characteristics such as the government-specified channel center frequency, the highest possible power output, channel bandwidth, spreading factor, and coding pace [23, 24].

The hardware components of the proposed IoT-Based Renewable Energy Monitoring System are discussed below:

A. Arduino Nano

The Arduino Nano, as the name implies, is a small, full, and breadboard-compatible microcontroller board. The Nano board weighs around 7 grammes and measures 4.5 cms by 1.8 cms (L to B). This article goes through the technical specifications of the Arduino Nano board, namely the pinout and functionality of each and every pin [25].

B. Power Supply

The Arduino Nano-based circuit receives electricity from a regulated power source. The transformer steps down the alternating current input, 230V from the mains supply, to 12V and feeds it to a rectifier. The rectifier's output is a pulsing d.c voltage. To obtain a pure d.c voltage, the rectifier output voltage is routed via a filter, which removes any a.c components present even after rectification. This voltage is now sent into a voltage regulator to produce pure continuous dc voltage [26].

C. Voltage sensor

A voltage sensor is a sensor that calculates and monitors the amount of voltage in an item. Voltage sensors can determine the level of AC or DC voltage. This sensor's input is voltage, and its output is either switches, an analogue voltage signal, a current signal, or an audio signal [27].

D. Solar Panel

A Photo-voltaic panels (usually referred to as "PV panels") are devices that convert light from the sun, which is made up of energy particles known as "photons," into electricity that may be used to power electrical loads. Solar panels may be utilized for a broad range of applications, such as remote power systems for cabins, network equipment, remote sensing, and, of course, the generation of energy by residential and commercial solar electric systems [28].

E. LoRa

LoRa is a wireless modulation method based on Chirp Spread Spectrum (CSS). It uses chirp pulses to encode information on radio waves, similar to how dolphins and bats communicate! LoRa modulated transmission is resistant to interference and may be received over long distances. LoRa is suited for applications that need to send tiny amounts of data at low bit rates. Data may be sent over a greater distance than using Wi-Fi, Bluetooth, or ZigBee. Because of these characteristics, LoRa is highly suited for low-power sensors and actuators [29].

F. Wi-Fi Module

To send and receive data over Wi-Fi, Wi-Fi modules or Wi-Fi microcontrollers are utilized. They can also receive commands over Wi-Fi. Wi-Fi modules are utilized for device connectivity. They are most widely utilized in the IoT industry. The most popular Wi-Fi module is the ESP8266. Espressif Systems has created a low-cost microchip with a full TCP/IP stack and microcontroller functionality [30].

G. LCD

A thin (10-12 micro millimeter) layer of liquid crystal fluid is encased between 2 glass plates to form a Liquid Crystal Display. The output status and operation instructions are shown on a 16 X 2 LCD. We desire to utilize the HD44780U. The HD44780U dot-matrix liquid crystal display controller as well as driver LSI are used to show information on LCD screens [31].

V. PROBABLE ADVANTAGES AND APPLICATIONS

The probable advantages and applications of the proposed Renewable Energy Monitoring System are mentioned in the following sub sections.

A. Advantages

The advantages of the proposed Renewable Energy Monitoring System are given here:

- Extremely sensitive;
- Works in accordance with sun direction;
- Fit-and-forget system;
- Detects in both night and day modes;
- Low cost and dependable circuit;
- Complete manpower removal;
- Increased efficiency up to 40–50% compared to traditional solar panels.

B. Applications

The applications of the proposed Renewable Energy Monitoring System are given as follows:

- Solar water heaters;
- Garden lights;
- Street lights;
- Applications for hotels, hostels, and homes
- Offices
- Industries, and
- Several other customary applications

VI. RESULTS AND DISCUSSION

The subsequent findings are acquired on a personal computer using various sensors, and various voltage and temperature plots are generated in the PC application's (Thingspeak) user interface. The sensor's value is updated every minute, and the IOT device logs the new value.

This graph shown in figure 3 displays the 12-volt measurement which the voltage sensor recorded.

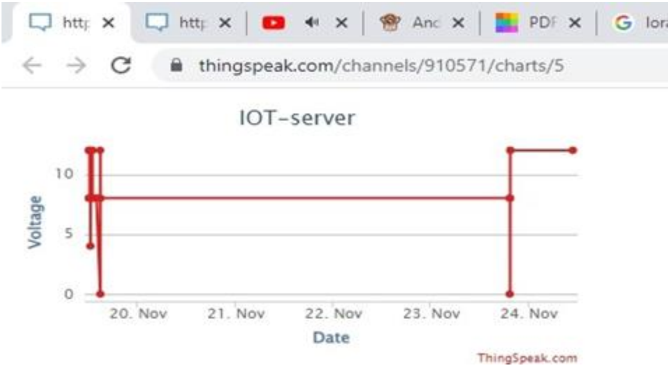

Figure 3 Voltage graph in things

VII. CONCLUSION AND FUTURE WORK

Using the system design, implementation strategy, and analysis programme, we explain the implementation of a monitoring system for renewable energy generating facilities in this project. We leverage a variety of open IoT platforms, including. This model has demonstrated a renewable resource-based pre-indication power management system. Furthermore, it offers a continuous renewable energy monitoring system from a remote site (a solar array) and transmits the appropriate information to the appropriate person without the need of Bluetooth, Wi-Fi, or the Internet. Using open IoT platforms like Arduino and Raspberry Pi, we present a low-cost and effective renewable energy monitoring system. Also, our system uses a base station-free, low-powered, low-cost LoRa network. From solar power plants, we gather data on energy status, and numerous analytical services are offered via web-based protocols.

The future directives of the proposed Renewable Energy Monitoring System are provided below:

• After running on the test bed location for a while, we will conduct research on the performance analysis and improvement options.

• Due to the LoRa system's versatility, low cost of development, and ease of implementation, we can include it into future energy systems.

In addition to developing PV grids for electricity distribution, we can also operate other factors like power and temperature.

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Cite this article as :

M. Uday Satya Kiran, Dr. M.Ramesh Patnaik, "LoRa-based Renewable Energy Monitoring System on Lcd Display and IOT Platform", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 10 Issue 2, pp. 448-453, March-April 2023.

Journal URL : https://ijsrst.com/IJSRST2310149