A GUI Based Monitoring and Controlling for PV Panel Micro Grids Using Single Board Computer.

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ABSTRACT

Smart energy monitoring and controlling unit for micro grids with automatic switching for islanding mode are very crucial for a smooth and perfect operation of solar energy systems. In this project the monitoring system is based on the Graphical User Interface which provides the facility to monitor and control the micro grid from remote location. since it comes with routing functionality, the manual switching of solar energy to the grid can be switched from anywhere in the world. the real time characteristics of solar irradiance and solar power output is plotted. the dashboard provides the input solar irradiance, dc parameters and the ac parameters at the inverter side. in this project a low cost, reliable data logging, efficient monitoring and user-friendly system has been developed. the hardware is designed by using a small single board computer (raspberry pi) and sensors. the node red GUI server runs in raspberry pi and the sensors such as digital LDR, temperature and power measurement sensors for both ac and dc

Keyword: - *Raspberry pi, Node red, GUI, Solar irradiance, Remote iot*

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1. INTRODUCTION

The advancement of technologies such as wired and wireless networks, smart devices like tablets, smartphones. It results to evolve IOT (INTERNET OF THINGS) which is now in widespread use. It has received attention over past few years [1-3]. At present photo voltaic generation has increased importance because of advantages such as no fuel cost, less maintenance, clean and pollution free inexhaustible energy source. In distribution generation prevention of islanding is more important. The prevention of Electrical islanding is explained in [2] Paper.

Display the power usage of renewable solar energy. monitoring is done by using IOT devices [4]. The communication between sensors to server can be wireless or wired medium. The monitoring using wireless communication such as Zigbee sensors network also report in [5-6].

Over the last decade an additional interest in connecting photo voltaic generation to electricity grid has arisen. Due to many advantages of using renewable energy in distributed generation systems. These are typically small-scale units connected to distribution network which is near to customers side. The Distribute generation or Decentralization generation (DG) is a concept That has been used widespread and is expected to become an important way to provide electricity in future power systems [7].

The remote monitoring using GSM network also report in [8-9]. The concept of smart grids, including hybrid Photo voltaic which can overcome the issue of global warming [10]

2.0 PROPOSED SYSTEM

The proposed system utilizes the node red server in which the user will have the GUI to monitor the block diagram of the proposed system is as shown in fig. 1.

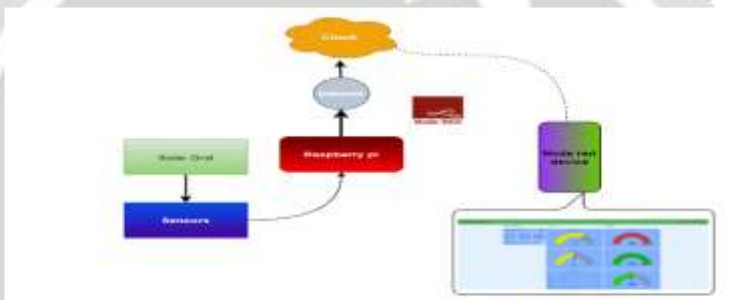

Fig. 1. Block diagram of Proposed system

Node-Red:

Node red is an open-source project developed by IBM. Node red is a browser-based programming tool and editor for wiring hardware devices and online services. It is a powerful tool for building IoT applications and services. It supports all platforms like windows, android, Linux distros. The flow created in node red interfaces raspberry pi with several sensors. The Node-Red creates server in Raspberry pi and the devices connected to it will be its clients. As the node-red server provides web browser-based UI, data will be accessed from any client which has browser.

It comprises of two components

A. Nodes

Nodes are written in node.js. It can be easily installed from the Node-Red library.

B. Flows

Node-Red Flow Diagrams are created by integrating various Nodes that are configured and are stored using JSON and the below shows the flows and nodes in fig. 2.

Figure 2 Node Red flows

3.1 Performance exploration:

Modules used

1.Adafruit TSL2591 light sensor

The TSL2591 light sensor shown in fig.3 is a high sensitivity light to digital converter that transforms light intensity to a digital signal output. It has two photodiodes one is for visible infrared plus and another is for infrared.

Figure 3 Light sensor

2.AdafruitHTU21D-F temperature and humidity sensor

The HTU21D-F shown in fig.4 is a Digital temperature and humidity sensor with I2C interface. It consumes less power and has fast response time. Interfacing with microcontroller is easy.

Fig.4. Temperature sensor

3.INA219 current sensor

The INA219 current sensor is an I2C interface-based zero drift and bi-directional current/power monitoring module. It has ability to sense shunt voltage, current and power at the same time and submit the digital data via I2C protocol It has 0.1 Ohms, a 1% shunt resistor to fulfil the requirement of current measurements. It has a powerful 12-bit ADC that converts the current sensed by a precision amplifier.

Fig.5. INA219 current sensor

4. PZEM-004T A.C sensor

The PZEM-004T shown in fig.6 is an A.C power module. The module is mainly used for measuring AC voltage, current, active power, frequency, and power factor. The data from the module is read using TTL (Transistor Transistor logic) interface. It also measures active energy

Fig. 6. PZEM power module

5.Relay module

A power relay module is an electrical switch that is operated by an electromagnet. The electromagnet is activated by a separate low-power signal from a micro controller

3.0 PROBLEM ELUCIDATION:

The scheme of micro grids with the monitoring and sensing equipment is as shown in fig.7. The 1st relay determines whether to operate on-grid or off-grid & the system operation depends on two parameters

1.) supply from the grid

2.) condition of the battery

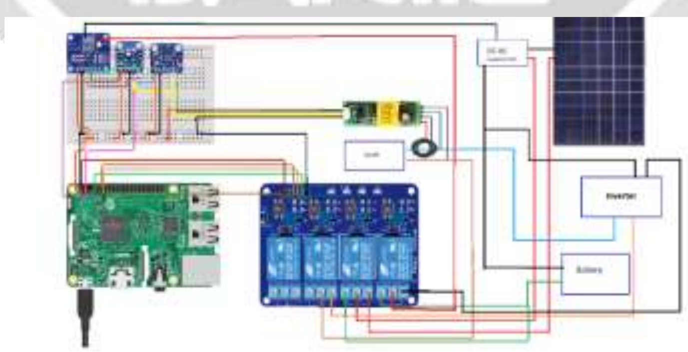

Fig. 7. Scheme of micro-PV grids with the proposed monitoring and controlling unit

The 1st relay gives priority to charge the battery. If the battery were fully charged the charge controller would give a signal to the 1st relay which would then cut off the supply to the battery. Then the supply from solar panels would be directly forwarded to grid. The parameters can be monitored locally and remotely in node red with simple user interface and can be controlled. The parameters are represented in gauges and graphs automatically to understand quickly. The function of the 3rd relay is to disconnect and connect the supply from the solar panel to grid. The 3rd relay is used to prevent electrical islanding of solar panel. If there was no power detected from the grid (due to maintenance/power failure due to faults/shutdown) the 3rd relay would cut off the supply. If the power detected from the grid, then the power supply from the inverter would be forwarded to grid.

An extra relay is connected to 3rd relay in series for extra protection which can be used in emergency conditions manually/automatically. The function of the 2nd relay is to connect or disconnect power supply from the pv panels to the load. If there is no power supply detected from the grid, then the 3rd relay push message to 2nd relay to connect the batteries/Inverter to the load so there will be no power interruption. If the power supply detected from the grid the 3rd relay push message to 2nd relay to disconnect the load from the batteries. Remote controlling is secure and more reliable. All events and logs can be recorded and stored in the server.

3.1 Performance Exploration

The node red UI & Dashboard is entitled with the gauges for magnitude indication, charts for magnitude plot with respect to time, value display text boxes to display temperature and panel electrical parameters, color indicators to indicate the level of solar irradiance. The higher the solar insolation the brighter the color. The green indicates average solar insolation, red indicates the peak irradiance, blue indicates least irradiance, orange indicates better irradiance.

Fig. 8. Node Red UI dashboard with solar insolation, dc unit & ac unit

The fig.8 shows the dashboard, the dashboard is categorized into three sub parts namely parameters, DC unit and AC unit. The Parameters consists of the panel parameters such as the voltage, current, Temperature and solar irradiance.

The ac side parameters such as voltage, current, frequency and the power factor are plotted with respect to time is shown in fig.9.

Fig.9. Multi Graph plot current, voltage, frequency wrt time

Similarly, the Reactive power, Active power, Apparent power delivered from the inverter side is plotted with respect to time is shown in fig.10.

Fig.10. multi plot power wrt time

4.0 CONCLUSION:

In this paper a low power consumption and cost-effective photovoltaic remote monitoring and controlling using Raspberry-pi Node-Red based server technology is introduced.

Node-Red web-based user interface with dashboard is developed for interacting and managing remote sensor systems (RSSs). The graphical user interface (GUI) is implemented to monitor dashboard in real-time parameters such as voltages, currents, and powers and the state of the pv system as well as environmental conditions. Tests were performed to evaluate the response of small-scale pv plant under several environmental conditions.

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