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Design and Implementation of Grid Connected Renewable Energy System with Internet of Things

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ABSTRACT: A low cost automation solution based on recent IoT technology using Arduino UNO for automation of a smart grid. This gives the advantage of cost reduction plus a plethora of connectivity options. In this paper, PIC C compiler software is used to control a feeder with help of IoT module. Analog and digital parameters from field are monitored and controlled using analog pins, interfacing relays and communication ports available in the controller. The automation sequences for control monitoring and protection of the system is defined using C program in such a way that it sends the input parameters in the field side to a remote through the networks, periodically. Similarly, it receives the control signals that are sent from the operators, and in accordance with those signals, it controls the relays. At times when current exceeds the limits, the microcontroller automatically trips the circuit breakers and sends that information to the user by SMS.

KEYWORDS: PV system, wind energy setup, Smart Grid, Arduino UNO, IoT.

I. INTRODUCTION

A large range of smart IoT applications are developed within last few years. Focused on the development of smart grid, this paper introduces the application of IoT in online monitoring systems of smart grid. As the smart grid evolved, many attempts started to introduce the IoT as enabling technology to the grid. Such technologies can improve the effectiveness, efficiency, reliability, security, sustainability, stability and scalability of the power grid. And further technology goes to the wireless sensor networks, which mainly use interconnected intelligent sensors to sense and for monitoring. Internet of Things (IoT) is a concept that considers pervasive presence in the environment of a variety of things/objects that through wireless and wired connections and unique addressing schemes are able to interact with each other and cooperate with other things/objects to create new applications, services and reach common goals. The IoT applications are; smart cities, smart energy and the smart grids, smart transportation and enabling traffic management and control.

The ESP8266 is a low cost Wi-Fi microchip with full TCP/IP protocol stack that can give any microcontroller access to Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. This project involves the detail design and construction of Smart grid with PV renewable system and wind energy using ESP8266 module with Internet connection. The automation may be semi or fully controlled and monitors the utility grid by connected sensors. This project is a demonstration of how to design and built a multipurpose remotely controlled system that can monitor the smart grid by accessing an ESP8266, which is programmed to control the systems in smart grid, when the person is away from work station and enable a

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person to get the related information on phone. The system will provide feedback indicating the current state of the system stopped or functioning.

Problem Formulation

The goal of the system is to create a small smart environment, where sensor can be monitor and controlled only based on the data received from the grid site sensors. This data is processed and control action placed accordingly. The system has to be implemented in a loop, so no human intervention is allowed. This means that the system is adaptive to the environment. The whole control device of the system it's a small ESP module and Arduino UNO. This computing system is used due to the fact to prove that the whole grid system can be automated just with a card size computing system or a microchip and the power grid environment data can be viewed or monitored from IoT. IoT technology provides interactive real-time, two way and high speed data sharing across various applications, enhancing the overall efficiency of the smart grid.

Objective

1. To make Smart grid environment which enables the user to monitor and control grid parameter on real time basis using Mobile device.
2. To monitor the electrical parameters continuously and hence to guard the grid due to the constraints such as overload, over temperature and high input voltage.
3. To monitoring the grid system that will be comprised of a function substation protection relay, wireless communications, a data collection and monitoring device, and a fault recognition and notification system.

The flow of the paper is as follows: Section II describes the related work in the IoT with smart grid operation. Proposed system described in section III and in section IV the result and discussion is explained. In section V overall paper is concluded.

II. RELATED WORK

Krupal dhimpar, Jenish patel, Yasin sheikh, Anas musani, Krishna has implemented a substation monitoring and control using microcontroller & GSM. In this paper the remote electrical parameters like voltage, current and frequency send these real time values over GSM network using GSM modem/phone along with the temperature at power station. Here, the user can send commands in the form of SMS messages to read the remote electrical parameters. It also can automatically send the real time electrical parameters periodically that are based on time settings in the form of SMS. The author's Ghous Buskh narejo, Shahyan pervez Bharucha, Danny Zarir pohwala has discussed the clarification which the prevention of equipments like power transformer from burning due to over load, short circuit fault, over voltages and surges. Under such conditions, entire unit is shut down via control section comprising of relays sensing it, and immediately turning the circuit breaker off. SMS alerts can also be generated to indicate this. The Author's V.Thiyagarajan, T.G.Palanivel has implemented an innovative design to develop a system based on AVR microcontroller that is used for monitoring the electrical parameters of distribution parameters in a substation. Providing the protection to the distribution transformer can be accomplished by shutting down the entire unit with aid of the radio frequency communication. The transmitter and the display units in the substation is where the electrical parameters are continuously by AVR microcontroller and is displayed through the display unit.

The controlling unit in the main station by means of a PC and RF that are transmitted by the transmitter unit and reacts with accordance to the received signal. Henning Tresk, Lukasz wisniewski, Emanule Toscano has designed a paper that flexible approach for real time wireless communications in adaptable industrial automation systems. That a new isochronous medium access control (Iso MAC) for WLAN's along with the scheduler, specifically tailored for it. Both mechanisms are part of the overall flex WARE system architecture. The Iso MAC approach is new medium access control which additionally requires resource reservation along with admission control and scheduling. A.Garrab, A.Ben Abdullah has explained the growing demand of energy, the capacity limitations of energy

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management, one-way communication, the need of an interoperability of the different standards, the security of the communication and the green house gas emissions, leads to emerge a new infrastructure grid: Smart grid.

III. PROPOSED SYSYTEM

The block diagram of the system is shown in fig. 1, here is the proposed system that having mainly IoT module and the Arduino UNO which is already programmed. Smart grid is own as user friendly technology that the user can check daily consumption from any location using internet. Smart grid represents one of the most promising and prominent internet of things application. More efficient transmission of electricity is possible. The ESP 8266 is used as a microcontroller in Arduino UNO board because the faulty percentage is less. It consumes low power for their operation and works on high speed. It provides a wide operating voltage range of 2.0V to 5.5V and it is used in commercial and industrial temperature ranges. The performance of the Arduino UNO is very fast and wide compared to PIC microcontroller. The ESP 8266 is an IoT module which is reliable, flexible and cost effective technology with excellent security and scalability.

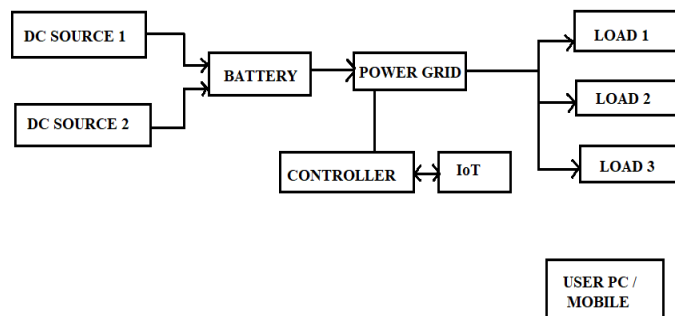


Fig.1. Block diagram

It aims to expand the benefits of connected internet connectivity continuously, the ability to share data, remote control and mainly it can be monitored from anywhere by using the free IoT service provider. The IoT module is to upload the electrical parameters such as voltage, current and frequency to the web using cloud server. It offers low data rate transmission with the help of things speak website we can monitor the project. All PCB design products include an auto router and basic mixed mode SPICE simulation capabilities. Schematic capture in the proteus design suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations. It supports for both interactive and graph base simulations. CPU models are also available for popular microcontrollers such as the PIC and 8051 series.

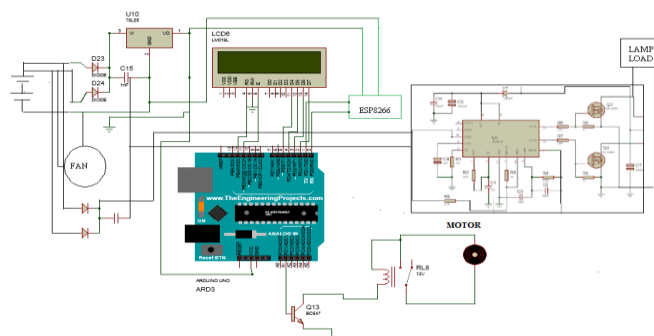


Fig.2. Proposed System

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IoT helps in information collection from equipment with the help of its connected IoT smart devices. It is applied for controlling the smart grid through application interferences. If there is any variation in the current and potential values are to display, the information continues to displaying the values in LCD with the help of the IoT web application servers. This project makes use of a microcontroller with IoT. Reduce operations and management cost for utilities, and ultimately lowers power costs for consumers. Time saving technology and also tamper detection to reduce electricity theft.

IV. RESULT & DISCUSSION

By applying the various Loads under various time period is observe. The equation is form by the observation and as shown in equation 1

$$z = 2.3986y * 0.0517x \quad (1)$$

Where ‘y’ is the current, ‘x’ is the voltage at signal conditioning output and ‘z’ is the output power. Observation is also made with various values.

The conventional methods which are used today like SMS are costly. Since, IoT is cost effective compared to SMS, monitoring of energy usage at lower cost is made possible. The system is more reliable and accurate reading values are collected from energy using Grid. Live readings of Grid can be viewed using android application. Also, the readings can be viewed online from anywhere. The human interface is avoided and all the values are kept maintained in the central server. There are many applications for smart grid systems that have been developed are still in the development phase. Different applications usually have different requirements for communication. Hence, the decision on whether IoT can be used for specific smart grid applications should be considered case by case. Based on analysis, we can see that IoT is a reliable, flexible and cost effective technology with excellent security, and scalability. It offers low rate data transmission with an intensive latency.

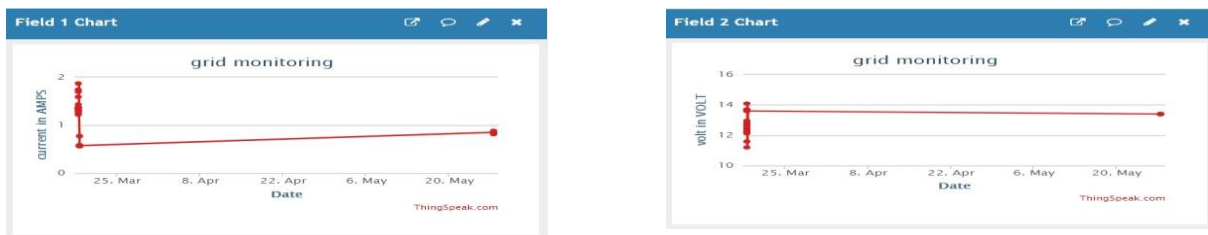


Fig.3 Current and Voltage Outputs

S. no	Panel voltage (volts)	Battery voltage (volts)	Grid voltage (volts)	Grid current (Amps)	Output power (watts)
1	10	12	230	1	230
2	10.5	12	230	1.5	345
3	11	12	230	1.7	391
4	11.5	12	230	1.8	414
5	12	12	230	1.85	425.5

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The tabular column contains the various electrical parameters in the proposed system and their values are calculated and they are tabulated.

V. CONCLUSION

As mentioned in the Section II, we get the information of the SOA-IoT that is Service Oriented Architecture IoT. We also get the idea about the System overview of ESP module. We are aware from the new trends in the smart grid and IoT technologies. The authors also discuss the various challenges in the IoT and also in smart grid constrain. How handle this challenge is also discussed by the authors.

The authors also survey the smart grid considering the IoT perspective. A good comparison done by the author in which why to use IoT in smart grid is explained. As ESP 8266 is small in size and also consumed less power along with doing complex processing of collected data. There are lots of wastage in energy at substation by hiding the real status of the installed grid system. This system try to minimize the energy waste by providing sufficient information to the owner or top level hierarchy persons via remotely and can be made appropriate decision. It also helps to analyze the overview consumption of power and material requirement. In this system, a grid connected PV system with IoT were introduced and analyzed. By utilizing the concept of IoT, each device can hold a unique address that can upload its status and download control commands via internet. Because of these advantages, the proposed system is also suitable for various applications like smart home appliances, substation devices and distributed renewable energy resources.

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