IOT BASED POWER GRID MONITORING SYSTEM

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ABSTRACT

The Internet of Things (IoT) is used for all types of applications, including intelligent energy monitoring as well as industrial automation. Smart Grids is an implementation of smart grid from which IoT devices are actively used at different processes to track and control grid parameters to provide reliable and efficient power supply. The integration of IoT into the Smart Grid infrastructure has many advantages, but problems related to the integration of IoT–SG are also addressed for the improvement of grid performance. This paper discusses a broad overview of Smart Grids and IoT based Smart Grids systems, particularly an IoT – enabled power monitoring system that is designed to measure and analyse key electrical parameters in cases such as voltage, current, active power as well as energy consumption for connected loads.

Keywords: IoT, Power Grid, Energy Monitoring, Grid Power Monitoring, Smart Grid.

1. INTRODUCTION

The rapid development of the Internet of things (IoT) has radically changed several sectors such as energy management and industrial automation. In Smart Grids (SG), IoT plays an important role in real time monitoring and control of electrical parameters to ensure efficient and reliable power distribution. As Smart Grid Systems take integration of IoT with SG, utilities can optimize its consumption of energy, improve grid stability and fault detection mechanisms. In this presentation, a discussion is made about smart Grids and IoT – enabled power monitoring systems which play an important role in collecting critical parameters such as voltage, current, active power and energy consumption. More than that, challenges in Internet of things – SG integration are discussed along with possible solutions to improving the grid performance.

1. Real time monitoring: Monitors energy flow / system performance via IoT sensors.
2. Predictive Maintenance: Anticipates equipment failures, reducing downtime.
3.Remote Control: Allows remote operation and automation of grid components.
4. Renewable Integration: Supports solar and wind energy integration.
5. Data Analytics: Analyze data for smarter energy management decisions.

2. OBJECTIVE

In resolving the issues posed by classical power grids, traditional power grid monitoring systems based on IoT technology employ smart technologies for real-time tracking, data harvesting, and control automation. Automated control. Such systems aim at achieving optimal reliability, functionality, and security in power distribution by the continuous tracking of a multitude of parameters including voltage, current, frequency, and power quality. This system, utilizing IoT sensors and communications technologies, can efficiently ensure early detection of faults, power outages, and abnormal conditions which will allow prompt response and reduction of downtime. Predictive maintenance may also be enabled for these systems through the analysis of accumulated data to forecast equipment failures beforehand. Moreover, remote access and control permit utility providers to manage and optimize the grid remotely from one central console thereby increasing energy efficiency, lowering operation costs, and improving the overall resiliency of the power system infrastructure.

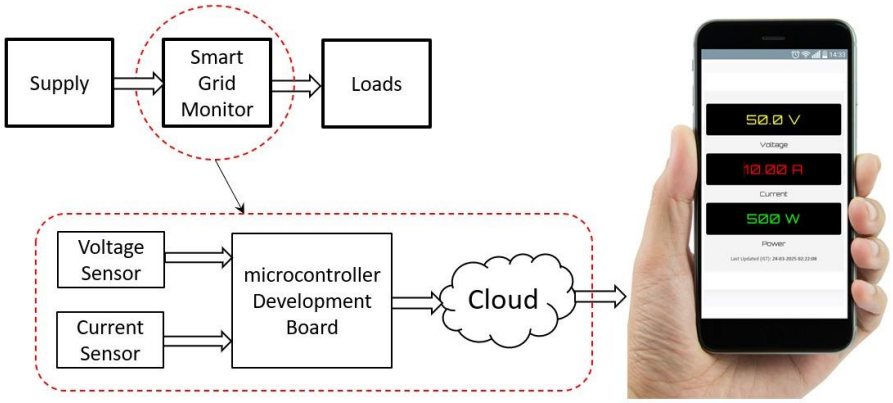

Fig.1 Block Diagram Representation

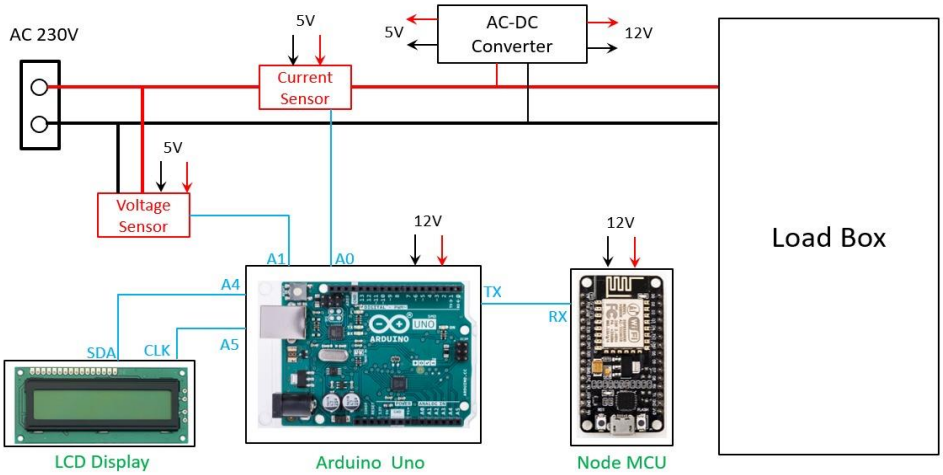

Fig.2 Connection Diagram

It is collectively to improve the reliability & efficiency. It starts with a power supply that supplies electricity into the grid for distribution. There are also Voltage and Current sensors available that ensure accurate measurements of real – time parameters like voltage, current and power consumption, monitoring the grid performance. A microcontroller development board processes the data, functioning as the system's brain, allowing it to analyse and manage the information captured. After processing, the data is then sent to cloud storge because it requires safekeeping, and can later be accessed for further analytics purposes or monitoring during real

– time. The system comes with an interface on a smartphone that allows critical metrics such as voltage and current levels to be pulled out and displayed, allowing users monitor grid utilization and energy consumption conveniently. The system also caters to the Loads which are the different appliances or equipment that use electricity within the grid. All these components work hand in hand in enabling predictive maintenance, remote controlling, and renewable energy resource integration, thus optimising the power grid and making it smarter.

3. HARDWARE COMPONENTS

The following components are the Hardware Requirements of the proposed paper.

3.1 Hardware Requirements

1.Arduino UNO
2.Node MCU
3.Voltage sensor
4.Current sensor
5.Power Supply
6.LCD Display

3.1.1. Arduino Uno

The Arduino UNO, one of the frequently used microcontroller boards by beginners is built on the chip ATmega328P. Its features consist of having 14 digital I/O pins, 6 analog input pins, a clock speed of 16MHz, and operating at 5volts. With 32KB of flash memory, 2KB of SRAM, and 1KB of EEPROM, the board can be used in various electronics projects.

Fig.3 Arduino UNO

The extensive capabilities of the UNO allow hobbyists to easily build industrial projects such as robots, home automation systems, and other interactive systems. The board can easily be programmed using Arduino IDE through a USB connection, overcoming many of the barriers for new learners.

3.1.2. Node MCU

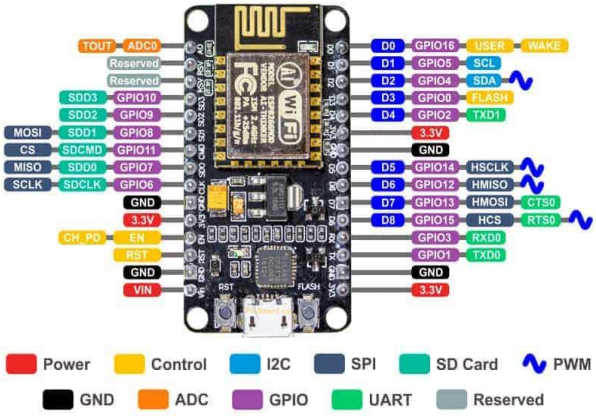

Fig.4 Node MCU

This board is tailored to suit projects aimed at the Internet of Things (IoT). The integration of a low power Wi-Fi module and 32-bit microcontroller allows the board to

intuitively link multiple devices to the internet. Like other IDEs, The Node MCU features GPIO and ADCs which enable programming making it very simple to use. Due to its compact dimensions, affordable pricing, ease of handling, and elevated user friendliness, Node MCU is now considered one of the top selections for smart appliances and home automation technologies.

3.1.3. Voltage Sensor

A voltage sensor should more accurately be referred to as a device that measures an electrical circuit's voltage abstraction since it provides an output which is usually in analog or digital signal form.

Fig.5 Voltage Sensor

Apart from connecting it to other sensors, the measured voltage can be useful when applied with other electronics such as microcontrollers like Arduino or Node MCU for various electronic projects. Most of these devices are used for monitoring power systems, performing battery management, and circuit protection from battery over-voltage.

3.1.4. Current Sensor

The appliances that measure the value of current flowing in a complete or closed circuit are recognized as current sensors. As Sensors achieve this goal through accomplishing either one of the following tasks: detecting the magnetic field caused by the electric current or measuring the voltage across a resistor which is placed into the circuit. Current sensors are highly effective for energy monitoring in management systems with batteries such as in overcurrent protection circuits and many other fields. Using current sensors with Node MCU and Arduino enables monitoring, control and management of the current on devices using microcontrollers or Arduinos.

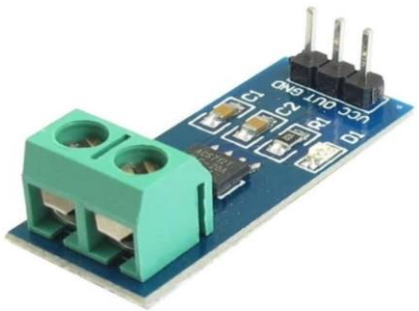

Fig.6 Current Sensor

3.1.5. Power Supply

5V power supply is a very reliable source of direct current power in electronics. With a voltage output of 5 volts, it is possible to power microcontrollers such as Arduino Uno and Nedelcu, sensors, communication modules and even LEDs.

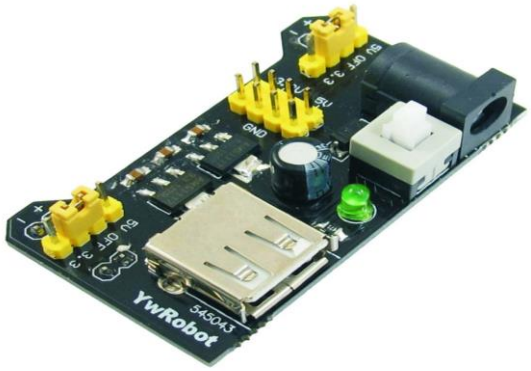

Fig. 7 Power Supply

The 5V power supply is compact and light in weight thus making it suitable for projects where space is a restriction. It also provides energy efficiency along with protection from overvoltage, over current, and short circuits. Thus, it protects delicate electronic components. Furthermore, a wide range of electrical devices can be powered using a 5V power supply due to its versatility and regulated output which can be used in both prototyping and industrial applications

3.1.6. LCD Display

Using seven segments, the multi–LCD Digit Display is able to display almost all of the numerical symbols. The juices that crystal displays are put to use, The 7-segment display works with simple switches since each of the segments is" ON" or "OFF" switch. With this technology, it is more than simple it is of low power and high performance. Best examples would be digital watches and desk calculators, since they require versatile input.

4. WORKING OF IOT BASED POWER GRID MONITORING

A power grid monitoring system which is IoT based employs features such as Arduino Uno, mountable sensors for voltage and current, a powering device, and a screen to monitor the grid's performance. Current and voltage sensors capture real time electric parameters. These parameters are processed by the Arduino Uno microcontroller. A Wi-Fi capable Node MCU transmits the information to cloud storage where it can be accessed remotely, as well as visualized. Locally, the display module projects the data so that it can easily be referred to. All component's functions are ensured by a constant power supply. This setup improves efficiency and reliability of a power grid as real time monitoring, fault identification, and corrective actions that are either automated or manual, can be undertaken.

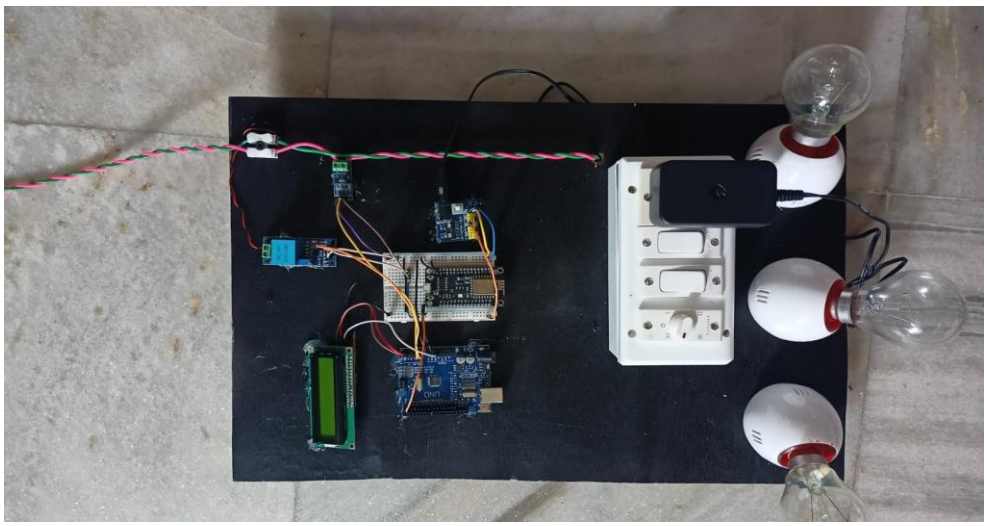

Fig.8 Hardware of IOT based Power Grid Monitoring

5. CONCLUSION

Energy management is changing due to IoT – based power grid monitoring because it collects data and evaluates the power systems automatically, increasing grid reliability, and reducing downtimes and energy waste through smart grid attributes. By means of sensors and communication technologies, it allows for advanced fault detection, proactive load balancing, and demand-response management which lowers costs and decreases the carbon footprint. In any case, integration, cybersecurity issues, and lack of qualified workforce are constant headaches to deal with. Even with these challenges, IoT based monitoring has enormous potential to create smarter, more sustainable power grids.

6. FUTURE SCOPE OF THE PROJECT

An IoT based power grid monitoring system includes scope in its design, development and implementation methodologies of a smart system to monitor and manage a power grid on a continuous basis. The project aims to integrate IoT technologies such as sensors, microcontrollers, and communication interface modules to monitor and capture critical volumetric parameters like voltage, current, power factor, and frequency at different sections of the grid in real time. It will make the data remotely accessible over mobile/web applications or cloud platforms and enable utility providers to troubleshoot, distribute load, and maintain the system proactively. In addition, the project will develop notification systems for conditions such as abnormal power surges, outages, abnormal durations of power supply, and equipment malfunction. The system can also be extended to cover larger areas of the grid or combined with renewable energy sources, which makes it highly modular. Attention to details for ensuring security of the data, reliability, and low latency in the communication to enable quicker response for timely decision making for efficient energy usage is also included within the scope.

REFERENCES

[1]. A. Y. Devadhanishini, et.al "Smart Power Monitoring Using IOT "5th International Conference on Advanced computing & Communication Systems (ICACCS) 2019.

[2]. Q. Ou, Y. Zhen, X. Li, Y. Zhang and L. Zeng, "Applications of Internet of Things in Smart Grid Power Transmission, "Mobile, Ubiquitous and Intelligent Computing (MUSIC), 2012 Third FTRA International Conference on, Vancouver, BC,2012, pp. 96 - 100

[3]. V. Dehal war, R. K. Baghel, M. Kolhe. Multi- Agent based Public Key Infrastructure for Smart Grid, The 7th International Conference on Computer Science & Education (ICCSE 2012) July, 2012. Melbourne, Australia.

[4]. A. Al- Ali and R. Aburukba, "Role of Internet of Things in the Smart Grid Technology," Journal of Computer and Communications, vol. 3, no. 05, p. 229, 2015.

[5]. U. S. DOE, "Communications requirements of Smart Grid Technologies, "Tech. Rep., US Department of Energy, 2010.

[6]. W. Shu-wen, "Research on the key Technologies of IOT Applied on Smart Grid", IEEE, (2011).

[7]. Priyanka Bhausaheb Deshmukh Prof V.M Joshi (2017) "IOT based Smart Grid to Remotely Monitor and Control Renewable Energy Sources using VLSI ". IJIRSET Volume 6, Issue 11.

[8]. Vijayapriya P, 2Sreedip Ghosh, 3Kowsalya M (2018) "Internet of Things (IOT) Application for Smart Grid ". IJPAM volume 118 No. 18.

[9]. Mr. Adinath S. Satpute. Prof. / Dr. G. U Kharat (2020) "Smart grid System to Monitor & Control Renewable Energy Source based on IoT "IJERT Vol. 9 Issue 06, June – 2020.

[10]. M. Burunkaya, T. Pars, "A smart meter design and implementation using ZigBee based Wireless Sensor Network in Smart Grid", 2017 4th International

Conference on Electrical and Electronic Engineering (ICEEE), Ankara, pp. 158 – 162, 2017

[11]. Y. Kabalci, "A survey on smart metering and smart grid communication", Renewable and Sustainable Energy Reviews, Vol. 57, pp. 302 – 318, May 2016.

[12]. Dr.B. Muthuvel, Mr.B.Vijayakumar, Prof.A.N.V.J.Raja Gopal, and Dr.S.Arulkumar, "Energy Efficient Power Management System Using Internet of Things", Journal of Emerging Technologies and Innovative Research (JETIR) ISSN 2349-5162 Volume 6, Issue 6, June 2019 PP 259-266.

[13]. Dr.B. Muthuvel, Dr.S.Arul kumar, Mr.SK.Akbar, Prof.A.N.V.J.Raja Gopal, and Mr.G.Madhu Ganesh, "A Power Quality Improved Bridgeless Converter Based Computer Power Supply", Journal of Emerging Technologies and Innovative Research (JETIR) ISSN 2349-5162 Volume 6, Issue 6, June 2019 PP 739-747.

[14]. Dr.B. Muthuvel, G.Devi priya, S.S.R.Ganesh, A.Sai baba and Mr.I.Vamsiram, "Performance Evaluation of Power Quality in E-Vehicle Charging Station", The International journal of analytical and experimental modal analysis (IJAEMA) ISSN 0886-9367 Volume XII, Issue III, March 2020 Page No:2066 -2076.

[15]. Dr.B. Muthuvel, Mr.Chaladi Maniteja, Mr.Sekhar Bodaballa and I.Vamsiram, "Power Quality Improvement in E-Vehicle Charging Station", Journal of Interdisciplinary Cycle Research (JICR) ISSN 0022-1945 Volume XII, Issue IV, April 2020 Page No: 355-364.

[16]. Dr.B. Muthuvel, Dr.S.Arulkumar, Prof.A.N.V.J.Raja Gopal and Mr.Mohiddin Khan, "Simulation of 9 Level Output H-Bridge Multi Level Inverter", The International journal of analytical and experimental modal analysis (IJAEMA) ISSN 0886-9367 Volume XII, Issue IV, April 2020 Page No:1853 -1864.

[17]. Dr.B. Muthuvel, Dr.N.Muralikrishnan, Prof.A.N.V.J.Rajagopal and Dr.S.Arulkumar, "Simulation and Hardware Implementation of Z Source Buck Boost Converter Under Various Frequency Conditions", International Journal of Electrical Engineering and Technology (IJEET) ISSN Print: 0976-6545 and ISSN Online: 0976-6553 Volume 11, Issue 3, May-June 2020: PP 142-154.

[18]. Dr.B. Muthuvel, Dr.N.Arunkumar and Dr.B.Senthilkumar, "MMC controller and Controllable Capacitor based Reactive Power Control in HVDC Systems", Compliance Engineering Journal (CEJ) ISSN 0898-3577 Volume 12, Issue 2, February 2021 Page No: 29-38.

[19]. Dr. Muthuvel B, Dr. Rama Rao J V G, Chandra Prakasa Rao S, Vavilala Venkatesh, Sanaboina Amalodbhavi, "Tracking and Control of Power Oscillation Damping's in Transmission Lines using PV STATCOM", The Scientific Temper, E-ISSN 2231-6396, ISSN 0976-8653 Vol.14.3: July - September, 2023. PP 601-608.

[20]. Dr. Muthuvel B, Dr. Rama Rao J V G, Ganga Bhavani C S, Adilakshmi Devi M, Durga Devi Kona, "A TLBO Algorithm-Based Optimal Sizing in a Standalone Hybrid Renewable Energy System", The Scientific Temper, E-ISSN 2231-6396, ISSN 0976-8653 Vol.14.3: July - September 2023. PP 629-636