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*Original Article*

# Smart Grid Power Distribution Management Using IoT Technology

**Dr. P. Annapandi[1], Esakki Muthu A[2], Abdul Hameed M[3], Maniraja M[4], Selvam M[5]**
[1,2,3,4,5]*Dept. of Electrical and Electronics Engineering, FX Engineering College (Autonomus), Tirunelveli, Tamilnadu, India.*

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***Abstract:*** *In the last decade, much of the attention is made towards introducing the smart systems and appliances to meet the requirement of the century and make life comfortable. During the same period, electric power sector also made the necessary innovation to compensate the demand of today's electric supply and to make use of electric resources effectively by introducing "Smart Grid Power Distribution Management Using IoT Technology". The smart grid is a part of transformation and reformation in the power industry sectors. The smart grid is a future modern power system that utilizes internet of thing to monitor, control and create various intelligent communications in the electrical system. The goal of this project is to fulfill the electricity demands using three systems such as solar power, gas grid and battery storage. By using IoT device grid, officers can monitor users demand and the system will trigger by following users requirements. IoT device will collect remote electrical data such as current, the power station, and deliver these real-time values across the network. This project also includes some relays that will switch each other by user's demands. When the electrical parameters surpass the predefined values, this relay is actuated. This system can update real-time electrical parameters on a regular basis. This system can be set up to transmit alerts whenever the relay trips current exceeds predetermined limitations. This project uses a microcontroller and an android app; however, because this is a prototype of the proposed concept, we have used a microcontroller ESP8266 for demonstration purposes. The controller is able to communicate with the computer in a timely manner.. By following users demands relays will be triggered. Meanwhile, there will be no blackout. If we want to trip any feeder we can also trip the feeder by sending command from app.*

***Keywords:*** *Smart Grid, IoT Technology, Power Distribution Management.*

## I. INTRODUCTION

The distribution of digital power is increasing greatly day by day. The existing power grids are converted into smart grids so as to meet the growing power requirements. Information is accumulated from sensors, smart meters and several other devices for the sake of analysis and understanding. For the purpose of implementing IoT in smart grids, mobility support, location awareness, distributed coordination and latency sensitivity are to be considered. Smart Grid systems in combination with IoT can assist the consumption, distribution, transmission and generation of energy . IoT allows smart monitoring and control of smart grid. In electronics connected via internet, smart plugs, home gateways and smart meters, application of IoT facilitates proficient resource management. The consumers can obtain information regarding consumption of energy and price on a real-time basis thereby moderate the energy consumption. The producer can forecast energy requirement and moderate distribution. Hence the system serves beneficial to both ends [7]. Millions of users interact with smart grids and its information flow. It is important to focus on scalability of this system. Cloud computing serves as an optimal solution for this purpose. Several architectures such as event processing for load forecasting, lambda, kappa and cyclic architectures are designed and implemented for processing the data generated by these systems. In IoT based Smart Grid architectures, the components communicate with each other through the internet. Resource constraint and scarcity of spectrum are major issues in the wireless nodes of these systems [8]. Pan Wang et al [10] presented a programming model and fog based architecture that serves the requirements of smart grid. The paper also demonstrates its operation on a smart electric automobile prototype for the purpose of evaluation. A traditional power grid consists of a large number of loosely interconnected synchronous Alternate Current (AC) grids.

## II. SYSTEM IMPLEMENTATION

### A. Existing System

The existing system would likely involve a smart grid infrastructure that incorporates advanced communication and control technologies. This includes smart meters, sensors, and intelligent devices. Integration of IoT devices for real-time monitoring and control. These devices could be deployed across the power distribution network, including transformers, substations, and other critical points. Robust communication networks to facilitate data exchange between devices. This could involve wired (fiber optics, power line communication) and wireless (Wi-Fi, cellular, etc.) communication technologies. Implementation of data analytics to process the vast amount of data generated by IoT devices. This helps in extracting meaningful insights, identifying patterns, and predicting potential issues.

**B. Proposed System**

Upgrading the existing metering infrastructure to smart meters with two-way communication capabilities. Smart meters provide real-time data on energy consumption and allow for better demand-side management. Deploying a network of sensors throughout the power distribution grid for real-time monitoring of various parameters. This can include voltage, current, temperature, and other relevant data points. Introducing edge computing capabilities to process data closer to the source, reducing latency and enabling quicker responses. This is particularly crucial for time-sensitive applications such as fault detection and response. Implementing advanced analytics and machine learning algorithms to predict potential failures or faults in the power distribution system. This helps in proactive maintenance, reducing downtime, and improving overall reliability. Enhancing cyber security measures to protect against evolving threats. This includes secure communication protocols, intrusion detection systems, and measures to safeguard against unauthorized access. Strengthening integration with renewable energy sources and implementing mechanisms to manage the variability associated with these sources. This could involve advanced forecasting techniques and dynamic grid management. Introducing autonomous or semi-autonomous features in grid management. This may include automated responses to faults, rerouting of power, and optimization of energy distribution based on real-time conditions. Implementing more sophisticated demand response programs enabled by IoT devices. This allows utilities to dynamically adjust electricity consumption patterns in response to supply and demand conditions. Upgrading surveillance systems with high- resolution cameras, infrared sensors, and other advanced monitoring devices. Video analytics can be employed for anomaly detection and rapid response to security incidents.

**C. Block Diagram**

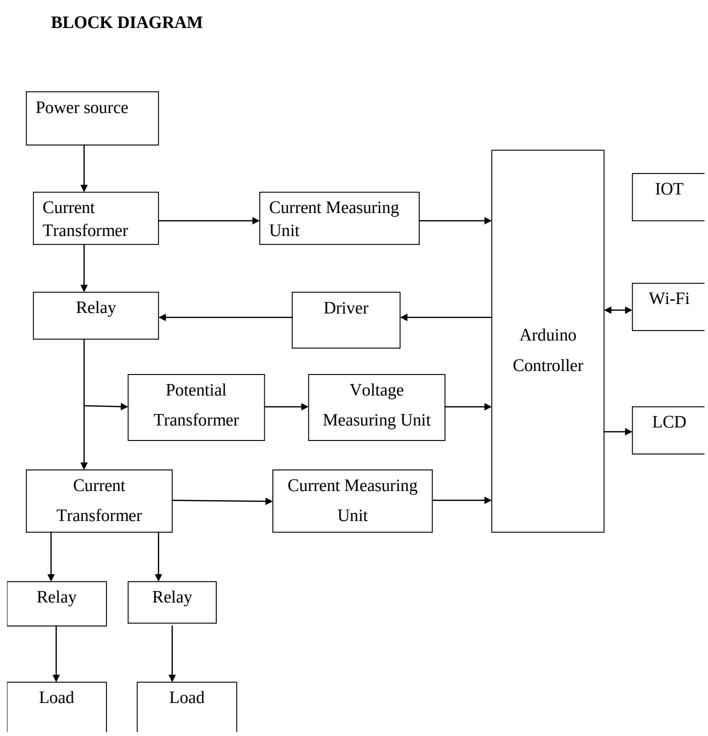


***Figure 1: Block Diagram***

*a) Block Diagram Description*

*i) Power Source*

- "Power Source" refers to the origin or supply of electrical energy that can be used to provide electricity for various devices and systems.

- Similar to the first relay, the second relay provides additional switching or control capabilities in the system. It may be used to manage different parts of the grid based on specific conditions.
- An IoT-based power distribution and surveillance system within a smart grid, "Load 1" and "Load 2" represent electrical loads or devices that consume electrical power.
- The driver receives input signals or commands from the microcontroller or control system. These signals typically indicate whether the relay should be activated or deactivated.
- An IoT-based power distribution and surveillance system within a smart grid, the Voltage Measuring Unit (VMU) is responsible for accurately measuring and monitoring the voltage levels at various points in the power distribution network.
- An IoT-based power distribution and surveillance system within a smart grid, the Arduino controller serves as the central processing unit that orchestrates the operation of the entire system.
- IoT-based power distribution and surveillance system within a smart grid, the Internet of Things (IoT) refers to the network of interconnected devices, sensors, and systems that communicate with each other over the internet to collect, share, and act upon data.
- IoT-based power distribution and surveillance system within a smart grid, Wi-Fi (Wireless Fidelity) is a wireless communication technology that facilitates the transmission of data between devices over a local area network (LAN) or the internet.
- IoT-based power distribution and surveillance system within a smart grid, an LCD (Liquid Crystal Display) serves as a visual interface for providing real-time information, status updates, and user interaction.

**D. Circuit Diagram**

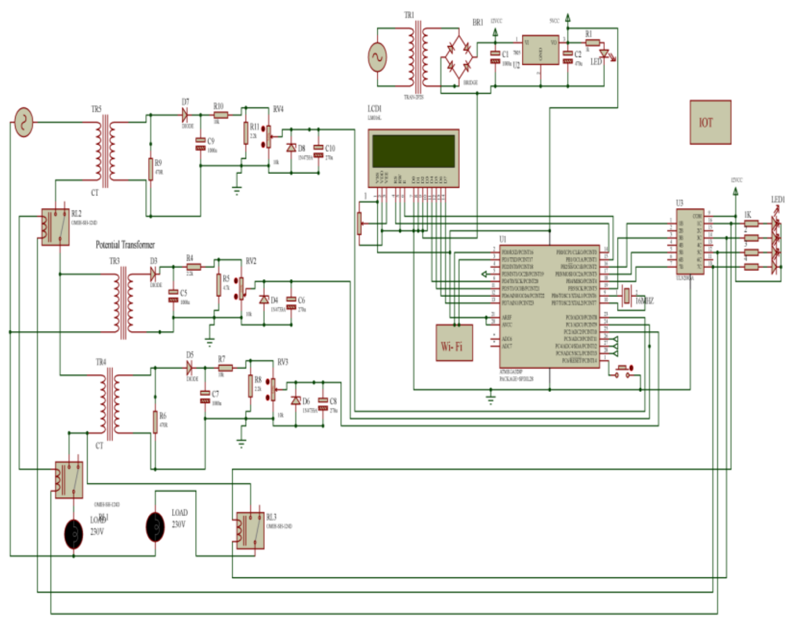


***Figure 2: Circuit Diagram***

*a) Circuit Description*

The power source would be connected to the main power input of the system, supplying power to all components. CTs would be placed in series with the power lines to measure the current flowing through them. The secondary side of the CTs would be connected to analog input pins of the Arduino for current measurement. PTs would be connected in parallel with the power lines to measure the voltage. Similarly, the secondary side of the PTs would be connected to analog input pins of the Arduino for voltage measurement. The Arduino would serve as the central processing unit of the system. It would receive inputs from the CTs, PTs, and possibly other sensors, process the data, and control the operation of other components accordingly. The relays would be connected to digital output pins of the Arduino. They would control the power flow to the loads. For example, one relay could control one load, and the other relay could control the other load. If necessary, drivers could be used to provide additional power or control signals to the relays or other components. sThe Wi-Fi module would be connected to the Arduino, enabling it to communicate with other devices or systems over a Wi-Fi network. This could be used for remote monitoring and control. The LCD display would be connected to the Arduino to provide real-time feedback on system parameters such as voltage, current, power consumption, etc. The loads would be connected to the relays, allowing the Arduino to turn them on or off based on certain conditions or commands.

## III. HARDWARE DETAILS

### A. Single Power Supply:

Power supply gives supply to all components. It is used to convert AC voltage into DC voltage. Transformer used to convert 230V into 12V AC.12V AC is given to diode. Diode range is 1N4007, which is used to convert AC voltage into DC voltage. AC capacitor used to charge AC components and discharge on ground. LM 7805 regulator is used to maintain voltage as constant. Then signal will be given to next capacitor, which is used to filter unwanted AC component. Load will be LED and resister.LED voltage is 1.75V.if voltage is above level beyond the limit, and then it will be dropped on resister.

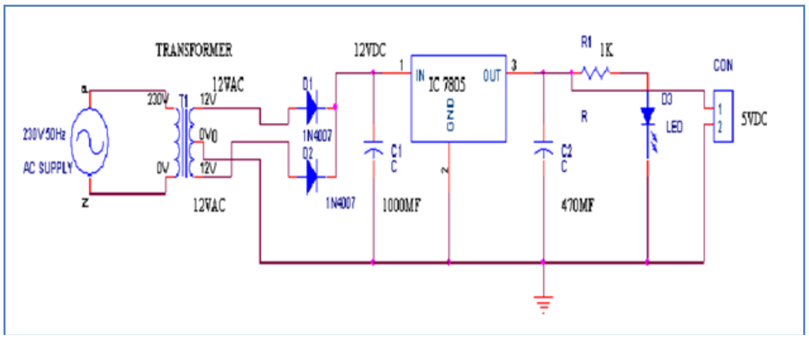


***Figure 3: Single Power Supply***

### B. Wi-Fi Module (ESP8266)

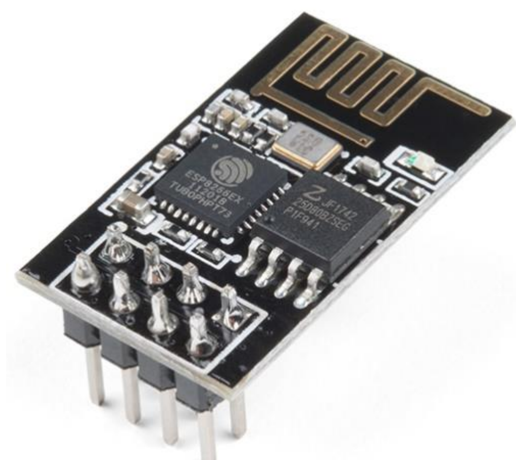

***Figure 4: The ESP-01 ESP8266 Serial WIFI Wireless Transceiver Module is a self-contained SOC with integrated***

*Features:*

- Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack
- It features an integrated TR switch, balun, LNA, power amplifier and matching network
- Equips integrated PLL, regulators, DCXO and power management units
- Integrated low power 32-bit CPU could be used as an application processor
- SDIO 1.1 / 2.0, SPI, UART
- STBC, 1×1 MIMO, 2×1 MIMO
- A-MPDU & A-MSDU aggregation & 0.4ms guard interval
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)

**C. Push Switch**

***Figure 5: Push Switch***

**D. LCD Display**


***Figure 6: LCD Display***

Liquid Crystal Displays (LCDs) have materials, which combine the properties of both liquid and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal. An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. One each polarizer are pasted outside the two glass panels. This polarizer would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarizer and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction.

## IV. CONCLUSION

In conclusion, the implementation of IoT technology in smart grid power distribution management offers significant advantages in terms of efficiency, reliability, and sustainability. By leveraging real-time data analytics, remote monitoring, and automated control systems, IoT enables utilities to optimize energy distribution, minimize downtime, and respond promptly to grid disruptions. Moreover, IoT facilitates proactive maintenance strategies, reducing operational costs and enhancing system resilience. Despite these challenges, the future of smart grid power distribution management using IoT technology is promising. With ongoing advancements in AI, machine learning, and renewable energy integration, smart grids will continue to evolve, paving the way for a more efficient, sustainable, and resilient energy infrastructure.

## V. FUTURE DEVELOPMENT

Predictive analytics can be used to forecast energy demand more accurately, optimize energy distribution, detect anomalies or faults in the grid, and improve overall system efficiency.As renewable energy sources like solar and wind power become more prevalent, integrating them into the smart grid system will be crucial. IoT technology can be used to monitor and manage the fluctuating output of these sources in real-time, enabling better integration with the existing grid infrastructure.Implementing demand response programs can help balance energy supply and demand more effectively, reducing peak loads and improving grid stability. IoT-enabled devices such as smart thermostats, appliances, and electric vehicles can communicate with the grid to adjust energy consumption based on pricing signals or grid conditions.

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