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Application prospect of integration of smart grid and Internet of Things technology in distribution automation

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ABSTRACT

Power distribution and automation stand to gain greatly from the widespread use of connected devices made possible by the advent of the Internet of Things (IoT). The reliability of a SCADA (Supervisory Control and Data Acquisition) system has been extensively shown in the substation environment. The fundamental problem with distribution automation is the lack of distribution-side management, mostly from the field's geographically dispersed workforce. As a result of their dispersed locations, there has been inadequate tracking of their distribution channels. The smart grid is a power system incorporating evolutionary computing, bidirectional communication, two-way electrical flow, and real-time monitoring. Hence, this paper Internet of Things based Integrated Smart Grid Distribution Management System (IoT-ISGDMS) with fog computing has been presented that addresses issues such as power quality assurance, pole transformers health, and customer consumption in distribution automation. In this paper IoT-ISGDMS uses fog computing which analyzes distribution automation in real-time, making this possible. As a first step, IoT-ISGDMS uses intelligent acceptance systems (IAS) to improve coordination between smart grids and other electronic infrastructures. The second step is to perform comprehensive data analysis, automatically recognize any possible problems, and offer more intelligent fault detection and diagnosis to cut down on time and money spent on maintenance. In conclusion, as the degree of system intelligence rises safeguarding data privacy and the safety of networks will become critical priority areas.

Keywords: Smart Grid (SG), Internet of Things (IoT), Fog Computing (FC), intelligent acceptance systems (IAS), Distribution Automation System (DAS), SCADA

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1. Introduction of Internet of Things-based distribution automation system with SCADA

As a core component of the smart grid, distribution automation technology, supported by advanced science and technology such as Internet of Things, cloud computing, big data, etc., allows the smart grid to realize more accurate and efficient power monitoring and rapid fault location, which promotes the operational efficiency and level of the smart grid [1-3]. Electrical automation is a product of the integration of information technology, electrical technology and other technologies, characterized by integration and comprehensiveness [4]. As the latest scientific and technological achievement of information technology development, the Internet of Things (IoT), with the purpose of interconnecting everything, provides a broader platform for the further development of electrical systems [5-7]. And power distribution system automation, as an important component of the electric power system, can make the power supply quality and operational efficiency of the electric power system continuously improve by further improving its intelligence and automation. Under the background of intelligence and informationization, it is of great practical significance to further analyze the application of Internet of Things (IoT) technology in power distribution automation system [8-12].

The emergence of IoT technology provides powerful help for the construction of distribution automation system. Firstly, by integrating the IoT technology with the power system, it can realize the real-time monitoring of the power system, ensure the stable supply of the power system, and greatly improve the safety and efficiency of power transmission and supply [13-15]. Secondly, by intelligently analyzing the huge amount of key data collected by IoT technology, the power distribution automation system can automatically adjust the power distribution strategy and optimize the power distribution, making the power distribution system more intelligent, efficient and reliable [16-18]. Finally, applying IoT technology, the power system can carry out real-time monitoring of energy use, which in turn can effectively optimize resource allocation, further improve the efficiency of energy use, and provide positive help for the subsequent high-quality development of the power system [19-21]. However, in the process of construction and application, this technology also has challenges and problems such as network security, data fusion, etc., and it is necessary to strengthen the research and development of technological innovation, improve the network security system, and promote the development of data fusion and sharing technology, in order to better promote the application and development of power distribution automation system [22-23].

In order to effectively promote the smooth application of distribution automation technology, and then promote the progress and development of smart grid technology, some scholars have studied the relevant measures. Wu, H. et al. for the distribution network automation master system of the network communication protocol access problem, put forward suitable for the distribution business data transmission characteristics of the MQTT protocol data collection architecture, can realize the distribution of Internet of Things terminal data collection directly, effectively reduces the smart grid communication maintenance cost [24]. Bitebo, A. T. et al. pointed out that smart grid and IoT technologies bring information security threats while improving the quality of grid services, for this reason, a DIAM security scheme is proposed to secure IoT distribution automation, which strengthens the identity and access management of the smart grid [25]. Adari, G. C. et al. emphasized that cybersecurity is a major challenge for smart grids and that IoT-enabled smart grids are more susceptible to attacks, and proposed different digital devices and communication protocol schemes to address the cybersecurity threats present [26]. Luo, F. et al. pointed out that the unreliability of terminal information still exists in IoT-based distribution automation systems and information systems, and the mechanism of the impact of unreliable transmission information on the power supply of the distribution system was modeled through a quantitative assessment [27]. Hidayatullah, N. et al. described the application of IoT in smart grids, which allows monitoring, control and intelligent communication creation functions between terminals, proposing a smart grid transmission and distribution monitoring application communication and framework to strengthen the quality of service of the power system [28]. Zhu, M. et al. used edge computing technology to design an intelligent acceptance system for distribution automation terminals, which was integrated into the smart grid and could effectively alleviate the technical challenges as well as security issues faced by distribution automation terminals [29]. Gupta, D. N. et al. showed that smart grid systems are characterized by high efficiency, sustainability, and reliability compared to traditional power systems, and that distribution automation and energy management systems can be established with the help of technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI), which can further enhance the experience of using electricity [30].

The main contribution of this paper:

1) Designing the proposed IoT-ISGDMS to monitor the smart distribution grids and systems for energy management.

2) The proposed IoT-ISGDMS utilizes the fog computing technique for monitoring transformer pole health and IAS has been used to enhance the distribution in the smart grid.

3) The numerical results and the proposed IoT-ISGDMS have been performed to achieve high performance and efficiency compared to other methods.

2. Proposed Methodology

Integrating information technology into the electric grid system has resulted in Smart Grid, gaining much attention and momentum since it promises to solve many issues plaguing today's traditional electrical networks. The power distribution system is one aspect of SG that must be monitored and controlled. In SG several detecting and acting technologies have been implemented. SCADA technology is extremely well demonstrated inside the substation area. Due to the dispersed nature of the distribution network, there has been very little oversight. Connecting many devices to the internet is now possible, which has tremendous implications for the efficiency and effectiveness of electricity distribution and automation. Therefore, it has been suggested to use an IoT-ISGDMS to monitor and manage customer consumption, outage management, power quality control, and pole transformer health. Fog computing, which does streaming analytics in real-time, enables this. First, IAS will be deeply integrated into electronic infrastructures like smart distribution grids and energy management systems. The second phase analyses all available data identifies potential issues and provides better fault detection and diagnostics to reduce maintenance costs and downtime. In conclusion, protecting data privacy and ensuring the security of networks will become crucially important as the degree of system intelligence increases.

SG relies significantly on IoT technology for detecting, transmitting, and analyzing data. The SG program aims to automate the power grid and enhance planning, maintenance, transmission, and operations. For instance, when a consumer reports an outage on the conventional power system, the utility provider knows the problem. By particular SG components ceasing to relay the acquired sensor data, the utility provider will be alerted to the interruption in service automatically in SG. Due to the need for IP addresses and bidirectional communication between all grid components (see Figure 1), the IoT plays a crucial role in making this scenario a reality. The IoT technology offers an interactive real-time network of things connected to the user’s services and devices through various conversation technologies, power machinery through many reasons IoT smart components, and the cooperation necessitated to realize real-time, mutually beneficial along with high-speed data expressing throughout various programs, strengthening the overall efficiency of an SG.

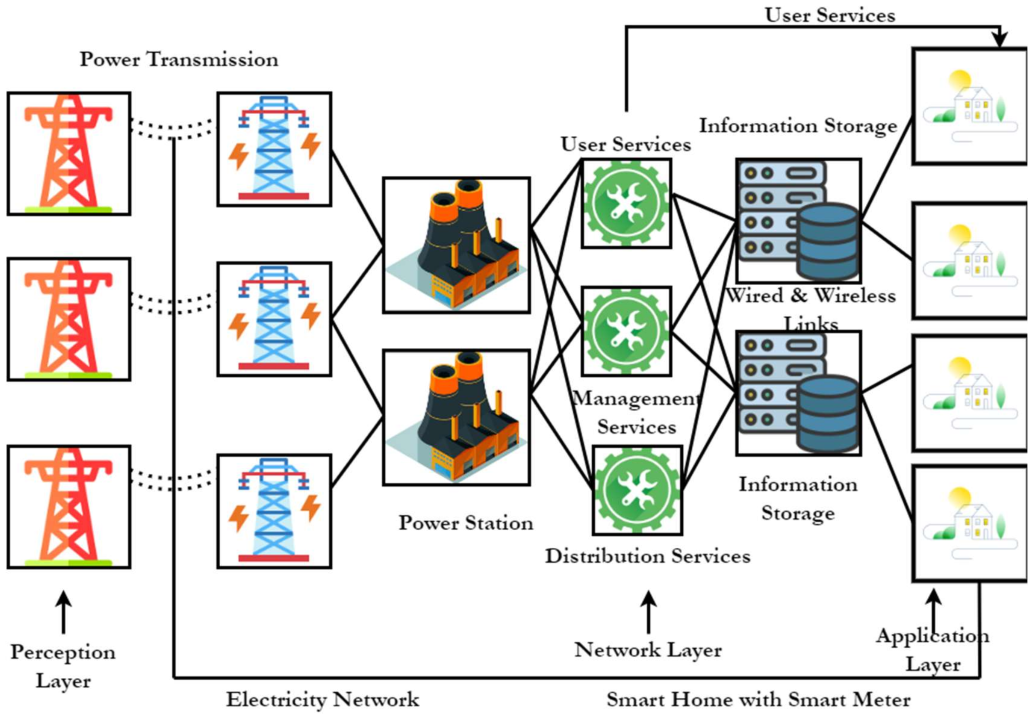

Fig. 1. IoT-based Smart Grid Operation

The use of the IoT in SGs may be grouped into three kinds based on the three-layered IoT architecture. First, the IoT is used at the perception layer of the IoT to install different IoT-connected gadgets for monitoring equipment status. Second, IoT is used to gather data from machines with the aid of IoT smart devices linked to the machines via various communication methods (at the IoT network layer). Finally, the application APIs (at the IoT application layer) are used to manage the SG.

Figure 2 deliberates the proposed IoT-ISGDMS. Various smart grid-related technologies, including wireless sensors, Internet of Things (IoT) protocols, and Fog computing, will be briefly discussed here. Wireless Sensor: Smart Grids' full efficiency is achieved using wireless sensors. Regarding the evolution of smart grid technologies, wireless sensor networks (WSNs) are invaluable because of the "smart sensing peripheral information" they provide. Incorporating WSN technology into the smart grid will help boost WSN's industrial growth. These WSNs have several technological benefits, including an online monitoring system with an early warning for disasters, the ability to pinpoint the precise location of defects and a reduction in the time needed to rectify them.

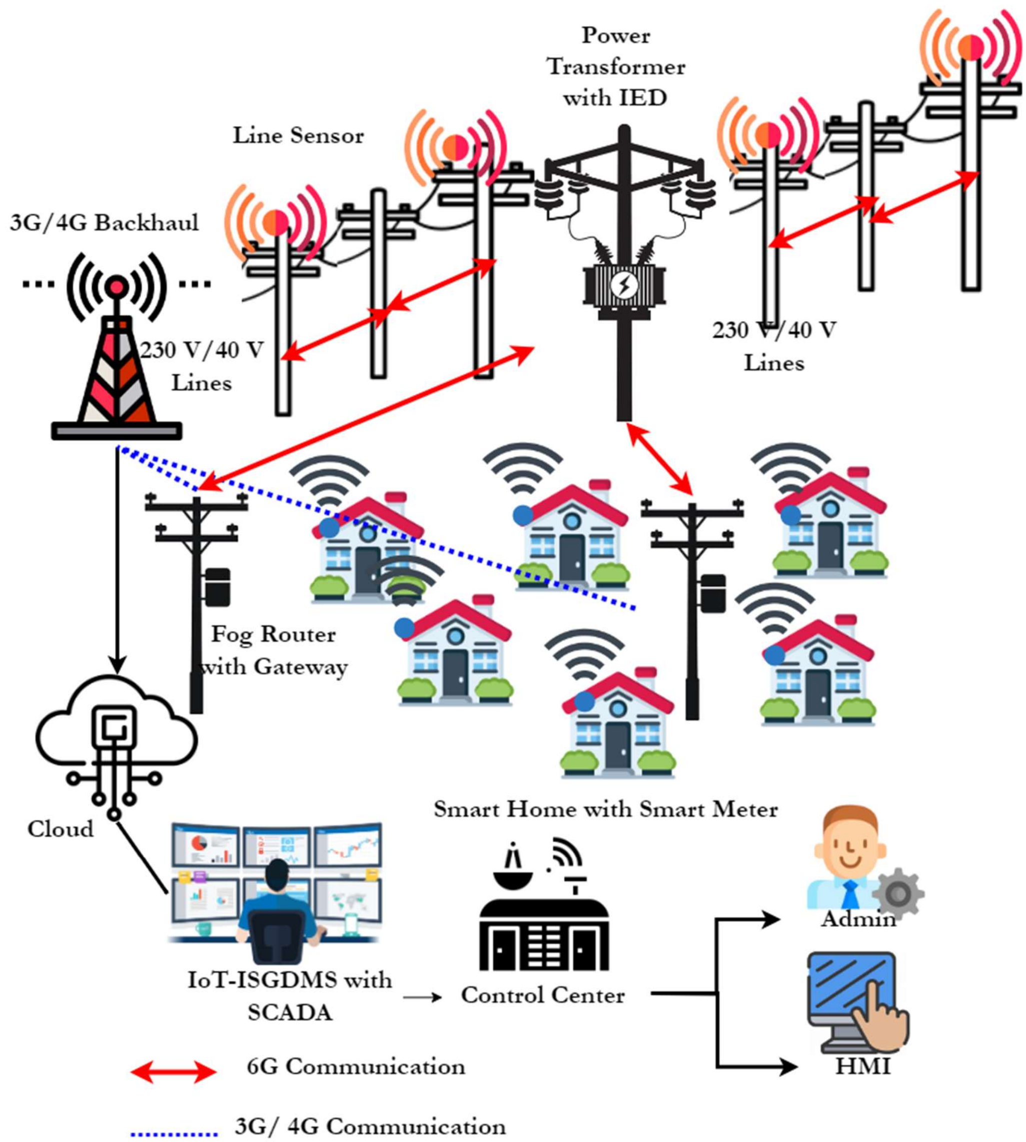

Fig. 2. Proposed IoT-ISGDMS

When bringing to fruition the vision of Smart Grids (SG), WSN has shown to be an invaluable enabling technology, particularly in power production, transmission, metering infrastructure, and the provision of efficient control mechanisms at low cost. Green communication and other information and communication technology (ICT) are carried out via SG. The scope of SG and the associated difficulties in communication and security have been discussed. The research details the essential parts and components of the SG communication system, serving as a reference architecture. The four primary SG applications and how they determine the most important specifications for smart grid communication networks are discussed in that study.

1) Cloud-based SCADA.Cloud-based SCADA is a position field of study with few published works. They outline designs for SCADA in the cloud, although they emphasise building something from scratch rather than adapting an existing system. Provides a high-level introduction to cloud computing and SCADA suggests that the latter may theoretically be deployed there. Each SCADA part is suggested to be exposed as a service and deployed via an LDS. This adaptable method allows customers to tailor the SCADA system to their needs and requirements by enhancing current services or creating brand new ones on the Rack space cloud. Incorporating the scalability and dependability of the cloud into this SCADA system was a priority throughout its development. The field devices were left behind while

the rest of SCADA was migrated as a single service, and expert-level knowledge of SCADA replication across clouds was made available.

2) 6G Communication (6LoWPAN) with Line Sensor.New 6LoWPAN (6G communication) protocols based on IPv6 via low-power embedded devices have been developed by the IETF. Recent protocols developed by the Introduce group, known as the routing algorithms for Low-power Lossy compression Networks (RPL), are described in RFC 6550. Therefore, 6LoWPAN-enabled line monitors may help satisfy the need for a production system that requires constant control and monitoring.

3) IoT-ISGDMS.Distribution of power automation using an Internet of Things–based SCADA with Fog integration has been outlined. The sensing region for distribution automation is broken down into 1) Intelligent meters to track and manage domestic energy use. 2) Sensors placed along the lines to measure and record line voltage and current. 3) IEDs (Intelligent Electronic Devices) keep tabs on the environment, loading, power, voltage, and current. A fog router is deployed to intermediate the pole conversion and customers to maintain track of anything from power lines and intelligent meters to transformers. Fog routers installed on utility poles are strategically located such that IEDs connected to the pole transformer may make just one hop before reaching the router. The 6LoWPAN standard must be used for all residential smart meters. Since this is an IP-based communication infrastructure, each r is assigned its unique. This creates the 6LoWPAN (6G communication)-based LAN in the nearby neighbourhood. Fog Routers receive information on household voltage, current, and power use from these. Pole Transformer-mounted IEDs can communicate over 6LoWPAN (6G communication). The Fog Router communicates with a wide range of sensors and meters that use 6LoWPAN and are linked to 6LoWPAN (6G communication) aggregators. Data from IEDs, smart meters, and power line sensors may be gathered and processed in real-time via the communications infrastructure (3G or 4G) and the internet. These Fog routers enable variability, internet integration, and dispersed data analytics while taking advantage of the reduced latency of vast and dense geographical dissemination. This decreases the overall network congestion and latency and gives Scalability. DA contributes to the SG's increased dependability. It aids in increasing productivity and preserving assets for a longer period.

2.1. Intelligent Acceptance System (IAS)

The cloud layer analyses and processes data using high-powered computer resources and machine learning techniques.(see Fig. 3) It's sophisticated data analysis and algorithms for mining enable intelligent detection and forecasting of power equipment problems, indicators of performance, and abnormal situations. Based on the results of the data analysis, the cloud layer provides suggestions on how to proceed. Complete acceptance news accounts, defect diagnosis reports, and apparatus assessment reports are all attainable via the system, allowing for more informed decisions.

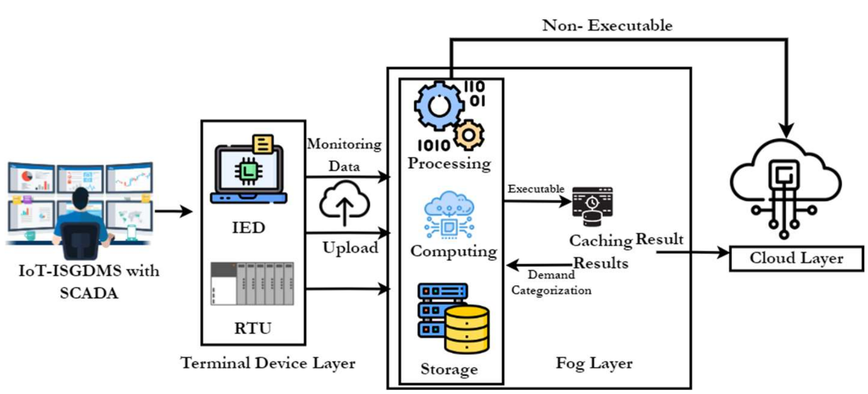

Fig. 3. Intelligent Acceptance System (IAS)

Data cleansing and organization before application. Edge layer processing and filtering of unprocessed information from the mobile device layer reduces data transfer volumes and eases processing burdens in the cloud. It may perform elementary data processing tasks including cleaning, denoising, most and averaging to improve data quality and accessibility. Decision-making and analysis in real-time: With the computational and analytical power at the edge layer, processed information may be evaluated beforehand and choices can be made in real-time. To quick algorithm computation and rule processors, real-time monitoring, problem identification, and alerts are feasible in power systems. Edge nodes may save certain data in regional caches for fast access and response.

2.2. IoT with SCADA

Each little part of a smart grid contributes to the whole by sharing resources like communication and protection. It is the key component of the substation's control centre, a monitoring system that offers communication linkages. For intelligent remote control, it is implemented in the distribution network of an intermediate voltage substation. By improving the reliability of the electric supply and decreasing operational expenses, power utilities may profit from this regulating and monitoring infrastructure. As may be seen in Figure 4, the four main components of SCADA are data collection, information display and monitoring, supervision control, and alarm notification. Human-machine interfaces (HMIs), programmable logic controllers (PLCs), data-collecting servers (DCCs), and remote terminal units (RTUs) are some of the key software and hardware elements. Smart grids relay heavily on electronic devices with intelligence in their distribution networks. Overcurrent relays in substations trip circuit breakers when line current exceeds set limits or when transformers fail, and the IEDs attached to and controlling the load switches get an alert signal. Let's pretend that electricity is restored after a couple of circuit breaker tripping and everything is normal. A momentary problem is what the relay will report in such a situation. If the system keeps tripping and won't reclose, the IEDs in the circuit breaker will talk to the load switches to figure out where the issue is. When the feeder terminal unit's load switch raises the fault flag, the defect has been identified and localized, and the IED's next job is to isolate the region by tripping off the corresponding load switch. The load switch quickly turns off the power supply to the rest of the network. It transmits instructions to each IED of the network's elements, comprising relays, breaker panels, and tie switches needed for power supplier restoration in the substation's problematic region. If the inactive switch cannot restore power to the substation via the main source, it will switch to a different, fault-free energy side.

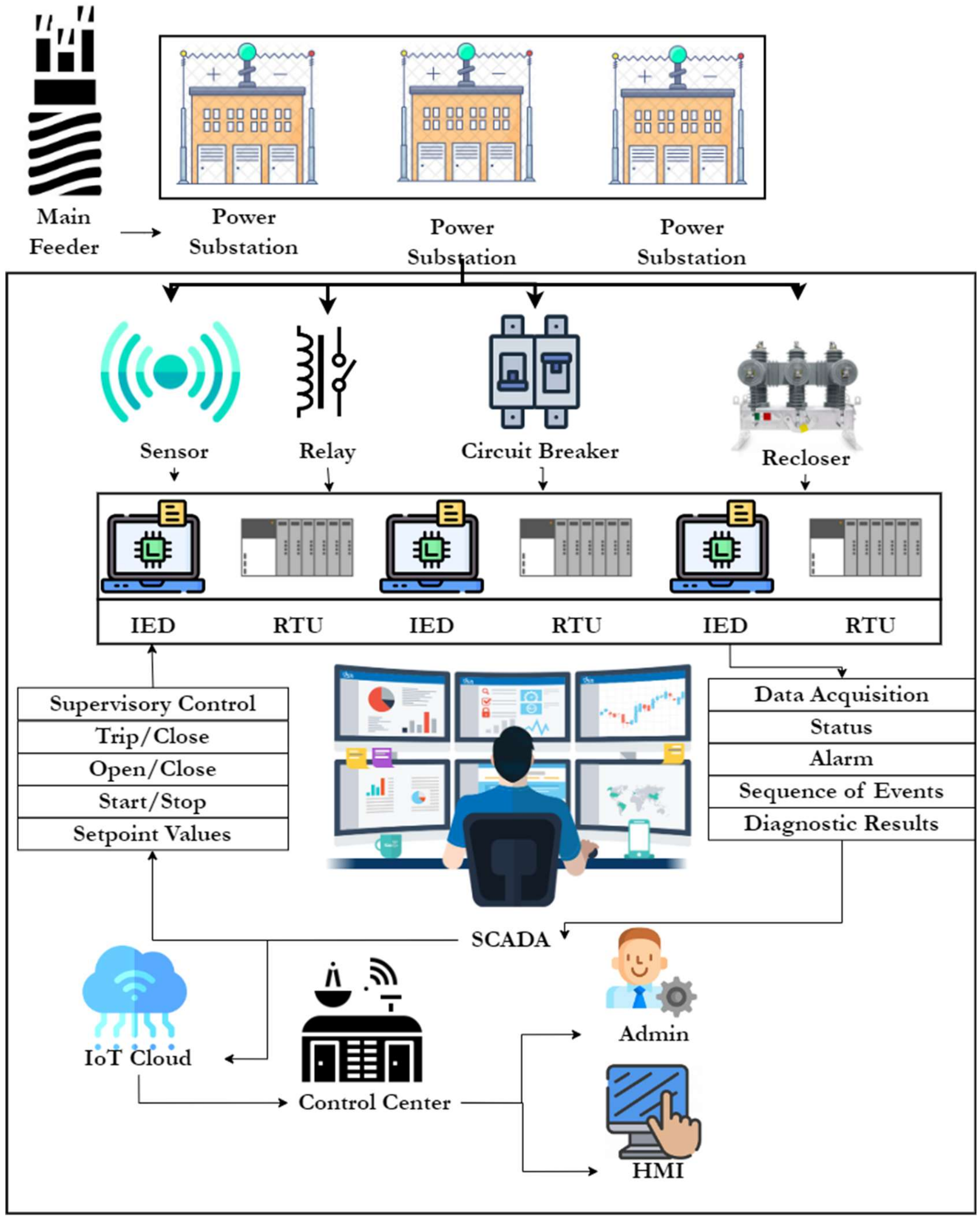

Fig. 4. IoT with SCADA

SCADA is a legacy system many utilities use for voltage and current management within operational requirements throughout the electric distribution system. This is accomplished by monitoring and controlling substation relays, distribution switches, equipment, and sensor points. It offers a foundation for a variety of management of distribution tasks when combined with other DA systems. SCADA systems take operational data from the field and present it on operator screens in the control centre known as the HMI. Grid operators, who may send operator orders, respond to display alerts triggered by abnormal situations. DMS may dynamically issue SCADA commands.

By employing SCADA to pinpoint the exact location of malfunctions, utilities can swiftly fix the damage and get services back up and running, making the system more resilient. When system circumstances call for load curtailments, SCADA technology at the distribution and intermediate levels is employed to strike a balance between system safeguards and the diverse demands of consumers. To further increase security and energy management, SCADA systems are being utilized to monitor customer-owned generation. With the help of software designed for SCADA and master stations equipped with the right switches and reclosers, it is possible to locate ports of entry for customer loads and to monitor in real-time all forms of dispersed generating assets, including backup generators. Real-time operational and switching data coming from DMS. Submitting Metrics and Information to DMS and Data Historians, Information gleaned via data warehouses or other measurement and data management systems. When integrated with other systems, SCADA enables the following: Control of distribution equipment, including substations, feeders, and inter-tie points. Load management, outage analysis, and demand management benefit from event sequencing, time-stamped data, trends, and diagnostic information. 24/7/365 web-based access for engineers, managers, and other personnel responsible for running the show and the system in case of an outage.

2.3. Distribution Automation System

Distribution Automation System is shown in Figure 5.

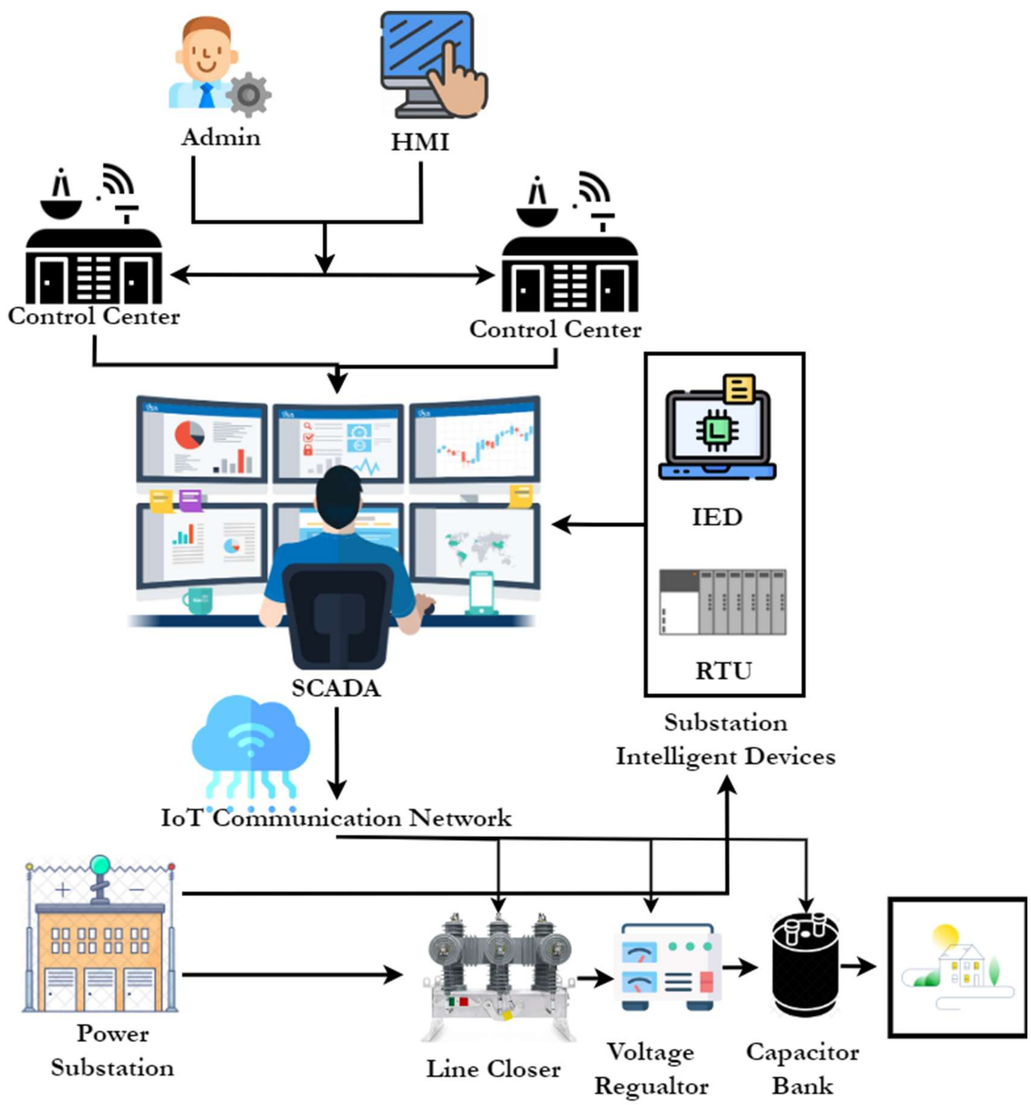

Fig. 5. Distribution Automation System

Improvements in problem location, isolation, and service restoration capabilities lead to fewer interruptions, lower functioning maintenance and repair costs, a decreased likelihood of machinery breakdown or damage, and less customer annoyance due to automation of distribution technologies and systems. By automatically decreasing the size of large outages and enhancing operators' capacity to assess and repair malfunctioning machinery, the electricity network has become more resilient to adverse weather: lower operating expenses, better capital asset utilization, fewer equipment breakdowns better monitoring and preventive maintenance. A decrease in emissions, a shorter turnaround time to restore service, and cheaper operating costs all result from better use of repair staff and truck rolls. As an example of a distributed energy resource (DER), thermal energy storage in commercial and municipal structures may be better integrated into the grid.

1) Fault Detection. It is one of the sensors that detect the feeder current and voltage deviation from acceptable values. Operators may use this information to quickly pinpoint the source of the problem (such as a faulty piece of equipment) or to differentiate between a malfunction and transient high-load demands.

2) Relay. To pinpoint the source of malfunctions, smart relays use complex software. Substations may use them for feeder protection, and automated switching equipment can put them on devices. The equipment settings and methods trigger device controls. Data collected by the relays is stored and processed before being sent directly to the SG operators

3) The Main Feeder and Recloser. Automation feeder switches open and shuts to identify the failures and replace the feeder with the defect to return power to clients on line segments lacking a fault. They are often set to cooperate with smart relays to function in response to directives from an autonomously control system, management of distribution systems, and communications from grid administrators. In the event of a determined fault current, the switches may be set to shut and open at regular intervals. To isolate the problematic area of the feeder, electricity is diverted around it by reclosing the switches; this is done that the feeder may be re-energized when the blockage has been removed naturally.

4) Capacitor Bank. Reactive power demands from inductive loads, such as those created by client equipment, transformers that are or upstream power line impedances, may be mitigated using a capacitance bank (a collection of capacitors) installed by the utility. A flat temperature across the feeder and less energy lost as electricity is lost in the feeding line are the results of accounting for reactive power, decreasing the entire amount of power that power plants must give.

5) Voltage Regulators. Transformers of the voltage-regulating kind respond to variations in load by making minute adjustments to the supply voltage. Substations are where you'll find them. The aforementioned transformers adjust the load taps at substations and the distribution lines to control upstream voltage.

6) Control Centre. Transmission line and apparatus loadings may be monitored by feeder monitors, which will sound alarms if the loads on either begin to reach dangerous thresholds. The devices deliver data in genuine time back to the mechanisms that infrastructure can successfully determine the modifications in load developments and take the corresponding actions, such as taking instruments off service, transmitting load on substitute feeder, or maintaining equipment whenever necessary without causing any electricity outage.

3. Results and Discussion

There has been a lot of interest and movement in the SG toward incorporating technological advances into the electricity distribution system to resolve the many problems plaguing today's and yesterday's power networks. It is important to monitor and manage the SG power distribution system constantly. Several detecting and reacting technologies have been included in the Smart grid. The substation is an ideal demonstration ground for SCADA systems. There has been minimal monitoring because of how far apart nodes are in the distribution chain. There are huge ramifications for the efficacy and efficiency of power distribution and automation now that many devices may be connected to the internet. Fog computing, which conducts streaming analytics in real-time, allows this. First, IAS will be incorporated more thoroughly into additional electrical infrastructures like sophisticated distribution grids and energy management systems. The next step is to examine all the data collected, pinpoint any problems, and provide improved fault detection and diagnostics to cut down on maintenance costs and downtime. In conclusion, as a system's intelligence level grows, safeguarding personal information and maintaining the integrity of digital networks will become more pressing concerns. Therefore, it has been suggested that a pole-based IoT-ISGDMS be used to monitor power consumption, outage administration, electrical performance, and transformer condition.

Dataset Description: One of the most pressing concerns in science and engineering over the last decade has been finding ways to improve the reliability and efficiency of our nation's electrical infrastructure. Renewable energy integration, efficient and effective grid monitoring, transmission expansion planning, grid vulnerability analysis and control, cyber security, and the design of energy markets are just a few of the many facets of power systems that are challenged by this issue. Most of these issues can't be fixed without using actual geographical locations and grid topologies. Topologies of power transmission networks, especially the locations of substations and lines, are often not made public or are difficult to get to protect from exposing weaknesses. Because of this gap, the Network Imitating Method Based on Learning (NIMBLE) was developed to create artificial networks with the same spatial and structural characteristics as real ones. This website provides access to a NIMBLE-generated, Western Interconnection (WI)-based synthetic network.

1) Performance Analysis (%)

$$Distribution\ Energy=\frac{E_{renewable\ energy\ sources}}{E_{total}} \tag{1}$$

Where $E_{renewable\ energy\ sources}$ and E_{total} is the energy (MWh) and indicates the amount of generated power from the RES. Figure 6 and equation (1) illustrate the performance analysis. This paper utilized a smart grid-based automated distribution management system based on the dataset analysis. Using formal techniques in SG aims to create a formalized model efficiently, reducing the likelihood of implementation mistakes. Detailed requirements for an Internet of Things-based automated shipment administration system are offered. The IAS framework's enabled properties aid in ensuring appropriate and cost-effective functioning of the system at both the user end and the service provider end, as the structure was designed for electrical substations technology, communications line failure identification and replacement, components administration (including the transformers), and the requirements of smart meters. Due to the need for formal techniques in safety-critical systems, the suggested methodology is accurate, consistent, and appropriate.

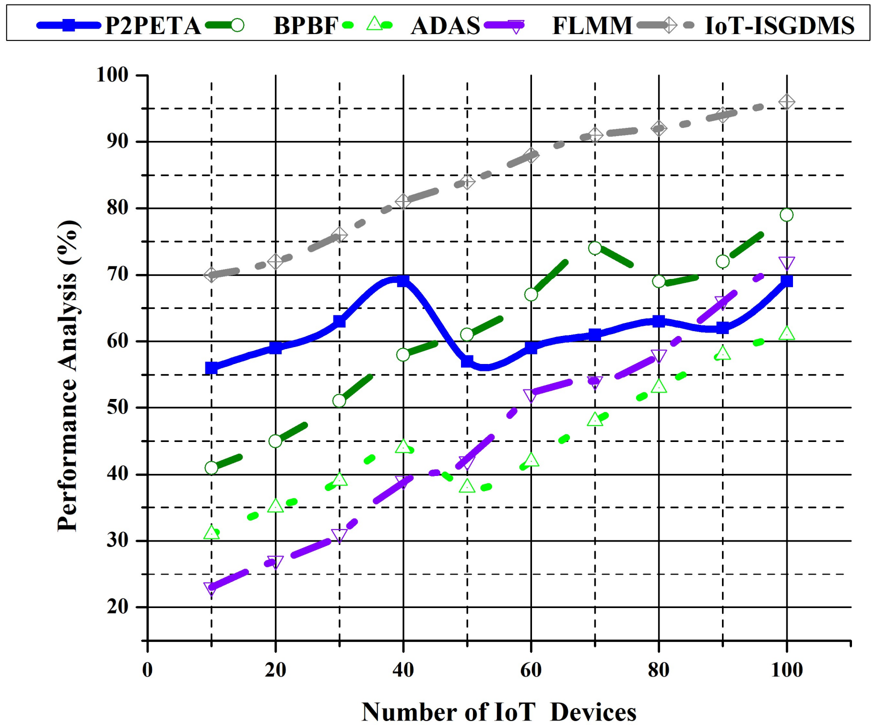

Fig. 6. Performance Analysis (%)

2) Monitoring Ratio (%)

$$Y_s = F_s(x_s, m_s), S \in N \tag{2}$$

Figure 7 expresses and equation 2 the monitoring ratio. In this equation Y_s, x_s is a status of monitoring devices, m_s is a noise from an observer's device, F_s is an evaluation of monitoring devices. This paper proposed IoT-ISGDMS to monitor the SG operation through IAS utilizes the dataset. By polling smart meter networks for information on voltage and current, the fog router will aid with one of the most important aspects of our work: outage management. Analysis algorithms are put on a fog router mounted on a utility pole to analyze power quality, outages, and consumption patterns. IEDs are installed in Pole Transformers to allow for 6LoWPAN connectivity. In real-time, the Fog router would maintain tabs on the power distribution transformer's temperatures, electrical draw, and supply voltage. The frequency of tapping of capacitor banks must be adjusted at the distribution location regularly to manage voltage using logical computations. Finally, a Human Machine Interface (HMI) hosted as software as a service (SaaS) would be added to the substation's SCADA system for monitoring power distribution remotely by admin. Software as a Service (SaaS) is a means to offer programs via the Internet. It's a must-have for every Cloud-based HMI development project. SaaS facilitates online access to and usage of software applications hosted in the cloud. It eliminates the need for businesses to deploy apps on-premises or host them in their data centres.

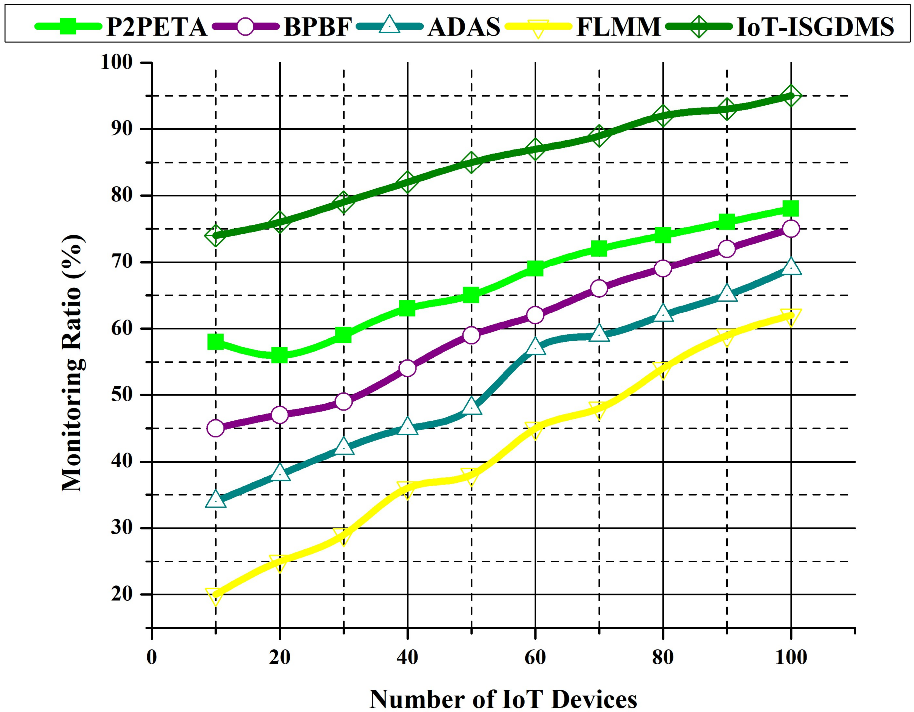

Fig. 7. Monitoring Ratio (%)

3) Fault Detection Ratio (%).The time it takes to find a fault, from when it occurs to when it's discovered, is divided into two halves. The amount of time it takes for values to be measured by sensors and for the data logger to collect and transmit that information to the monitoring station is denoted by the time-constant S_{data}. The suggested algorithm's S_0 reaction time is the time it takes to receive data, analyze it, and send an alert about a malfunction in smart grid equipment. The MATLAB logs the timestamps of data reception from the S_{rec} and faults indication on the devices, allowing us to compare them and determine how quickly they respond. For a given defect, the suggested fault detection system has a reaction time of where:

$$S_0 = S_D - S_{rec} \tag{3}$$

Figure 8 and equation (3) describe the fault detection ratio. This paper proposes IoT-ISGDMS to identify the distribution network fault detection based on the dataset. The other goal here is to describe and develop an IoT and finite automaton-based fault-free distribution management system that is efficient, reliable, and sustainable. While many approaches have been used to monitor, identify, and isolate smart grid problems, this is the first such effort. This study employs formal methodologies and a design model for problem diagnosis, isolation, and operation rehabilitation within distributed management systems to strengthen the intelligent grid's distributor management system. The fundamental objective is to formalize the model in a way that verifies it, decreases the possibility of implementation issues and then puts it into action. Fault isolation contains all probable trouble locations and service restoration contains the optimal switching order sequence needed to pinpoint the source of the problem and restore service.

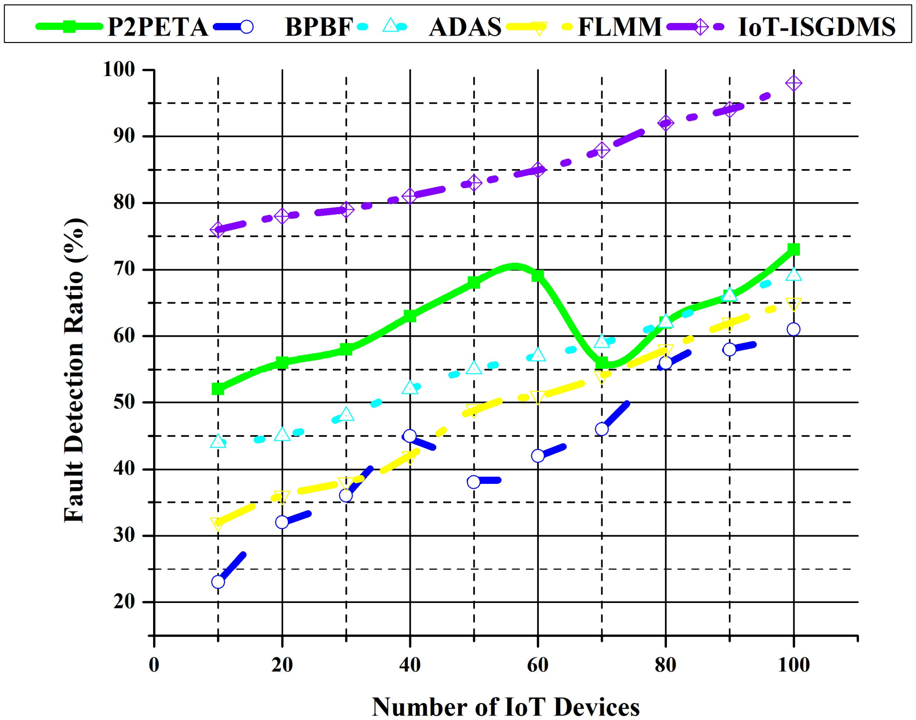

Fig. 8. Fault Detection Ratio (%)

4) Power Utility Analysis (%)

$$E = P \times (\frac{s}{1000}) \tag{4}$$

Figure 9 and equation (4) explore the power utility ratio. Where E is the energy measured, P is a power unit in watts, s is the duration of use of the energy source. A SCADA system that utilizes fog for distributing electricity and automated, high-tech meters to track and manage residential energy use. Line sensors to evaluate the current and voltage levels. As a third point, IEDs monitor things including heat, work, electricity, and voltage. Because of this, a Fog router is installed between the North Pole Transformer and the customer's end so that the Transformers, which are linked to electricity and smart metering systems, may be monitored. Fog routers installed on utility poles are strategically placed so that IEDs deployed from Pole Transformers may make a direct connection to them. All home smart meters must conform to the 6LoWPAN standard. Due to the IP-based nature of this communication, each energy meter is given its address. Using 6LoWPAN establishes a local area network in the immediate area. The voltage and current drawn by a home are sent to fog routers.

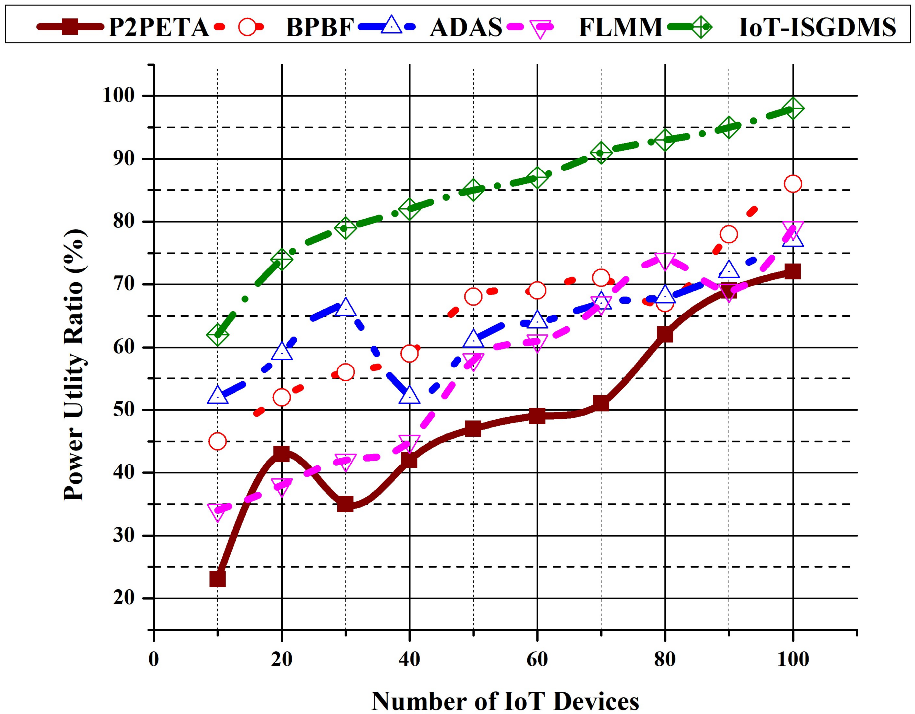

Fig. 9. Power Utility Ratio (%)

4. Conclusion

In conclusion, several sensing technologies are being implemented in Smart Grid to provide improved power delivery and efficiency. An IoT-ISGDMS is proposed to manage and monitor consumer usage, outage administration, reliability of power, and pole transformers' health. This is made possible by the streaming analytics capabilities of fog computing. Consequently, less information is sent across the network, and control response times are enhanced. The experimental results show the proposed IoT-ISGDMS to achieve a high-performance ratio of 98.3% compared to other methods. In the future, the suggested architecture will be verified in the direction of a trustworthy routing protocol in the Internet of Things for the distribution of power and Automation for the effective transmission of data. This demonstrates that a distributed autonomous system built on the IoT works quite well.

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