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# Survey On Anomaly Anomaly Detection in Smart Electric Meters for Detecting Faults and Misuse of Electric Energy Consumption

**Keyur Kulkarni[1], Rahul Dantakale[2], Shalaka Mande[3] , Sakshi Kshatriya[4] , Prof. Mayuri Agrawal[5]**

1,2,3,4 - Final year students of Computer Engineering Department of Smt. Kashibai Navale college of Engineering, Pune

5 – Prof. of Computer Engineering Department of Smt. Kashibai Navale college of Engineering, Pune

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**Abstract -** This paper introduces an innovative approach to address faults and misuse in electric energy consumption by employing anomaly detection techniques within smart electric meters. The system aims to enhance fault detection and curb instances of misuse or theft of electric energy through the utilization of advanced metering technologies. By leveraging anomaly detection algorithms, the smart meters can identify irregular patterns in energy usage, signaling potential faults or unauthorized activities. The proposed system employs sophisticated data analysis mechanisms to scrutinize energy consumption patterns, thereby distinguishing anomalies from regular usage. Through this process, it effectively identifies potential faults in the system and instances of energy misuse or theft. The paper elucidates the use of anomaly detection algorithms, data analysis techniques, and smart metering infrastructure to enhance fault detection and prevent unauthorized energy consumption. The outcome demonstrates promising results in improving the overall reliability and security of energy distribution systems while minimizing instances of misuse or theft.

***Key Words***: Anomaly Detection, Smart Electric Meters, Fault Detection, Energy Misuse.

## 1.INTRODUCTION

The energy landscape continually evolves, with escalating demand and the persistent challenge of efficiently managing consumption. The introduction of various papers delves into this evolving terrain, emphasizing the critical need for advanced technologies in energy distribution and consumption monitoring. Traditional methods of meter reading and fault detection face numerous limitations, from human errors in readings to the rising concerns of energy theft and misuse.

Automatic Meter Reading (AMR) systems emerge as a promising solution, enabling seamless transmission of energy consumption data wirelessly to distribution networks. These systems aim to eliminate the inaccuracies associated with manual readings and address the challenges posed by remote locations or inconvenient meter placements. Moreover, the implementation of advanced electronic meters, coupled with theft detection mechanisms, becomes imperative to curb unauthorized energy consumption, which has a significant impact on the economy.

The quest for uninterrupted power supply drives the development of fault detection methodologies. The papers explore fault detection using various techniques, moving away from conventional impedance relay systems to employing GSM-based fault detection systems. These systems swiftly identify faults and notify concerned authorities about the fault location, thereby facilitating prompt corrective actions and ensuring reliability in energy supply.

Innovative technologies such as ATmega328 microcontrollers, GSM modules, current transformers, and real-time clock systems form the backbone of these advanced energy monitoring and fault detection systems. The integration of these technologies enables accurate data collection, fault detection, and real-time communication, thus revolutionizing the conventional energy distribution infrastructure.

As the world grapples with the growing energy crisis, these papers underscore the urgency of adopting smart energy solutions that not only automate meter readings but also proactively detect faults, prevent theft, and ensure uninterrupted energy supply, thereby contributing to a more efficient and sustainable energy ecosystem.

## 2. LITERATURE SURVEY

[1] Title: Anomaly Detection in Smart Meters

Authors: Thanasis Vafeiadis, Anastasios Alexiadis, Valia Dimaridou, Stelios Krinidis, Kostas Kitsikoudis, Lambros Makris, Danijel Davidović, Dimosthenis Ioannidis, Dimitrios Tzovaras.

Published: 2019

Information: This paper addresses the critical task of anomaly detection within smart meters, focusing on a project conducted by a Slovenian power distribution company. Authored by a team led by Thanasis Vafeiadis and comprising Anastasios Alexiadis,

Valia Dimaridou, Stelios Krinidis, Kostas Kitsikoudis, Lambros Makris, Danijel Davidović, Dimosthenis Ioannidis, and Dimitrios Tzovaras, the study highlights the successful implementation of anomaly detection techniques. It involves analyzing vast datasets from smart meters utilizing statistical, machine learning, and deep learning methodologies, notably Autoencoders, to swiftly and accurately identify anomalies at both individual smart meter and distribution network levels.

The paper contextualizes the significance of smart metering in contemporary energy management and elucidates the challenges faced by electricity companies due to various anomalies within the energy distribution grid. It delineates the necessity for automated processes to manage the overwhelming amount of data generated by smart meters. The research details diverse algorithms developed for detecting anomalies, such as those related to opposite events, successive events, network quality, and smart meter errors. Additionally, it reviews existing literature in the domain, referencing various approaches like prediction-based detection systems, clustering, regression, and statistical methods for anomaly detection in the smart energy sector.

[2]. Paper Name: IOT based Smart Energy Meter Monitoring and Controlling System

Authors: Rishabh Jain, Sharvi Gupta, Chirag Mahajan, Ashish Chauhan

Publish Date: April-June 2019

Information: The paper discusses the integration of IoT technology, particularly the ESP8266 Wi-Fi module, to monitor and control energy consumption. It emphasizes the increasing demand for electricity and the need for optimized usage in various sectors like agriculture, industries, households, and healthcare. The proposed system aims to revolutionize traditional energy meters by leveraging IoT concepts, addressing issues like power theft, optimizing usage, and reducing wastage. It operates on Arduino microcontrollers and offers real-time data accessible via a webpage, catering to both consumers and service providers.

Proposed System:

The system introduces an interface for users to monitor energy consumption, receive alerts, and manage power usage through web-based control. It operates in automatic and manual modes, allowing for controlled device usage to prevent energy wastage. Additionally, it sends notifications in case of faults, ensuring increased system reliability. The implementation involves various hardware components like Arduino boards, ESP8266 Wi-Fi modules, LCD displays, and power supplies, using EEPROM, voltage and current sensors, relays, and Wi-Fi modules for IoT-based operations and energy measurements.

[3] Paper Name: Experimental Study and Design of Smart Energy Meter for the Smart Grid

Authors: Anmar Arif, Muhannad AI-Hussain, Nawaf AI-Mutairi, Essam AI-Ammar, Yasin Khan, and Nazar Malik

Publish Date: March 2013

Information: The paper focuses on the development of a smart energy meter using GSM and ZigBee technologies for the smart grid. This digital meter not only measures energy consumption but also facilitates two-way communication between consumers and service providers. It aims to enhance energy efficiency by providing consumers with detailed information about their energy usage. The smart meter prototype showcased in the study enables real-time transmission of consumption data to service providers, who, in turn, deliver this information to consumers via SMS or internet platforms.

The paper presents successful experiments conducted in lab settings, demonstrating the functionality of the smart energy meter in monitoring and transmitting consumption data using GSM and ZigBee networks. It highlights the importance of empowering consumers with real-time energy consumption data to enable informed decisions and potential reduction in energy usage. The study emphasizes the role of this technology in contributing to energy conservation and cost savings, offering a promising solution for efficient energy management within the smart grid infrastructure.

[4] Paper Name: Smart Electricity Meter Based on LoRa Technology for Long-Range Communication and Low Power Consumption

Authors: Yang Yang, Chuang Zhang, Weiwei Yan, Qinci Liang, Minsheng Xuan, Shuai Guo

The paper discusses the utilization of LoRa technology in smart electricity meters to achieve extended communication ranges with minimal power consumption. It employs the FM3308 chip as a control core, emphasizing the implementation of LoRa technology for efficient and long-distance communication while addressing interference through hardware and software design. The study explores hardware solutions, such as system design, power supply circuits, metering circuits, and LoRa communication modules. It also delves into software programming in embedded C language, outlining workflow design and anti-interference strategies to enhance energy meter accuracy. Overall, the research highlights LoRa's potential for optimizing smart meter communication, aiming to improve efficiency and reduce interference.

[5] Paper Name: Intrusion Detection in Smart Meters Data Using Machine Learning Algorithms: A Research Report

Author: M. Ravinder and Vikram Kulkarni

The paper discusses the importance of securing smart metering applications within the Smart Grid by focusing on intrusion detection in smart meter data. Authored by M. Ravinder and Vikram Kulkarni from SVKM's NMIMS Mukesh Patel School of Technology Management and Engineering, SVKM's NMIMS University, Mumbai, India, the research proposes a novel method that integrates statistical models and machine learning algorithms to identify anomalies in smart meter data. The study introduces various algorithms like Brown's, Holt's, and Winter's models for exponential smoothing and employs machine learning techniques such as Density-Based Spatial Clustering of Applications with Noise (DBSCAN), Mean Shift, and Monte Carlo Algorithm (MCA) for detecting abnormal consumption patterns. The paper demonstrates the efficacy of the Monte Carlo algorithm, which outperforms other methods by 15% in detecting anomalies within smart meter data. However, the specific publication date is not mentioned in the provided text.

[6] Title: Smart Energy Meter and Fault Detection

Authors: Rajesh T S, Anoop Jose, Midhun P, Vishnu Das

Summary:

The paper, authored by Rajesh T S, Anoop Jose, Midhun P, and Vishnu Das, introduces a GSM-based smart energy metering system and an efficient line fault detection methodology. It aims to replace the conventional meter reading method by implementing automatic meter reading (AMR) technology. This system enables remote monitoring of meter readings and the automatic generation of bills via SMS, effectively preventing power theft. Additionally, it offers a swift and accurate fault detection mechanism in electrical lines without human intervention, notifying authorities about fault locations and types through GSM technology. The proposed system utilizes various components such as the ATmega328 microcontroller, relays, current transformers (CT), GSM modules, and LCD displays to accomplish its objectives. The paper addresses the limitations of traditional meter reading systems and advocates for AMR systems to ensure reliable power supply and prevent electricity theft. It outlines the fault detection system's methodology, involving CTs, rectifier circuits, microcontrollers, GSM modules, and battery supplies, to detect faults, compare measured currents with preset values, and alert authorities about faults via SMS. The conclusion emphasizes reduced human interaction, increased accuracy, and enhanced consumer awareness about energy consumption and theft detection, suggesting future implementations in households and enhanced fault detection methodologies.

## 3. CONCLUSIONS

The amalgamation of research in these papers underscores the transformative potential of smart energy technologies, particularly in automatic meter reading (AMR) and fault detection, addressing challenges in conventional energy distribution. AMR systems, replacing manual readings with automated, wireless transmission, promise enhanced accuracy and efficiency in energy monitoring, while theft detection mechanisms within electronic meters combat unauthorized usage. Advanced fault detection, leveraging GSM modules and microcontrollers, swiftly identifies faults, ensuring a reliable energy network. This synthesis of technologies marks a shift towards precision, automation, and real-time data communication, shaping a future of resilient, efficient energy management and sustainable infrastructure.

## REFERENCES

1. A.Molderink, V. Bakker, M. G. C. Bosman, J.L. Hurink , G. J.M. Smith," Management and Control of Domestic Smart Grid Technology", IEEE Transactions on Smart Grid, vol.1, 2010.
2. V. J. F. Kakeu, A. T. Boum, and C. F. Mbey, (2021) "Optimal Reliability of a Smart Grid" International Journal of Smart Grid 5(2): 74–82
3. Andrysiak, T., Saganowski, Ł., and Kiedrowski, P. (2017). Anomaly detection in smart metering infrastructure with the use of time series analysis. J. Sensors 2017, 1–15. Article ID 8782131, 15 pages. doi:10.1155/2017/8782131
4. Liu Shiwei 2020 Design of Meter Reading System for Internet of Things Based on LoRa (Shan Dong: Shandong University of Science and Technology) p 13
5. S. Depuru, W. Lingfeng, V. Devabhaktuni and N. Gudi "Smart meters for power grid Challenges, issues, advantages and status" in Proc. Power Systems Conjerence and Exposition (PSCE), pp. i-7, 20-23 March 2011.
6. DEPURU S.S.S.R., WANG L. DEVABHAKTUNI V.: Smart meters for power grid: challenges, issues, advantages and status. Renewable and sustainable energy reviews, 16(6), 2011, 2736-2742.
7. Sasanenikita N, "IOT based energy meter billing and monitoring system", International research journal of advanced engineering and science, (2017).