INTERNATIONAL SCIENTIFIC JOURNAL OF ENGINEERING AND MANAGEMENT (ISJEM) ISSN: 2583-6129
CONFERENCE PROCEEDINGS: VOLUME: 05 ACME – 2026 DOI: 10.55041/ISJEM.ACME147
AN INTERNATIONAL SCHOLARLY || MULTIDISCIPLINARY || OPEN ACCESS || INDEXING IN ALL MAJOR DATABASE & METADATA

Smart Energy Monitoring and Alert System

Alluri Priyanka
Department of Electronics and communication Engineering
Annamacharya institute of technology and Sciences
Tirupati,India
priyanka123aluru@gmail.com

Chikkala Navya
Department of Electronics and communication Engineering
Annamacharya institute of technology and Sciences
Tirupati,India
chikkalanavya7@gmail.com

Yallapalli Thanuja
Department of Electronics and communication Engineering
Annamacharya institute of technology and Sciences
Tirupati,India
thanujagoud1435@gmail.com

Peram Durga Bhavani
Department of Electronics and communication Engineering
Annamacharya institute of technology and Sciences
Tirupati,India
bhavanireddy000111@gmail.com

Kummara Yugandar
Department of Electronics and communication Engineering
Annamacharya institute of technology and Sciences
Tirupati,India
yugandarkummari@gmail.com

Abstract-In the current era of rapid urbanization and digital transformation, the efficient use of electrical energy has become an essential factor in promoting sustainable living and industrial development. The Intelligent Energy Meter with Alerting System using Arduino Uno and IoT technology is designed to provide users with real-time monitoring, control, and management of electrical power consumption. The proposed system continuously measures the power usage of household or industrial appliances and transmits the data to an IoT-based cloud platform for analysis, visualization, and reporting. The Arduino Uno serves as the central processing unit that collects data from voltage and current sensors such as the ACS712 current sensor and a voltage divider circuit, calculates the power consumption, and communicates with an IoT Wi-Fi module (ESP8266) to upload the data online. When the energy usage exceeds a predefined threshold, the system automatically generates alerts to the user through IoT-based notifications or buzzer indications. This threshold-based cost management mechanism helps prevent unnecessary energy wastage and high electricity bills. The system can also control or automate appliances based on user-defined parameters, thereby improving energy efficiency. Furthermore, users can remotely access detailed energy consumption analytics through the IoT platform, which provides insights into load patterns, daily or monthly usage reports, and anomaly detection. Overall, the proposed system enables proactive energy management, encourages conservation, and contributes to the vision of smart homes and smart grids. It represents an economical and scalable solution adaptable to both residential and industrial environments.

Keywords- Intelligent Energy Meter, Alerting System, IoT Technology, Real-Time Energy Monitoring, Power Consumption Tracking, Threshold-Based Alert, Smart Energy Management, Appliance Automation, Energy **Usage Analysis, Electricity Cost Management.**

I.INTRODUCTION

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, sometimes with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use.Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale. Physically embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

In general, "embedded system" is not an exactly defined term, as many systems have some element of programmability. For example, Handheld computers share some elements with embedded systems — such as the operating systems and microprocessors which power them — but are not truly embedded systems, because they allow different applications to be load and peripherals to be connected. An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular kind of application device. Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines, and toys (as well as the more obvious cellular phone and PDA) are among the myriad possible hosts of an embedded system. Embedded systems that are programmable are provided with a programming interface, and embedded systems programming is a specialized occupation. Certain operating systems or language platforms are tailored for the embedded market, such as Embedded Java and Windows XP Embedded. However, some low-end consumer products use very inexpensive microprocessors and limited storage, with the application and operating system both part of a single program. The program is written permanently into the system's memory in this case, rather than being loaded into

© 2026, ISJEM (All Rights Reserved)

RAM (random access memory), as programs on a personal computer are.

II. LITERATURE SURVEY

In recent years, researchers and engineers have explored multiple approaches to developing smart metering systems that enhance user awareness and improve energy efficiency. Early systems utilized electromechanical meters to record energy consumption, which required manual readings and offered no remote communication. Later, digital meters were introduced, improving accuracy but still lacking interactive or automated control features. The integration of microcontrollers such as Arduino, PIC, or Raspberry Pi into metering systems has enabled automated monitoring and control capabilities. Several studies have incorporated GSM-based communication for sending power usage alerts via SMS. For instance, researchers in [1] developed a GSM-based energy meter that transmitted unit readings to users periodically; however, it was limited by message costs and network availability. Another study [2] demonstrated a ZigBee-based monitoring system for industrial energy usage, but it suffered from short-range communication and high hardware costs.

Recent advancements in IoT technology have revolutionized the concept of energy monitoring by enabling real-time cloud-based data analytics and remote control. Systems such as those proposed by [3] and [4] used ESP8266 Wi-Fi modules with Arduino Uno to send live power readings to platforms like ThingSpeak or Blynk, providing visual dashboards and threshold-based notifications. However, many of these systems lacked advanced alerting mechanisms or detailed energy analysis features such as load segmentation or historical data storage.The proposed system improves upon these earlier works by combining IoT connectivity, threshold alerting, and automation support in a single integrated framework. Using Arduino Uno, ACS712 current sensors, and voltage monitoring circuits, it ensures high accuracy and affordability. The IoT interface allows users to track and analyze data over time, making it suitable for both household and commercial applications. This fusion of hardware and IoT analytics creates a foundation for future smart grid implementations, where user participation in energy optimization will play a vital role in sustainability.

III.PROPOSED METHODOLOGY

The proposed Intelligent Energy Meter with Alerting System uses Arduino Uno as the main controller to monitor and manage electricity consumption. Voltage and current are measured using a voltage divider circuit and an ACS712 current sensor, and the Arduino calculates the instantaneous power and total energy usage. The collected data is transmitted to an IoT platform through the ESP8266 Wi-Fi module, allowing users to monitor energy consumption in real time through a web dashboard or mobile application.

The system also includes a threshold-based alert mechanism that notifies users when energy usage exceeds a predefined limit. Alerts can be generated through indicators such as a buzzer, LED, or cloud notification. Additionally, users can remotely control connected appliances through the IoT platform, helping to reduce energy wastage and improve efficient power management.

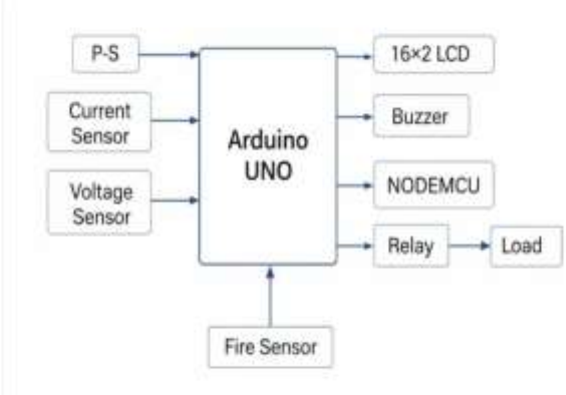

Fig 1: Blcok Diagram of Alerting System

The Arduino UNO acts as the main controller that connects all input sensors and output devices.

1. Power Supply (P-S):
   The power supply unit provides the required regulated voltage to the Arduino UNO and other components in the system. It ensures stable operation of the entire circuit.

2. Current Sensor:
   The current sensor (such as ACS712) measures the current flowing through the connected electrical load. This sensor sends an analog signal to the Arduino UNO, which is used to calculate the power consumption.

3. Voltage Sensor:
   The voltage sensor measures the supply voltage of the load. The measured voltage value is provided to the Arduino UNO, enablingit to determine the instantaneous power and total energy consumption.

4. Fire Sensor:
   A fire sensor is included for safety purposes. If fire or abnormal heat is detected, the sensor sends a signal to the Arduino UNO so that appropriate actions such as triggering an alarm or disconnecting the load can be taken.

5. Arduino UNO (Controller):
   Arduino UNO is the main processing unit of the system. It receives input data from the current sensor, voltage sensor, and fire sensor. The Arduino processes these signals to calculate power consumption, detect abnormal conditions, and control the connected output devices.

6. 16×2 LCD Display:
   The LCD display is used to show real-time information such as voltage, current, power consumption, and system status to the user.

7. Buzzer:
   The buzzer acts as an alerting device. When energy consumption exceeds the preset threshold or when the fire sensor detects danger, the Arduino activates the buzzer to warn the user.

8. NodeMCU (Wi-Fi Module):
   NodeMCU enables IoT connectivity. It sends the measured energy data from the Arduino UNO to a cloud platform or mobile application so that users can monitor their energy usage remotely.

9. Relay Module:

The relay is used as a switching device to control the electrical load. Based on commands from the Arduino or the IoT platform, the relay can turn the load ON or OFF automatically.

10. Load:

The load represents electrical appliances such as lights, fans, or other devices whose energy consumption is being monitored and controlled.

The sensors continuously send electrical parameters to the Arduino UNO. The controller processes this data, displays it on the LCD, and transmits it to the IoT platform through NodeMCU. If abnormal power usage or fire is detected, the system triggers alerts and can automatically disconnect the load using the relay, ensuring both energy efficiency and safety.

IV. RESULTS AND DISCUSSION

The Intelligent Energy Meter with Alerting System was designed and tested to monitor electricity usage and improve electrical safety. The system was developed using hardware components such as Arduino Uno, current sensor, voltage sensor, NodeMCU Wi-Fi module, relay module, LCD display, and a fire sensor. These components were connected together to form a complete monitoring and alert system. During the testing phase, the system operated properly and demonstrated its ability to measure electrical parameters and respond to abnormal conditions. The sensors collected voltage and current data from the connected electrical load. The Arduino Uno processed these values and calculated the power consumption using standard electrical formulas. This allowed the system to continuously monitor how much electricity the connected device was using.

One of the main features of the system is real-time data display. During the experiment, the measured voltage, current, and calculated power values were shown on a 16×2 LCD display. This display provided a simple and direct way for users to view the electrical readings without needing additional devices. The LCD updated the readings continuously as the load conditions changed, which helped confirm that the system was functioning accurately.

Another important part of the system is the IoT-based monitoring capability. The NodeMCU Wi-Fi module was used to send the measured electrical data to an IoT platform through a wireless internet connection. Once the data was uploaded, it could be viewed on a mobile phone or web dashboard. This feature allows users to monitor electricity usage remotely from anywhere with an internet connection. It also makes it easier to observe patterns in electricity consumption over time. By analyzing these patterns, users can identify appliances that consume more power and take steps to reduce unnecessary energy usage.

The system also includes an alerting mechanism to warn users when energy consumption becomes too high. During testing, a threshold limit for power consumption was set in the system. Whenever the calculated power value exceeded this predefined limit, the system immediately activated a buzzer alert. This audible warning informs the user that the electricity usage has crossed a safe or desired level. In addition to the alert, the relay module can automatically disconnect the electrical load if the consumption remains too high. This helps prevent overloading of electrical equipment and reduces the risk of damage.

Another key safety feature included in the system is the fire detection mechanism. The fire sensor constantly monitors the environment for signs of heat or flame. During the experiment, when the fire sensor detected abnormal temperature or flame conditions, the system responded immediately. The buzzer alarm was activated to warn the user, and the relay module turned off the connected load to cut the power supply. This quick response helps prevent electrical fires from spreading and protects both the equipment and the surrounding environment.

The experimental results show that all components of the system worked together effectively. The sensors accurately measured electrical parameters, the Arduino successfully processed the data, and the NodeMCU transmitted the information to the IoT platform without delay. The LCD display provided clear local monitoring, while the IoT dashboard allowed remote access to the same data. The alert and safety mechanisms also performed reliably during abnormal conditions such as high energy consumption or fire detection.

Fig:Genarating the bills

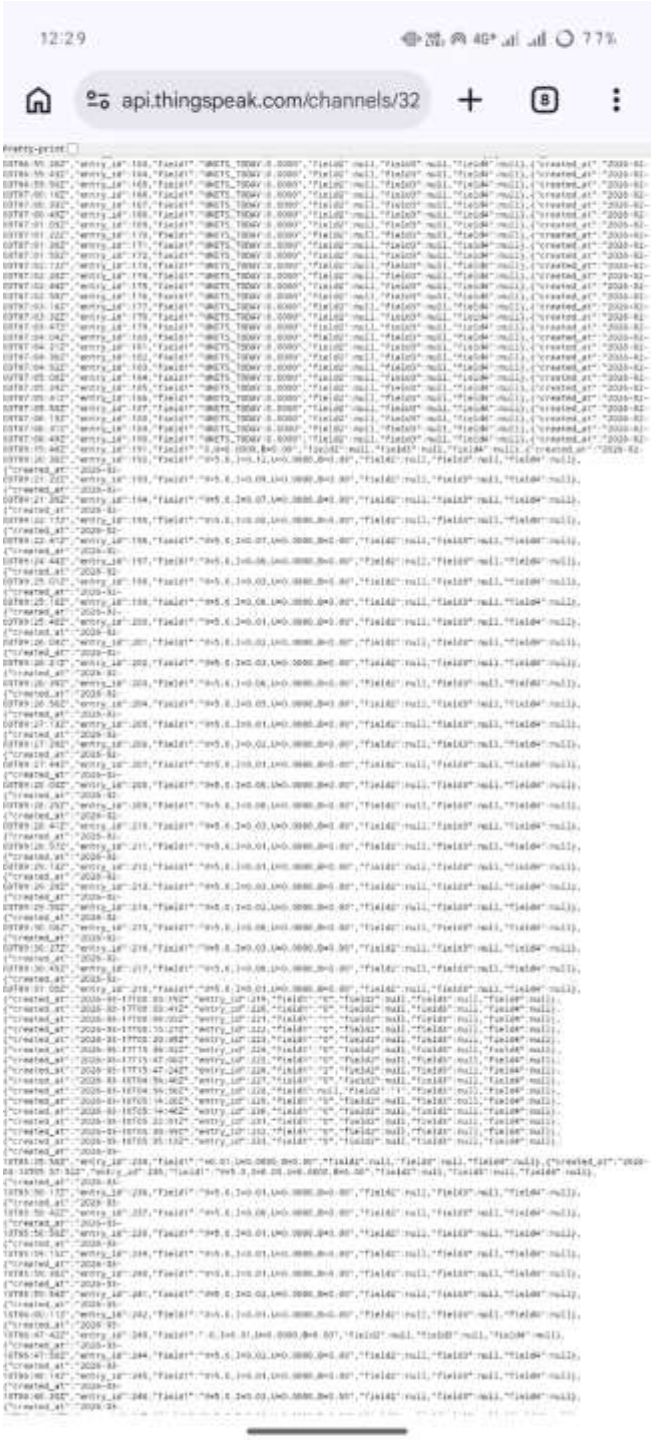

Fig: bill generating

Overall, the developed system proved to be efficient, reliable, and practical for real-world applications. It provides real-time monitoring of electricity usage, remote access through IoT technology, automatic alert generation, and safety protection through load control and fire detection. Since the system uses affordable and easily available components, it can be implemented in residential homes, small offices, and commercial environments. In addition, the system encourages users to become more aware of their electricity consumption, which ultimately helps promote better energy management and conservation.

V. CONCLUSION

The Intelligent Energy Meter with Alerting System using Arduino Uno and IoT represents a significant advancement in modern energy management systems. By integrating sensor-based measurement, IoT communication, and threshold-based alerting, the system provides an effective solution for reducing energy wastage and optimizing consumption. Unlike traditional meters, this system empowers users with real-time visibility, remote control, and data analytics capabilities.Its implementation contributes to smart energy ecosystems, where individual user awareness translates into large-scale conservation. The system's flexibility allows it to be adapted for various applications—from homes and offices to industries—making it both economical and scalable. Future enhancements may include the use of machine learning algorithms to predict usage trends, integration with smart grids for automated billing, and mobile app control interfaces for enhanced user interaction.In conclusion, the proposed system demonstrates how IoT, when combined with low-cost embedded technologies like Arduino, can drive intelligent automation and sustainability. It provides a pathway toward achieving smart cities where energy efficiency, user empowerment, and environmental consciousness are seamlessly interconnected.

VI. REFERENCES

V. Subashini et al., "Intelligent Energy Meter with Alerting System," *2025 International Conference on Computational Robotics, Testing and Engineering Evaluation (ICCRTEE)*, DOI: 10.1109/ICCRTEE64519.2025.11052969.

1. P. Sharma and R. Gupta, "IoT-based Smart Power Monitoring System using Arduino," *International Journal of Innovative Technology and Exploring Engineering*, 2023.
2. A. Ramesh and S. Natarajan, "Energy Management through IoT-based Smart Metering," *IEEE Transactions on Smart Grid Technologies*, vol. 11, no. 3, 2024.
3. K. Kumar and D. Raj, "Real-Time Electricity Monitoring and Control using ESP8266," *International Conference on IoT Applications and Smart Systems*, 2022.
4. S. Priyadharshini et al., "Home Energy Automation using Arduino and IoT," *Journal of Engineering and Applied Sciences*, vol. 13, no. 4, pp. 201–207, 2023.
5. Josephine Selle Jeyananthaan et al., "IoT-based Smart Energy Meter for Load Management," *Proceedings of IEEE ICCMC Conference*, 2024.
6. Raza, Muhammad Haseeb, et al. "Smart meters for smart energy: A review of business intelligence applications." *IEEE Access* 11 (2023): 120001-120022.
7. Sentamilselvi, M., et al. "An Efficient Energy Management and Theft Alert System using IoT Enabled Smart Meter." *2023 9th International Conference on Advanced Computing and Communication Systems (ICACCS)*. Vol. 1. IEEE, 2023.
8. Selvaraj, Rajalakshmi, Venu Madhav Kuthadi, and S. Baskar. "Smart building energy management and monitoring system based on artificial intelligence in smart city." *Sustainable Energy Technologies and Assessments* 56 (2023): 103090.
9. Saleem, M. Usman, et al. "Design, deployment and performance evaluation of an IoT based smart energy management system for demand side management in smart grid." *IEEE Access* 10 (2022): 15261-15278.
10. Gonzalez, Isaias, Antonio José Calderón, and Francisco Javier Folgado. "IoT real time system for monitoring lithium-ion battery long-term operation in microgrids." *Journal of Energy Storage* 51 (2022): 104596.

11. Liu, Zhi, Ying Gao, and Baifen Liu. "An artificial intelligence-based electric multiple units using a smart power grid system." *Energy Reports* 8 (2022): 13376-13388.
12. Ullah, Zia, et al. "IoT-based monitoring and control of substations and smart grids with renewables and electric vehicles integration." *Energy* 282 (2023): 128924.