IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 5, Issue 10, May 2025 Impact Factor: 7.67

Smart Energy Monitoring and Warning System

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Abstract:*Smart Energy Monitoring & Warning System analyse real time power consumption and & current. In this research an IoT (Internet of Things) based device have been developed that canmonitor and notify consumers about their real time energy consumption. If powerconsumption of a certain section or equipment is high, then user inthat area is warned about overconsumption. It is the mostsignificant demand to decrease the energy expenditure from thebusinesses. Smart energy monitoring system technique tracks theusage of energy of different regions of the plant throughout round-the-clock. By setting up alerts to notify you of excessive consumption and it also detects the need of preventive maintenance by analysing the current, voltage, frequency, power, and power factor graphs..*

Keywords: Smart Energy Monitoring, current, voltage, frequency, power, and power factor graphs,Overload Warning,Over Power Consumption Warning, Over Current Warning, Internet of Things, Sensors

I. INTRODUCTION

A Smart Energy Monitoring and Warming System Is an Advanced Solution Designed to Optimize Energy Usage, Improve Efficiency, And Provide Idea About Requirement of Maintenance. Such Systems Use Sensors, Data Analytics, And Connected Devices to Monitor Energy Consumption and Ambient Conditions in Real Time, Enabling Smarter and More Precise Management of Energy Resources. The Primary Goals of These Systems Are to Reduce Unnecessary Energy Waste, Cut Down on Utility Costs. Smart Energy Monitoring Components Track Energy Usage Patterns, While the Warming System Adjusts Heating Output Based on Occupancy, Time of Day, And Weather Conditions. These Systems Often Incorporate Iot (Internet of Things) Technology, Machine Learning Algorithms, And Integration with Mobile Apps or Web Platforms, Giving Users Real-Time Insights and Control Over Their Energy Use.

In Homes, Businesses, And Industrial Settings, A Smart Energy Monitoring and Warming System Can Identify Inefficiencies, Automate Heating Schedules, And Allow for Remote Control, Ultimately Creating a More Energy-Efficient and Environmentally Friendly Building. As Energy Demands Grow and Environmental Concerns Increase, Such Systems Offer a Promising Solution for Reducing Greenhouse Gas Emissions and Lowering Energy Expenses. The Increasing Demand for Energy and The Need for Efficient Energy Management in Both Residential and Commercial Settings Have Become Critical Issues. Many Consumers Lack Real-Time Visibility into Their Energy Consumption Patterns, Leading to Inefficient Usage and Unnecessary Costs.

II.LITERATURE SURVEY

2.1 Power Consumption Monitoring using IoT and Embedded Systems (2016)

This Study Demonstrated the Use of Microcontrollers and Current Sensors to Monitor Household Power Usage in Real Time. The System Used a Wi-Fi Module to Send Data to a Cloud Server.

2.2 Real-Time Power Management and Alert System (2017)

Introduced A Smart Energy Management System Using GSM For Alert Generation in Case of Overconsumption. It Emphasized the Importance of Remote Communication in Rural and Industrial Applications. This Paper Discusses An IOT-Based System for Real-Time Monitoring of Power Consumption, Utilizing Microcontrollers and Cloud Platforms for Data Visualization and Management.

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2.3 IoT Based Overload Monitoring for Industrial Loads (2018)

This Paper Focused on the Implementation of Overload Detection Using Current Transformers (Cts) And Relays. It Proposed an Automatic Shutdown Mechanism for Protection, Improving Safety in High-Load Scenarios.

2.4 Design and Implementation of Smart Energy Monitoring System (2019)

Presented A Comprehensive System Using an Arduino and GSM Module for Monitoring Power Consumption and Sending SMS Alerts During Abnormal Consumption. It Supported Real-Time Data Display on an LCD And Proposed a Practical Solution for Low-Cost Energy Monitoring.

2.5 IOT Based Real-Time Energy Monitoring with Thingspeak Cloud Integration (2020)

Highlighted the Use of ESP8266 With Thingspeak for Real-Time Power Data Collection and Visualization. It AlsoIntroducedMATLAB Analytics for Advanced Data Processing and Preventive Analysis.

2.6 Smart Power Management with Overcurrent Protection (2021)

Proposed A System Combining Microcontroller-Based Sensing with Automatic Load Control During Overcurrent Conditions. The System's Primary Contribution Was a Prototype Capable of Controlling Loads to Prevent Damage.

2.7 Predictive Maintenance Using Power Consumption Data in Industrial Iot (2022)

Emphasized The Use Of AI/ML Techniques to Predict Equipment Failure from Abnormal Power Usage Trends. This Paper Provided a Solid Foundation for Incorporating Preventive Maintenance into Monitoring Systems.

2.8 Integration of Cloud and Edge Devices for Real-Time Energy Analysis (2023)

Focused On Modern Hybrid Systems Using Edge Computing Along with Cloud Platforms Like Thingspeak and Firebase. Real-Time Processing and Analytics Were Used to Enhance Responsiveness and Reliability. His Comprehensive Review Elucidates the Promise and Potential That Edge AI Holds for Reshaping the Internet of Energy (Ioe) Ecosystem. It Discusses How Edge AI Can Address Challenges Associated with Cloud Computing, Such as Latency and Energy Consumption

III. METHODOLOGY

The Methodology for Developing a Smart Energy Monitoring and Warning System Involves Several Phases, Including Planning, Data Collection, Data Processing, System Automation, And User Interaction. Each Phase Combines Hardware and Software Components to Create a System That Provides Real-Time Monitoring, Predictive Analytics.

3.1 Power Monitoring

For Monitoring the Real Time Power Consumption There Must Be Need to Measure the Voltage, Current and Power Factor. For Sensing such Parameters PZEM-004t Module is Used. This Module Works as Smart Meter Which Uses Conventional Current and Voltage Sensors to Measure Current and Voltage and Calculates Power.

3.2 Supply Rectification

Most of the Circuit Elements Works on DC Supply So Here We Used Rectifier Circuit Adapters Which Convert 230V AC into 12V DC.

For Stable Operation of Electronic Circuit There is Need of Stable Input Supply Voltage Which is Provided by Voltage Regulator 7805.

3.3 Microcontroller Units (MCUs) in SEMS

Microcontrollers are the Heart and Brain of SEMS. A Typical Microcontroller Unit (MCU) is a Small Computer Unit on a Single Metal-Oxide-Semiconductor IC Chip. They Usually Include Three Major Parts: The Processor (CPU), the Memory, and the Input/Output (I/O) Units on a Single Chip. Many Microcontrollers are Used in Various SEMS Designs, Considering Their Architecture, Flash Memory Size, Operating Voltage and Current, Number of I/O Pins, and Programming Processes. Among the Most Popular MCU Used in SEMS Designs is At-Mega328.

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3.4 Data Transmission by IOT

In IoT applications, Wi-Fi acts as the heart of it. In this work, Wi-Fi is used to communicate with the smart App for changing the threshold value and to ON & OFF the energy meter. The energy units' consumption is also communicated through this and displayed on the webpage. The Consumers are able to access the raspberry board and meter with help of Wi- Fi. The pricing details of per units are communicated to consumers using Wi-Fi in their smart App Speed control in this setup is achieved using **voltage control on the VREF pin (Pin 13)** and supported by the **TACHO (Pin 8)** output, which provides feedback on rotor speed. This enables closed-loop or open-loop speed regulation.

3.5 Overconsumption SMS Alert

To Send the Overconsumption SMS Alert GSM Module is Used. A GSM (Global System for Mobile Communications) Module is a Hardware Device That Allows Embedded Systems (Like Microcontrollers or Arduino) to Communicate Over a Mobile Network Just Like a Phone.

It Can Send/Receive: Voice Call and Text Message.

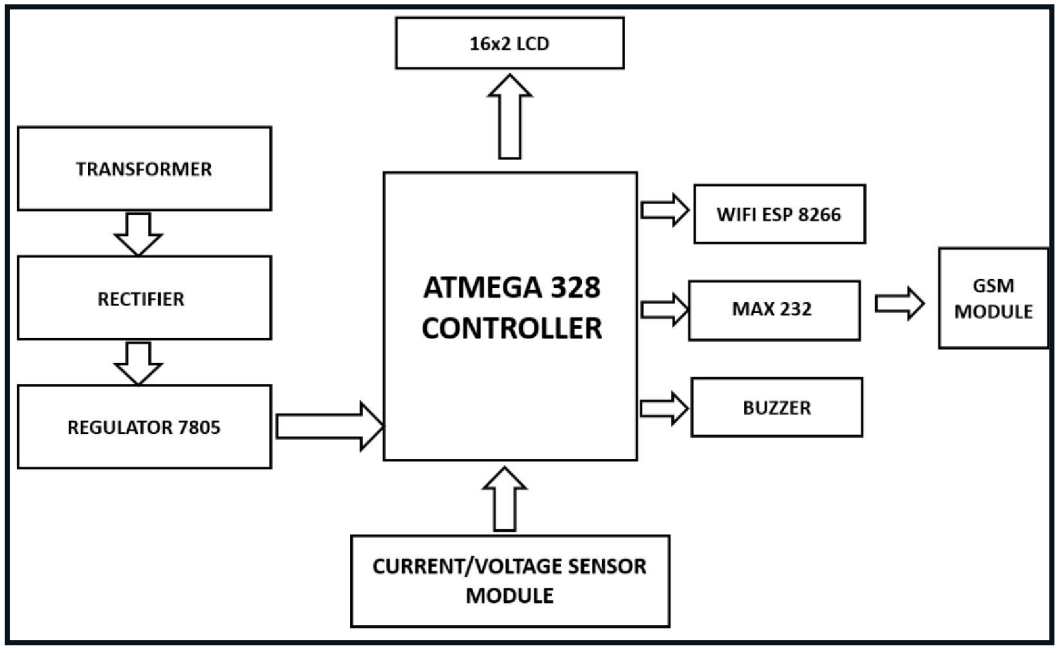
3.6 Controlling of Indication Modules

To Control All the Indication Devices Atmega328 Microcontroller is Used. The Atmega328 is an 8-Bit AVR Microcontroller Made by Microchip (Formerly Atmel). It's Widely Used in Embedded Systems and is the Heart of the Arduino Uno. Indication Devices Includes SMS Alerting GSM Module and Buzzer.

3.7 Cloud and warning system

In this system we use 'Thingspeak' cloud which is free for students use. ThingSpeak is an open-source IoT analytics platform and cloud service provided by MathWorks. It collects data from system and display it in the form of graphs.

BLOCK DIGRAM



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IV. CONCLUSION

The Developed Real-Time Power Consumption Monitoring and Overcurrent/Overconsumption Warning System Successfully Demonstrates the Integration of Sensors, Microcontrollers, and Cloud Platforms to Enable Smart Energy Monitoring. By Continuously Tracking Power Usage and Providing Immediate Alerts in Case of Overcurrent or Abnormal Consumption, The System Enhances Electrical Safety, Energy Efficiency, and Preventive Maintenance. Through the Use of GSM/Wi-Fi Modules, Data is Transmitted to the Cloud (e.g. Thingspeak) for Real-Time Visualization and Analysis, Making it Accessible from Anywhere. The Warning System Using SMS Alerts, Buzzers Ensures That Users are Promptly Informed of any Critical Situations, Thereby Reducing the Risk of Equipment Damage or Fire Hazards.

Overall, This Project Proves to be a Practical, Scalable, and Low-Cost Solution for Both Residential and Industrial Energy Management. Future Enhancements can Include Support for Smart Load Control and Mobile App Integration Based Anomaly Detection to Further Optimize Power Usage and Enhance System Intelligence.

V. FUTURE SCOPE

Developing Smart Energy Monitoring and Warning System Can Enable the System to Identify Abnormal Power Consumption Patterns That Indicate Early Signs of Equipment Failure. By Continuously Monitoring Power Behaviour, The System Can Predict Potential Faults, Reduce Unplanned Downtime, And Schedule Timely Maintenance. Cloud-Based Logging and Reporting Can Support Trend Analysis and Long-Term Asset Health Tracking, Making the System a Valuable Tool for Predictive and Preventive Maintenance in Both Residential and Industrial Setups.

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