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Arduino-Based Electricity Grid Monitoring and Load Control System

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ABSTRACT

This paper aims to make easier tracking and energy usage without the interference of people. This simply monitors and manages the energy by connecting energy meters to the internet, this allows users to track electricity consumption through online. The system employs Arduino micro controllers and Wi-Fi modules for data transmission.The system enables real-time data transmission for detailed analysis and visualizations through THINGSPEAK application. Users can access their energy usage in watts on a webpage by entering the device's channel ID. This initiative aligns with the broader concept of smart grids in smart cities, promoting improved communication between energy providers and consumers to improve efficiency.Traditional grids often struggle with peak loads and security vulnerabilities, but smart grids address these issues by providing daily consumption data securely. Overall, this project simplifies energy monitoring and management, enhancing efficiency and security in electricity usage.

Keywords: Arduino UNO, Wi-Fi Module, 16*2 LCD display, Buzzer, Current Sensor.

I. INTRODUCTION

One big problem we are facing nowadays is not making enough energy, but rather using what we have more wisely. Many people don't realize how much energy they're using because they only find out when they get their monthly bill. It would be helpful if people could easily check their energy usage online from anywhere.
Power theft is a serious issue, especially in India, where it's harming the economy. It happens when people stole electricity, which not causes financial losses but can also be dangerous. To prevent this, there are solutions like tamper-detection meter and pre-payment meters.

In this project, we have designed a system using Arduino technology that automatically detects power theft. It alerts authorities when theft is detected and allows users to monitor their energy usage online. This system helps to save electricity and improve efficiency.

The internet of things(IOT) plays a big role in this project by connecting device to the internet. This allows for remote monitoring and analysis.by using IOT technology, we can make energy meter smarter and more effective in detecting theft.

II. LITERATURESURVEY

A. "Design of Smart Grid Monitoring System Using IOT"

Authors: Priyanka Sen, Vandana Jha, Akshaya Aditya Abinash, Sharda Prasad Das, SubhadarsiSrimat

Balancing different renewable energy sources, such as solar and wind, to maintain a consistent output and efficiently transfer it to the grid poses a significant challenge. Additionally, integrating renewable energy with conventional power sources adds complexity in balancing. Failure to effectively balance these sources can result in grid instability, energy waste, and compromised reliability of the power supply.

B. "IOT Based Smart Grid Monitoring Using Arduino Controller"

Authors: K. P. Prasad Rao, Tharun Akula, Mahesh Ummadi, GunnaiahManamasi, Mahesh Manamasi, SivamohankrishnaThalluru

Energy losses occur during distribution from device to device due to resistance in transmission lines and inefficiencies in transformers and other components. Minimizing the losses requires investment in efficient grid infrastructure, improved transmission technologies, and strategic placement of power generation facilities closer to demand centers.

C. "IoT Based Power Monitoring System for Smart Grid Applications"

Authors:Fahad Khan, Muhammad Abu Bakar Siddiqui, Ateeq Ur Rehman, Jawad Khan, Muhammad Tariq Sadiq, Adeel Asad

Designing a power monitoring system for smart grid applications is complex due to the diverse range of parameters that need to be monitored in real-time, including voltage, current, frequency, and power quality. Managing the vast amount of data generated by multiple monitoring points throughout the grid requires sophisticated data analytics and communication systems.

III.EXISTING METHOD

The current state of traditional power grids faces several challenges hindering efficient energy management. Firstly, the reliance on manual meter reading by utility workers introduces time consuming processes and the potential for errors in collecting energy consumption data. Additionally, consumers lack real-time visibility into their energy usage due to the limited availability of real-time monitoring systems. This absence of timely information hampers the ability to make informed decisions about energy consumption. Furthermore, traditional grids struggle with load balancing, particularly during peak hours, resulting in wastage and inefficiencies. Lastly, the existing system exhibit security vulnerabilities due to the lack of robust security measures, making them susceptible to unauthorized access and tampering.

IV. PROPOSED METHOD

The proposed system smart grid monitoring and control system utilizing Arduino offers a comprehensive solution to overcome existing limitations and enhance the intelligence and responsiveness of energy grids. Central to its functionality there are several key features:

Firstly, the system revolutionizes data collection by automating the process through the utilization of sensors, particularly current sensors. This shift from manual readings to real-time data collection ensures accuracy and timelines in monitoring energy consumption.

Secondly, seamless integration with the Internet of Things (IOT) is achieved through communication between the Arduino board and an ESP8266 Wi-Fi module. This integration facilitates swift and efficient data transmission to a dedicated webpage, enabling users to access vital information remotely.

Thirdly, the system empowers users with comprehensive energy consumption analytics via the dedicated webpage. Through this interface, users can monitor their energy usage in real-time and ultimately make informed decisions to optimize their energy consumption patterns.

Moreover, the system facilitates efficient load management by empowering consumers to understand usage patterns and optimize load distribution accordingly. This capability enhances overall energy efficiency and contributes to reducing wastage.

Lastly, by embracing IoT and smart technologies, the proposed system not only enhances individual consumer experiences but also contributes to a broader of building smarter cities with sustainable energy practices.

BLOCK DIAGRAM:

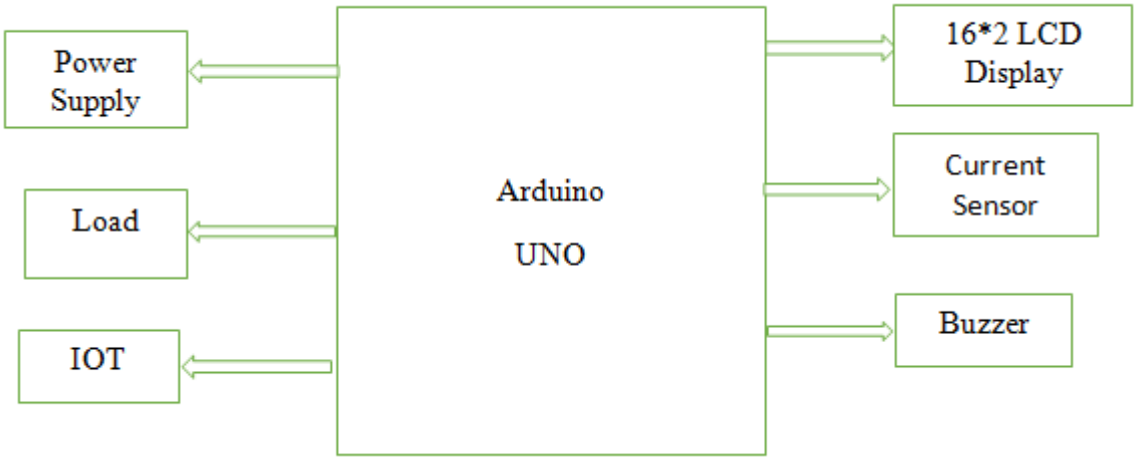

Fig. 4.1Block Diagram of Proposed System

V. RESULT

The experimental setup of the "IOT Based Electricity Grid Monitoring and Theft Detector using Arduino" is shown below fig 5.1.

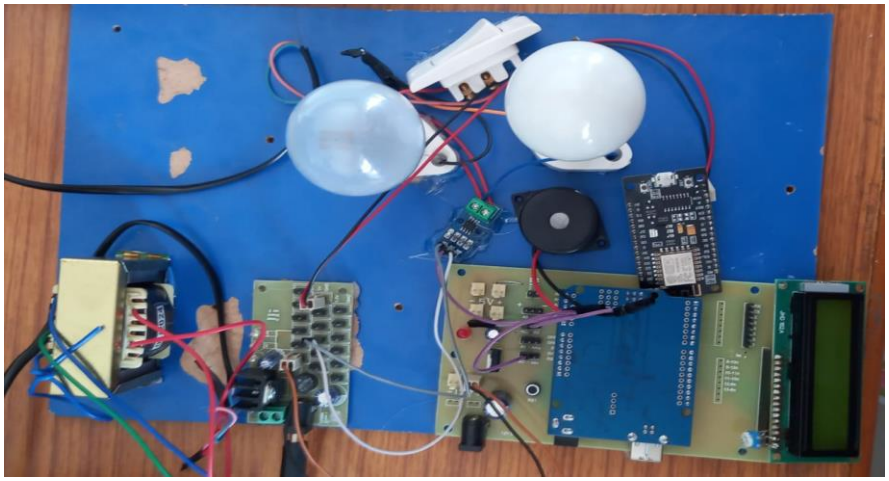

Fig 5.1 Experimental Setup.

When the setup is switched on Firstly, on the lcd display it will display the title as "ENERGY METER SMART MONITORING SYSTEM". This is shown in fig 5.2.

Fig 5.2 Title Display.

When the kit is switched on after displaying the title it will display the input voltage as 21.61 and current as 1711.57 these values are displayed on the lcd screen. when no load is connected. This is shown in fig 5.3.

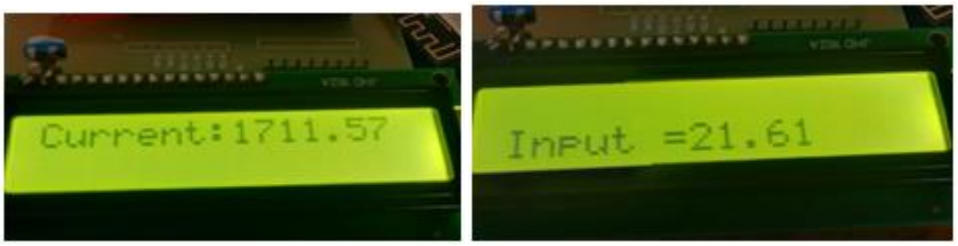

Fig 5.3 Initial Values.

When load 1 is connected the current value exceeds from 1711.57 to 1861.81 continues fluctuations in the current happens and input voltage decreases from 21.61 to 21.51 and these values are displayed on the lcd screen. i.e load is used as a bulb. This is shown in fig 5.4.

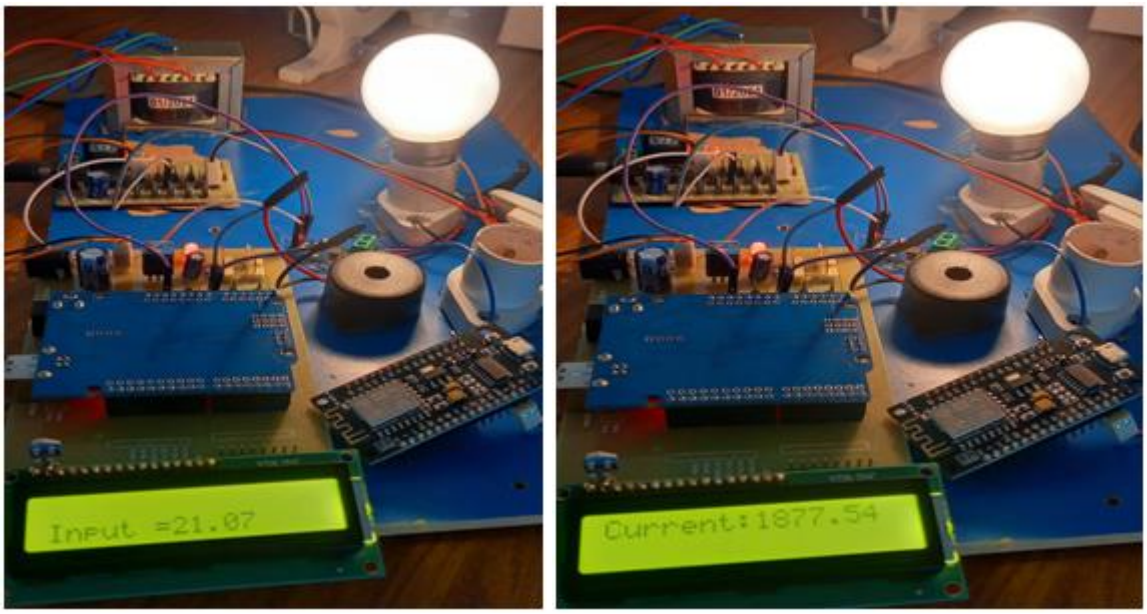

Fig 5.4 Load 1 Connected.

When load 2 is connected the current value increases and when the current value reaches more than 2000 the buzzer on' s that means there is a theft occurrence in the load. And finally, on the lcd screen the current value and theft occurred will be displayed. This is shown in fig 5.5.

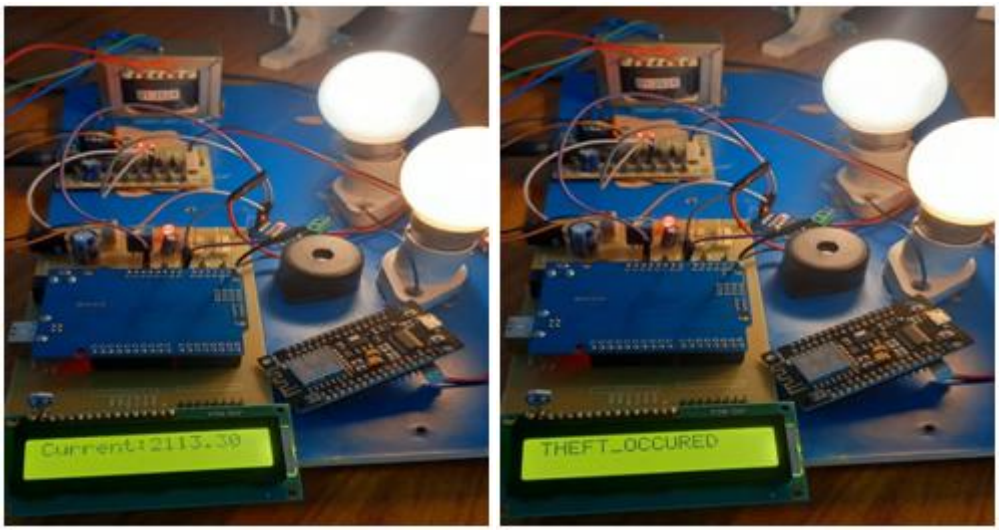

Fig 5.5 Final Output.

Finally, these readings are noted in the "ThingSpeak" application when the kit is on through the Wi-Fi module. This is shown in fig 5.6.

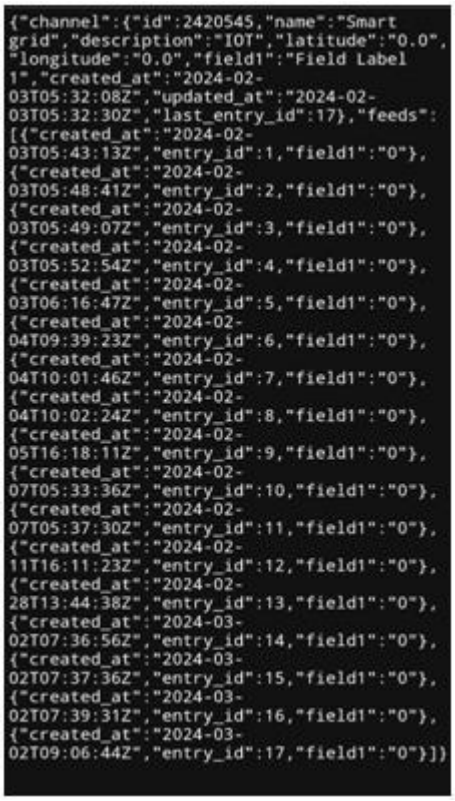
{"channel":{"id":2420545,"name":"Smart grid","description":"IOT","latitude":"0.0","longitude":"0.0","field1":"Field Label 1","created_at":"2024-02-03T05:32:08Z","updated_at":"2024-02-03T05:32:30Z","last_entry_id":17},"feeds":[{"created_at":"2024-02-03T05:43:13Z","entry_id":1,"field1":"0"},{"created_at":"2024-02-03T05:48:41Z","entry_id":2,"field1":"0"},{"created_at":"2024-02-03T05:49:07Z","entry_id":3,"field1":"0"},{"created_at":"2024-02-03T05:52:54Z","entry_id":4,"field1":"0"},{"created_at":"2024-02-03T06:16:47Z","entry_id":5,"field1":"0"},{"created_at":"2024-02-04T09:39:23Z","entry_id":6,"field1":"0"},{"created_at":"2024-02-04T10:01:46Z","entry_id":7,"field1":"0"},{"created_at":"2024-02-04T10:02:24Z","entry_id":8,"field1":"0"},{"created_at":"2024-02-05T16:18:11Z","entry_id":9,"field1":"0"},{"created_at":"2024-02-07T05:33:36Z","entry_id":10,"field1":"0"},{"created_at":"2024-02-07T05:37:30Z","entry_id":11,"field1":"0"},{"created_at":"2024-02-11T16:11:23Z","entry_id":12,"field1":"0"},{"created_at":"2024-02-28T13:44:38Z","entry_id":13,"field1":"0"},{"created_at":"2024-03-02T07:36:56Z","entry_id":14,"field1":"0"},{"created_at":"2024-03-02T07:37:36Z","entry_id":15,"field1":"0"},{"created_at":"2024-03-02T07:39:31Z","entry_id":16,"field1":"0"},{"created_at":"2024-03-02T09:06:44Z","entry_id":17,"field1":"0"}]}

Fig 5.6 ThingSpeak Readings.

VI. CONCLUSION

Smart Grids plays an important role energy sector. They are user-friendly, allowing consumers to monitor daily usage from anywhere. User can check every day consumption of data from any location using internet. Owners can control meters remotely, leading to efficient electricity transmission, faster restoration after disruptions, lower costs for utilities, and ultimately savings for consumers. It's a time-saving technology with added benefits like control over meter tampering.

VII. SCOPE OF ENHANCEMENT

The future scope of "IOT-Based Electricity Grid Monitoring and Theft Detector Using Arduino" leads to more efficient energy management, real-time data analysis, and improved security. With the advancements in IoT technology, the system could integrate machine learning for predictive maintenance and anomaly detection, enhancing overall reliability. Additionally, the integration of renewable energy sources and smart grids could further optimize energy distribution.

VIII. REFERENCES

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