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Smart Energy Meter (SEM)

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Abstract - *Electrical energy consumption is increasing day by day. Electric power demand is increasing rapidly as compared to its generation. This inequality between demand and generation tells the requirement and importance of energy saving tools. Also, it is very difficult for the officials to note the readings manually as it is time consuming as well as almost impossible/ very dangerous to visit each and every house during the time of crisis like covid-19. And it will require a large amount of money and time to completely replace the traditional meters with smart energy monitoring devices.*

The goal of this research paper is to develop the cheapest electricity metering system by converting the traditional meters to SEMs with automatic metering and billing capabilities which will monitor and display the information in a user-friendly manner. In this way, we will save the cost of replacing traditional meters by doing some modifications on already installed meters and thus converting them into smart meters.

Key Words: Smart, Energy, Monitoring, Metering, IOT, Embedded, Microcontroller.

1.INTRODUCTION

Saving energy is one of the most important things these days. Electric power demand is creating inequality between demand and generation. Electric power distributors are unable to keep track of the varying maximum load. Due to this, consumers face many problems like receiving due bills for the already paid ones, poor quality and reliability of electricity, etc.

Electric boards recruit employees to take readings from each and every home manually. Due to this, the labor cost increases. These employees then send the readings to their higher authorities which, with the help of some software, calculate and generate bills. As it sounds, this is a very hectic and complicated process with a high probability of errors and lack of accuracy. During the times of some pandemic (for e.g., covid-19), it gets very difficult for the officials to go to each and every home and note the readings manually as it can cause them their lives. So, estimated bills are not always the accurate ones. Consumers are not aware of the amount of electric power they are consuming per day or per hour. They do not even know whether the bills they are getting are accurate or not.

All these problems can be solved if we could keep a track of the consumer's load. With the help of smart energy meter proposed by us, we will be able to monitor the load in real time with features like automatic billing and bill generation, over-usage alerts, usage stats, user friendly web interface, prepayment option, etc. It will also include execution of logical functions, keeping a record of all the data by storing data in a relational database, disconnecting supply for unpaid bills after a certain warning period, etc.

Now the problem is that it will require a very large amount of money to replace all the traditional meters with smart energy meters. The smart energy meter proposed by us solves this problem as well. This project is cost effective as it includes smart energy meters which are actually modified traditional meters developed by doing some modifications on pre-installed traditional meters. In this way, this project saves the cost of replacing traditional meters.

2. SYSTEM ARCHITECTURE AND WORKING

Many power utilities are trying to develop different energy monitoring and management systems across the world. The smart energy meter proposed by us is based on the idea of creating a cost-effective SEM by upgrading the traditional meters to make our product market appealing. As it is a modification on a traditional meter so the installment is easy.

The architecture proposed in this paper comprises 3 main parts:

1. Backend
2. Frontend
3. Hardware.

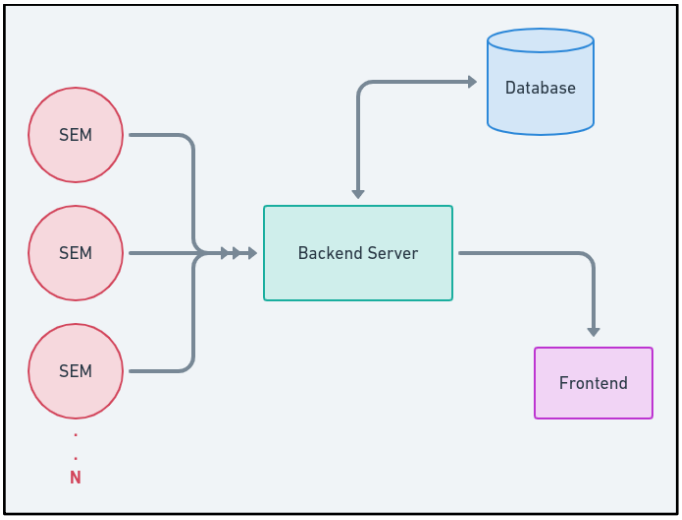


Fig-1: Block Diagram

2.1 System Architecture

Backend – The backend is centralized. Readings records of all the users are maintained in the backend. PostgreSQL database is used in the backend to store all the data in a to use and analyse it further. It consists of a single server software for all the users. The complete backend is designed using Python Django Framework. It sends the data to the frontend on user request.

Frontend – The frontend is designed using HTML, CSS and Javascript. It receives data from the server and displays it in easy to understand graphical and tabular ways in real time.

Hardware – In this project, NodeMCU is used to calculate and send readings back to the backend server. The light sensor module is connected with NodeMCU to calculate readings through our reading calculation algorithm programmed in C/C++ in Arduino IDE. After processing, NodeMCU sends the readings to the server with the help of the inbuilt wi-fi chip.

2.2 Working

The traditional meter is connected with a light sensor module (LDR or Optocoupler) which senses the LED blinks and thus helps in calculating the readings. The light sensor module is connected to NodeMCU microcontroller which keeps sending all the data to the backend server periodically. All the data is stored in a database. On a user request backend sends the data to the frontend from its database. The user-friendly frontend shows data to users in easy-to-understand graphical and tabular forms. User can add and manage multiple meters from the frontend itself.

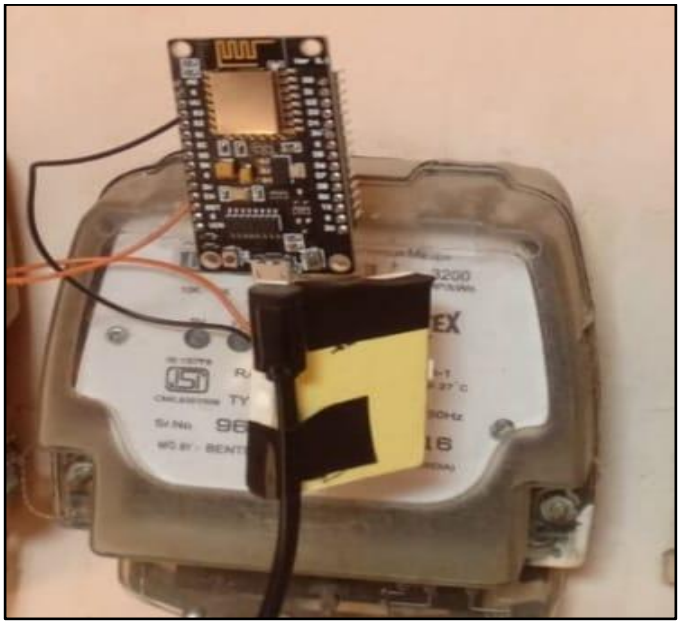


Fig-2: SEM Module Installed On Meter

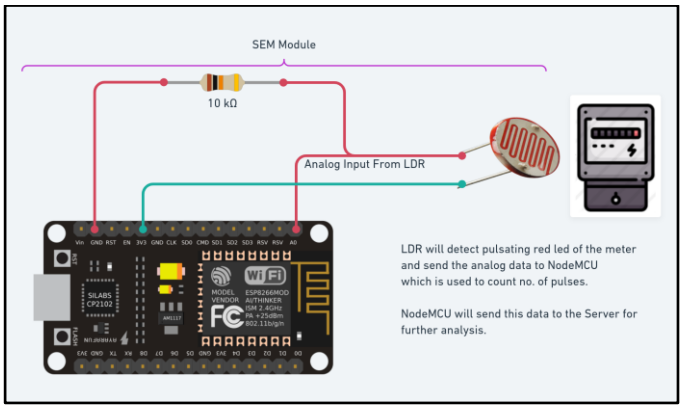
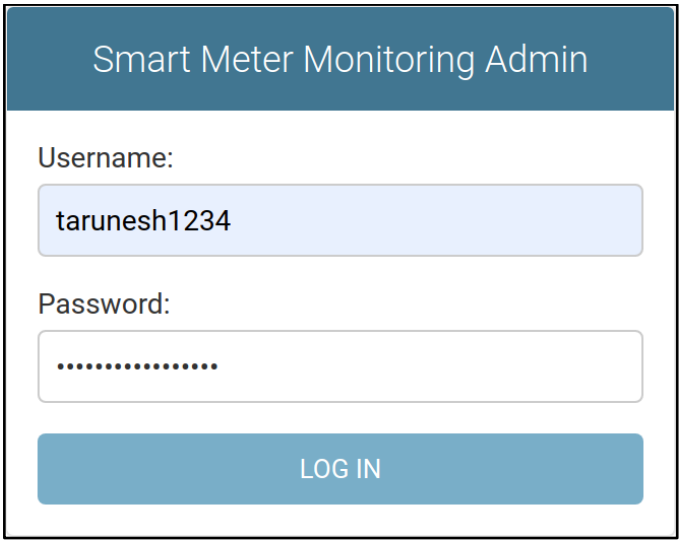


Fig-3: SEM Module

2.3 Readings Calculation

If we see carefully, there is an LED on traditional meters which keeps blinking. We are using the LED blinks to count the total units. In this project, these pulsating LED blinks are detected by a Light sensor module (LDR or Optocoupler) which employs a photoresistor. This photoresistor detects the intensity of incident light. This is the input to our NodeMCU module. Normally, 1 pulse denotes 1 Wh, i.e., 1000 pulses/kWh. This can vary from vendor to vendor.

1 pulse = 1Wh = 3600J
1 unit = 1kWh = 1000 pulses
Energy Consumed = Number of pulses * 3600J
Total units consumed = Number of pulses / 1000
Amount charged = unit consumed * unit rate
Note : *No of pulses is counted by NodeMCU module*



Fig–4: Login Page

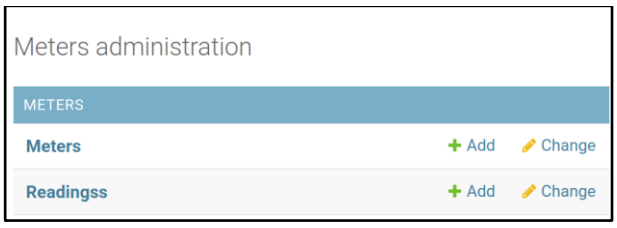


Fig-5: Meter Admin Page

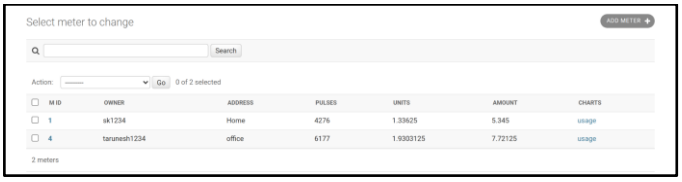


Fig-6: Installed Meters Page

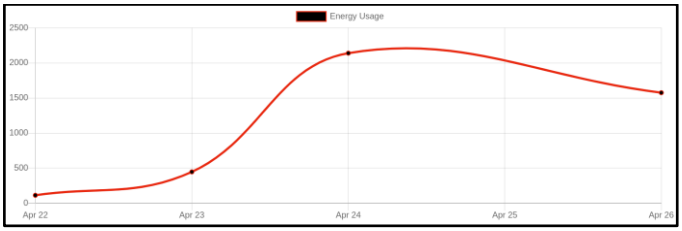


Fig-7: Real Time Usage Page

Users can also view hourly and weekly usage stats.

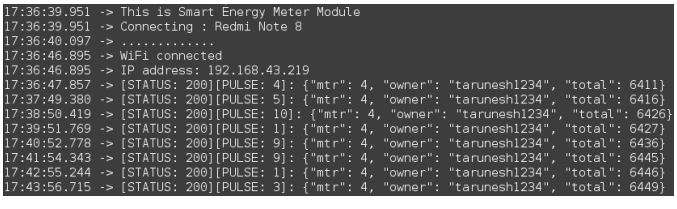


Fig-8: SEM Module Sending pulses

TIME STAMP	READING
April 28, 2021, 5:44 p.m.	3
April 28, 2021, 5:43 p.m.	3
April 28, 2021, 5:42 p.m.	1
April 28, 2021, 5:41 p.m.	9
April 28, 2021, 5:40 p.m.	9
April 28, 2021, 5:39 p.m.	1
April 28, 2021, 5:38 p.m.	10
April 28, 2021, 5:37 p.m.	5
April 28, 2021, 5:36 p.m.	4

Fig-9: Backend Receiving Readings

ELECTRICITY USAGE CHARGES	
Name	Subhash
Meter ID	1
UNITS	1.33625
Amount	5.345
Due Date	30-04-2021

Fig-10: Generated Bill

3. CONCLUSION

There are so many electric meters in the market but the process of billing is hectic when we use them. Some meters are available with the feature of automatic billing but they lack other features like over-usage alerts, user friendly interface, real time monitoring, etc. Also, they are very expensive. But our proposed smart energy meter is the cheapest as compared to them as we modified traditional meters already installed in our homes and did

not replace them completely. This project also prevents electrical energy wastage by providing the users real time data of their electricity consumption, thus creates awareness among all consumers. It completely ends manual intervention. In future, this project can be extended to automatic supply cuts if the bill is not paid in a certain period of time and theft detection.

Source Code : https://github.com/tarunesh1234/SEM

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REFERENCES

[1] H G Rodney Tan, C.H. Lee, V.H. Mok, "Automatic power meter reading system using GSM network", Conference (IPEC 2007).

[2] A. Arif, Muhannad AI-Hussain, Nawaf AL-Mutairi, "Experimental Study and Design of Smart Energy Meter for the Smart Grid" 978-1-4673-6374- 7©2013 IEEE.

[3] Laurent Lef`evre, Olivier Mornard, Jean-Patrick Gelas, Maxime Morel "Monitoring Energy Consumption in Clouds: the Compatible One experience" 9th IEEE International Conference on Dependable, Autonomic and Secure Computing, 2011 IEEE.

[4] Yasin Kabir, Yusuf Mohammad Mohsin1, and Mohammad Monirujaman Khan, "Automated Power Factor Correction and Energy Monitoring System" 2017 IEEE.

[5] International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT) 2016 Remote Location Tampering Detection of Domestic Load M.V. Bhatkar, India.

[6] A. K. Sawhney, A Course In Electrical And Electronic Measurements And Instrumentation, Publisher, Dhanpat Rai and Co., (2005).