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SMART ENERGY METER WITH THEFT DETECTION

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ABSTRACT

On a monthly basis, conventional electricity meters given by government power supply organizations monitor the energy use of an entire residence or enterprise. This implies that customers have no way of tracking individual appliance energy use. In addition, consumers are unaware of their everyday energy use habits. Smart meters may be created by incorporating IOT into our traditional electrical meters. The primary purpose of IOT-based smart meters is to improve the existing system's performance, reliability, and features through an active customer approach. Smart energy meters acquire all energy-related data at a low cost. It tackles power quality concerns while also highlighting the potential to improve Demand Side Management (DSM).

Keywords: MSmart energy, Theft detection, Energy, Efficient power.

INTRODUCTION

Because of the popularity of gadgets powered by wireless technology innovations such as Wireless Bluetooth, Radio Frequency Identification, Wireless-Fidelity, and built-in sensors, IoT has progressed from its early stages and is on the verge of replacing the current fixed internet with the well-equipped upcoming internet. The energy situation has recently become a big issue. This problem can be addressed by controlling and monitoring the usage of power. The concept of Smart energy meters using IoT would be of great advantage to reducing the consumption and proper monitoring of electricity. These smart meters would allow the service provider to be informed about electricity thefts using a theft detection unit that detects the tampering in the energy meter, sends the signal, and displays the message. The user can also monitor the energy consumption in units from a web page by providing the device's IP address.

The aim is to design a system so that the user can monitor the energy consumption of the devices. The service provider can be informed about the electricity theft, and if the user does not pay the bill on time, the power can be disconnected by the host until the payment is done by the user. In this way, electricity can be used efficiently, and the user can perform power management from time to time. The focus is on theft detection, power optimization, and providing apt information to the user regarding energy consumption.

LITERATURE SURVEY

Qie Sun et al (2016)., have discussed the implementation of smart electricity, gas, and heat meters. The development and deployment of each meter have been discussed along with

the function of the smart meter has also been discussed as monitoring, providing signals, recording the information of power usage of load, etc... Cost and advantage have also been discussed in the paper.Chella Santhosh et al(2021), have proposed an electricity meter by introducing GSM in it, which gives an upper hand as compared to old school meters. They have stated that with the use of GSM, the door-to-door man billing will be eliminated as all the information about the electricity used can be directly provided to the electricity office. Talking about the future of these meters on paper, they have talked about the introduction of these in the smart grids and users can also collect the electricity generated by renewable sources and provide it back to the grid and the user will get paid.Tanveer Ahmad et al.(2021), have discussed internet of things based, energy-related equipment and gadgets. The paper focuses on the challenges faced by energy equipment that uses IOT as its base. A comparison of power consumption by these devices with the conventional devices that we use has been done. Also, how these devices are shaping the future market and industry has been discussed. Rehmat Ullah et al.,(2017) have discussed the pool of smart electricity, heat, water, and gas meters also known as the AMI network. A new protocol has been discussed for the effective working of this network. The proposed metric or protocol helps in monitoring the left power and helps in lining up the nearby nodes. The efficiency of the network after its introduction of it in the grid has also been discussed.I.F.Siddiqui et al.(2017), have discussed the methodology of green cloud in smart grids. Green cloud is a platform that enhances the resources and devices associated with energy. The relation between green cloud and smart grid has been discussed, and how smart energy meters work in the smart grid has also been discussed. The performance and efficiency of smart meters in smart grids have been shown. Lifespan and error in smart energy meters have been demonstrated with the help of graphs and formulas.

M. Albu et al.(2017), have discussed smart meters in smart grids and how they will help in shaping the era of smart grids in the coming future. The problem related to associating power quality calculations with smart meters has been highlighted. A new algorithm has been introduced to associate power quality framework with smart energy meters, with the help of real-life monitoring and data collection from the meters. A. H. M. Jakaria et al.(2019),have discussed the attacks that can happen on AMI and measures of safety for the prevention of these attacks. As AMI has total surveillance as well as control over the smart grid and its information, the chance of an online attack is more compared to other networks. Infrastructure, attacking methods used, and defense steps to prevent this attack on AMI has been discussed.Chang-Sic Choi et al.(2011), have discussed inter-operability between smart grids and EMS (energy management systems). The design and architecture of EMS have been discussed and how it can be interconnected with the smart grids.Mohammad Belayet Hossain et al.(2022), have discussed privacy issues related to smart meters. The problem with the current CDP (Cost friendly differential privacy) has also been shown. Along with it how to deal with this problem through the introduction of RB (rechargeable batteries) has been discussed alongside a renewable energy source has been introduced to enhance the performance. Donghuan Yao et al.(2019), have discussed the lack of protection of data in the AMI also to minimize the stealing of electricity new algorithm and the network has been discussed.

Vinicius C. Cunha et al(2020). describes the usage of smart meters' measurements to measure the parameters of Low Voltage Systems. Then the problems to measure the topology and Line parameters are described and

the formulas related to them are given. Then he points out the methods related to the problems based on two types of meters I) real and II) virtual. Then he talked about three methods- I) Pairs only real meters II) pairs real and virtual meters III) pairs only virtual meters. Then he discussed the result like- metering error, meter update ratio, PV penetration, sample size/ meter, synchronization loss of clock meters, conductor size, and databases of mechanical structures.Usama Mir et al(2021). describe new approaches to managing the energy of smart buildings and homes. Here he discussed new and improved infrastructure called 'Smart Grid'. He indicates various theoretical solutions to build this new framework like-I) Statistical models II) Cloud computing III) Fog Computing and Smart metering IV) other solutions (Big data analysis, Data Science, AI, General IOT). He also points out the challenges that must face in building this new infrastructure as- Scalability, Security and Privacy, Performance Management, Cost Effectiveness, Big data processing, etc.Soham Chakraborty et al(2021). describe the applications of the smart meter in emerging distribution systems for protection and monitoring. First, he gives a brief illustration of smart meters like-measurement units, storage units, timekeeping units, communication units, security units, etc. Then he gave the uses of smart meters like- theft detection, fault detection, etc. Then he points out the future works that we can do with smart meters.M. Carratù (2019) gave a brief description of how to build a

smart meter at minimum cost. First, the present IoT infrastructure was described that includes short-range networks, the prototype of power meters, a software based on smart meters. Then the explanation to choose the power metrics is given. Then an amount of data regarding the results of some sample experiments is given.Amam Hossain Bagdadee et al(2020). describe wirelessly power quality control using the smart grid. First, the equations related to the problems are given. Then a system was designed with Arduino and the theory of power measurement, DMR meters. Then simulation of the system and the output is given in file.

BLOCK DIAGRAM

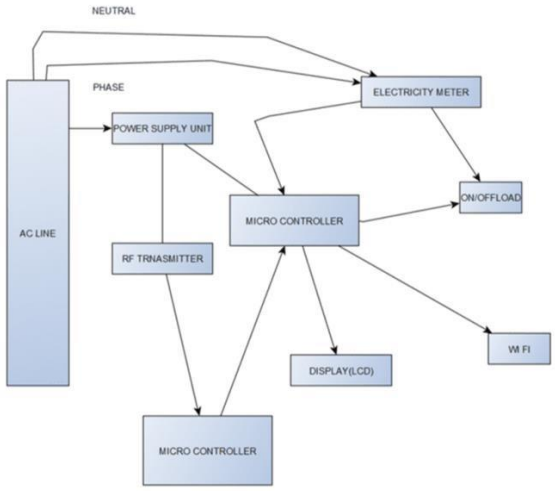

Fig. 1: Smart Energy Meter with theft detection unit (consumer end)

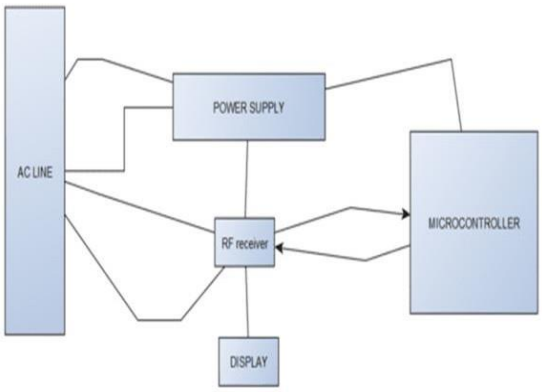

Fig. 2: Theft detection unit (service provider end)

In Fig1 on the consumer side, the ac line is connected to the power supply unit, which powers the microcontroller and the RF transmitter, the energy measuring meter is connected to the load and microcontroller, and the

data read by the microcontroller is displayed on the led display, the same information through RF transmitter is transmitted to the source side. In Fig2 at the source side, the RF receiver receives the information and is displayed on the LCD.

EXPECTED OUTCOMES.

- The consumer would be able to monitor the total energy consumed by all the appliances.
- The service provider would get notified about the electricity theft and could disable the connection until the bill is paid by the user.

CIRCUIT SIMULATION

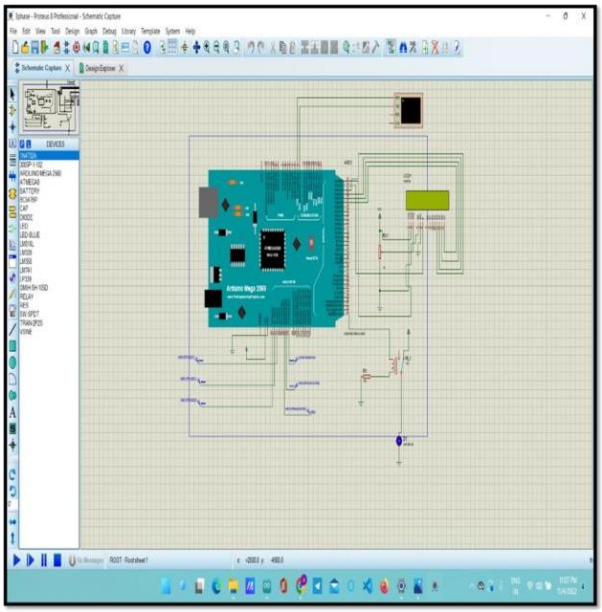

Fig.3: Smart Energy Meter Circuit Design

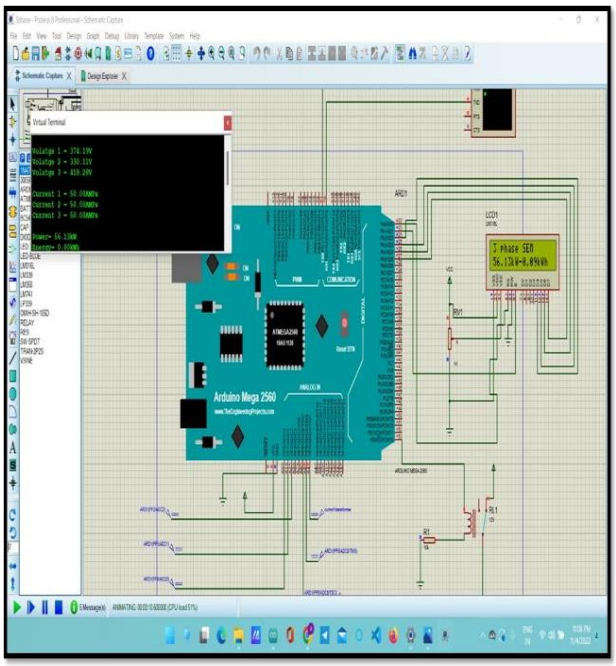

Fig. 4: Smart Energy Meter Output1

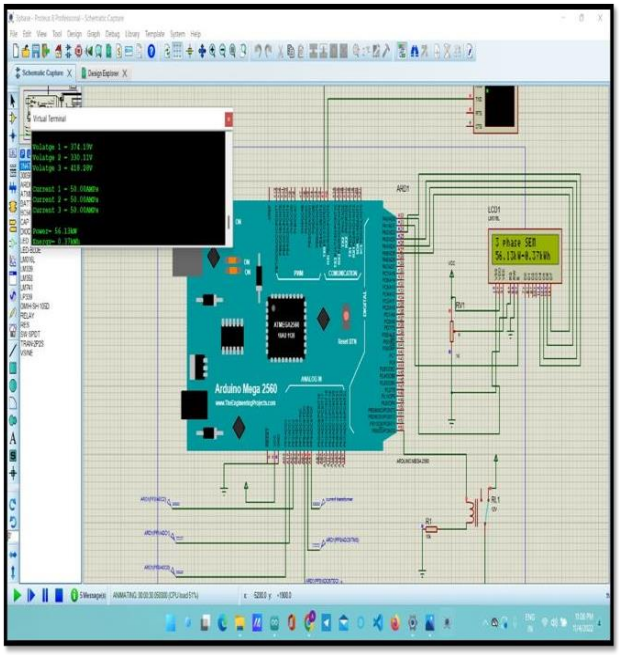

Fig. 5: Smart Energy Meter Output2

THEFT DETECTION UNIT-

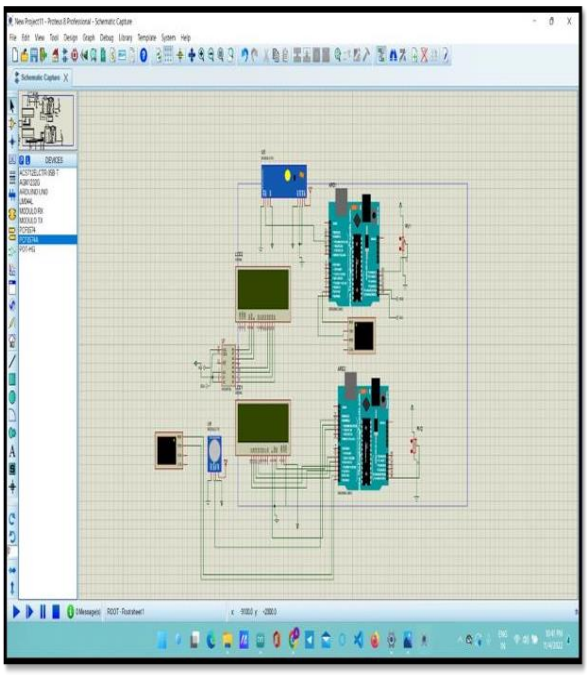

Fig. 6: Theft Detection Circuit Design

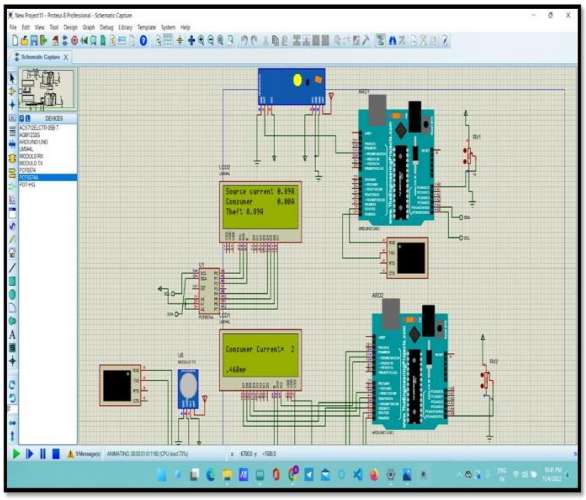

Fig. 7: Theft Detection Output1

PROPOSED MODEL AND WORKING-

In this proposed model the consumer can get to know about the energy usage from time to time so that he can manage power efficiently. From the provider's side, if the electricity theft is detected connection can be disconnected until the bill is paid by the consumer as shown in Fig 1 and Fig 2.

First, we will be interfacing the LCD with the Arduino, which will display the power consumed and the energy consumed by the user. Since it is a 3-phase smart energy meter, 3 voltage sensors and 3 current sensors will be used which will determine the current and voltage consumed by the load and give it to Arduino as we can see in fig3.

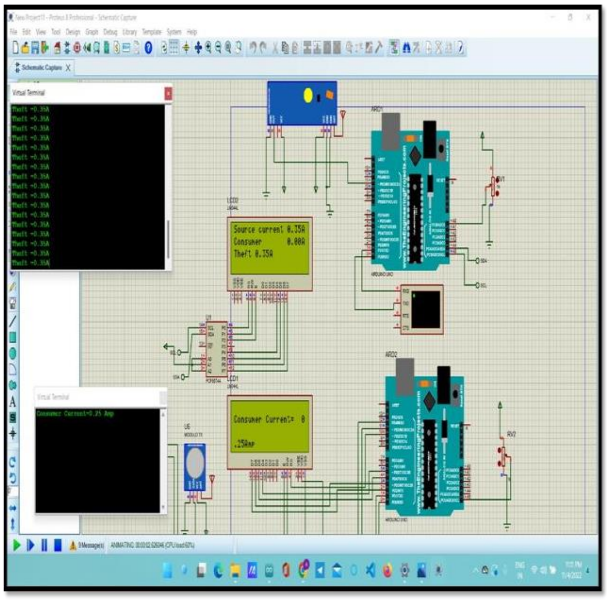

Fig. 8: Theft Detection Output2

As we know Arduino works, at a maximum of 5 V of input, these voltage and current sensor values are scaled up and given to Arduino, so that Arduino can work. We have also connected a serial monitor with the Arduino. A blue led is connected to Arduino which tells when a certain power is consumed by the load and will give a sign after the power consumed is exceeded the expected limit of the user.

As we can see in fig4 and fig5 the smart energy meter shows 3 voltage and current values from the load, and it is displayed on the LCD along with power and energy consumed.

Theft detection circuit-

Here we are using 2 Arduino, one on the source side and one on the consumer side. An RF TX and RF Rx are used to communicate between the two Arduino Fig 6.

Consumer side-

A potentiometer is connected to Arduino to monitor the current consumed by the load and gives the information to the Arduino. The Arduino is connected to an LCD and an RF transmitter, LCDs are the value of current consumed by the appliance and the transmitter is used to send the consumed current information to the receiver at the consumer side as in Fig 7 and Fig 8.

Source side-

Here the RF receiver gets the information from the consumer side RF transmitter, which it gives to Arduino. A potentiometer is connected to the Arduino which tells the amount of current that is provided from the source. Both the consumer and source current is known and with the help of SDC and SDA port, it is given to LCD for the display. The difference between the source current and consumer current gives the theft current as in Fig 7 and Fig 8.

DISCUSSION AND COMPARISON

Chella Santhosh et al.(2021), have proposed an electricity meter by introducing GSM in it, which gives an upper hand as compared to old school meters. They have stated that with the use of GSM, the door-to-door man billing will be eliminated as all the information about the electricity used can be directly provided to the electricity office. Talking about the future of these meters in a paper, they have talked about the introduction of these in the smart grids user can also collect the electricity generated by renewable sources and provide it back to the grid and the user will get paid.

In our proposed work we have worked on the development of a smart energy meter along with theft detection, which detects energy theft and notifies the service provider. Further, the service provider can disconnect the electricity until the bill is paid by the user. This leads to the elimination of door-to-door man billing.

Shishir Muralidhara et al(2020). proposed an IoT- based smart energy meter that can be installed in homes and industries to assess the power consumption of appliances at a cheap cost. Energy

use may be tracked by customers which enables them to minimize energy consumption. Whereas in our proposed work we have worked on the development of a smart energy meter along with theft detection, which detects energy theft and notifies the service provider. This makes it easier and more efficient for proper energy consumption. Further, the service provider can disconnect the electricity until the bill is paid by the user.

Karthick.T et al.(2021), has proposed an IOT-based smart compact energy meter utilized in commercials. They attempted to reduce the amount of energy utilized by clients. By moving secondary loads, this meter decreases peak demand. It also educates and tests power quality concerns at a cheap cost and with greater precision.

Whereas in our proposed work we have worked on the development of a smart energy meter along with theft detection such that the user and service provider can equally monitor the energy consumed by the appliances from time to time which detects the energy theft and notifies the service provider. Further, the service provider can disconnect the electricity until the bill is paid by the user. Since there is no theft of electricity by the consumer and a proper bill is paid on time it becomes easier to monitor energy consumption in a much more efficient way and save energy more accurately.

CONCLUSION

Thus, we have designed a smart energy meter with theft detection such that the user and service provider can equally monitor the energy consumed by the appliances from time to time. This makes it easier and more efficient for

proper energy consumption. It also proves to be beneficial for the service provider such that there is no theft of electricity by the consumer and a proper bill is paid on time which makes it easier to monitor the energy consumption in a much more efficient way and save energy. This can be achieved at a low cost and reduces the common human errors done in the conventional methods of billing and provides more secure ways to transmit energy.

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