Smart Prepaid Electric Energy Meter Monitoring System Using Machine Learning and Internet of Things (IoT)

Dr.P.A.Gowrisankar[1], Sivasankar.C[2], Dinesh Kumar.P[3], Jayaganth.T[4], Ravinther.P[5], Thirumalai.V[6], Sanjay.M.K[7]

[1]*Associate Professor Department of Electrical and Electronics Engineering, Knowledge Institute of Technology, Salem, Tamil Nadu, India.*
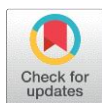
[2,3,4,5,6,7]*U.G. Student Department of Electrical and Electronics Engineering, Knowledge Institute of Technology, Salem, Tamil Nadu, India.*

Abstract: Energy is very precious for the living beings in recent times. The Energy consumption is consistently as increases as the population increases so the need power is also increases, The revenue in electricity system are increasing and also gets hard to monitoring the each system. It is quite Impossible to check out the consumer's residence at regular intervals. In this paper, a new procedure of using NODE MCU to monitor and control the energy meter power supply by remotely disconnect and reconnecting the service of a particular consumer. An notification is sent to the utility central server and consumer through wi-fi module whenever the load consumption is exceeds the consumer desired value. The NODE MCU, and WEB page handle the Real-time Monitoring the load consumption notification and shows current pursuing with costs through the online page. In this exploration, we complete the accuracy of meter perusing with the help of an LCD that shows which prone to KWh, voltage, current and power factor perusing.

Key Word: IOT, Smart Monitoring, Prepaid System.

1. Introduction

Electricity is one of the most important blessings that science has given to mankind. The Proposed system "Prepaid Energy Meter with Smart Monitoring System" using Controller and IOT is a simple and effective way to automate the process the Billing, Controlling and Monitoring the load consumption. The system consists of Node MCU(Microcontroller), PZEM-004T(Sensor), Relay, Web page. The System involves the use of Controller to control the flow of power to the Load. The system typically consists of Node MCU, equipped with a PZEM-004T sensor that detects the power, voltage, current consumed by load. The sensor is connected to Controller, which control the relay to disconnecting and reconnecting power to the Load. When the Load reached the Desired value, the controller give instruction to the relay to stop the flow Energy into the load. The Desired value can alter by using IOT interface by the Consumer Need through Web page. Overall, The Prepaid Energy Meter with Smart Monitoring System using Controller and IOT is a simple and reliable way to automate the process of Billing, Control and Monitoring the power consumption in Real time. It can be used in a variety of applications, such as in agricultural or industrial settings, where maintaining a consistent power supply is important.

2. Existing System

The electronic meters show the power consumed, power factor, the reactive power using digitally displayed on LCD or LED display, and also measure the other parameters such as load, supply, maximum rate of usage demands, voltages, power factor and reactive power used etc. "Traditionally, the electricity meters are installed on consumer's premises and the consumption information is collected by **meter-readers** on their fortnightly or monthly visits to the premises." It is a single way of communication.

1.1 Drawbacks of Regular Meter:

Depend upon the meter reader Human error cannot be avoided for the manual meter reading. There is no cross checking or recheck of human readers for energy utilization. So there is high chance of stealing. The expenses of meter readers are high Wherever energy meter installed inside the house, which may lead to non-checking of reading due to lock. The consumer is not receiving updates of his regular usage of energy. The consumer may not receive his energy bill as per regular interval of the due date. That cause huge loss to Electricity Department.

3. Proposed Method

A smart energy meter works on communication directly with wireless data protocol, so there will be precise reading and there's no necessary for a meter reader to take energy meter reading in consumer premises. There are so many different merits of smart energy meter such as:

- User new smart energy meters send precise reading on a regular interval in sequence about customer's energy usage to utility (Electricity provider). So the bills will be proper and labour cost is reduced for taking a reading in consumer residents.
- If the consumer did not pay the energy bill within time, the utility can remotely disconnect the service (line) of a particular consumer and after payment, the service continues to the consumer. So we can avoid sending an employee to cut off energy from the network and again to reconnect their connection.
- Whenever the power quality is not maintained from the distribution supply, then the customer equipment can be protected by disconnecting and reconnecting to the supply by relay.

The proposed system consists of Node MCU, PZEM-004T, Relay. After switching power on the Node MCU, turn on the Relay and connects the power line to load via Relay. Then read the value and display the current data. Controller checks the readings from sensor. If the value reach the desired value the controller send a notification to the consumer and if it exceeds the controller sends an information to relay to stop the flow of power to the system. Also, the Web page and Node MCU helps the utility for power disconnection when the bill is not cleared by the customer. From customer point, this is a benefit to monitoring their daily/monthly consumption, voltage fluctuation and get disconnected from the supply.

Table 1: Components and its Specifications

S.No	COMPONENTS	RANGE
1	NODE MCU	-
2	PZEM-004T	80-260V
3	RELAY	5V

3.1 System Architecture

The system architecture of Prepaid Energy Meter with Smart Monitoring System is shown in the Fig. 1. The energy consumption is being calculated using the sensor and controller. In order to prevent a power excess consumption, Tampering program is present in the Node MCU. The Prepaid energy meter with smart monitoring system is divided in several parts namely Node MCU, PZEM-004T, Relay, Web page. The figure 1 shows the block diagram of the proposed system
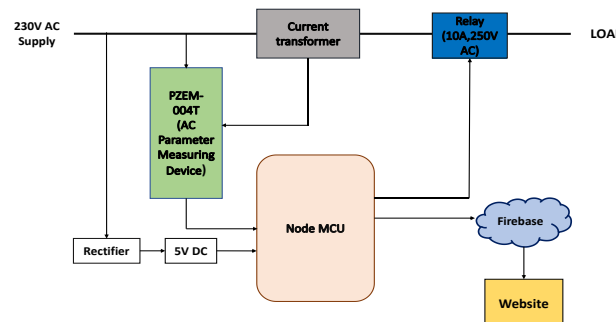
Fig. 1Block diagram of the proposed system Smart Prepaid Energy Meter

3.2 Hardware Setup
3.2.1. Software Implementation:

The software which is used to program the node MCUis **Arduino IDE.** This compiler compiles and uploads the code to the node MCU. This IDE uses Embedded C as a language to compile and upload the codes. It also uses C++ for some of its syntaxes and Libraries. The general structure of the program contains void setup and void loop. The void setup part contains the initial setup and void loop contains the condition which must be continuously executed. The program also has an ability to transfer the sensor readings and balance in real time to the Google Firebase for the easy monitoring. A website has been created to help customers to recharge their energy meters.

3.2.2. Hardware Implementation:

The Purpose system has modified new energy meter with a microcontroller, sensor and relay. The Node MCU measures the energy consumption in real-time and deducts credits from the customer's prepaid account as energy consumed

and manages the overall system, including processing sensor given data, managing prepaid accounts, and controlling the system's communications unit enables real-time data transmission between the controller and central system, providing customers and utility providers with accurate and up-to-date information on energy consumption and system performance.

3.2.2.1 NODE MCU:

It is an open source firmware for which open source prototyping board. It is 3.3V device with 128 KB memory and 4 MB storage with ESP8266 CPU(LX106). This is a Controller that control the flow of the power to the load system through relay by disconnecting and reconnecting the supply between supply line and load system. With wi-fi module in it send the information to the web page to monitoring the real time load consumption. It is operated with 5V separate DC voltage The Node MCU is displayed in fig.2.

Fig.2 Node MCU Microcontroller

3.2.2.2 Pzem-004t And Current Transformer:

This sensor is multi-functional and it is used to measure the AC supply voltage, current, frequency, power consumption to the controller this connected between the supply line and load system. The current transformer is a type of transformer that is used to reduce or multiply an alternating current. It produces a current in its secondary which is proportional to the current in its primary. The sensorPZEM-004T is displayed in fig. 3.

Fig. 3. PZEM-004T Sensor

3.2.2.3 Relay:

It is used to control a load such as a lighting system, motor, or solenoid. The maximum voltage and current is 5V. It is connected between the power line and load system. The Relay is displayed in fig.4.

*Fig.4 Relay Trip Circuit*

3.2.2.4 Web Page:
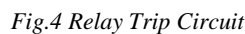
Web page helps to display the real time load consumption in a daily/monthly manner the data or information can be get for the controller to display to consumer. In this the consumer can see the plan and consumption. They can recharge the meter as per the plan show in page. This Web page is connected with Node MCU with the wi-fi module.

Fig. 5. Webpage Smart Energy Meter Reading Ouput
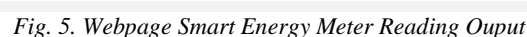
Hardware Setup:

Fig.6 Hardware Setup of the Proposed Smart Energy Meter
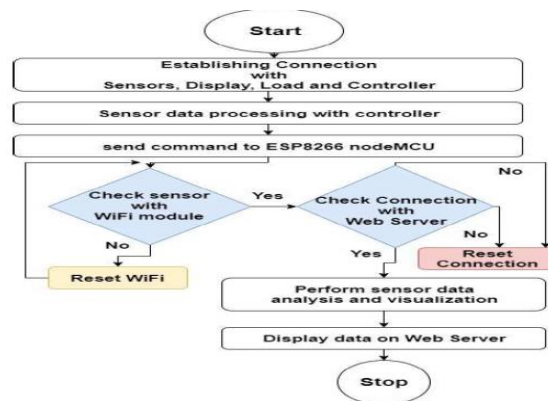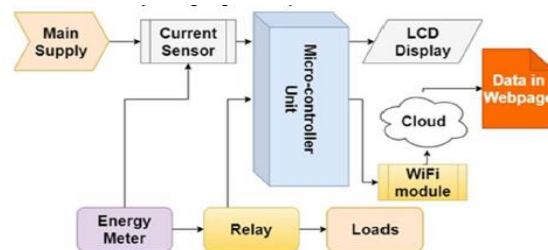
4. Result and Discussion

The development of smart energy meters using the IoT system is proposed and when the power is on, the relay switches the first relay on and all are rest. Overall system was designed and tested by us. We are introducing the home appliances controlling and regarding security issues. Our project has completed a successful implementation & testing. So, we said that our system was effective fast response, most secure and easy to construct.

Table 2. Prepaid Energy Meter Initial Recharged with Rs.100.
(Data Stored in Three Dimensional Array)

S.No	Parameters	Value	Units
1	Voltage	247.00	Volts
2	Current	0.07	Amps
3	Power	17.40	Watts
4	Frequency	50	Hz

| 5 | Balance | 0.3 | Rs |

Table 3. Prepaid Energy Meter reading after energy consumption balanced with Rs.0.
(Data Stored in Three Dimensional Array)

S.No	Parameters	Value	Units
1	Voltage	247.10	Volts
2	Current	0.08	Amps
3	Power	18.40	Watts
4	Frequency	50	Hz
5	Balance	0.0	Rs

5. Conclusion

This paper is the combined hardware advantage for both utility and the customer. The Smart Energy meter with Node MCU with in to read and data via wireless protocol using Wi-Fi module in Node MCU. Through this we can manage and controlling the supply to the load system through relay. In the case of unwanted load consumption can be identified through real-time showing of power consumption, power quality with its accuracy. This process will reduce the labor work and human error in the distribution system.

References

1. M. M. Mohamed Mufassirin, A. L. Hanees. "DEVELOPMENT OF IOT BASED SMART ENERGY METER READING AND MONITORING SYSTEM", 8th International Symposium - 2018, SEUSL
2. Dr O. Chandra Sekhar, Mr. B V Rajanna, and Mr. M .Kiran Kumar. "Automatic Meter Reading For Smart Metering By Using QPSK Modem With PLC Channel and GSM Modem.", Journal of Electrical Engineering, January 2015
3. B. Sivaneasan, E. Gunawan, and P. L. So. "Modeling and performance analysis of automatic meter-reading systems using PLC under impulsive noise interference," IEEE TRANSACTIONS ON POWER DELIVERY, [vol. 25, no. 3, pp. 1465–1475], Jul. 2010.
4. Garrab, A.; Bouallegue, A.; Ben Abdallah, "A new AMR approach for energy saving in Smart Grids using Smart Meter and partial Power Line Communication", IEEE First International Conference on Renewable Energies and Vehicular Technology (REVET), pp. 263 – 269, March 2012
5. M V Aleyas, Nishin Antony, Sandeep T, Sudheesh Kumar M, Vishnu Balakrishnan. "Automatic Meter Reading and Load Management Using Power Line Carrier Communication", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering. [Vol. 3, Issue 5, pp 9425-9432] May 2014.
6. S.V.Anushree, T. Shanthi. "IoT Based Smart Energy Meter Monitoring and Theft Detection Using ATMEGA", International Journal of Innovative Research in Computer and Communication Engineering. Vol. 4, Issue 11, pp. 19801- 19805, November 2016].
7. Patrick Mapulane, TshepangLetshwiti, MompatiMolibe, OagileGaogane, Keaboka M. Sethebe, N.M.J. Ditshego. "Smart Energy Meter," BIUST Research and Innovation Symposium 2019 (RDAIS 2019) ISSN: 2521-2292 [Page no 30-36]
8. Dakka. Obulesu, K. S. V. Phani Kumar and V. Mahesh. "Design and Implementation of IoT Energy Meter to Monitor Energy Flow at the Consumer End", Asian Journal of Electrical Sciences. ISSN: 2249- 6297, [Vol. 8, No. 2, 2019], pp. 1-4
9. Smart Energy Metering and Power Theft Control using Arduino and GSM, 2nd International Conference for Convergence in Technology (I2CT) in 2017.
10. A Smart Prepaid Energy Metering System to Control Electricity Theft, International Conference on Power, Energy and Control (ICPEC) in 2013.
11. Development of an Internet Based Prepaid Energy Meter, Institute of Electrical and Electronics Engineers (IEEE) in 2017.
12. Arduino Based Smart Energy meter using GSM, Institute of Electrical and Electronics Engineers (IEEE) in 2019.
13. Smart Energy Meter, International Journal of Engineering Science and Computing (IJESC) in 2018.