ISSN: 2278-4632
Vol-10 Issue-5 No. 9 May 2020

Smart Energy Meter for Power Consumption Monitoring with Over Power Detection for Household Applications

Shivani Singh[1], Gulhasan Ahmad[2], Pawan Kumar Tiwari[3], C.K. Dwivedi[4]

Dept. of Electrical Engineering, Sri Balaji College of Engineering and Technology, Jaipur, Rajasthan, India

Abstract: Despite many efforts, Energy crisis is the present-day problem and it is getting worse day by day. To overcome this situation people are finding various energy efficient resources. Among them, power is the main concern which needs to be monitored and controlled. With the rise in power consumption in every part of the world there is a subsequent rise in power theft and over usage of power. This is a serious problem which is being faced by the power utilities. In this paper, a model is designed which aims to control and monitor power consumption of a particular area or sector. The designed model monitors the power consumption of the end users and cut off the power supply when it exceeds the set limit. The device sends the power consumption data to the supplier's blynk server using Internet of Things (IoT) technology. The designed model can be placed before the transmission of the load in each house of that particular area. It consists a meter that generates a continuous unit pulse which can communicate with network through an Internet gateway WI-FI. With the help of internet accessibility, communication will be possible between end-user and the supplier. The supplier can monitor and control the power consumption of the end user from a remote place. Along with that the device sends notification to the supplier about status of power consumed.

Keywords: Energy crisis, IoT, Monitor and Control, Power consumption

I. Introduction:

Due to fraud of electricity consumers power utilities lose large amount of money every year. Electricity fraud can be define as a dishonest or illegal use of electricity equipment or service with the intention to avoid billing charge. It is difficult to distinguish between honest and fraudulent customers. Realistically, electric utilities will never be able to eliminate fraud. It is possible, however to take measures to detect, prevent and reduce fraud. Investigations are undertaken by electric utility companies to assess the impact of technical losses in generation, transmission and distribution networks, and the overall performance of power networks. At the time of purchasing the meter according to the requirement of customer the limit of meter will be set; in the same way the limit of transformer is also set according to the consumer requirement of the particular area. If the consumer uses the power beyond the limit of the meter in that case they have to pay the penalty. As many of the consumer's uses the high amount of power which crosses the limit of the transformer at that time the probability of busting of transformer increases. So in this paper we proposed a method to overcome above problem this paper mainly focusing on monitoring and controlling of power in the range of limit of the meter. The IoT has recently become universal to highlight the vision of a global structure of interconnected physical objects. As more number of electricity-consuming products coming into daily lives, such as electrical vehicles (EVs) and advanced heating, ventilation, and air conditioning systems, load demand increases dramatically and power required at high amount. In this project proposed a power consumption and monitoring system of the area that continuously monitor the consumption of consumer. If this consumption is beyond the limit of the meter in that case it cut off the power supply.

Internet of Things (IoT): IoT is an ecosystem of connected physical objects that are accessible through the internet. To transfer information wirelessly for power consumption monitoring and controlling NodeMCU Wi-Fi module is used. The NodeMCU development board is a powerful solution to program microcontrollers and be part of the Internet of Things (IoT).

Here for monitoring power the IoT ESP8266 modules take the calibration pulse from meter and perform necessary operations afterward it sends the required information like no. of units or power is on limit or not etc. in blynk server from there it continuously notified to the authorized person about the detail of consumption of power.

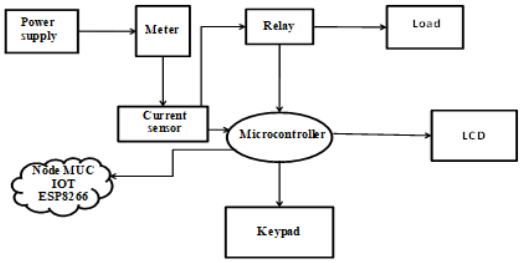

Figure 1.1: Block diagram of the system

The current sensing sensor sense the amount of current receives to the meter in the form of power

ISSN: 2278-4632
Vol-10 Issue-5 No. 9 May 2020

as power directly proportional to the current. Microcontroller is used for proper monitoring of power consumed by the meter. The reading of meter is displayed on LCD. Relay is used as a switch. The meter reading is transfer to the webpage of electricity board section using Node MUC IOT ESP8266.If amount of power used by meter is beyond the limit then the notification regarding theft is notified.

II. Working of the model:

Figure 2.1: Experimental setup at non-working state

The electrical power flows from distribution transformer to digital 1-phase sub- meter of the consumer through distribution phase conductors. Now, the circuit or the controlling model is connected at the o/p of digital meter, where the power flows in single phase to the LOAD. We need to sense the current flowing to the LOAD which is done by a CURRENT SENSOR placed in series with the LOAD and in the phase supply of source. It functions to sense the current flow and if it is more to LOAD (as per the demand), it senses and feedbacks to our controller device identifies and cut off the supply to load.

Secondly, the neutral is left to control (i.e. to on and off the LOAD) which is done by the ATMEGA328(the 8- bit microcontroller) where controller gets i/p from a keypad to set the threshold power(upper limit of power),so that when it gets i/p from current sensor it could match this i/p with i/p from keypad and provide processed o/p to the OPTO TRIAC set connected in parallel to it. This set triggers another TRIAC which is connected to neutral of the MAIN I/P SUPPLY to turn on and off the LOAD. Now, the o/p of the TRIAC SET and TRIAC is connected to the LOAD (completing the controlling circuit for LOAD) i.e. when the LOAD exceeds its PRE-SET value (through keypad), the controller would make the TRIAC SET to turn of the LOAD and make supply off until n unless it resumes its condition within THRESHOLD VALUE (pre-set value). Hence when again the LOAD is reduced the current through CURRENT SENSOR gets reduced thus controller gets less current i/p from sensor again matches with the i/p from keypad, finding it within the limit (threshold limit) it sends o/p to TRIAC SET and the set turns on the LOAD again.

Here; the OPTO-TRIAC SET works as it has an LED and a bidirectional diode connected in parallel to each other, where the LED lights up when it gets input and as per this i/p the triac works i.e. till the LED is on the triac set is on or in forward bias condition triggering the TRIAC connected with the SET which in turn switch on the load and as the LED turns off the TRIAC set gets deactivated turning the power flow off to load.

As electronic based controlling system is used we need to step down the input power/voltage rating to 5 volts DC, this is done by the STEP DOWN transformer that gives o/p of 12 volts than this 12volts AC is converted to DC by rectifier bridge circuit further its filtered by a capacitor and then the o/p of capacitor is further step down to 5volts by 7805 regulator (any noise found in o/p of regulator is further filtered by capacitor). Thus; this how the power flows in electronic controlling circuit which is fed to ATMEGA 328 MICROCONTROLLER. The micro controller has to get the pulse from meter for the billing purpose (unit based) which is performed by the OPTO COUPLER which has an LED and a transistor, as the LED lit s up the transistor gets activated in synchronous to LED, sending the pulse/ No. of units to the micro controller.

A high to low pulse is send with the function that by default the i/p of OPTO COUPLER is kept HIGH; as soon as it gets the pulse it becomes LOW; this is done with help of PULL- UP RESISTOR (10Kohms) connected in parallel with the opto coupler at the transistor i/p. next the o/p of this send to microcontroller as i/p to it, where the microcontroller processes the counts and sends the o/p to LCD screen for display of no. of units consumed along with the amount(in rupees) to be paid by the consumer. This majorly helps for the billing to be produced.

III. Result:

ISSN: 2278-4632
Vol-10 Issue-5 No. 9 May 2020

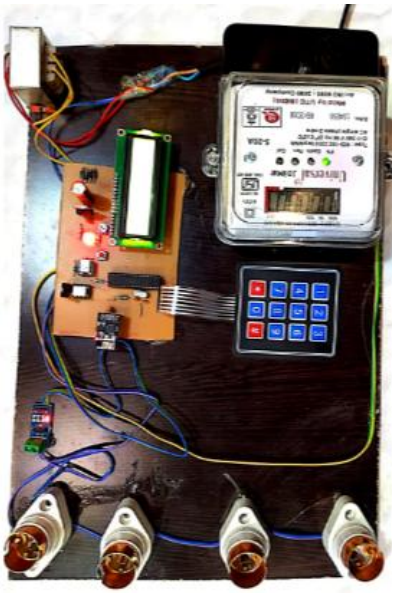

Figure 3.1: Hardware when power is supplied

Figure 3.2: Threshold power set to 300W, 100W bulb is connected

Figure 3.3: Two bulbs of 100W connected resulting in 200W

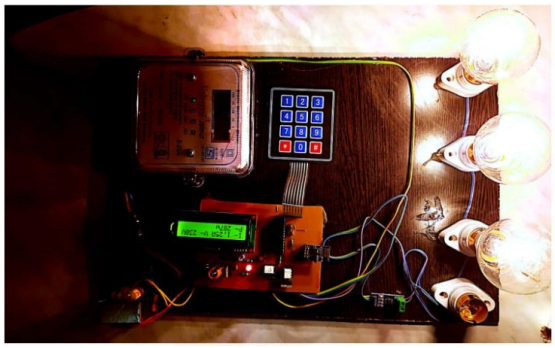

Figure 3.4: Two bulbs of 100W each and one bulb of 60W connected resulting in 260W

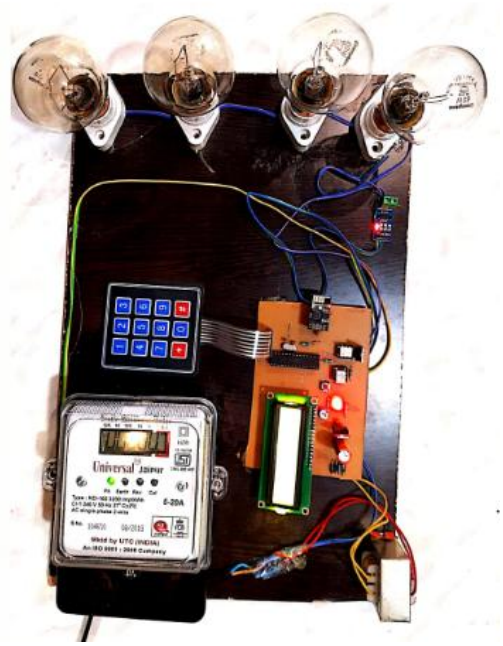

Figure 3.5: Four loads connected resulting in more than 300W which turns off the supply

As the total load connected exceeds the threshold value, the power supply to the load end stops.

Storing in Blynk IOT app:

ISSN: 2278-4632
Vol-10 Issue-5 No. 9 May 2020

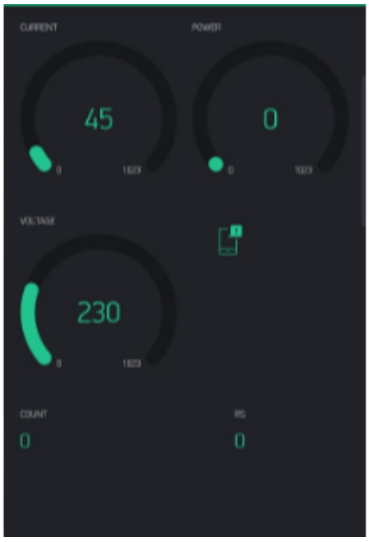

Figure 3.6: At no load condition and the supply is at on state

Figure 3.7: When 100W load is connected

Figure 3.8: When load adds up to 200W

Figure 3.9: When load adds up to 260W

Figure 3.10: Power to load end turns off when the power added exceeds the threshold value

Here the threshold value is taken as 300W. As the power adds up to more than 300W the supply is turned off and the popup notification is given.

Figure 3.11: When the load power is reduced below the threshold value the power supply is turned on

IV. Conclusion:

With the help of designed model power consumption of a customer is monitored. When the user exceeds his limit of power consumption the supply of power will

ISSN: 2278-4632
Vol-10 Issue-5 No. 9 May 2020

cut off automatically. The usage of every consumer in the region or sector is sent to the blynk server. Supplier will be notified about the power consumption of the entire region or sector. The supplier can monitor and control the power usage of the user as well as the entire region. If the generated data is provided to the customers, they can compare their usage with the data sheet. So this will help to identify the fraudulent user who is stealing the user's power by direct hooking method. As the Indian Government has also proposed formation of Smart Cities which will have an effective energy management, transportation, waste disposal and resource conservation strategy using primarily Internet of Things. This wireless IoT based technique is much useful to detect the stealing of the electricity worldwide. So, in this work variable voltage and variable power will set according to electricity board section as well as it provides safety as the limit of meter will change by the authorized person.

References:

[1] U. Grasselli, A. Prudenzi, 1990, Utilization of a PLC in power system protection applications, IEEE Applications of Industrial Electronics Systems.

[2] Yujun Bao and Xiaoyan Jiang, 2009, Design of electric Energy Meter for long-distance data information transfers which based upon GPRS, International Workshop on Intelligent Systems and Applications.

[3] B. S. Park, D. H. Hyun, and S. K. Cho, 2002, Implementation of AMR system using power line communication,IEEE/PES Transmission and Distribution Conference and Exhibition,Print ISBN: 0-7803-7525-4.

[4] Harsha Khandel, Suchitra Pandey, D. Reynolds, 2017, Internet of Things based Power Theft Detection System, International Journal of Advanced in Management, Technology and Engineering Sciences (IJAMTES), Vol.8, Issue 3 ISSN NO: 2249-7455.

[5] Harsha Khandel , Suchitra Pandey , D. Reynolds , 2017, A Review on IOT Based Power Theft Detection and Control Systems, International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering Vol. 5, Issue 9.

[6] Eduardo Werley S. dos Angelos, Osvaldo R. Saavedra, Omar A. Carmona Cortés, and André Nunes de Souza,2011,Detection and Identification of Abnormalities in Customer Consumptions in Power Distribution Systems, IEEE Transactions on Power Delivery.

[7] Ashna.k,Sudhish N George, 2013, GSM Based Automatic Energy Meter Reading System with Instant Billing, IEEE Automation, Computing, Communication, Control and Compressed Sensing (iMac4s), Electronic ISBN: 978-14673-5090-7.

[8] Sridhar S, Bharath H, Vishvesh V,2013, Gowtham K V, IoT based-Transformer power theft detection and protection, International Journal of Engineering Research Volume No.5 Issue: Special 4, ISSN: 2319-6890) (online), 2347-5013(print) pp: 992-1128.

[9] G. L. Prashanthi, K. V. Prasad, 2014, Wireless power meter monitoring with power theft detection and intimation system using GSM and Zigbee networks, IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) e-ISSN: 2278-2834,p- ISSN: 22788735.Volume 9, Issue 6, Ver. I (Nov - Dec. 2014), PP 04-08.

[10] Zanella A, 2014, Internet of Things for Smart Cities, IEEE IOT-J, Vol 1,Issue 1, ISSN: 2327-4662.

[11] Shivaji G. Shinde, Bhagyashri G. Jaind, 2016, IOT framework for energy efficient smart building,

International Journal of Application or Innovation in Engineering & Management (IJAIEM) Volume 5, Issue 4, ISSN 2319 – 4847.

[12] Maninder Kaur and Dr. Sheetal Kalra, 2016, A Review on IOT Based Smart Grid, International Journal of Energy, Information and Communications Vol.7, Issue 3, pp.11-22.

[13] World electricity distribution losses, International Energy Annual 2006, U.S. Energy Information Administration, [Online].Available: http://www.eia.doe.gov/pub/international/iealf/tables5 . xls

[14] World electricity distribution losses, International Energy Annual 2015, U.S. Energy Information Administration, [Online].Available: https://www.eia.gov/todayinenergy/detail.php?id=234 52

[15]Electricity sector in India [online].Available: https://en.wikipedia.org/wiki/Electricity_sector_in_In dia.

[16] B.Saikiran, R.Hariharan, 2014, Review of methods of power theft in Power System, International Journal of Scientific & Engineering Research (IJSER), Volume 5, Issue 11, 276 ISSN 2229-5518.

[17] Ajeeba A A, Anna Thomas, Risa Rasheed, 2017, IOT Based Energy Meter Reading, Theft Detection and Disconnection, International Research Journal of

ISSN: 2278-4632
Vol-10 Issue-5 No. 9 May 2020

Engineering and Technology (IRJET) e-ISSN: 2395 - 0056 Volume: 04, Issue: 04, p-ISSN: 2395-0072.

[18] Xi Chen, Jianming Liu, Xiangzhen Li, Limin Sun, Yan Zhen, 2011, IET International Conference on Communication Technology and Application (ICCTA), Electronic ISBN: 978-84919-470-9.

[19]Nabil Mohammad, Anomadarshi Barua and Muhammad Abdullah Arafat,2013, 2013 International Conference on Power, Energy and Control (ICPEC).

[20] Jianhua Wang, Jianxiang Huang, Weihai Chen, Jingmeng Liu∗, Dong Xu,2016, Design of IoT-based Energy Efficiency Management System for Building Ceramics Production Line, IEEE 11th conference on Industrial Electronics and Application (ICIEA).

[21]Karthikeya S, Bhuvaneswari P.T.V, 2017,IoT Based Real-Time Residential Energy Meter Monitoring System, IEEE Trends in Industrial Measurement and Automation (TIMA).

[22] Arango, L.G., Deccache, E., Bonatto, B. D., Arango, H., Ribeiro, P.F., Silveira, P. M., 2016,Impact of Electricity Theft on Power Quality,IEEE 17th International conference on Harmonics and Quality of Power (ICHQP),electronic ISSN: 2164-0610.

[23] Sridhar S, Bharath H, Vishvesh V, Gowtham K V, 2016,IoT based-Transformer power theft detection and protection,International Journal of Engineering Research(IJER), Volume No.5 Issue: Special 4,ISSN: 23196890 (online), 2347-5013 pp: 992-1128.

[24] Jawad Nagi, Keem Siah Yap, Sieh Kiong Tiong, Syed Khaleel Ahmed and Malik Mohamad,2010,IEEE Transactions on power delivery.

[25] Soma Shekara Srenadh Reddy Depuru, Lingfeng Wang, Vijay Devabhaktuni,2011,Electricity Theft: Overview, issues, Prevention and a Smart Meter Based Approach to Control Theft,Elsevier,Energy Policy 39 10071015.

