Asian Journal of Applied Science and Technology (AJAST)
(Open Access Quarterly International Journal) Volume 2, Issue 1, Pages 205-211, 2018

A Smart Electric Meter Reading and Monitoring System using Embedded Controllers

A.Tamilselvi[1], K.Ramya[2], T.Pavithra[3], Dr.J.Augustin Jacob[4], Mr.N.Ebenesar Jebadurai[5]

[1,2,3] *PG Scholar, Department of ECE, Sri Vidya College of Engineering and Technology, Virudhunagar.*
[4]*Associate Professor, Department of ECE, Sri Vidya College of Engineering & Technology, Virudhunagar.*
[5]*Assistant Professor, Department of ECE, Sri Vidya College of Engineering & Technology, Virudhunagar.*

Article Received: 27 November 2017 *Article Accepted: 24 January 2018* *Article Published: 29 March 2018*

ABSTRACT

Among the rapid development in technology and pervasive usage of web enabled services there is greater speculation among customers to look at reducing the manpower in electrical meter reading system. Few research efforts are made in the literature to automate the meter reading process, however the price of the system was not affordable to low power consumer. The reason is they used GSM based meter reading system. So there is a need of low cost smart electrical meter reading and monitoring system. Here a new smart electrical meter reading and monitoring system was proposed that reads and monitors the power reading and keep informing the power usage to the customers and electricity department through web associated interface. Live meter reading are read from the meter through arduino microcontroller and the Energy usage is monitored, analysed and stored in the Thingspeak server. Energy Usage and the Amount is displayed in a In Home Display installed in every home. Each Household is provided with a Login Id which can be accessed via a Smart Metering website (created especially for this purpose) , to acquire a knowledge on their Energy Consumption and think on Energy reduction measures if required. The Energy Usage and the Bill amount is periodically updated in the cloud. The officers at EB can retrieve the energy usage data and the amount of each users even as a spreadsheet for easy manipulation.

Keywords—Smart Meter, Energy Usage, Rate, Website, Thingspeak Server, Cloud.

1. INTRODUCTION

The traditional meter reading for electrical consumption is carried out by human operators by visiting the site in person. The man power and time required to accomplish the task increases linearly with the increase in area. Further human operator reading are prone to reading errors and sometimes the electrical meter in the house or building is placed in a location where it is not easily accessible. Also meter reading process affected by bad weather conditions. In addition to that additional cost associated with the meter reading process will be loaded over the consumers. With the increase in the development of residential housing and commercial building, accomplishing meter reading task with manual operator is a challenging task. This pushed the need to develop automated meter reading system. With the development in digital technology electromechanical meters are replaced by digital electronic meter. This offers greater convenience to implement Automated Meter Reading (AMR) system. The major challenges in AMR system are efficiency and reliability of retrieving meter reading. Various methods and technologies of AMR system are developed in [1] to [6] using RF module, Bluetooth. ZigBee and GSM, however they are expensive and requires complex interfacing structures. The proposed smart energy meter reading and monitoring system uses low cost microcontroller embedded with WiFi module reads the power continuously and update the values in the central data base through web associated interface.

2. PROBLEM IDENTIFICATION

With smart metering initiatives gaining increasing global popularity, the system seeks to challenge the increasingly entrenched view that providing householders with feedback about their energy usage, via an in-lcd-display, will lead them to substantially reduce their energy consumption. Specifically, draw on existing quantitative and

qualitative evidence to outline key problems with feedback: (a) the limited evidence of efficacy, (b) the need for user engagement, and (c) the potential for unintended consequences. And thereby conclude nothing that, in their current form, existing in-lcd-displays may not induce the desired energy-reduction response anticipated by smart metering initiatives.

If a system provides High Data accuracy, it in turn increases the processing time[6].When the system becomes complex it requires High cost to be implemented and leads to data inaccuracy. As platforms were larger in size, they were unsuitable for real time applications [9]. Some systems includes separate calculation, Transmission rate is low and leads to high data inaccuracy[10].In certain existing systems, Message were sent to the customers and requires manual work as the datas were not stored in the server [12]. Existing Systems used a complex approach in order to collect data and upload to webpage using MySQL database and external web server, Modbus, which are very heavy for the SBC type Board and also no front GUI system was designed for day to day monitoring. Instead, if the proposed system for smart metering effectively reduces energy consumption where there is a clear need to develop and test innovative new feedback devices that have been designed with user engagement in mind.

3. PROPOSED METHODOLOGY

Smart energy meters can be used with home energy management systems such as Web-based tools that utility provides or devices that can be installed in the home. Smart meters can display the home energy use, helps find ways to save energy and money, and even allows to remotely adjust the thermostat or turn appliances off. The proposed system consists of both hardware and software. The proposed system incorporates Energy Meter, Arduino, Pulse Monitoring circuit and a LCD. And this system reads the energy meter readings and automatically updates the Units consumed by the customer periodically, so that the householders receives the feedback about their energy usage. Figure 1 illustrates the Overall block diagram of the proposed system. The softwares required are Python IDLE, PHP, HTML, C-Programming . Model Calculation: Before proceeding for the calculations, first note the pulse rate of energy meter. There are two pulse rates of energy meter first is 1600 imp/kwh and second is 3200 imp/kwh. The energy meter used is 3200 imp/kwh pulse rate energy meter. So first calculate the Pulses for 100watt, means how many times Pulse LED will blink in a minute, for the load of 100 watts. Number of Pulses is given by the Equation 1,

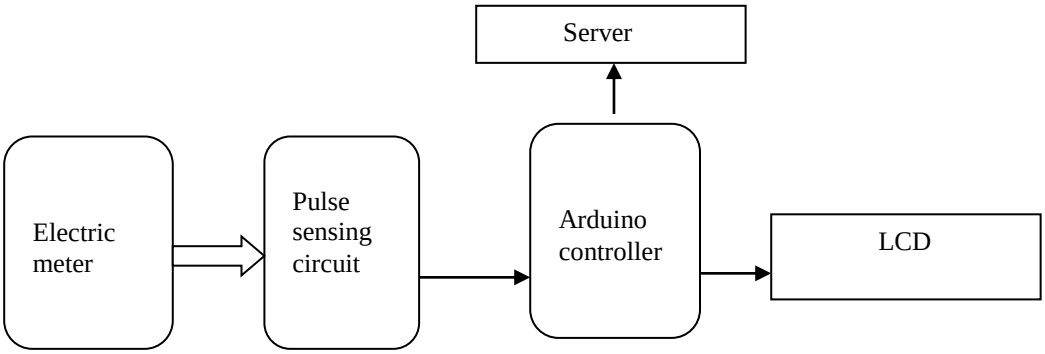


Figure. 1. Block diagram

Pulse= (Pulse_rate*watt*time)/ (1000*3600) ---- (1)

For 3200 imp/kwh electric meter., Pulses=3200*100*60/1000*3600 Pulses = ~5.33 pulse per minute

Power Factor is the estimation of electricity consumption per unit pulse.

Power factor is given by the Equation 2,

PF= watt/(hour*Pulse)-------- (2)

PF=100/60*5.33=0.3125watt in a single pulse Units consumed is given by the equation3,

Units= PF*Total pulse/1000 -------- (3)

Total pulses in an hour is around 5.33*60=320 Units = 0.3125*320/1000

Units = 0.1 per hour

If a 100 watt bulb is lighting for a day then it will consume Units

=0.1*24=2.4 units

Connecting Energy Meter with Arduino:

Firstly, the Analogue Electricity Energy Meter is opened and the Pulse LED or Cal LED's terminals (cathode and Anode) are found. Now two wires at both the terminals are taken out from the energy meter, soldered and then energy meter is closed. Figure 2 illustrates the connection between the Anode and Cathode of the energy meter to the Optocoupler. Secondly, a load is connected to the input of the energy meter and connect the anode terminal of LED (output terminals) at pin number 1 of Optocoupler (PC817) and cathode terminal to pin 2. Pin number four of optocouper should be connected to ground. A LED and a Pull-up resistor are connected at pin number 5 of optocoupler. And same terminal should go to the Arduino pin 8 too. The optocoupler is converts the 230V Spikes produced in the Anode and the Cathode terminals of the energy meter to 5V pulses. The Optocoupler is mainly used to provide Electrical isolation between the two devices (Energy meter operating at 230V and the Arduino operating at 5V).

Figure. 2. Connecting the Anode and Cathode to the Optocoupler

Arduino- LCD Interface:

Interfacing an Arduino with an LCD display consists of two parts, wiring and programming. A typical LCD display consists of 16 pins that control various features of the screen. The Arduino can output voltages of either 5 V or 3.3

V, so the LCD can be powered by connecting VSS and VDD to the ground and 5 V pins on the arduino. It is possible to adjust the contrast of the screen by wiring a variable resistor to V0 located at pin 3 on the screen.

Website Creation and Server Updation:

A user friendly website was created for Smart Metering to monitor, store and analyse the data from the energy meter. Each and every Household is given a Login Id so that they can easily get the Energy usage and the Bill Amount. In the EB office, each and every house's unit consumed and their bill amount would be stored in the database for them to manipulate easily. The Energy Usage and the rate is updated in the server via Pyserial (Python IDLE).A unique login ID is given to the users using a Thingspeak server. The data is updated in the Thingspeak Server using the Python IDLE.

4. RESULTS AND DISCUSSIONS

The Smart Energy Meter readings are monitored and displayed in the In home Display (LCD) which serves as a feedback for the Household to help in Energy reduction. Figure 3 shows the Energy usage and Bill Amount Displayed in the In Home Displays (LCD). Figure 4 shows the Hardware setup of the Smart Energy Meter.

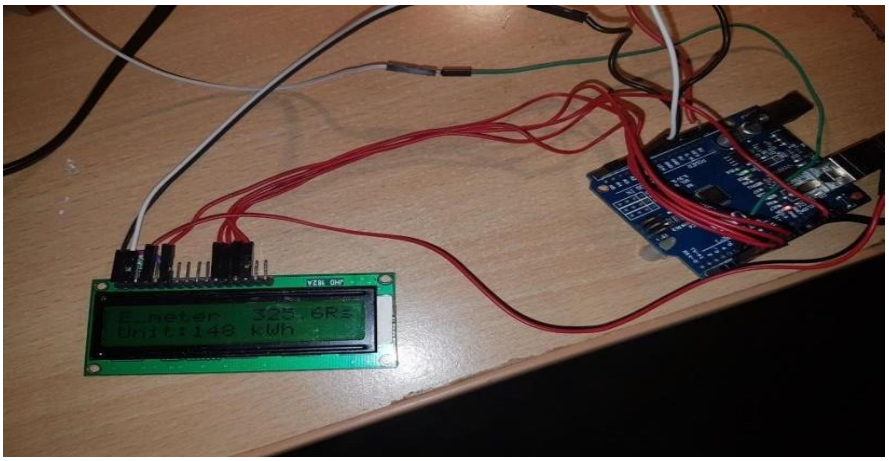


Figure. 3. Energy usage and Bill Amount Displayed in the In Home Displays (LCD)

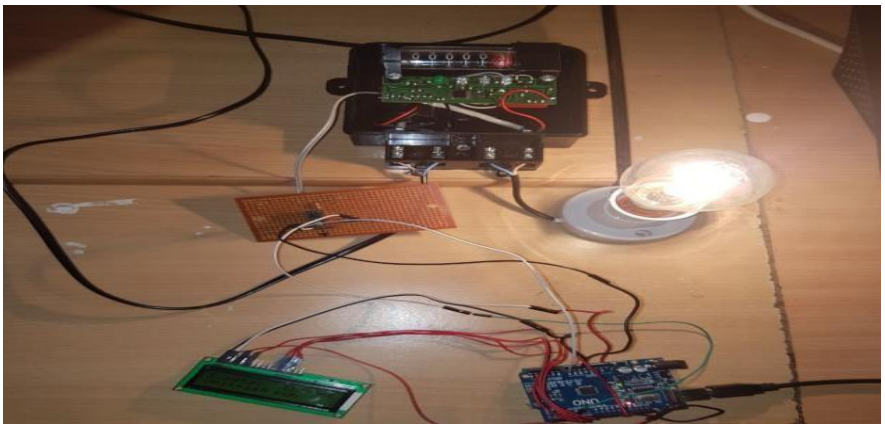


Figure. 4. Smart Energy Meter Hardware Setup

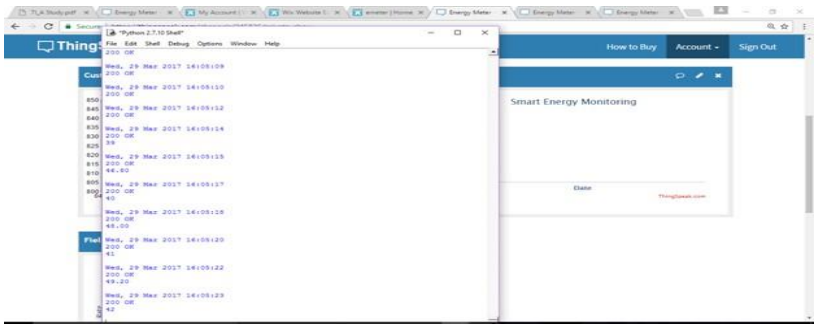


Figure. 5. Interface between Arduino and Python IDLE

Figure 5 shows the Interface between Arduino and Python IDLE. The Energy Usage and the rate is updated in the server via Pyserial (Python IDLE).A unique login ID is given to the users using a Thingspeak server. The data is updated in the Thingspeak Server using the Python IDLE. A user friendly website was created for Smart Metering to monitor, store and analyse the data from the energy meter. Each and every Household is given a Login Id so that they can easily get the Energy usage and the Bill Amount. In the EB office, each and every house's unit consumed and their bill amount would be stored in the database for them to manipulate easily.

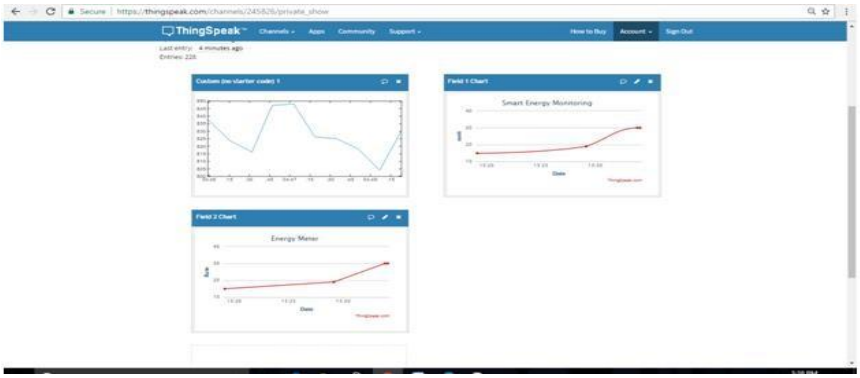
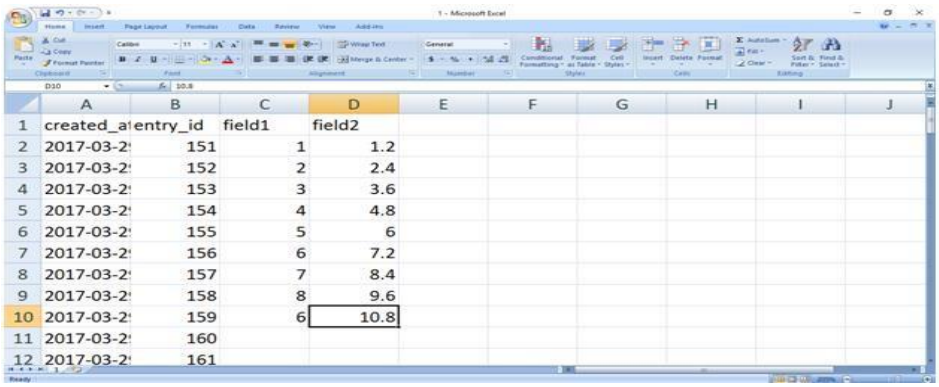


Figure. 6. Analysis Curves in the Thingspeak Server

Figure 6 shows the Analysis Curves obtained in the Thingspeak Server and Figure 7 and 8 shows the User Database and EB Database retrieved as a Spreadsheet.



	A	B	C	D	E	F	G	H	I	J
1	created_a	entry_id	field1	field2						
2	2017-03-2	151	1	1.2						
3	2017-03-2	152	2	2.4						
4	2017-03-2	153	3	3.6						
5	2017-03-2	154	4	4.8						
6	2017-03-2	155	5	6						
7	2017-03-2	156	6	7.2						
8	2017-03-2	157	7	8.4						
9	2017-03-2	158	8	9.6						
10	2017-03-2	159	6	10.8						
11	2017-03-2	160								
12	2017-03-2	161								

Figure. 7. User Database retrieved as a Spreadsheet

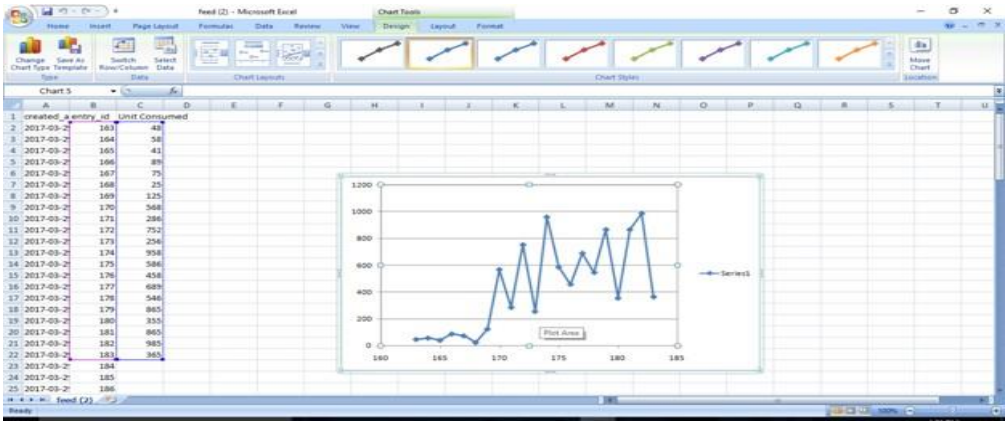


Figure. 8. EB Database retrieved as a Spreadsheet

5. CONCLUSION

A Smart Energy Meter to monitor, analyze and store the Energy Usage was designed using Arduino. The proposed design becomes highly efficient as it updates the Energy usage details periodically in the Thingspeak server. The Thingspeak server was accessed using a Unique Id by each and every user. The interface between Arduino and the server was established via python IDLE environment. The user would be able to view and analyze their energy usage details easily by various analysis plots. The proposed system effectively reduced the Human Intervention and turned into one of the best advancements in the technology. The Key problems persisting in the Energy Saving Environment such as the limited evidence of efficacy, the need for user engagement and the potential for unintended consequences have been addressed. In Indian scenario, smart metering is a mandatory requirement which has not yet been replaced by any automated system. This Smart Energy Monitoring system can be combined along with the Gas Usage details so that Households would have updates on gas Usage too. Both the Energy Usage and the gas Usage could be displayed in the In Home Displays making it more efficient.

REFERENCES

[1] Muthukumaran. N and Ravi. R, 'Hardware Implementation of Architecture Techniques for Fast Efficient loss less Image Compression System', Wireless Personal Communications, Volume. 90, No. 3, pp. 1291-1315, October 2016, SPRINGER.

[2] Muthukumaran. N and Ravi. R, 'The Performance Analysis of Fast Efficient Lossless Satellite Image Compression and Decompression for Wavelet Based Algorithm', Wireless Personal Communications, Volume. 81, No. 2, pp. 839-859, March 2015, SPRINGER.

[3] Muthukumaran. N and Ravi. R, 'VLSI Implementations of Compressive Image Acquisition using Block Based Compression Algorithm', The International Arab Journal of Information Technology, vol. 12, no. 4, pp. 333-339, July 2015.

[4] Muthukumaran. N and Ravi. R, 'Simulation Based VLSI Implementation of Fast Efficient Lossless Image Compression System using Simplified Adjusted Binary Code & Golumb Rice Code', World Academy of Science, Engineering and Technology, Volume. 8, No. 9, pp.1603-1606, 2014.

[5] X. P. Liu, W. Gueaieb, S. C. Mukhopadhyay, W. Warwick, and Z. Yin, ―Guest editorial introduction to the focused section on wireless mechatronics,‖ IEEE /ASME Trans. Mechatronics, vol. 17, no. 3, pp. 397–403, Jun. 2012

[6] D. Zhu and H. Aydin, ―Reliability-aware energy management for periodic real-time tasks, IEEE Trans. on Computers,Vol. 58, No. 10, pp. 1382– 1397, 2009.Ruban Kingston. M,Muthukumaran. and N, Ravi. R, 'A Novel Scheme of CMOS VCO Design with reduce number of Transistors using 180nm CAD Tool', International Journal of Applied Engineering Research, Volume. 10, No. 14, pp. 11934-11938, 2015.

[7] Muthukumaran. N and Ravi. R, 'Design and analysis of VLSI based FELICS Algorithm for lossless Image Compression', International Journal of Advanced Research in Technology, Vol. 2, No. 3, pp. 115-119, March 2012.

[8] Manoj Kumar. B and Muthukumaran. N, 'Design of Low power high Speed CASCADED Double Tail Comparator', International Journal of Advanced Research in Biology Engineering Science and Technology, Vol. 2, No. 4, pp.18-22, June 2016.

[9] N. Muthukumaran, 'Analyzing Throughput of MANET with Reduced Packet Loss', Wireless Personal Communications, Vol. 97, No. 1, pp. 565-578, November 2017, SPRINGER.

[10] P.Venkateswari, E.Jebitha Steffy, Dr. N. Muthukumaran, 'License Plate cognizance by Ocular Character Perception', International Research Journal of Engineering and Technology, Vol. 5, No. 2, pp. 536-542, February 2018.

[11] GSM based Automated Embedded System for Monitoring and Controlling of Substation, Amit Sachan, M.Tech.Thesis, Page no 7-9 June 2012.

[12] N. Muthukumaran, Mrs R.Sonya, Dr.Rajashekhara and Chitra V, 'Computation of Optimum ATC Using Generator Participation Factor in Deregulated System', International Journal of Advanced Research Trends in Engineering and Technology, Vol. 4, No. 1, pp. 8-11, January 2017.

[13] Keziah. J, Muthukumaran. N, 'Design of K Band Transmitting Antenna for Harbor Surveillance Radar Application', International Journal on Applications in Electrical and Electronics Engineering, Vol. 2, No. 5, pp. 16-20, May 2016.

[14] Akhil. M.S and Muthukumaran. N, 'Design of Optimizing Adders for Low Power Digital Signal Processing', International Journal of Engineering Research and Applications, Vol. 5, pp. 59-65, March 2014.

[15] Embedded Automobile Engine Locking System, Using GSM Technology, Jayanta Kumar Pany1 & R. N.DasChoudhury2 International Journal of Instrumentation, Control and Automation (IJICA) ISSN : 2231-1890 Volume-1, Issue-2, 2011.

[16] C. Moser, L. Thiele, D. Brunelli, and L. Benini,―Adaptive power management for environmentally powered systems, IEEE Transactions on Computers, Vol. 59, No. 4, pp. 478– 491, 2010.