International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 9, Issue 7, July 2022

Smart Metering System with LoRa Network Using IoT Technology

[1]Femina Sharu.D , [1]J.Jenitha , [1]C. Ashta Lakshmi, [2]Dr.S.Esakki Rajavel
[1]UG scholar, Electronics and Communication Engineering,
[2]Assistant Professor, Electronics and Communication Engineering
[1,2] Francis Xavier Engineering College,Tirunelveli

Abstract: There are many issues with the measurement and billing process, including: B. Change meter reader to each customer meter and manually get meter readings, customer may be absent during this period, lack of integrity and reliability of some meter readers, security The Outback area (especially Iraq) represents a non-negligible disadvantage. On the other hand, traditional types of energy meters in use (usually inductive types) have well-known measurement errors. The above problems lead to two major points: a large amount of waste due to the large number of employees (meter readers) and a power shortage due to weak power management. The paper presented provides an excellent solution (automatic electrical energy billing) to the above problems. The system is based on using a smart energy meter to read the consumed electrical energy and obtain accurate readings. The energy meter readings are then sent to the power plant control center using LoRa technology. The power department's system receives and processes readings and extracts invoices paid by customers. The system also sends a message to the customer's mobile phone every two months, including the current billing amount, due date, and total billing amount (in compliance with Iraqi regulations). have to be paid. In addition, the system has the option to print a paper copy of the customer's invoice. Finally, the proposed system has the ability to automatically shut down if a customer fails or delays payment of an invoice via e-Mail message for a certain amount of time. The designed system was implemented in collaboration with the engineers of the Directorate General of Power Distribution in the Euphrates River, and applied to three customers. The results obtained in this document proved that the system performance was high. Accuracy and reliability.

Keywords: Energy Efficiency, Internet of Things, LoRa, smart meter.

I. INTRODUCTION

Today humanity can be classified as living in a machine society the technological tools are predominantly at different levels interfacing in the day-to- day activity of man. This is livelihood activities constituted and deliver economic, social and political benefits and potential risks survivability of nation especially developing Nation like ours. Electricity has become one of the basic requirements of human civilization, being widely deployed for domestic, Industrial and agricultural purpose. In spite of the very well developed the source of electricity, there are a number of problems with distribution, metering, billing and control of consumption. Electricity is one of the vital requirements of assignment of Comforts of life and so it should be used vary judiciously for its proper utilisation. But in our country , we have lot of localities where we have surplus supply for the electricity while many areas do not even have asses to it. Are policies of distribution also partially responsible for this because we are still not able to correctly estimate are exact requirement and still power theft is prevailing.

On the other hand consumers are also not satisfied with the services of power companies, most of the time they have complaints regarding statistical error in the monthly bills. Does this project presence and innovation towards the minimisation of Technical errors and reduction in human dependency at the same time. With the help of this project the monthly energy consumption of a consumer will be received from a remote location directly . In this way human effort needed to record the metre reading which are now recorded by the visiting every house individually is reduced

This it is considerable hours of human power and also provide considerable details regarding the average confusion of the locality so that power supply can be made according to these data. This will help the officials in designing the specialisation of Transformer and the other instruments required in Power Transmission and distribution. This idea economically efficient as well because the metre reading can be take note of very low cost. The implementation is done in such a way that Mail is deliver to the you there reading is to be noted and then that M replies to the server in

the Mail format it is known that Mail cost also very low. LoRa take advantage of available advantage infrastructure of Lora wide coverage the short message Mail broadcasting feature to request and retrieve individual houses and building power consumption reading back to the energy provider widely.

II. OBJECTIVE

The purpose of this project is the remote monitoring and control of the domestic energy meter, its aims includes: to design a circuit which continuously monitors the meter reading and sends message to electricity company, programming of the LoRa with AT (Attention) command sequence, interfacing the programmable chip with the personal computer, interfacing the programmable chip with the energy meter, interfacing of LoRa module with the programmable chip, using IoT to monitor data and IFTTT to trigger the mail.

III. LITERATURE SURVEY

Yi Wang Qixin Chen Tao Hong Chongqing Kang (2018) proposed a Review of Smart Meter Data Analytics: Applications, Methodologies, and Challenges but it has a massive amount of electricityconsumption[2].

Rosvando Marques Gonzaga Junior Sergio Marquez-Sanchez La Jorge Herrera Santos Rodrigo Maximiano Antunes de Almeida Joao Bosco Augusto Landen Junior O and Juan Manuel Corchado Rodriguez (2022) inveterate a Validation of Embedded State Estimator Modules for Decentralized Monitoring of Power Distribution Systems Using IoT Components but the Smart Grid initiatives have the complexity of power distribution systems[3].

Michail Sidorov, Phan Viet Nhut, Yukihiro Matsumoto and Ren Ohmura (2017) proposed a LoRa Based Precision Wireless Structural Health Monitoring System for Bolted Joints in a Smart CityEnvironment but it has Data stored is modified dueto weak security[4].

Anup Marahatta Yaju Rajbhandari Ashish Shrestha Ajay Singh Anup Thapa Francisco Gonzalez-Longatt, Petr Korbs and Seekjoe Shin (2021) established Evaluation of a LoRa Mesh Network for Smart Metering in Rural Locations but In this system the maximum number of devices simulated in a mesh were 250 also the gateways and nodes to rout and manage data packets based on simulation[5].

Lluis Casals, Bernat Mir, Rafael Vidal and Carles Gomez (2017)established Modeling the Energy Performance of LoRaWAN but in this system Transmission increases the energy cost of data delivery.

Zhuoqhn Xia, Hong Zhou, Ke Gu Bo Vint, YouYou Zeng, Ming Xu (2017) inveterate Secure Session Key Management Scheme for Meter-reading System Based on LoRa Technology in this system that Static key cannot be updated after pre distribution and also It is secure and effective[7].

Francisco Sanchez-Sutil, Antonio Cano-Ortega and Jesus C. Hernandez.Design proposed and Implementation of a Smart Energy Meter Using a LoRa Network in Real Time (2021) but it has a limited construction of networks that makes it possible to collect data in homes in 0.5s or less it also the development of network with large coverage and low consumption.

Huang-Chen Lee and Kai-Hsiang Ke (2018) inveterate Monitoring of Large-Area IoT Sensors Using a LoRa Wireless Mesh Network System: Design and Evaluation but the cost in the terms of power consumption will be an issue if the system is to be implemented with battery power nodes[9].

Preti Kumari, Ranul Mishra, Hari Prabhat Gupta, Senior Member, IEEE Tanima Dutta, Member, IEEE, and Sajal K. Das (2021) established Energy Efficient Smart Metering System using Edge Computing in LoRa Network, but this system has a usage of large size compressor model which take more time and energy while compressing and also they are using edge computing which cost high[10].

C. Karupongsiri, K. S. Munasinghe, and A. Jamalipour, “A Novel Random Access Mechanism for Timely Reliable Communications for Smart Meters long range communication protocols support a wide coverage with high transmission rates but at the cost of high powerconsumption [14].

J. P. Shanmuga Sundaram, W. Du, and Z. Zhao, “A Survey on LoRa Networking: Research Problems, Current Solutions, and Open Issues butThe Long Range Wide Area Network(LoRaWAN), with its scalable star of stars network architecture and simple medium access mechanism, fulfills the requirement of smart metering, i.e., long-range communication with low energy consumption[15].

IV. SCOPE OF THE PROJECT

This thesis work deals with hourly energy consumption values acquired from the energy provider. These standard values help energy utilities and consumers to know their energy consumption which is reported on an hourly basis. In fact, behaviour of the

consumers can be studied and results obtained can help the consumers in changing their behaviour, in particular when correlated with a potentially varying price. This work explains a gap between the consumers and energy utilities so that they can communicate more efficiently through the implementation of conservation strategies. The consumers need to be educated with broader knowledge regarding the meter so that wrong perceptions can be altered. A case study is conducted on the standard data obtained for sixteen sets of households. The variation in change of the usage has been well understood and determined. The research work can also help users to think intelligently when using their power. Moreover, daily patterns for the complete day on hourly basis are examined. Future savings which consists in determining when to use which appliance can be done by using prediction models and flattening techniques.

V. METHODOLOGY

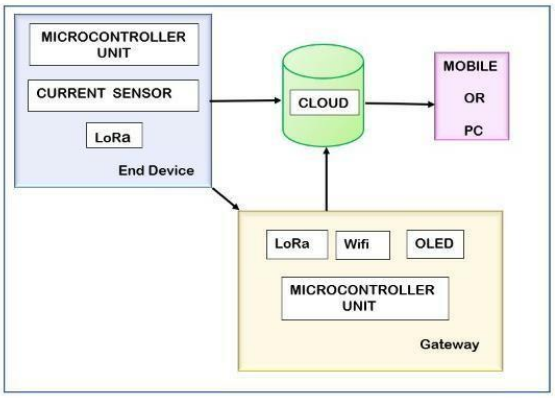

Fig 1.1 Block Diagram

The block diagram of the proposed system is show in figure 1.1, an embedded system is designed to detect the power consumption and the data is published to the user using cloud interface . The system consists of two devices – an end device and a gateway. The communication between end device and gateway is established using LoRa protocol. The gateway is then connected with the cloud through an Open IoT platform called Adafruit. An alert message is sent to the concerned authorities using a cloud interface and IFTT. The end device hosts a microcontroller unit, Current sensor, LoRa. The microcontroller unit is used to process the incoming and outgoing data. The detection in the embedded system is done using the current sensor. The LoRa in the end device is used to connect the end device with Adafruit , through which the voltage across each post can be constantly monitored. The gateway hosts the microcontroller unit, LoRa, the WiFi module, OLED. The OLED is used to provide alert to the passers-by. The WiFi in the gateway is used to connect the gateway with Adafruit, through which the post number in case of a fall can be detected online. The microcontroller unit is used to process the incoming and outgoing data. LoRa can act as a transceiver module, in this project the LoRa in the end device is used and that in the gateway is used as a receiver.

VI. WORKING

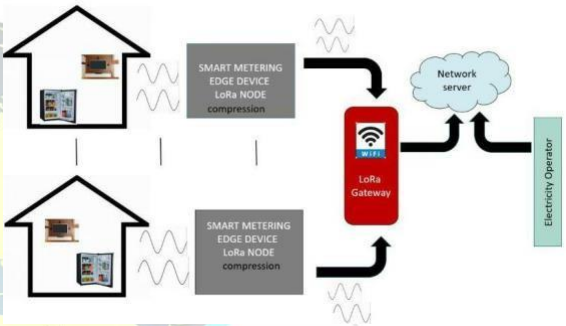

Fig 1.2 Working Diagram

Multiple House connection we are updating it in common gateway, through that gateway we are connecting that with cloud adafruit. From that cloud adafruit we are publishing the email to the corresponding owner. [4] proposed a novel method for secure transportation of railway systems has been proposed in this project. In existing methods, most of the methods are manual resulting in a lot of human errors. This project proposes a system which can be controlled automatically without any outside help. [6] discussed that the activity related status data will be communicated consistently and shared among drivers through VANETs keeping in mind the end goal to enhance driving security and solace. Along these lines, Vehicular specially appointed systems (VANETs) require safeguarding and secure information correspondences. Without the security and protection ensures, the aggressors could track their intrigued vehicles by gathering and breaking down their movement messages. [8] emphasized that Security is an important issue in current and next-generation networks. Blockchain will be an appropriate technology for securely sharing information in next-generation networks. Digital images are the prime medium attacked by cyber attackers. In this paper, a blockchain based security framework is proposed for sharing digital images in a multi user environment. [11] emphasized

that people who are visually impaired have a hard time navigating their surroundings, recognizing objects, and avoiding hazards on their own since they do not know what is going on in their immediate surroundings.

In end device it will read current value and convert to watt where it will be sent to the gateway from that gateway the consumption watt will be transferred to cloud from cloud we will use IFFTT and we will sent it to the end user. The end user will receive the consumption value.

VII. HARDWARE DESCRIPTION

In this project, we use Current sensor, Node MCU, Arduino UNO , LoRa.

1.1 *Current Sensor*

The ACS712 is a fully integrated Hall effect based current sensor that uses its conductor to measure the amount of current applied via indirect sensing.

1.2 *Node MCU*

Node MCU is a low-cost open source IoT platform. It Initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-32 module.

1.3 *Arduino UNO*

Arduino is an open source electronics platform based on easy to use hardware and software.

1.4 *LoRa*

LoRa is a wireless technology that provides long distance, low power consumption, and secure data transmission for M2M and IoT applications.

2 SOFTWARE DESCRIPTION

In this project ,we use Adafruit IO, IFTTT,Arduino IDE , Pycharm compiler

2.1 *Adafruit IO*

Adafruit IO is a cloud service available on your network that allows you to control devices such as:

B. Arduino board to connect. Its main function is to save the data collected by one or more boards connected to the sensor and display it both in real time and retroactively, but it can also perform other interesting functions.

2.2 *IFTTT*

IFTTT (IF This Then That) is a free web-based service that allows users to create a simple chain of conditional statements called applets that coordinate small tasks between the Internet and web services.

2.3 *Arduino IDE*

The Arduino integrated development environment or Arduino software (IDE) includes a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, andnumerous menus.

2.4 *Pycharm Compiler*

PyCharm is a dedicated Python integrated development environment (IDE), a wide range of essential tools that are tightly integrated for Python developers to create a working environment for productive Python, Web, and data science development Provide.

3 PROCEDURE

I. In a high current carrying capacity wire ,the current flow for 1 minutes and the current consumption is calculated using current sensor.

II. The data obtained from the current sensorhas been send to NodeMCU which acts as a gateway using LoRa.

III. In a NodeMCU multiple devices can be connected through LoRa network.

IV. Then the NodeMCU is connected to the cloud (Firebase).

V. Firebase is a Google-backed application development software which stores the real time data in a secured manner.

VI. Using this firebase script the data will be noted and a mail is automatically generated and send to the particular individuals.

3.1 *Software Procedure*

- To configure Adafruit IO, you must first log in to Adafruit IO. To sign up, go to the Adafruit IO website https://io.adafruit.com and click Start Free in the upper right corner of the screen.
- Then you will see a window where you need to enter the data. In the login window, enter details such as your name, email ID, and username. Then click Save Settings to create your account. To get the AIO key, click Show AIO Key. 3. A window

will open with the Adafruit IOAIO key. Copy this keythat you will need later in your Pythoncode.

- Then you need to create a feed. Click Feed to create a feed. Then click Actions. From them you will see some options. Click Create New Feed. 5.
- After this a new window will open where you need to input:
- Name – In name option, write a short descriptive name of your feed. You can use letters, numbers, and spaces.
- Description A longform description of your data. This field is not required, but you can write a description of your data.
- Click Create to see the new feed.
- Next, you need to create a dashboard and add a new toggle block. Creating a dashboard is the same as creating a feed. Therefore, follow the same procedure. Then, to add a block, click the "plus sign" in the upper right corner of the screen, then click the first option.
- Then select the feed you created earlier and click Next Step. Ten Change the block settings as needed, or leave them as they are and click Create Block.

VIII. RESULT

There are mainly two parts in the project i.e, electronics part and software part. The connection of all the electronics part like Node MCU, Arduino UNO,Current Sensor , LoRa ,etc are done using the soldering in PCB board. The LoRa SX1278 is not 5V friendly so do not supply 5V to it else the board will get damaged. Use 3V3(3.3V) of Arduino to connect it to VCC pin. Connect all the GND pins to GND. Connect the RST pin to D9 and DIO0 to D2 of Arduino. Connect the SPI Pins NSS, MOSI, MISO, SCK to Arduino D10, D11, D12, D13 of Arduino respectively as shown in circuit diagram given below

As it has said that 5v supply cannot be used we are using 3V3 pin of LoRa SX1278 is connected to 3V3(3.3) pin of Node MCU.The current sensor Vcc has been connected to 5v to Arduino uno,the GND of current sensor is connected to the GND of Arduino UNO and the current sensor's output is connected to A0 of Arduino UNO.The connect sensor input pin is connected to the adapter and the output ipin is connected to the holder. In order to connect the Node MCU , we have to set the wifi , SSID and password

Fig 1.3 Adafruit ouput

In the Arduino UNO , LoRa modules and Nodu MCU the codes are dumbed . The Adafruit IO acts as the dashboard were the readings and amount are displayed and then by using the IFTTT the mail is triggered . IFTTT acts as an bridge connecting Adafruit IO and email.

Fig 1.4 Email

IX. CONCLUSION

By using this project, we can reduce the manual effort to take the reading from the energy meter which is cost effective.Divergence in service is going to be the key competitive factor to the improve market share in the present power markets prepaid meters with their advantages over conventional ones are likely to help power providers to differentiate and offer value –added services to users. Encourage clients to opt for prepaid meters on a voluntary basis and offering tariff or non-tariff incentives to those users who prepaid their power changes would help the utilities to execute this system.Reduces man power. It is user friendly and we can enhance this project, in which an electricity department can send message to the consumer about the billinginformation.

REFERENCES

1. Q. Sun et al., "A Comprehensive Review of SmartEnergy Meters in Intelligent Energy Networks," in IEEE Internet of Things Journal, vol. 3, no. 4, pp. 464-479, Aug. 2016.
2. Y. Wang, Q. Chen, T. Hong and C. Kang, "Review of Smart Meter Data Analytics: Applications, Methodologies, and Challenges," in IEEE

Transactions on Smart Grid, vol. 10, no. 3, pp. 3125-3148, May 2019.

3. Junior RMG, Marquez-Sanchez S, Santos JH, de Almeida RMA, London Junior JBA, Rodriguez JMC. Validation of Embedded State Estimator Modules for Decentralized Monitoring of Power Distribution Systems Using IoT Components. Sensors. 2022; 22(6):2104.

4. Christo Ananth, K.Nagarajan, Vinod Kumar.V., "A Smart Approach For Secure Control Of Railway Transportation Systems", International Journal of Pure and Applied Mathematics, Volume 117, Issue 15, 2017, (1215-1221).

5. Marahatta, Anup, Yaju Rajbhandari, Ashish Shrestha, Ajay Singh, Anup Thapa, Francisco Gonzalez-Longatt, Petr Korba, and Seokjoo Shin. 2021. "Evaluation of a LoRa Mesh Network for Smart Metering in Rural Locations" Electronics 10, no. 6: 751.

6. Christo Ananth, Dr.S. Selvakani, K. Vasumathi, "An Efficient Privacy Preservation in Vehicular Communications Using EC-Based Chameleon Hashing", Journal of Advanced Research in Dynamical and Control Systems, 15-Special Issue, December 2017,pp: 787-792.

7. Z. Xia, H. Zhou, K. Gu, B. Yin, Y. Zeng and M. Xu, "Secure Session Key Management Scheme for Meter-Reading System Based on LoRa Technology," in IEEE Access, vol. 6, pp. 75015-75024, 2018.

8. Christo Ananth, Denslin Brabin, Sriramulu Bojjagani, "Blockchain based security framework for sharing digital images using reversible data hiding and encryption", Multimedia Tools and Applications, Springer US, Volume 81,Issue 6, March 2022,pp. 1-18.

9. H. Lee and K. Ke, "Monitoring of Large- Area IoT Sensors Using a LoRa Wireless Mesh Network System: Design and Evaluation," in IEEE Transactions on Instrumentation and Measurement, vol. 67, no. 9, pp. 2177-2187, Sept. 2018.

10. P. Kumari, R. Mishra, H. P. Gupta, T. Dutta and S. K. Das, "An Energy Efficient Smart Metering System using Edge Computing in LoRa Network," in IEEE Transactions on Sustainable Computing,2021.

11. Christo Ananth, Stalin Jacob, Jenifer Darling Rosita, MS Muthuraman, T Ananth Kumar, "Low Cost Visual Support System for Challenged People", 2022 International Conference on Smart Technologies and Systems for Next Generation Computing (ICSTSN), 978-1-6654-2111-9/22, IEEE, 10.1109/ICSTSN53084.2022.9761312, March 2022,pp. 1-4.

12. M. Collotta and G. Pau, "An Innovative Approach for Forecasting of Energy Requirements to Improve a Smart Home Management System Based on BLE," IEEE Transactions on Green Communications and Networking, vol. 1, no. 1, pp. 112–120, 2017.

13. M. S. A. Muthanna, M. M. A. Muthanna, A. Khakimov, and A. Muthanna, "Development of Intelligent street lighting services model based on LoRa technology," in Proc. EIConRus, 2018, pp. 90–93.

14. C. Karupongsiri, K. S. Munasinghe, and A. Jamalipour, "A Novel Random Access Mechanism for Timely Reliable Communications for Smart Meters," IEEE Transactions on Industrial Informatics, vol. 13, no. 6, pp. 3256–3264, 2017.

15. J. P. Shanmuga Sundaram, W. Du, and Z. Zhao, "A Survey on LoRa Networking: Research Problems, Current Solutions, and Open Issues," IEEE Communications Surveys Tutorials, vol. 22, no. 1, pp. 371– 388, 2020.

16. F. Van den Abeele, J. Haxhibeqiri, I. Moerman, and J. Hoebeke, "Scalability Analysis of Large-Scale LoRaWAN Networks in NS3," IEEE Internet of Things Journal, vol. 4, no. 6, pp. 2186–2198, 2017.

17. S. Tripathi and S. De, "An Efficient Data Characterization and Reduction Scheme for Smart Metering Infrastructure," IEEE Transactions on Industrial Informatics, vol. 14, no. 10, pp. 4300–4308, 2018.

18. A. Abuadbba, I. Khalil, and X. Yu, "Gaussian ApproximationBased Lossless Compression of Smart Meter Readings," IEEE Transactions on Smart Grid, vol. 9, no. 5, pp. 5047–5056, 2018.

19. B. said, M. F. Al-Sa'D, M. Tlili, A. A. Abdellatif, A. Mohamed, T. Elfouly, K. Harras, and M. D. O'Connor, "A Deep Learning Approach for Vital Signs Compression and Energy Efficient Delivery in mhealth Systems," IEEE Access, vol. 6, pp. 33 727–33 739, 2018.

20. Tong, C. Kang, and Q. Xia, "Smart Metering Load Data Compression Based on Load Feature Identification," IEEE Transactions on Smart Grid, vol. 7, no. 5, pp. 2414–2422, 2016.

21. L. Casals, B. Mir, R. Vidal, and C. Gomez, "Modeling the Energy Performance of LoRaWAN," Sensors, vol. 17, no. 10, pp. 1– 30, 2017.