

GSM Based Automatic Energy Meter Reading and Billing System

Mohammad G. Mortuza, Zia U. Ahmed, Hassan Jaki, Md. Razu Ahmed, Mohammed J. Uddin, and Md. Humayun Kabir

Abstract—These instructions give you guidelines for preparing papers for an existence without electricity can't be thought of since it turns into an integral part of human life. In a developing country, people use postpaid electricity for their own purposes. Be that as it may, they do not know the amount of electricity they have consumed and how much cost they have done likewise till they receive the consumption bill at the end of the month. Also, in prepaid meters, to see consumption details, people have to go in front of the meter. In this research, a system has been designed based on GSM technology to solve this problem. The prepaid meter must be recharged; as a result, clients can use the electricity. The system alerts the client for any kind of emergency. Besides, when the client is away from the house, he can easily switch off the supply of electricity by sending an SMS. This project will support both society and country because it helps to reduce the wastage of electricity and to check electricity consumption and bill from remote distances.

Index Terms—GSM, Automatic Meter Reading, Electricity Meter.

I. INTRODUCTION

In the propelled time of development, we came to consider distinctive remote-control structures for our mechanical assemblies or machines. GSM Based Automatic Energy Meter examining System is the progression of along these lines gathering use, interpretive, and status data from importance metering devices and trading that data to a region database for charging, asking about, and separating. This development, for the most part, spares utility suppliers the cost of broken trips to each physical zone to dismember a meter. Another favored viewpoint is that invigorating can be resolved to close driving forward use rather than on appraisals subject to past or anticipated utilize. This ideal data joined with the examination can associate with both utility suppliers and clients better control the use and strategy of electric energy, gas utilities, or water use. The Automatic Meter Reading structure is moreover prepared to give a course of action of different organizations, which are

important for the administration associations in their undertaking and orchestrating And bolster; they are stack organization, power outage and accuse uncovering, customer organizations, Control Quality checking, mastermind organization, theft area, charging, balance settling, vitality settling, asset organization, energy usage information, intrusion announcing and so forth.

Global System for Mobile (GSM) is a standard created by the European Telecommunications Standards Institute to depict the traditions for second-age instigated cell structures used by phones, for instance, tablets. It was first sent to Finland in December 1991. Beginning in 2014, it has transformed into the overall standard for compact trades – with over 90% bit of the pie, working in excess of 193 countries and areas.

The electricity meter is a contraption that checks the level of electric energy eaten up by a living methodology, a business, or an electrically controlled device. Electric utilities use electric meters to appear at customers' premises for charging purposes. They are routinely adjusted in charging units; the most all things considered surveyed that one being the kilowatt-hour (kWh). They are routinely investigated once each charging period. Unequivocally when imperativeness saves assets in the midst of particular periods are required, a few meters may measure ask for, the most absurd use of force in some between times.

Automatic meter reading (AMR) is the movement of in like manner collecting use, illustrative, and status information from water meter or energy metering contraptions and exchanging that information to an area database for charging, looking, isolating. Another fantastic position is that invigorating can be resolved to close moving use as opposed to on evaluations subject to past or foreseen utilize. This worthwhile data joined with examination can bolster both utility suppliers and clients' better control of the utilization and enhancement of electric energy, gas utilities, or water utility. AMR improvements unite handheld, adaptable, and organize drives dependent on correspondence stages (wired and remote), radio rehash (RF), or electrical cable transmission.

II. RELATED WORK

V. Preethi and G. Harish mention that the energy meter is a contraption that gauges the proportion of electric energy eaten up by a home, business, or an electrically filled device [1] Noor-E-Jannat, M. O. Islam, and M. S. Salakin mentions that A GSM digitizes and reduces the data, by then sends it down through a channel with two unmistakable surges of client data, each in its own particular timetable opening [2].

Published on June 23, 2020.

M. G. Mortuza, International Islamic University Chittagong, Chittagong, Bangladesh. (e-mail: mortuzaete@gmail.com)

Z. U. Ahmed, International Islamic University Chittagong, Chittagong, Bangladesh. (e-mail: zia.ete10@gmail.com)

H. Jaki, International Islamic University Chittagong, Chittagong, Bangladesh. (e-mail: hassanjaki11@gmail.com)

M. R. Ahmed, International Islamic University Chittagong, Chittagong, Bangladesh. (e-mail: razu17@iiuc.ac.bd)

M. J. Uddin, International Islamic University Chittagong, Chittagong, Bangladesh. (e-mail: jashimcuet@yahoo.com)

M. H. Kabir, International Islamic University Chittagong, Chittagong, Bangladesh. (e-mail: mdhkrabby@gmail.com)

L. C. Saikia, H. Das, and T. Malakar mention that The electromechanical enrollment meter works by checking the unrests of a non-drawing in, a metal plate which turns at a speed concerning the power experiencing the meter [3]. A. Jain, D. Kumar, and J. Kedia mentions that Electronic meters demonstrate the energy used on an LCD or LED show, and some transmit readings to remote spots [4]. R. G. Sarangle, U. Pandit, K. Prof, and J. Modi mention that the AMR framework is an effect for remote checking and controls private significance meter. AMR framework gives the data of meter dismembering [5] control cut, mean stack utilized, control free and cementing on intrigue, or in many cases especially between times through SMS. The designing of web organizations based customized meter scrutinizing system has delineated. O. Kesav and B. Rahim mention that data sent and gotten by concerned energy Provider Company with the assistance of Global structure for flexible correspondence facilitate. Energy supplier gets the meter surveying inside a second without visiting a man [6]. H. G. R. Tan, C. H. R. Lee, and V. H. Mok mention that In [7], a novel Automatic Meter Reading (AMR) structure has proposed using the IEEE 802.15.4-obvious remote frameworks to visit with energy meter. The work deal with based Automatic Utility Data Collection System (AUDCS) gives a cost-capable design by inquisitive about the self-affiliation, self-settling limits of the work organization, and using semiconductor chips and the radio handsets superb with IEEE 802.15.4 standard. Thusif ahamed and A.Sreedevi mention that Analog signals are been seen from the two information channels, which will be changed over into Digital signals by ADC uninhibitedly. With the two affected information signals transmitted to the microcontroller by techniques for SPI custom, dsPIC33F figures the power accordingly, imperativeness ate up will be gathered after a foreordained period. [8] Sarwar Shahidi, Md. Abdul Gaffar, Khosru, and M. Salim mention that AMR is a framework whereby the Energy Meter sends the recorded power usage of a nuclear family in the particular between the time period to a "remotely" related, which could be a (PC) or central server of intensity dispersing affiliations [9]. Priyanka Dighe, Tushar Dhanani, and Kumar Gangwani mention that GSM is an approach to remotely screen and control centrality meter readings. Its tendencies to take a gander at imperativeness meters without visiting each house/affiliation [10]. This structure contains a microcontroller, which takes the readings at general breaks and records it in its memory

III. SYSTEM DESCRIPTION

The outline of the GSM-based Automatic Energy Meter perusing framework is given below. In the block diagram, we see an electric energy meter is interfaced with an Arduino board. The Arduino board is further interfaced with a 5V relay module, a 20X4 LCD display, and a SIM 900A GSM module.

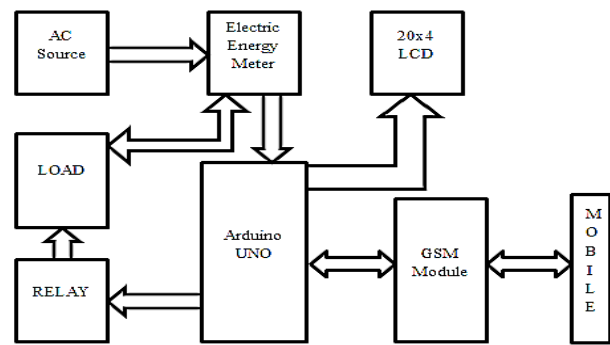


Fig. 1. Outline of GSM Based Automatic Energy Meter perusing framework

A 12V 3A power supply has been used as the GSM module needs high current flow to be activated. The pulse pin of the energy meter is connected with the Arduino UNO development board. This meter gives 3200 pulses for 1 unit of energy consumed. The total energy consumed is calculated by this information. The GSM module intercepts SMS and sends the data to Arduino. Arduino gives responses to those SMS by AT commands. The outputs are shown in the onboard display as well as the clients can see those data through SMS.

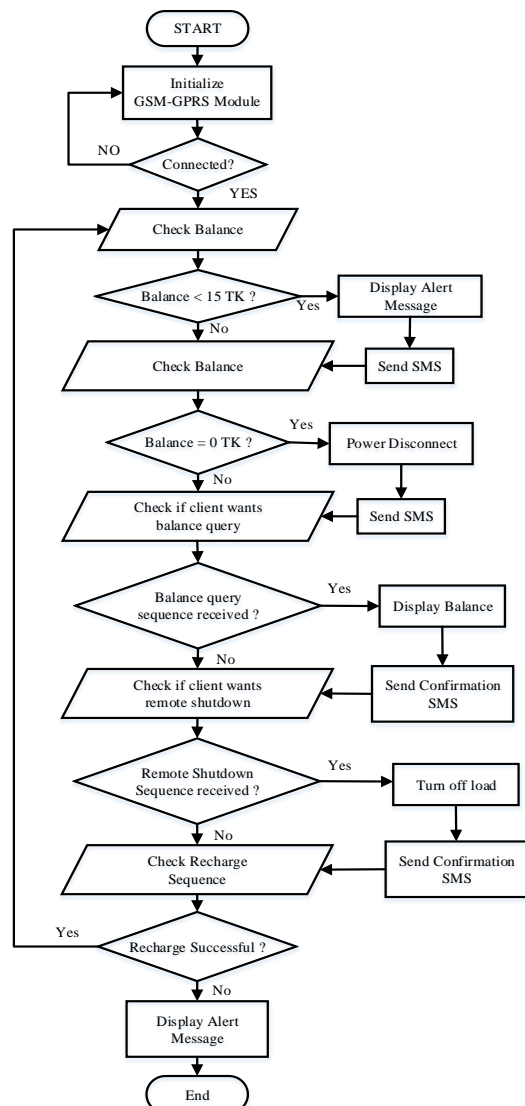


Fig. 2. Flowchart of the procedure

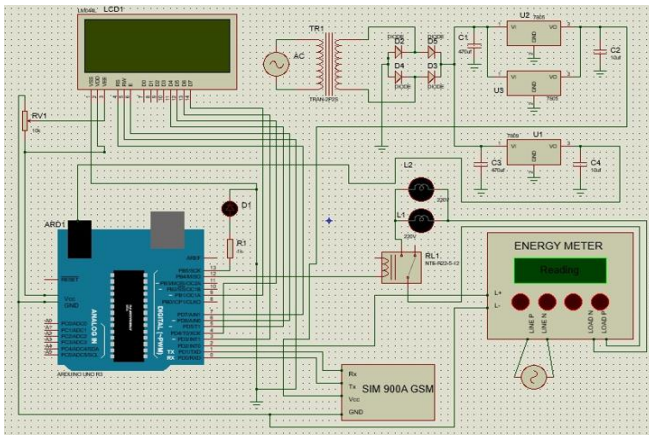


Fig. 3. Simulation Circuit of the System

In this project shown in Fig. 3, the watt, total pulse, and total cost have measured. The measuring value has shown in a 20x4 liquid crystal display (LCD) including balance. These measured data have sent to the distributor's cell phone via SMS by GSM 900A module. Here, line voltage has connected with the Arduino board which has calibrated by a 12*2V, 3A transformer. The rating of voltage, current, and energy has shown in the LCD display. The output value of energy (unit) and unit cost has sent to the distributor mobile. There is also a manual switch when we press it SMS send to distributors mobile. When power is supplied from line voltage, we see in the LCD display that it initializes with a heading "Automatic Energy Meter by Ashif & Jaki". Then the microcontroller of the Arduino tries to detect the GSM module by showing the "Finding module" text on LCD. After successful detection, "Module connected" text appeared in the LCD. Then the module tries to find network (showing in LCD "Finding network") to whom it would send SMS to inform about a watt, total cost, balance, total pulse. When the network is found, a "Network Found" text is shown in the display. Then a "System Ready" text is displayed in the LCD indicating that the whole system is ready to inform. The founded network which we may call consumer mobile gets an SMS as "System Ready". The consumer gets a low balance alert when the balance is under a certain balance (here 15tk) level alarming him to recharge his energy meter soon. The consumer further gets an SMS indicating light cut down due to very low balance (hereunder 5tk) and suggesting him to recharge very soon. The consumer can recharge by sending SMS as typing *A.balance amount# (such as *A.20#). To know information at any time, the consumer can send an SMS by typing *A.total#.

IV. EQUIPMENT DETAILS

A. Hardware Module Description

In this paper different instruments and technologies have been used for achieving the better output within the desired architecture. Sensors and modules are discussed below:

B. Arduino Nano

Arduino Nano is an exceedingly small development board which supports ATmega328 microcontroller. It has vast technical features. Nano has 14 digital I/O pins among which PWM output is provided by 6 pins.

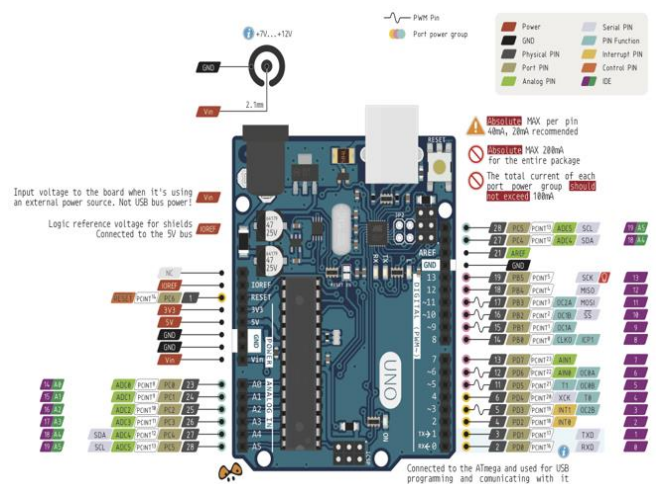


Fig. 4. Pinout of Arduino ATmega328 [11]

It has 8 analog input pins. It also has 32 KB of flash memory, 2 KB of SRAM and 1 KB of EEPROM. Nano's clock speed is 16 MHz. Besides, it has an operating voltage of 5 V at logic level and recommended input voltage is 7-12V [12].

C. Liquid Crystal Display (LCD)

LCD displays has seen everywhere. Computers, calculators, television sets, mobile phones, digital watches use display to display the time. An LCD is an electronic display module, which uses liquid crystal to produce a visible image. The 20x4 LCD display is a basic module commonly used in DIYs and circuits. The 20x4 translates a display 20 characters per line in four such lines.

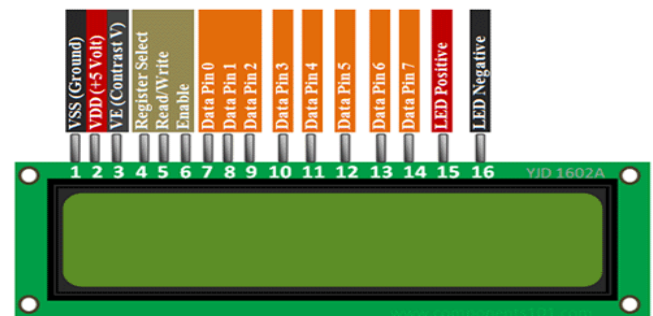


Fig. 5. Liquid crystal display [13]

Fig. 5 shows the external view and pin function of 20x4 LCD display. It is use for displaying output voltage, current, unit and unit cost [13].

D. A.C 1 phase 2-Wire Static Energy Meter

Single phase static electronic energy meter is designed to meter residential and small commercial energy consumers in distribution networks. The meter is designed to offer reliable energy measurement in single phase circuit and is highly suitable for metering and remote communication purposes. Best Suitable for Billing tenant & for cross checking Energy Meter being used in home.



Fig. 6. A.C 1 phase 2-Wire Static Energy Meter [14]

E. SIM 900A GSM GPRS Module

The SIM900A is a complete Dual-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications.

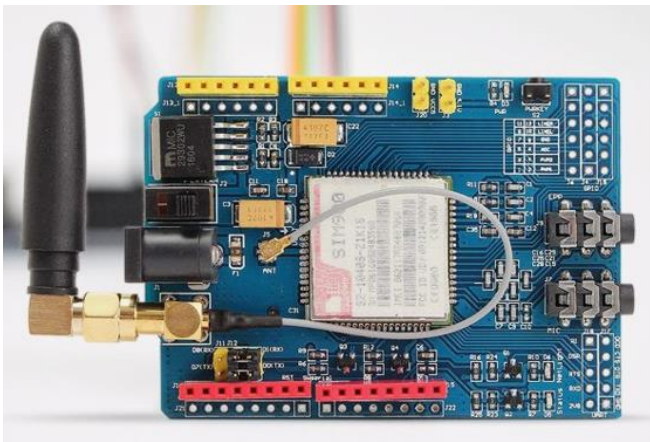


Fig. 7. SIM 900A GSM GPRS Module [15]

Featuring an industry-standard interface, the SIM900A delivers GSM/GPRS 900/1800MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mmx24mmx3mm, SIM900A can fit in almost all the space requirements in user applications, especially for slim and compact demand of design [15].

F. Relay Module

5V Relay Module is a relay interface board, it can be controlled directly by a wide range of microcontrollers such as Arduino, AVR, PIC, ARM and so on. The Relay Module is a convenient board which can be used to control high voltage, high current load such as motor, solenoid valves, lamps and AC load. It uses a low-level triggered control signal (3.3-5VDC) to control the relay. Triggering the relay operates the normally open or normally closed contacts. It is frequently used in an automatic control circuit.

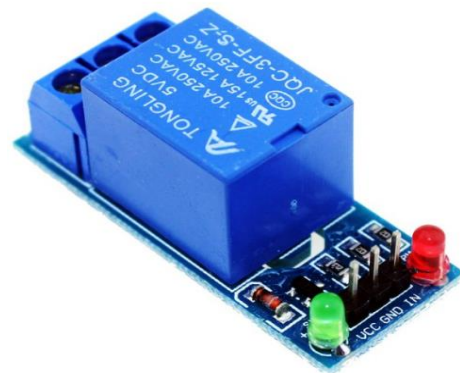


Fig. 8. Relay Module [16]

To put it simply, it is an automatic switch to control a high-current circuit with a low-current signal [16].

V. HARDWARE IMPLEMENTATION

In this system shown in figure 4, the power supply is provided to the meter. A GSM unit shows the interfacing with the microcontroller.



Fig. 9. Hardware of GSM based Automatic Energy Meter Reading system

Transmission of usage details is sent to the office modem using a user modem. Every consumer has a unique number provided by corresponding authority. The use of an embedded system improves the stability of wireless data transmission. For long-distance transmission, GSM telecommunication has shown excellent performance in any condition.

VI. PROJECT RESULT

Result of the project and result analysis shown in below



Fig. 10. Shows the total watt, cost, balance, and total pulse for 100 W load



Fig. 11. Message in consumer's mobile

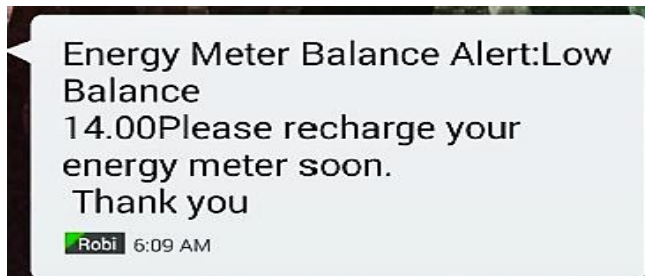


Fig. 12. Message showing low balance alert

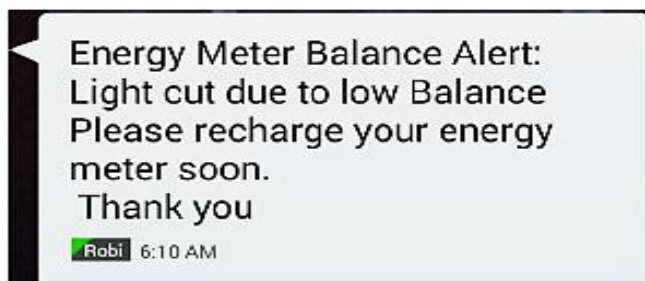


Fig. 13. Message showing light cut down alert

The result has taken for a 100-watt load. Also, the GSM module successfully sent SMS.

The process of getting outputs as shown below. At first, it takes some time for initializing, then it measures voltage, current, energy (unit), total pulse, and cost. Later, this information is sent to the distributor mobile by SMS.

Figure 10 shows the output information to be sent by the GSM module to the consumer's mobile. Figure 11 shows message/SMS in consumer's mobile sent via GSM module. Figure 12 shows a low balance alert in the consumer's mobile when the balance is below 15tk.

Figure 13 shows light cut down alert due to a very low balance alert when the balance is below 5tk.

VII. CONCLUSION

This project is finished with extraordinary supervision and care of circuit outlining and collecting. Saving electricity and efficient distribution of it is a prime concern of modern technologies. In progressing countries like Bangladesh, assuring efficient electricity consumption and distribution is a must. Often people have to leave their houses for different purposes and want remote access to their energy meter for turning on / off it. Sometimes people want to plan how much electricity he wants to consume in a month and schedule accordingly. So, they need to know how much has been consumed and how much left of the plan. Also, if the target reaches before the term, the target should be modified. But existing models don't support this feature. Our project will complete these purposes. It will lessen the

risk of energy theft and unnecessary consumption of energy. The principle vision of this task is that it lessens the manual control and robbery. It spares a considerable measure of time. The framework is quick and exceedingly dependable as it gives constant information. It is effortlessly incorporated with information securing and information exchange. This venture can be a commitment to the exertion of the Govt. of Bangladesh to make Digital Bangladesh.

ACKNOWLEDGMENT

The author is thankful to the Project Supervisor **Engr. Md. Raju Ahmed**, Associate Professor, Department of Electronic and Telecommunication Engineering, International Islamic University Chittagong, Kumira, Chattogram-4318, Bangladesh, **Engr. Mohammad Jashim Uddin**, Chairman and Assistant Professor of the Department of Electronic and Telecommunication Engineering, International Islamic University Chittagong, Kumira, Chattogram-4318, Bangladesh, for providing research facility and valuable suggestions for this work. Also, thanks to **Md. Humayun Kabir**, Adjunct Faculty, Department of Electronic and Telecommunication Engineering, International Islamic University Chittagong, Kumira, Chattogram-4318, Bangladesh, for Writing - review, editing and formal analysis of this research work.

REFERENCES

- [1] Preethi, V & Harish, G. (2016). Design and implementation of smart energy meter. 1-5. 10.1109/INVENTIVE.2016.782322.
- [2] M. M. Rahman, Noor-E-Jannat, M. O. Islam and M. S. Salakin, "Arduino and GSM based smart energy meter for advanced metering and billing system," *2015 International Conference on Electrical Engineering and Information Communication Technology (ICEEICT)*, Dhaka, 2015, pp. 1-6.
- [3] L. C. Saikia, H. Das, N. B. Dev Choudhury and T. Malakar, "GPRS enabled smart energy meter with in-home display and application of time of use pricing," *2016 IEEE Annual India Conference (INDICON)*, Bangalore, 2016, pp. 1-5.
- [4] A. Jain, D. Kumar, and J. Kedia, "Design and Development of GSM based Energy Meter", *International Journal of Computer Applications (0975 - 888)*, Volume 47- No.12, June 2012
- [5] R. G. Sarangle, U. Pandit, K. Prof, and J. Modi, "GSM Based Power Meter Reading," vol. 1, no. 4, pp. 273-279, 2012.
- [6] O. Kesav and B. Rahim, "Automated Wireless Meter Reading System for Monitoring and Controlling Power Consumption," *Proc. - 2014 IJES Natl. Conf. Intel. Electron. Common. Eng. (NCIECE 15)*, no. 2, pp. 70-74, 2015.
- [7] H. G. R. Tan, C. H. R. Lee, and V. H. Mok, "Automatic power meter reading system using GSM network," *2007 Int. Power Eng. Conf. (IPEC 2007)*, pp. 465-469, 2007.
- [8] Thousif ahamed, A.Sreedevi, 2014, "Design and Development of PIC Microcontroller Based 3 Phase Energy Meter," *International Journal of Innovative Research in Science, Engineering and Technology*. Volume 3, Special Issue 1, 2014
- [9] Sarwar Shahidi, Md. Abdul Gaffar, Khosru M. Salim, 2013, "Design and implementation of Digital Energy Meter with data sending capability using GSM network," *2nd International Conference on Advances in Electrical Engineering (ICAEE 2013)*, 19-21 December, 2013
- [10] Priyanka Dighe, Tushar Dhanani, Kumar Gangwani, "Design and Implementation of Automatic Meter Reading System Using GSM," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol2, edition 5, May 2012
- [11] Pinout.guide: arduino and attiny pinouts. (2020). Retrieved 10 June 2020, from <https://arduino.pinout.guide/>
- [12] Z. U. Ahmed, M. G. Mortuza, M. J. Uddin, M. H. Kabir, M. Mahiuddin and M. J. Hoque, "Internet of Things Based Patient Health Monitoring System Using Wearable Biomedical Device," *2018 International Conference on Innovation in Engineering and*

Technology (ICIET), Dhaka, Bangladesh, 2018, pp. 1-5, doi: 10.1109/CIET.2018.8660846.

- [13] 20 X 4 Character Lcd Vishay. (2020). Retrieved 10 June 2020, from https://eighbooks.xyz/read.php?q=20_X_4_Character_Lcd_Vishay
- [14] Beige Cover AC 1 Phase 2 Wire Static KWH Meter, Simple Single-Phase Power Meter. (2020). Retrieved 10 June 2020, from <http://www.digitalkwhmeter.com>
- [15] SIM 900A GSM GPRS Module - ePro Labs WiKi. (2020). Retrieved 10 June 2020, from <https://wiki.eprolabs.com>
- [16] R. (2020). 5V Relay Module (Black). Retrieved 10 June 2020, from <https://www.rhydolabz.com>.



Mohammad Golam Mortuza (M. G. Mortuza) received his B.Sc. degree in Electronic and Telecommunication Engineering from International Islamic University Chittagong in 2018. He worked as Teaching Assistant in the same department for six months after that. He currently works as freelance embedded system designer and hardware system analyst for some progressive startup companies. His research interests include Internet of Things (IoT), robotics, wireless sensor network design, embedded system design, wireless communication etc.



Zia Uddin Ahmed (Z. U. Ahmed) completed B.Sc. degree in Electronic and Telecommunication Engineering from International Islamic University Chittagong in 2018. After graduation he worked as web application developer from 2019 to 2020. He is currently working in a startup company, Developing IoT based Oil tank monitoring for large vehicles. He shows interest in different sectors like Internet of Things (IoT), Robotics, machine learning, Algorithm, Embedded system etc.



Hassan Jaki (H. Jaki) received his B.Sc. degree in Electronic and Telecommunication Engineering from International Islamic University Chittagong in 2017. He worked as a Telecom Maintenance Site Engineer at Zamil Infra Pvt. Ltd. for half of a year. He currently works as an Assistant Teacher in Al-Hidaayah International School at Department of Scienc. His Research interests include Cooperative Wireless Communications and Network Coding, Networks for Environment Pollution Monitoring and Network for Health Monitoring..

Md. Razu Ahmed (M. R. Ahmed), M.Sc. Engg. in Telecommunication at Asian Institute of Technology, Bangkok, Thailand. He has been serving as

an Associate Professor in the department of Electronic and Telecommunication Engineering under the Faculty of Science and Engineering of International Islamic University Chittagong (IIUC), Bangladesh. His work has been published in more than 10 papers in the International Journal and Conference. His research interest includes Internet of Things (IoT), Wireless Communication and Error Correction Coding. Engr. M. R. Ahmed has served as a Technical Program Committee Member for the IEEE and the IEEE International Conference on Innovations in Science, Engineering and Technology..



Mohammed Jashim Uddin (M.J. Uddin) was born in 1979 in Chittagong, Bangladesh. He received a B.Sc. degree in Electrical and Electronic Engineering from Chittagong University of Engineering & Technology (CUET), Chittagong, Bangladesh, and the M.Sc. degree in Electronic and Communication Engineering from University of Greenwich, Medway, UK in 2004 and 2009, respectively. Since 2004, he has been involved at PHP Float Glass Industry, Chittagong, Bangladesh as an Assistant Engineer, where he was engaged with the 10MW power plant for Gas and Diesel generator. In 2006, he joined MARS Textile Limited, Chittagong, Bangladesh as a Senior Engineer. In 2008, he worked for Texcel Technology plc, Dartford, UK as a Test Technician, where his responsibility was involved with PCB Testing, Inspection, and Assembly. His research interests are Renewable and Sustainable Energy, Solar cell, RF and Microwave Power Amplifier, and Antenna & Wave Propagation and signal processing. He is currently serving as an Assistant Professor in International Islamic University Chittagong under the Electronic and Telecommunication Engineering Department. He has authored or coauthored over 15 publications. Engr. M. J. Uddin has served as a Technical Program Committee Member for the IEEE and the IEEE International Conference on Innovations in Science, Engineering and Technology.



Md. Humayun Kabir (M. H. Kabir) received his B.Sc. (2018) in Electronic and Telecommunication Engineering from International Islamic University Chittagong, Bangladesh. He is currently serving as an Adjunct Lecturer in Electronic & Telecommunication Engineering at International Islamic University Chittagong. His research interests include Next Generation Wireless Communication, Internet of Things (IoT), Smart Grid, Optical Fiber Communication, Computer Network, and Network Security. His work has been documented in more than 9 research publication and research poster in the international journal papers or conference proceedings. More information about his research is available at https://www.researchgate.net/profile/Md_Kabir14.