DESIGN AND IMPLEMENTATION OF INTERNET OF THINGS BASED SMART ENERGY MONITORING AND CONTROLLING SYSTEM

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Abstract—**With the progress and development of national economy as well as power system, reliability of balanced power system have been more important. Development of metering system has done in that reason. The measure voltage, current, energy and cost is needed for energy consumed. In the starting point it takes some times for initializing then it measure voltage and current. After that microcontroller calculates power(watt). Then, it calculate energy in kilowatt-hour (unit) rating and calculating unit cost consumed by the load. Then, microcontroller has shown the output in LCD display. After every two-minutes microcontroller sent SMS to distributor mobile by IoT module, which contains total unit and unit cost. In addition, reset the previous data. It count unit from initial point. In previous systems, the series electromagnet is excited by the load current flow through the current coil. The coil of the shunt electromagnet is directly connected with the supply and hence carry the current proportional to the shunt voltage. This coil is called the pressure coil. This system is not as efficient as digitalized systems. And there is no option for IoT monitoring. Here this project presents design and implementation of an embedded system to monitor load. The implementation online monitoring system integrates IoT, with single chip microcontroller and sensors. This system contains current sensor, voltage sensor to keep the information visible via IoT could to authority.**

Keywords—Smart Energy Meter, Energy Monitoring & Controlling, IoT Panel, Bylnk Server, Load Consumption, ESP 32 Microcontroller ,Load prediction.

I. INTRODUCTION

Power sector plays strategic role in the process of economic development of a country. Due to increasing demand of electricity, power utilities and governments are facing a number of problems like power shortage. Power shortage is one of the biggest problems of a developing country like Bangladesh. Without a proper management of power usage, it is nearly impossible to reduce power shortage, maintain proper billing as well as consumer satisfaction. Nowadays, electricity consumers are asking for better customer service, high accuracy in energy measurement and timely data. Nevertheless, the electromechanical meter that we use today have many drawbacks like poor accuracy and jack of configurability. They have many moving parts that are prone to wear over the time and varying operating. temperature and conditions. In this case, smart metering is the key of better service with high accuracy. Technology is probably a solution to reduce costs and prevent loss of resources. Many advantages has attributed to smart metering, including lower metering cost, more reliability of supply and accurate pricing scheme. However, in this report a IOT based smart energy meter system has proposed by which a consumer can easily know how much energy has consumed at real time. This measurement system will help the consumer to calculate and compare day-to-day usage. It has also capability of sending monthly as well as real time usage data cost to distributor by notification. Thus, it has become much easier to calculate electricity bill, minimizing power wastage and reduce bill-manipulating cost.

II. RELATED WORK

A. Arduino Based Energy Meter Using GSM.

In terms of bilateral coordination and management of loads, the device brings smartness[1]. The suggested system detects the amount of LED blinks of the traditional metering method.
The proposed device uses LDR as a sensor and an amplification circuit to provide the microcontroller with the required input signal. The device is waiting for the RTC output to act as a microcontroller interrupt and to update the consumer and server through the GSM shield.
If the consumer needs some energy information or wants to prevent the load from the supply between the cycle, it can be

conveniently transmitted by simply sending a text message via the GSM shield, which will produce an interrupt to the microcontroller and will revert accordingly. For the appropriate details, the user may also refer to the registry. The ways for sharing informations are fibre optics or co-axial cables that used for the application of cable technologies. Whereas it is possible to use wireless, GSM, Wi-Fi or Zigbee technology[2][3][4][5], users have 15 days to pay their bill until the bill is produced, or else their supply will be disconnected via relay[6]. The number of LED blinks is synchronized with the energy consumed in the traditional metering system, which is used successfully in the proposed system for measuring the units by LED sensing.

Though they used arduino UNO module for measuring the parameters but there is no IoT Panel in this System.

B. ***Smart Energy Meter Surveillance Using IoT.***

In this system, A unique ID is given for each energy meter in this system. This unique ID number is interlinked with the unique smartphone ID number [8] of the customer. It keeps checking the energy meter continuously. Via the web server, the electricity usage from each house is sent to the control station and the billing and power break data are sent to the residential energy meter from the control station. In the current energy meter, the energy used from the date of installation is indicated by the meter. The daily energy consumed in this device is measured using the Arduino microcontroller and is reflected on the LCD. It is also transmitted via IoT to the consumer's smartphone. The billing information for the energy used are transmitted to the user on a monthly basis via the IoT web portal and through the GSM application as a message. The power cut will be declared in advance. The power cut information is sent to the consumer's specific ID using IoT from the EB web server and it is also sent as a message via the GSM module to the consumer's smartphone.

Though they used an interactive IoT Panel for load controlling but there is no devices for energy monitoring.

III. METHODOLOGY

Block Diagram:

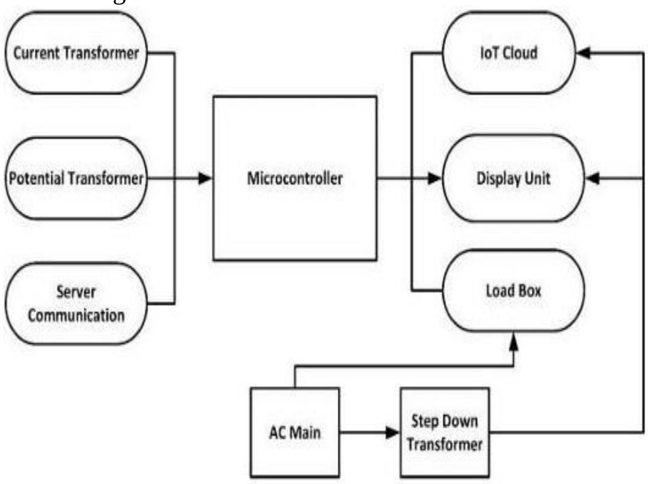
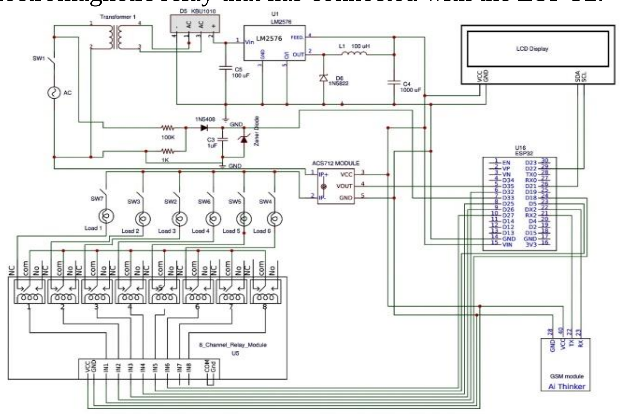


Fig-1

The overall block diagram of this project has shown in **Fig - 1**. In this project, we have used an ESP32 to connect all the peripherals. Three current sensor has used to measure the load current and a voltage divider has used to measure the AC voltage. A 16x2 LCD display has used to visualize all the results on the display. A 6-channel SPDT relay has used to connect and disconnect the loads in certain condition.

A.Circuit Diagram

All the components has interfaced in the circuit by using ESP 32. We have used the analog pins to get the values from the sensor. To measure the current we have used ACS712 current sensor to measure the total current of the circuit. The current sensors have interfaced with the D34, D35, D32 GPIO pin of the ESP 32. To measure the voltage we have prepared a voltage divider circuit with the winding of step down transformer. The output of the voltage divider circuit has connected with the D33 GPIO pin of ESP32. A 16x2 LCD display has used to visualize all the data on the display. This display has interfaced by using an I2C Module. All the peripherals that has used in the circuit has powered by LM2576 regulator, which has set up to provide 5V constant supply. The loads are connected with an electromagnetic relay that has connected with the ESP 32.



This system is designed with the following components:

B. Hardware

ESP 32: ESP 32 is a mini wifi board with 4MB flash based. The ESP 32 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced Espressif Systems. This module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style command.

ACS712 Current Sensor: The ACS712 is a bi-directional, Hall Effect current sensing IC. The current is passed through the IC; with little to no effect on the voltage, and the IC measure the magnetic field generated by the current.

Step Down Transformer: In this project a step down transformer has used where primary coil take 220-volt as input and secondary coil output is 12 volt. This step down transformer has use to energize motors, solenoid valve, hot gun that has used in this project.

LCD Display: LCD displays has seen everywhere. Computers, calculators, television sets, mobile phones, digital watches use some kind of display to display the time. An LCD is an electronic display module, which uses liquid crystal to produce a visible image. The 16×2 LCD display is a very basic module commonly used in DIYs and circuits.

And other devices are Relay, Diode,Buck regulator etc.

C. Softwares: Arduino IDE and language is used to write the code and upload into the EPROM of ESP 32. Finally connect to the BYLNK server for user interaction.

D.Flow Chart:

The flowchart of the whole system has shown in **Fig 4.3**. This flow chart describes all the initialization and procedural of this project. At the beginning, the system will show the intro message. This will provide a basic understanding on topic of our project. We have initialized and declared all the variables here. Then the status of the input output pins has mentioned in the setup function. After executing setup, the program will execute the loop function. Here we have sub divided the system into few user defined functions.

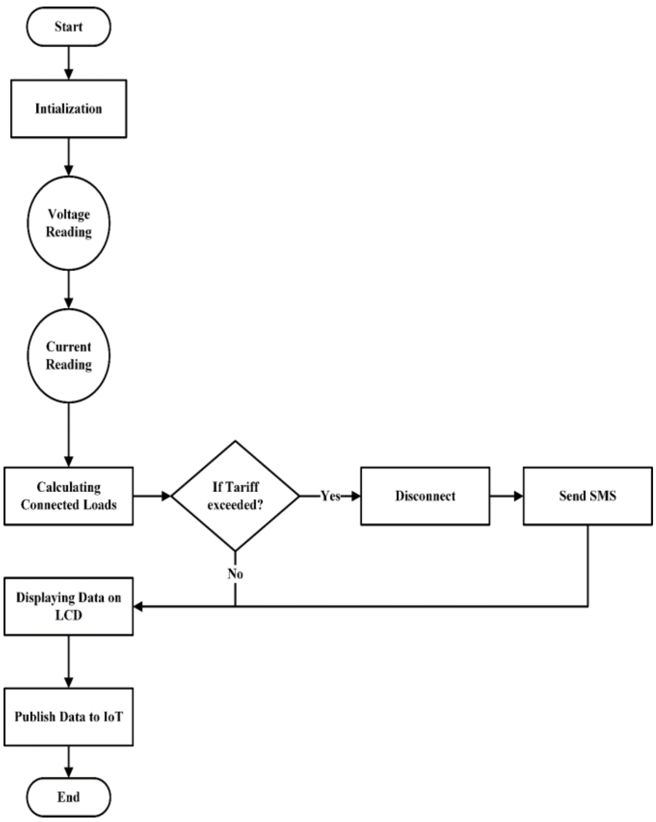


Fig-3 **3** Overall Flow Chart

As shown in **Fig 4**, we have measured the voltage here. The voltage sensor sends analog reading to the microcontroller and the microcontroller than analyze the values to convert into readable values. To measure voltage accurately we have taken the mean of 20 results, therefore the value is stable. Then the system execute the current reading sub process that has demonstrated in **Fig 5**.

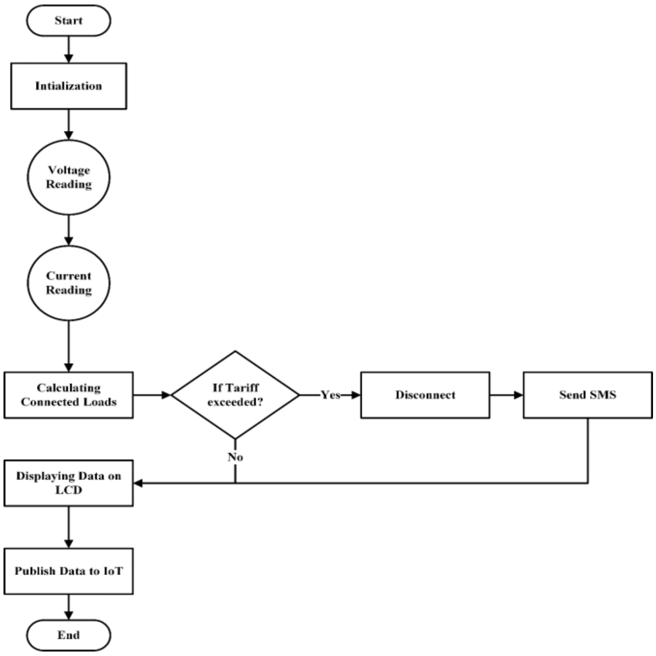


Fig-4 Reading Voltage Block Diagram

As shown in **Fig 5** the ACS712 current sensor measure current, which provided an ADC value with proportional to the current through the line, measured from another ADC channel. The measured data gives the instantaneous current value. By taking several samples and applying RMS, formula to get average RMS current and then recorded.

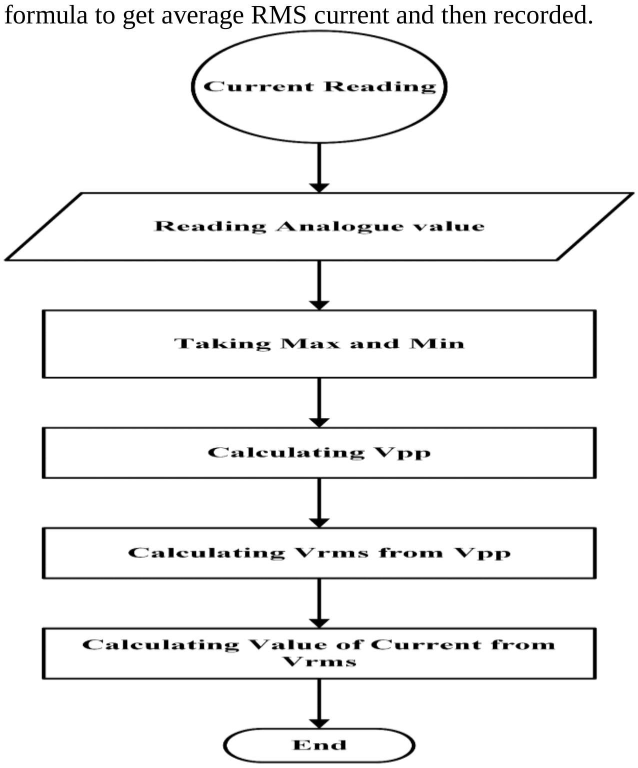


Fig-5 Reading Current Flow Chart

As shown in fig-6 after reading all these values the system checks the values and if any value crosses the threshold point, it will immediately shut down the output section and shows the fault on the display and IoT. It creates a webserver to its localhost and create a connection to the provided network device. A user can monitor the IoT panel by browsing to the host address of the network device and observe the data real-time.

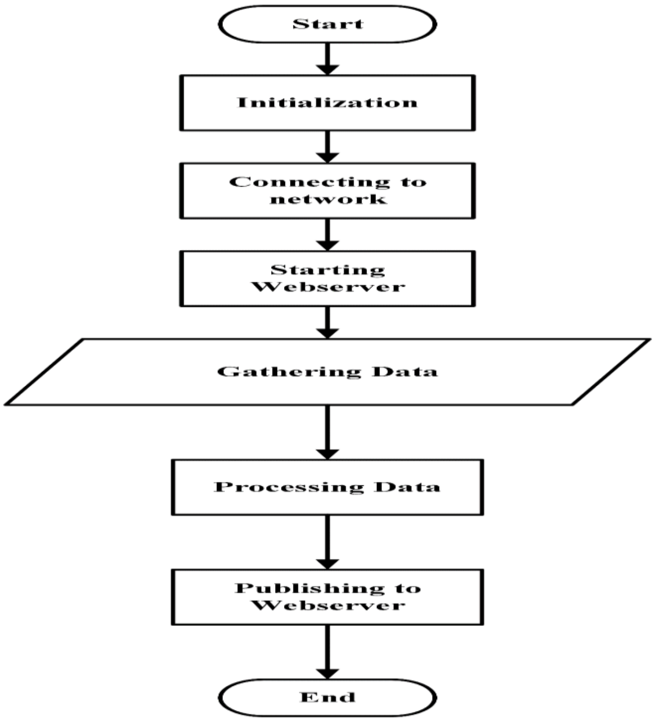


Fig-6 IoT Flow Chart

EXPERIMENT RESULT :In Fig. 4.1, you can see the whole scenario of this project . We controlled the loads by using a 6 channel Relay. We have used a current sensor to monitor the current, and a potential transformer to detect the voltage.

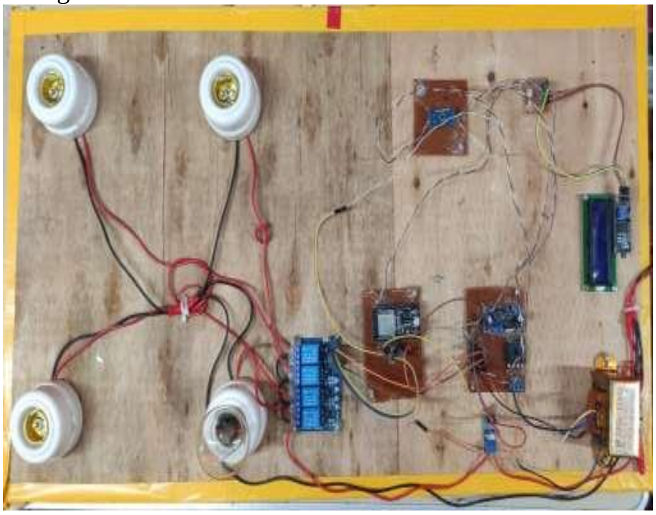


Fig-7 Image of the System

The power has provided using a voltage regulator and all the peripherals are controlled by using an ESP32.

Outcomes of different loads are measured by our proposed System shown in table-1.

Obs.	Voltage (V)		Current (A)		Power (Watt)	
	Practical	Measured	Practical	Measured	Practical	Measured
1	204	218	0.37	0.35	200	204
2	209	217	0.64	0.66	400	410
3	203	213	0.74	0.74	600	615
4	214	215	1.00	1.01	800	821
5	212	215	1.34	1.34	1000	1034
6	202	219	1.60	1.65	1200	1241

Voltage, current, energy rating and cost are the result of the project. The value of energy consumption and unit cost has sent to users by a IOT module as a notification. Here, we observe output for different value of load and we calculate that our energy meter accuracy is 97.17%.

Fig-8 Initializing

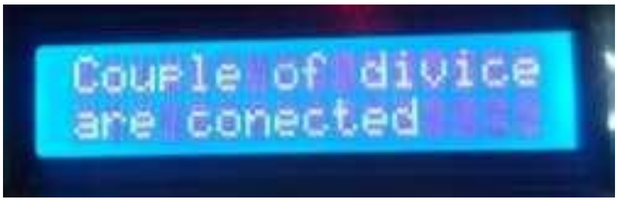


Fig-9 Showing connected Device

Fig-10 Showing Consumption

We can also see consumption in IoT panel.Now we descibe how we connected our hardware with BYLNK server.
At first we connected hardware pin with the microcontroller ESP32 of our project.We interface all our hardware via programming and uploaded them at EP-ROM.If we create an account on BYLNK server it will send us API key via mail which set up in EPROM along wifi id and password .The data which we given to the device would hit the API key of microcontroller through MQTT. After log in to the IoT panel that is in our mobile will hit the same API key.When send data thosendata are shown in our IOT panel.The layout of the panel's widget like button,switch are connected to device with the virtual pin.

Fig-11 IoT Panel

CONCLUSION: The outlook and assembly of the project have been supervised carefully and dealt with. This task was most hardest due to the combination from the lower voltage digital components, like the ESP32 microcontroller the actual LCD screen and additional IoT section with the primary line. Because of hard work, patience and effort eventually make it become successful.

REFERENCE:[1]
V. Preethi and G. Harish, "Design and implementation of smart energy meter," in *2016 International Conference on Inventive Computation Technologies (ICICT)*, 2016, pp. 1–5.

[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," *2nd Int. Conf. Electr. Eng. Inf. Commun. Technol. iCEEiCT 2015*, no. May, pp. 21–23, 2015.
[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," in *2016 IEEE Annual India Conference (INDICON)*, 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] P. Okafor, "PHCN: BENEFITS OF THE NEW PREPAYMENT METERS - Nigeria Technology Guide", *Nigeria Technology Guide*, 2017. Available: http://www.naijatechguide.com/2012/11/phcn-benefits-of-new prepayment.

[6] Mr.Rahul Ganesh Sarangle, Prof.Dr.UdayPanditKhot, Prof. JayenModi, "GSM Based Power Meter Reading And Control System", *International Journal of Engineering Research and Applications (IJERA)*, ISSN: 2248-9622 Vol. 2, Issue 4, June-July 2012, pp.664-671

[7] N.T. Makanjuola, O. Shoewu, L.A. Akinyemi and A.A. Ajasa, 2015. *Design and Development of a Microcontroller Based Digital Wattmeter (MIDIWAT).*
[8] R. G. Sarangle, U. Pandit, K. Prof, and J. Modi, "Gsm Based Power Meter Reading," vol. 1, no. 4, pp. 273–279, 2012.