MQTT based Monitoring and Controlling for Personal and Commercial Automation

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Abstract: Energy is one of the most important parameters in the universe. It is one of the key parameters without which we cannot do so many works so its monitoring is a very important. In our current energy meters at our homes we can just see the LCD display that shows power consumption units and at end of month we get a bill showing the used units and charges, in last few years the advancements came like we can pay the bill amount online so no need to stand in lines anymore but nothing changed in the method of monitoring energy consumption so here the purpose is the do something in that aspects so the implementation will read the present energy parameters like voltage, amperes, power, and units continuously as our conventional meter does but it will display all the quantities on the device and it will be continuously sending those readings to the server or web app so if you want to see the present consumption just take a look at your laptop and mobile phone no need to go and see in device, and also control the equipment connected to the meter means we can on/off anytime from anywhere so no need being tensed about the device at home is ON and consuming energy when you are not at home just see the readings on the mobile phone. This can be possible using the internet of things (IoT). This everything will be done using AVR series Microcontroller and the module for sending and receiving will be the Wi-Fi module. What makes it better is the MQTT protocol for data transfer between the metering device and the server and that data can be seen in mobile or laptop.
Keywords: Smart energy meter, AT mega 328 microcontroller, IOT, Wi-Fi module

I. INTRODUCTION

1) *Background:* Electrical power has become necessary to human survival and progress. Apart from efforts to meet growing demand, automation in the energy distribution is also necessary to enhance people's life. Traditional meter reading by human operator is inefficient to meet the future residential development needs. So, there is increased demand for smart Meter Reading systems which collects meter readings electronically, and its application is expanding over industrial, commercial and utility environment. At present, most of the houses in India have the traditional mechanical watt hour meters and the billing system is not automated. At the end of each month a person from the electricity board goes to every house and takes the meter reading manually. These meter readings are used for electricity bill calculation and this bill sent to consumer house by post. Customer goes to electricity department for paying this bill amount. But in this technique, we are required great number of persons for reading the meters. The procedures of sending the bills to customer are very hard working. Due to the increasing number of consumers and residential areas, Distribution Company need to send more energy meter officers to read the energy meter at consumer's house. It is quite costly to send more officers just to read the energy meter reading. Sometimes, the energy meter in consumer's house is inaccessible by the energy meter officer. The energy meter may be inaccessible by the energy meter reader officer due to bad weather condition (raining or stormy).

2) *Existing System:* The existing meter reading techniques in India are analyzed and different energy measuring instrument are available. In existing system either an electronic energy meter or an electro-mechanical meter is fixed for measuring the usage. The meters currently in use are only capable of recording Kwh units. The Kwh units used then recorded by meter readers monthly. The recorded data need to be processed by energy meter reading company. The currently existing domestic energy meters in India had some technological advancement when the static meters were introduced which could calculate the power consumed without any rotary motion by using a discrete IC. In electronic metering which reduced a few blemishes of the previously used dynamic meters. In this improvement, the procedure carried out to read the energy meter and get the billing detail is done manually by an authorized member of the board at the beginning of every month. The smart energy meter gives real time consumption as well as online billing. A possible solution is a Wireless Energy Meter which is able to send its data via wireless communication to PC or a remote device where monitoring and analysis of the data will be easily made.

3) *Proposed Solution:* The current system of electricity billing is time consuming and error types. Human error is introduced in the electro-mechanical meter, while processing the paid bills. Overcome this problem, smart energy meter is a technique which can reduces the problem associated with billing and manpower taking meter reading. This type of meters has many advantages from both suppliers as well as consumer. Overview of smart energy meter, which can control the usage of electricity on consumer side to avoid wastage power

II. BLOCK DIAGRAM AND WORKING

This block diagram consists of monitoring part, controlling part, and Wi-Fi unit. Controlling part consist of AT mega 328 microcontroller. Wi-Fi module is the main component used in the IOT operation. Current sensor, voltage sensor or voltage measuring circuit, relay are other components in the system. The measuring of load current and voltage using sensor and energy metering IC, which converts it into real power consumed by the load. Power factor is measured by measuring the phase shift between voltage and load current. Microcontroller used to perform the calculation related to power and energy consumed and shows the reading on LCD as well as it sends the reading of smart energy meter with the help of Wi-Fi module. Active power, reactive power, voltage, load current, power factor and units (Kwh) are measured and displayed successfully. Energy meter reading are sent from Wi-Fi module and received on mobile or laptop.
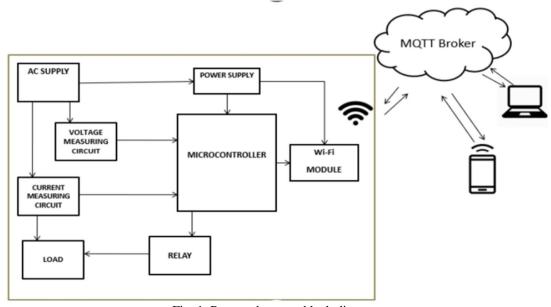

Fig. 1. Proposed system block diagram

III. HARDWARE DESCRIPTION

The hardware component requirements required for this paper are:

A. Transformer
A transformer is static electric device that transfer electrical energy between two or more circuit. A transformer transfer power from one circuit to another without changing its frequency. In this step-down transformer is used.

B. Rectifier
A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification.

C. Capacitors
A capacitor is a passive two-terminal electrical component that stores electrical energy in an electric field. It is a device used to store an electric charge, consisting of one or more pairs of conductors separated by an insulator.

D. AT mega AVR Series MICROCONTROLLER
At mega 328 microcontroller is main unit. It is one of the most popular microcontrollers for its high performance and low cost.
It is low power CMOS 8-bit microcontroller based on AVR RISC architecture by executing powerful instruction in a single clock cycle, the AT mega 328 achieves throughout approaching 1 MIPS per MHZ, allowing the system designer to optimize power consumption versus processing speed. The At mega 328 has 28 pins. It has 14 digital I/O pins of which 6 can be used as PWM outputs and 6 analog inputs pins. These I/O pins account for 20 of the pins.
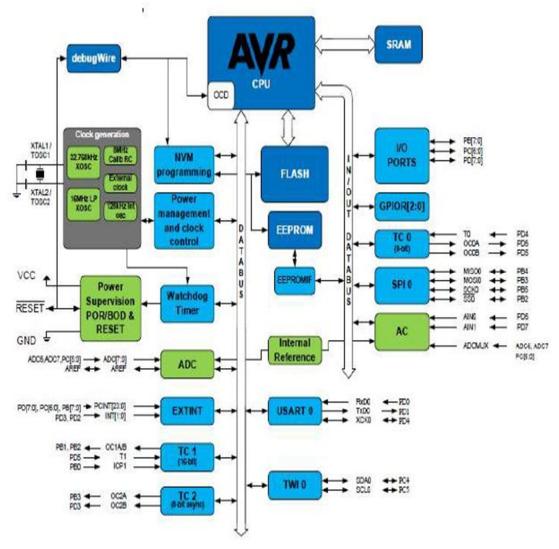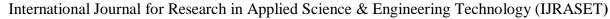
Fig-2 Block Diagram

E. Relay Unit

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

F. LCD (Liquid Crystal Display)

LCD screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters. It has two registers, namely, Command and data.

G. Wi-Fi (Wireless Fidelity)

Wi-Fi is a wireless networking means of connecting computers at home or office to the network. The distance up to 100 feet is acceptable wherein the computers are connected through radio waves. Here I have used ESP 8266-12E Wi-Fi used. The ESP 8266 Wi-Fi module is a low-cost component with which manufacturers are making wirelessly networkable microcontroller module. ESP 8266 Wi-Fi module is a system on a chip with capabilities for 2.4GHz range. It employs a 32-bit RISC CPU running at 80 MHz it is based on the TCP/IP (Transfer control protocol). It is the most important component in the system as it performs the IOT operation. It has 64 kb boot ROM, 64 kb instruction RAM, 96 kb data RAM.

H. Current Transformer

30 AMP, Current transformer are mainly used in energy meter as the current sensor. The features of current transformer with PC housing for better insulation, environment protection and variable available in self-wire (flying leads) or PCB malting type CT. This type of CT in basic primary current are 5amp and maximum primary current are 30amp. The main application of CT is energy meter, electronic circuit breaker, current sensor, and motor speed controller.

IV. SOFTWARE REQUIREMENT

A. Arduino IDE

The Arduino Integrated development environment (IDE) is a cross platform application (windows, macros, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino board. The Arduino IDE supports the languages C and C++ using special rules of code structuring.

B. EAGLE

EAGLE is a scriptable electronic design automation (EDA) application with schematic capture, printed circuit board (PCB) layout, auto-router and computer-aided manufacturing (CAM) features EAGLE stand for Easily Applicable Graphical Layout Editor is a design software by CAD soft Computers. It is widely used by educationalists, students, hobbyists and professionals. It is supported by Windows, Mac and Linux.
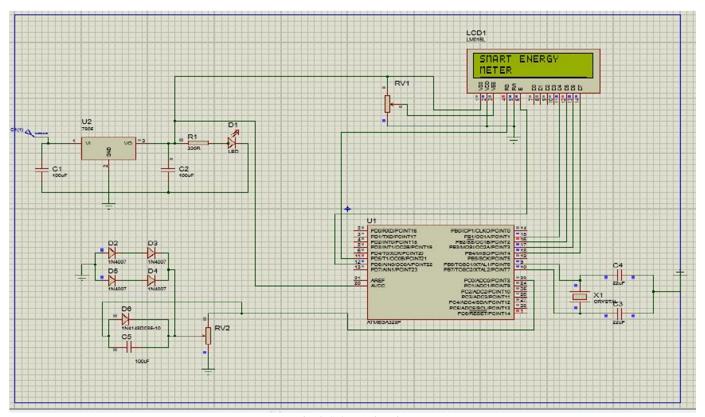

Fig-3 Schematic Diagram

V. TECHNOLOGY OVERVIEW

A. IOT (Internet of things)

The IoT is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.

B. MQTT (Message Queuing Telemetry Transport)

MQTT is M2M communication protocols. It is a publish/subscribe messaging protocol designed for lightweight M2M communications in constrained networks. MQTT client publishes messages to an MQTT broker, which are subscribed by other clients or may be retained for the future subscription. Every message is published to an address, known as a topic. Clients can subscribe to multiple topics and receives every message published to each topic. MQTT is a binary protocol and normally requires fixed header of 2-bytes with small message payloads up to maximum size of 256 MB. It uses TCP as a transport protocol and TLS/SSL for security. Thus, communication between client and broker is a connection oriented. Another great feature of MQTT is its three levels of Quality of Service (QoS) for reliable delivery of messages. MQTT is most suitable for large networks of small devices that need to be monitored or controlled from a back-end server on the Internet. It is neither designed for device-to-device transfer nor for multicast data to many receivers. It is a very basic messaging protocol offering only a few control options.

VI.CONCLUSIONS

This paper represents introduction and overview of hardware and software component and which technology are used in this project. The main advantages of Wi-Fi based smart energy meter have low infrastructure, low operating costs, more data security and less man power required.

VII.   ACKNOWLEDGMENT

Research work, lays the foundation of student's career today. The satisfaction that comes with successful completion of task would be but incomplete without the mention of the people who made it possible. It gives us immense pleasure to acknowledge all those who have extended their valuable guidance and magnanimous help.

It is a matter of great pleasure and privilege to have this Research entitled:

 "MQTT Based Monitoring and controlling for personal and commercial automation"

With a deep sense of gratitude, I wish to express sincere thanks to my honourable guide Prof. Nirav Patel (Assistant Professor, Electrical and Electronics engineering, GMFE,) who has the attitude and +substance of a genius and has been a great source of inspiration throughout the project. I am fortunate to be given the opportunity of working under him. In spite of a tight schedule, he always found time for my difficulties and patiently answered to all my queries. He not only provided the necessary guidance and support, but also continuously motivated me to give my best in this advanced project.

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