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SMART POWER METER BASED ON IOT

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Abstract-*IoT is a network used to interrelate multiple things including mechanical and computer machines. It passes data to a computer interface over the networks without the help of humans or computers. This enables control of various parameters, including electrical, physical and environmental parameters. The amount of electricity consumed is also a parameter to be measured. So to do this we need power meterwhich is much expensive. Thus, in this literature the proposed system adopts a basic portable low- cost power monitoring system with Wi-Fi capabilities. Different test results are provided to demonstrate the feasibility of our proposed IoT powered power monitoring system for calculating consumed electricity and secure data transmission via Wi-Fi module to the cloud server.*

I. Introduction

Internet of Things is a technology that integrates detection and communication with common equipment to collect useful data. Such devices are used for the measurement of different physical and environmental parameters [1]. Such research is further used to evaluate, recognize and address many of the problems that we face in our daily lives. Our main problem now is to make efficient use of electricity. Our device will help solve all of our problems by providing information on day to day electricity consumption.

Normal electric meters supplied by electricity suppliers measure the power consumed throughout the building in the current scenario. Actually consumers have no idea about their consumption of electricity for individual equipments [2]. These meters also lack an option of analyzing data since there is no communication facility in the meter. So the electricity used at each and every position has to be recorded manually for billing. It can be susceptible to human error due to this method.

Using our smart power meter device, the power read manually can be automated, analyzed and the electricity can be cut off if the electricity bill is not paid on time. This will also help in the identification and awareness-raising of major power consumer [3]. The details of how much power consumed can be sent safely to the platform of the manufacturer and its section of the network. By this the error due to manual reading.

Communication capabilities in smart power meters have been developed beforehand. High cost, big size, weak security, installation complexities are the demerits in this design. By recommending low cost, incorporate a stable, power monitor sensor implementation and low-complexity design to address problems in these designs. The intended sensor incorporated wireless communication with IEEE 802.1. Remote server can store and analyze data from instantaneous power consumption by using the wireless network via computer or smartphone over the Internet to retrieve data onserver.

The entire article is laid out as follows. Similar studies and developments are listed in Section II of the proposed design. Section III explains deviceoverview of the proposed power monitoring sensor.Reports from the implementation and the quality review of of the proposed system are depicted in section IV. Section V explains the study concluded.

II. Related works and Contribution ofpaper

Wireless communication technologies havepreviously been used to develop smart power monitoring devices. A different microcontroller design is used for the contact system interface and the power calculation modules [4]. Some of these microcontrollers are Arduino boards, ATMEGA microcontroller, etc.... Such devices increase overall network capacity, cost and complexity. Wireless connectivity for IoT devices is suggested for secure transmitting of power monitoring data according to IEEE standards. Wi-Fi provides a huge data, wide range of communication and consumes a high power [5]. Compared to Wi-Fi, ZigBee and Bluetooth consumes a lower power.Bluetooth suffers a lower range and data rate.

Like all other ZigBee products, certain transmitters and receivers do require additional hardware deployment. To overcome this issues, we use IEEE 802.11(Wi-Fi) module which does not require additional circuit and has higher range [6]. Anotherissue in the system that is already presented is that if the electricity tariff is not paid on prescribed time a person from electricity board will cut the supply. This method consumes some man power and the person from electricity board can be easily bribed and the consumer can use electricity without paying. To order to avoid that, we have also implemented an electronic device with the power meter that immediately stops the power supply if the electricity bill is not paid ontime [7].

The contribution of the paper includes following:

- Through removing the need for an external microcontroller to suggest low- cost power monitoring sensor implementation, and also using a house- built current sensor.
- The proposed system has a simple snap- fit configuration for current sensors, made possible by the use of a custom designed 3D printed case and also has a compact size and small form factor.
- We also incorporated encryption algorithms in a proposed system to provide protection against unauthorized exposure and hacking of data in the power meter sensor.

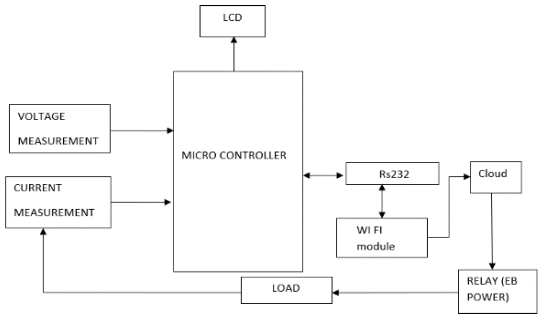

Fig 1. Block diagram of smart energy meter.

III. SYSTEM DESCRIPTION

The idea suggested as shown in Fig. 1 Can be separated into three different subsystems. First, the ESP 8266 Wi-Fi (Node MCU) frame, second potential transformer, and last, the current transformer.

A.ESP 8266 Wi-Fi module (Node MCU)

Manufactures are making wireless networkable microcontroller module by using low cost ESP 8266 Wi-Fi module. The ESP 8266 Wi-Fi module is known as a system-on - a-chip with a frequency of 2.4GHZ.ESP 8266 Wi-Fi is a 32-bit RISC CPU operating at 80 MHz based on the TCP

/ IP (Transfer Control Protocol) protocol. This conducts most critical process such as service of IOT. ESP 8266 Wi-Fi module has RAM data of 96 kb, ROM boot of 64 kb and RAM instruction of 64 kb. IOT procedure conducted by Wi-Fi device to send data from the energy meter to the database that can be accessed via IP address. The Arduino Microcontroller's 7 and 8 pins are connected via TX and RX pins.

Fig 2. ESP 8266 Wi-Fi module

B.POTENTIAL TRANSFORMER

The high voltage and currents associated with distribution systems and power transmission are notan easy way to measure. Hence the potential transformer is used to step down these values to themeasurable values. For the purpose of measurement and protection of the system, the measuring meters or measuring instruments and protective relays are not connected to the low voltage devices.

Fig 3. Potential transformer

C.CURRENT TRANSFORMER

The current transformer could be described as the current at its primary is commensurate to the current at its secondary.

It includes the current transformer and the instrument transformer. Instrument transformer is used to reduce the large value of current or voltage to smaller values, measuring instruments and protective relays are easy way to handle the standardized values. The instrument transformer protection circuits from primary system high voltage. It is defined as secondary current that is precisely proportional to the current in primary flow. The current transformer is negligible for the primary circuit.

Current sensing unit of primary system is called as current transformer. And current transformers used in industrial and commercial electric power distribution.

D.PIN CONFIGURATION OF WiFi MODULE

In ESP module there are so many IDEs and methods are available. But Arduino IDE is most commonly used one.

The ESP 8266 Wi-Fi module works with

3.3 V only, anything more than 3.7 V would killthe module hence be caution with your circuits. Future Technology Devices International(FTDI) board that supports 3.3 V programming. That everyone faces with ESP-01 is the powering up problem is the one common problem. At the time of programming the ESP 8266 Wi-Fi module is a bit power hungry and we can power it with a 3.3 V pin on Arduino. So small voltage regulator is important to make for 3.31V that could be greater than of 500 mA. ESP826601 module simplified circuit is given below.

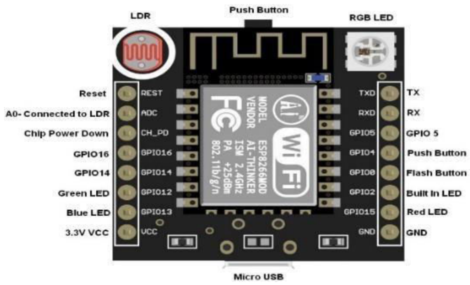

Fig 4. Pin configuration

E.TRIP OFF USING RELAY CIRCUIT

Relay is an electromagnetic switch contains three pins are Normally open (NO), Common and Normally close(NC). In the circuit relay is connected to transistor collector terminal Q2. Normally relay is used to design the circuit to control the load. The given load may be motor load and any other load. The relay is used to ON and OFF the load. By the pair of switching transistor (BC 547) to control the ON and OFF of the relay.

Supply voltage is given to common pin present in relay. NO (normally open) is connected with load. The transistor conducts when the high pulse signal is transmitted to the Q1 transistor base terminal and when the Q2 transistor collector terminal and emitter terminal and base terminal are attached to zero (0 Volt) voltage.

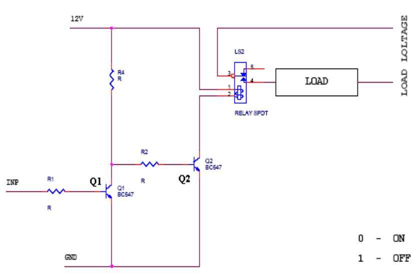

Fig 5. Schematic diagram of relay

IV. RESULTS AND PERFORMANCE ANALYSIS

The efficiency of the implemented power monitoring system is evaluated, and conclusions are provided below based on security, accuracy and cost of materials.

A. Security Analysis

Given that electricity suppliers can also use the power monitoring sensor for billing purposes, safe transmission of power data is required. Sufficient security mechanisms should be ready to make sure data reliability and to deter unauthorized users from accessing or altering power data.

We also introduced AES encryption algorithm on the processor module for this reason, which gives data confidentiality. The processor module's clock-frequency is 160MHz. The algorithm runs with this clock rate in about 800 milliseconds. This lag can be compromised due to the protection advantages provided by the algorithm.

B. Accuracy Analysis

To check the accuracy, using Hioki Power Analyzer 3390 to calibrate the power values first. Of greater accuracy we use a three-point test. To assess uncertainty in the calculation, the measured values are then correlated with the actual values. The findings are shown in Table I. It can be seen that the control analysis has very high precision.

TABLE I
PERCENTAGE ERROR IN POWER MEASUREMENT

Actual Value (Watt)	Measured Value (Watt)	% Error
20	19.92	0.40
30	30.16	-0.53
40	39.60	1.00
50	49.90	0.20
60	59.90	0.17
70	70.40	-0.57
80	80.20	-0.25
90	89.70	0.33
100	100.10	-0.10
110	111.60	-1.45
120	120.70	-0.58
130	131.00	-0.77
140	141.30	-0.93
150	151.80	-1.20

C. Cost Analysis

System costs are very minimal. The Power Monitor Sensor uses no external microcontroller plate. In fact, the new sensor is manufactured at comparatively low cost in-house compared to current sensors that are available commercially. Computer casing is designed and developed utilizing 3D printing machine at low cost.

D. Simulation results

Fig 7.Output of the collected data

V. CONCLUSION

In an emerging area such as IoT Power monitoring, a groundbreaking technology is being created to read from any corner of the world the power used by each and every system within home remotely over the web. The actual collected current is monitored and viewed over the internet using IoT in our proposed project sensor i.e. current sensor. The machine changes its reading every 3 seconds.

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