Design Smart Energy Meter and Smart Appliance Control System

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ABSTRACT

Electricity is extremely important in everyday life. Since 2000, India's power consumption has climbed by thrice. In 2014, the average Indian family used 90 units (kWh) of electricity per month, which is enough to power four tube lights, four ceiling fans, a television, a small refrigerator, and small kitchen appliances with certain use hours and efficiency levels. The Internet of Things (IoT) is made up of smart machines that interact and communicate with one another, as well as other machines, objects, environments, and infrastructures. The main goal of this device is to demonstrate how we can use IoT to harness power over time. This project made use of a programme called Node-RED. The design and installation of an energy monitoring system is extended in this project. This technology also has the benefit of allowing a user to understand and control the amount of power consumed by electrical gadgets in their daily lives. The electrical company informs the customer about the bill amount, payment options, and specifics about the scheduled power outage. So, based on the facts, the customer must pay. If the customer fails to pay the bill, a warning message is issued automatically, and the remote server's power is turned off. So, in this proposed system, all of the work is done automatically utilising a programme called Node-Red and the Internet of Things.

INTRODUCTION

We can define a Watt hour metre as an equipment that consumers use to measure the quantity of electrical energy they utilise. Utilities install these instruments in a variety of locations, including homes, businesses, and organisations, to control the amount of power consumed by loads such as lights, fans, and other appliances. Watts are the most basic unit of electricity. One kilowatt equals 1,000 watts. One kilowatt is considered one unit of energy used if used for one hour. These metres calculate the product of the instantaneous voltage and current and offer instantaneous power. The energy used over that time period is calculated by integrating the power over a period.

The device is used to regulate home appliances using a relay system while also calculating the system's apparent power. The system is based on IoT. (Internet of things). The Internet of Things connects physical devices, such as weather sensors and smartphones, to software applications. The connections enable apps to deliver functionality based on the data that can be gathered from linked devices. The system is built on Node-RED (flow-based programming for internet of things), where Node-RED is a tool that is used to construct applications and gateways on the IBM IoT platform. IoT has applications across many industries, including government, insurance, energy, and smart homes. With a Raspberry Pi-based HMI device, the system can operate home appliances and calculate real-time apparent power, while also providing features to control equipment using mobile phones or other computers linked to the same WIFI system's router. The idea for working on this project was to design a smart energy metre and smart appliance control system, with the software based on Node-RED, a flow-based development tool originally developed by IBM for wiring together hardware devices, APIs, and online services as part of the internet of things, and other hand arduino programming used to calculate power where CT-sensor is connected and used to get raw data.

PROPOSED SYSTEM

This proposed system is quite efficient as it decreases the need of labor and it is a cost efficient as well as it is a time saving process. This device uses relay system which can control home devices. This proposed system allows applications to provide

functionality based on the information it can drive from the things that are connected. As it is based on IoT, so it allows us to control home devices using mobile phone only

DEVICE DESCRIPTION

The main components that was used for this system are Arduino UNO, Wi-Fi module ESP8266- 01, current transformer (CT), potential transformer (PT), voltage regulator AMS1117, and one 16x2 LCD display. The tool that was used is Node-RED and later on the programming part was done in Arduino IDE.

Functional block diagram of the developed smart energy meter is shown in Fig.

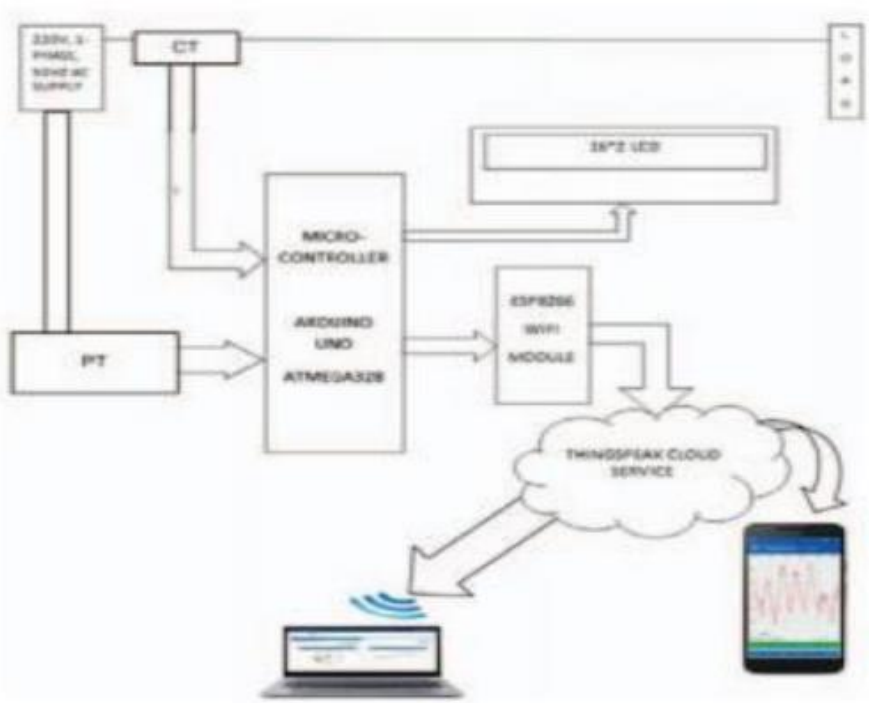
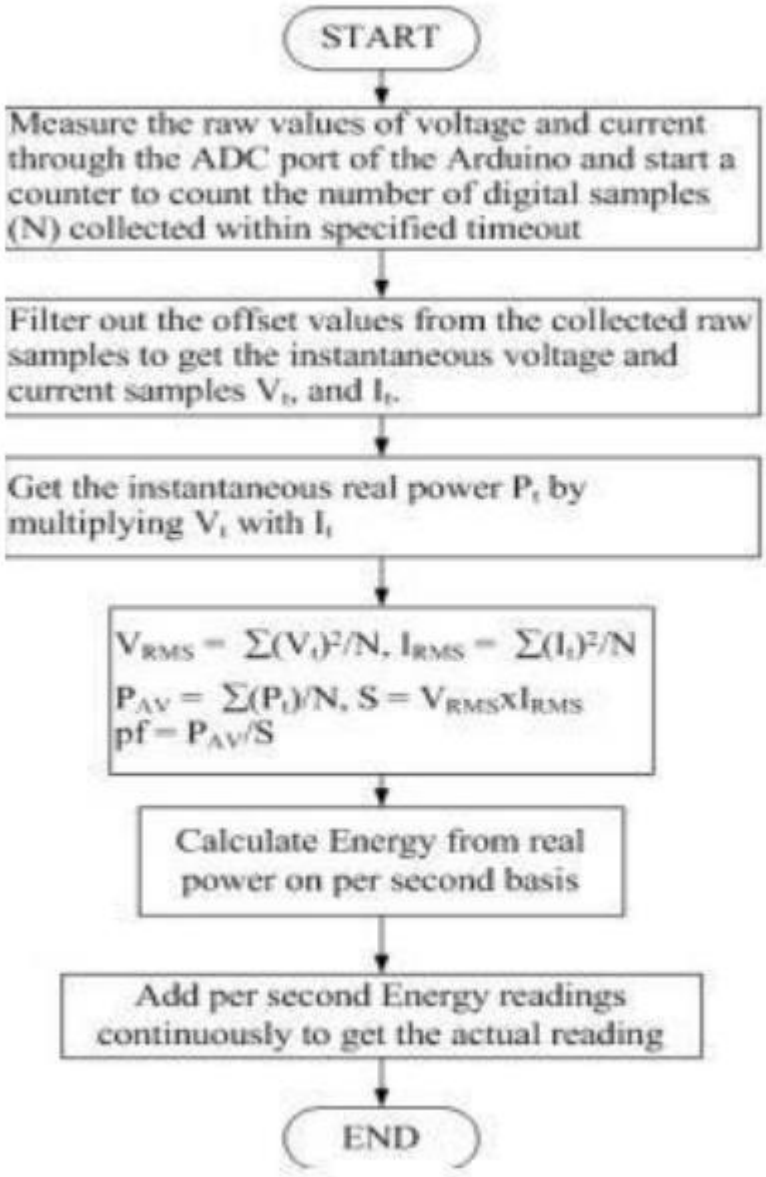


Fig. 1. Functonal block diagram of the developed IoT based smart energy meter.

HARDWARE AND SOFTWARE DESCRIPTION

The Arduino analog input pins were used here. They are used here after being stepped down by CT and PT to collect the line current and line voltage data. Output current of the CT was made to flow through a fixed value. Suitable value of DC offset is added to those signals so that they can be brought within the measurable range of 0-5 V in the Arduino. Values after scaling down the input voltage and current were calculated and locally displayed on the 16x2 LCD and were updated on a time loop. The WiFi module ESP8266-01 was connected to the router for internet access so that the module could successfully send all relevant data to the IoT platform once it is secured.

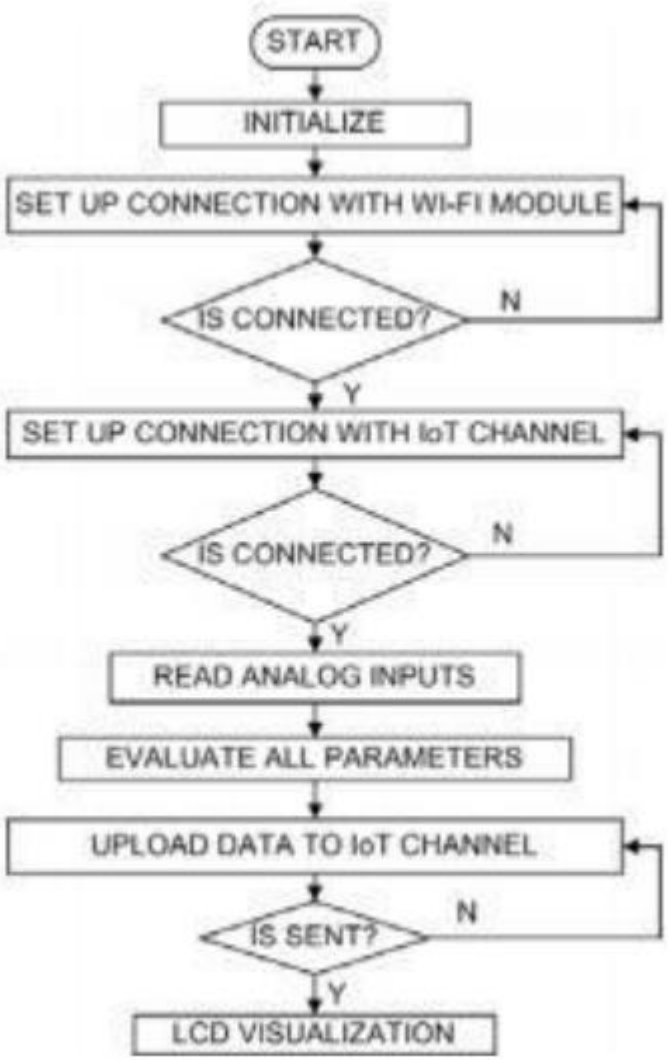


Flow chart for computation of electrical parameters from measured raw signals

1. Arduino IDE

It is used to write and run programs to compatible boards and also with the help of vendor development boards.

Integration of software with hardware is backbone of such a “smart” device. Flowchart depicting the working process of a smart meter in which the device is connected to internet so it collects the data, evaluates the parameters and displays the results. Flowchart of connection that is to be made with the IoT channel is also shown.



2. Wi-Fi module ESP8266-01

The ESP8266 WiFi Module is a protocol stack that is integrated with TCP/IP, that can allow access of wifi network to any microcontroller. We can load different firmwares to make your own application on the modules' memory and processor like At commands firmware. It's a very economic module and has a huge and growing community support.

It has 80Mhz low power 32 bit processor. It means without any external controller we can host some webpages.

The ESP8266 alsosupports co-existance bluetooth interfaces.

3. Current transformer (CT)

We can define current transformer (CT) as a type of transformer that can multiply the alternating current or reduce the alternating current. What it does is, in it's secondary coil it produces current proportional to the current present in it's primary coil.

Here we define the instrument transformer as potential and current transformer. It change the high values of current or voltage to small that means it protect the circuit from high current or voltage.

4. Potential Transformer (PT)

We can define potential transformer as an instrument that can be used to change / transform higher value voltage to the lower value voltage. To easily measure the voltage values it step down the high voltage to a safe value. Like wattmeter and watt-hour meters, etc are low voltage measuring instrument.

To keep magnetizing current small it is made with high quality core so that it'll have low flux density. It should be designed such as the voltage ratio variation with load and phase shift between the output voltage and input voltage should be minimum.

The primary and secondary winding have a large number of turns and much small number of turns respectively. The insulation cost is also reduced by dividing the primary winding into the sections which reduced the insulation between the layers

5. Voltage regulator AMS1117

The AMS1117 series of adjustable and fixed voltage regulators are designed to provide up to1A output current.

Its applications are

- High Efficiency Linear Regulators
- Post Regulators for Switching Supplies
- Battery Chargers
- Active SCSI Terminators
- Power Management for Notebook
- Battery Powered Instrumentation

6. 16x2 LCD display

Nowadays, we always use the devices which are made up of LCDs such as CD players, DVD players, digital watches, computers, etc. These are commonly used in the screen industries to replace the utilization of CRTs. Cathode Ray Tubes use huge power when compared with LCDs, and CRTs heavier as well as bigger. These devices are thinner as well power consumption is extremely less. The LCD 16×2 working principle is, it blocks the light rather than dissipate.

The term LCD stands for liquid crystal display. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

CONCLUSIONS AND FUTURE SCOPE

An IoT based smart energy meter will be developed using the software of system based on node- RED. It has the following features:

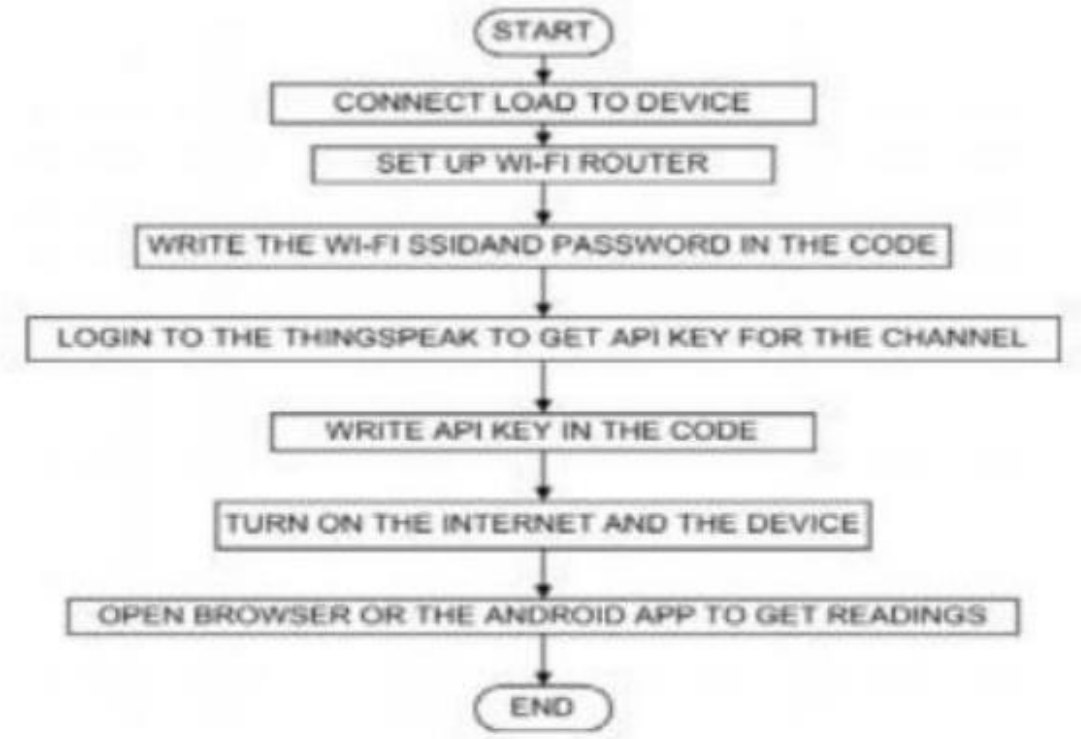
- Through internet the data management system collects data which will provide the user energy usage information.
- It will work in real time as all the data are connected to internet.
- The android app directly connects the user to the energy management. Thus each and every consumer becomes the contributor to the efficient energy management.
- Since it includes cloud service so it's more secured.
- Bill can be processed without any delay because human involvement will be limited.
- Transparency will be there.
- The components used will be robust and modern updated ones, accuracy is guaranteed.

This smart meter can be very effectively used as one of the major components of a smart grid. In addition to being used for cyber security related studies, the developed device can have some immediate future advancement possible:

- It can be enhanced for power theft detection using IOT.
- The Android application can be used for online payment of bill.
- Load analysis of single entity is performed in the proposed method. Also it can be boosted for area wise load analysis which will help for load forecasting in future.
- There can be an option for prepayment that can be added with the model to develop pre- paid energy meters

RESULTS

Once the device is ready, the user has to follow certain steps as detailed in the flowchart for displaying the records in a browser over internet. The IoT platform ThingSpeak is used to collect and store data in the cloud and develop further IoT applications.



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