Real Time Energy Monitoring System using Raspberry Pi

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Abstract— Home automation is growing popularly nowadays. An automatic remote meter-reading system based on Wi-Fi presented in this project can be considered as a part of home automation. The Energy data collection system is a very important step and part in the research of energy visualization and analysis. Through this system, consumer can easily know their electricity usage at any instance and the need to reduce their energy consumption and costs. Wi-Fi based smart energy meter system is presented in this paper in order to reduce errors. There are many possibilities for the collection of energy data. The main aim of this project is to develop remote energy measurement system using Raspberry pi board consisting of an ARM11 processor. Data is stored in the Raspberry pi and is sent over Wi-Fi through the home's wireless router to the cloud platform. Furthermore, we can display all data such as energy consumed, Power, etc on a touchscreen. The cloud platform collects the energy data, stores it in a database and uses it for energy visualization, calculation and analysis using GUI application.

Key words: Raspberry PI, Energy Monitoring System

I. INTRODUCTION

Increasing economic growth and consumption patterns are leading to ever growing demand for energy. Since most of the energy supply is from fossil fuels, the resource is depleting thereby increasing the cost of energy. Burning fossil fuels has also increased the concentration of carbon di oxide in the environment leading to extreme weather patterns. Hence it is imperative that industries and commercial enterprises and households take steps to reduce energy wastage, become energy efficient and reduce costs. Industry in India consumes 45% of the 900 billion Units of power produced. 35% of electric power produced is lost, and the losses are due to Transmission & Distribution (16%), theft (10%), Inefficiencies among users (10%). The 10% inefficiencies are largely among the industrial and commercial users who have high KVA HT connections. Inefficiency can also arise due to harmonic problems, faulty wiring, feedback from sub systems, and neighbouring electrical systems. This leads to a drop in power factor and higher utilization of energy leading to higher rate slabs and penalties. Some organizations like Data centres measure Power Usage effectiveness where units consumed per annum is much higher than that required to power their total equipment. All these are applicable to industries like SMEs, cement, steel, auto, heat treatment/cooling, food processing, chemicals, plastics, textiles, commercial spaces using HVAC equipment, hospitals, hotels etc. Energy Management System for Smart Home has been developed to manage energy at the level of appliances. So, a Smart Home Energy Management System Architecture been developed. In this system, Sensors control the energy consumption of home appliances. An energy monitoring system provides feedback on electrical energy use. Devices may be used to display amount of current, voltage, power etc. The measurements can be made with an inductive clamp or through communicating with a smart meter or by direct connection to the system. The display portion is separate from the system and can be used for remote access. Use of online displays enables users to get a visual realisation of energy consumed anytime anywhere. A means to reduce household energy consumption is to provide real time-feedback to the consumers thereby making them aware of their usage. Hence the customers can take necessary energy conservation steps with the data available.

II. LITERATURE REVIEW

1) Terry Chandler (2005), explained the rapid development ICT technology, power metering technology and power monitoring in addition to the past, present and future status of automatic meter reading system. This work also gave the idea that the next generation of power monitoring systems will include multilevel AMR with PQ monitoring and Wi-Fi connections with intelligent monitoring systems. This literature helped us to understand the historical review of AMR and its future scope.
2) William J.Rose (2006), described the applications of Wi-Fi in smart meters and also the real time use of Wi-Fi over other communication protocols. The out of the box experience of consumer and cost analysis on various communication protocol presented in this paper helped in knowing the efficiency of various communication protocols.
3) DR.S.S.Lokhande et al (2011) presented the implementation of Automatic Meter Reading System using PLC and GSM and explained the components of AMR system, architecture of the system along with the hardware design. This helped in developing the hardware circuit of smart meters.

III. PROPOSED SYSTEM

Smart metering system driven by IoT gives practical and feasible solution to several problems that prevail in conventional system of metering. It is proposed to model and build a energy monitoring system incorporating a digital energy meter and IoT services to have real time knowledge of energy consumption. The energy meter would be installed as usual near the mains supply and connections would be taken from it to various equipment. The data from energy meter would be fed to a raspberry pi through a RS485 to USB converter module. From the raspberry pi, the data would be processed to a easily understandable form and be displayed in an IoT platform. The mode of communication adopted here is Wi-Fi. Thus, this proposed system enables the user to be aware of his energy consumption and take necessary steps for energy conservation.

IV. METHODOLOGY

The hardware design describes the way in which the components are connected and the suitable medium in which they are to be placed. The energy meter is to be connected suitably to the supply mains in a manner similar to the connection of an ordinary energy meter. The meter has provisions for 3 phase 3/4 wire or single phase connection. According to requirements, suitable input terminals are given in to the meter and output wires are taken out from the other end. A preliminary checking of the meter is done by connecting an appropriate light load like a bulb just to ensure that the meter is capable of performing as desired and whether all necessary parameters are being measured. Two ordinary twisted pair cables are used to connect the CH 340 to the energy meter. One end of the cable is connected to the port labelled A in the energy meter and the corresponding other end is connected to the terminal d+ on the CH 340. Another wire is used to connect the terminals B and d-. The USB end of the CH 340 is connected to any one of the four USB ports of the raspberry pi. The raspberry pi is powered through a suitable source via the micro USB port with 5V. Peripherals if any are required for smooth operation of the raspberry pi, then they are connected to the USB port accordingly. They include extension of the visual display interface through a touch screen or monitor and providing user control via a keyboard and mouse. The visual display unit used here is a HDMI touch screen of 5 inches. It provides ample visual representation along with effective means of control. The pin socket of the touch screen is connected to the GPIO pins of the raspberry pi. Now, the combined new system is powered by providing supply through the supply port in the touch screen instead of that in the raspberry pi. The system is connected to the internet by means of Wi-Fi. The raspberry pi is configured according to requirements and the connections are given as described. The loads are connected and the supply is switched on. The meter will quantify the amount of energy consumed and the same will be processed and displayed in a real time manner through the raspberry pi. The output will be displayed on the touch screen as well as an online IoT platform through suitable visual platforms.

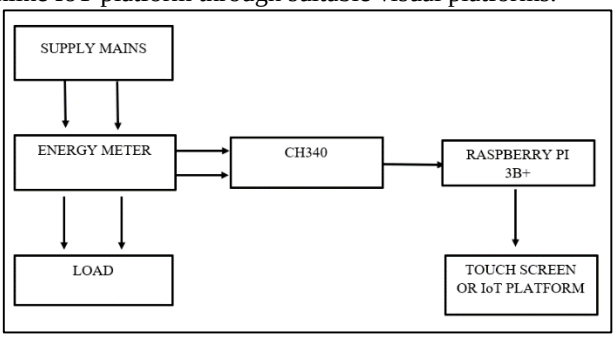

Figure 1: block diagram of the proposed system

The figure above displays the block diagram of the project. Power flows in from the supply to the load through the energy meter. From the A and B terminals of the energy meter, RS485 output is taken and fed to the CH340. It produces an output which is sent to the raspberry pi via USB communication. The raspberry pi processes the data and uploads it to cloud storage.

V. EXPERIMENTAL OUTPUT

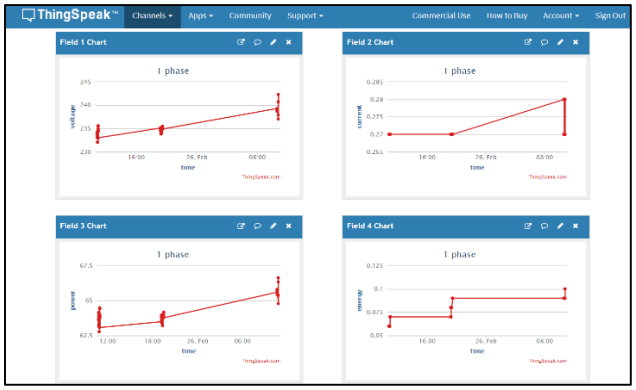

Figure 2: Output of the proposed system displayed in an IoT platform

Once the system has been connected as specified in the target area, automatically readings from the energy meter will be processed in the raspberry pi and displayed through a touch screen or in a IoT platform such as ThingSpeak or Grafana. Figure 2 displays the output of the proposed system in ThingSpeak. Parameters which need to be monitored and displayed can be customised as needed. The output can also be viewed via mobile phones, computers thereby giving real time energy consumption data to the user irrespective of his/her location.

VI. CONCLUSION AND FUTURE SCOPE

Smart meters are an integral part of smart cities program. This project, Real time energy monitoring using Raspberry Pi throws light on feasibility of transforming the smart city from dream to reality. It shows the practices of smart metering concept which could be embedded into current metering system. The proposed model enhances the ease of operation, lessens man power burden and increases the reliability on metering system. Thus, smart metering system turns the concept of man-machine interface to machine-machine interface which is less erroneous and increases reliability in operations. In a nut shell, this project opens doors for wide opportunities on building automation programs with regard to energy sector. If adopted it could bring forward a threshold of changes in current metering system and could act as a giant leap for a digital transformation and a step closer to turn the smart city concept into reality.

This project can also be used to control other peripherals like relays which operate on feedback from sensors attached to various electrical apparatus. This system can be extended to act as an energy conservation and control unit by using sensors and control elements as needed. This will provide and enable the user to have a hold on his energy consumption in a real time manner. Further this project can be extended to greater heights. Installation of smart meters can also be used for power factor calculation in industries. Illegal power theft can be detected. The project has huge scope for research and analysis purposes in the power and energy sector.

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