An Innovative Ghost Power Wastage Reduction System

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***Abstract*—The research paper presents an innovative system for the reduction of energy wastage due to ghost or vampire power with the help of Visible Light Communication, Very large scale integration (VLSI) devices and the Internet of Things (IoT) technology. The system assembles daily energy usage data using an Intelligent Energy Meter system on a cloud server. The data of electricity consumption requirement of various devices is processed on the server. An intelligent energy switch is designed which lets the power supply of an appliance connected to it to turn off and thus avoids the excess electric leakage loss. The switch is operated using visual light communication technique, it also utilizes the use of a relay and Very large scale integration (VLSI) techniques for fast turn off action. The total power consumption is also measured by the intelligent energy meter.**

***Keywords*—Internet of Things, Mobile Application, Power, Very large scale integration, Visible light communication.**

I. INTRODUCTION

With an incrementation in technological invention and engenderment of incipient electrical devices which are used for commercial purposes the energy utilized and wasted by them need to be monitored.

At present most of the houses have many electrical devices which are utilized for daily need including a mobile phone charger, geyser, TV, Stereo Systems, Home theater, A.C., etc.

It is often observed that a user switches off the plug of a device when they find that the device is completely charged or when its use is over 1. But some electrical appliances actually never turn off and these still consume power in the standby mode. Albeit the power loss due to a single electrical device is very less and can be considered to be negligible but when we consider the energy wastage for a large number of devices, the energy wastage is sizably voluminous and needs to be minimized. Various devices draw a minuscule value of energy when they are turned off, this energy wastage occurs in most of the appliances that utilize electricity. The energy wastage can be minimized by detaching the appliance or by using various techniques that cut off the puissance to the electronic devices [2]. This energy is termed as Standby Power also termed as Vampire or Ghost Power. A report estimates that 40% of worldwide power utilization and consumption takes place in residential places [3], also a study conducted in France found that 7% of total residential consumption was accounted to vampire power [4]. Thus contribution to standby power by a large number of devices results in a substantial amount of energy loss over a long duration of time that needs to be minimized. The standby power poses a great risk to life. Fire may also result from devices in standby mode [5]. Various technologies have been developed that have achieved success in standby power reduction [6]. The paper presents an innovative approach for standby energy wastage reduction based on visible light communication technique that involves interaction between a centralized LED or a light source present in a room with an intelligent switch present in the room. The light source is operated using IoT devices using user mobile via a hybrid mobile application.

II. GHOST POWER AND ENERGY WASTAGE

A. Power Estimation

Heat dissipation results from power wasted due to standby. The standby power used by various devices can be estimated from their consumption tables [7)][8]. The total standby power estimation can be carried out by measurement of the total residential power with all appliances in the standby mode, then disconnecting them [7] but this technique is exposed to large faults and errors [9]. Wattmeter gives information about the energy used by home applications along with some indication of standby usage.

B. Reduction of Standby Consumption

Different appliances that incorporate rechargeable batteries are plugged and results in power wastage issue due to standby when the battery is completely charged. Quick Start Mode is available on various appliances, the standby wastage can be eliminated if this mode is not used. For example, a reduction in power from 18 watts to 1 watt is observed by not using WiiConnect24 and Standby Connection options in a Wii console [10][11].

III. TECHNOLOGIES USED IN THE PROPOSED SYSTEM

A. Internet of Things (IoT)

Various devices including smartphones, laptops, tablets, smart watches, etc. and new technological inventions that are produced in modern day world are equipped with Internet Connectivity. These devices exchange data with Internet [12]. IoT is becoming one of the most developing technologies in the modern day world. It finds various application in industries, home, logistic counting and modern cities [13]. Internet of things technology is also of great use in airlines, healthcare organizations, warfare and other data exchange processes [14].

B. Visible Light Communication

Visible light communication (VLC) utilizes visible spectrum band of light for digital communication [15]. The device that uses visible light communication contains photodiode and light receivers [16]. VLC has various applications in

communication because light producing devices are present almost everywhere [17]. VLC has found its way in security [18][19] and has achieved communication link up to 10Mbit/s [20]. Light Fidelity or Li-Fi is a communication technology based on light communication in which data is transmitted by light waves instead of radio technology [21]. It is an efficient and economical viable version of Wireless Fidelity [22][23].

C. MOSFET and Diode Devices

The proposed solution utilizes MOSFET and diode for proper functioning. MOSFET devices [24] are capable of acting as a switch. A diode has the capability of protecting devices when placed parallel to it. In practical use, whenever a device with a coil is operated and the power signal applied to it is stopped, a negative voltage gets build up which is enough to kill a small device like MOSFET thus diode is attached parallel to the device and protects it from negative voltage. Photodiode acts as an excellent light detector sensor that helps in visible light communication. Infrared light communication can also be utilized in places with bright lighting conditions.

D. Use of Relay Devices

Electromagnet finds its special use along with a set of contacts for the formation of Relay [25][26]. The proposed model utilizes solid state relay [27][28] which is connected to the main power supply and can be used to cut the power supply to the device when required by the user.

E. Microcontroller

Cheap microcontrollers can be utilized for the working of the proposed model. For the operation of a single switch, an IoT based microcontroller is required to connect to the Internet for data transfer and mobile controlling operation. The smart switch also requires a microcontroller for its operation.

IV. PROPOSED METHODOLOGY

The system comprises of various processes-data acquisition from Intelligent Smart Energy Meter using sensors, processing of the data and storing it online on the server, applying the algorithm to soothsay energy requisite & standby power consumption and finally utilizing the developed mobile application to remotely connect to the light source devices present in a house by Internet of things technologies. The light devices can perform a line of sight communication with the Smart Switch predicated on a devised coding technique and can perform the cut off process by setting a timer as per user requirement. The working of the system is explained in the next subsections.

A. System Working

The user is provided with a mobile application which communicates wirelessly with the microcontroller present with the light sources, which in return can interact with the switches via visible light communication technique and set time duration for power cut. The circuit provided with the switch sends a signal to relay which is connected to the appliances to turn them on or off. The information cognate to the potency consumption is read by the energy meter. The sensor senses the value of energy meter and provides the data to an Internet-connected device which uploads the data to a server. This data is monitored through the mobile application.

B. Data Acquisition from Intelligent Energy Meter

The energy meter monitors data of energy consumption of various devices connected in a house or place. The data is analyzed and uploaded to the server using the Internet.

C. Use of Visible Light Communication

The system utilizes LED devices and light sources based communication due to the advantage of near range communication, unregulated broad bandwidth and cost-efficient equipment [29]. The LED and other light sources that are present at centralized position in a room or place are controlled using an Internet of thing device and a microcontroller. The user can control the flash rate and produce an encoded signal based on an innovative coding technique. The flashes can be perceived by the light sensor receiver [30] embedded with the Smart Switch and can be decoded to produce the desired result. Visible light communication can be easily used in RF Signals prohibited areas that include Medicare facilities and airports [31].

D. Coding Technique Utilized by the System

A coding technique is devised for visible light communication; the technique performs two important functions

- Identification of switch that needs to be set on the timer mode for standby power control.
- The time duration that needs to be set by the user for power cut.

The flash rate from the LED Sources are monitored and received by the switch sensor in two time intervals each of 3 seconds duration. In the first 3 second duration the flash rate determines the switch selection, for example, selection of switch A3 in a room consisting of 5 switches numbered from A1 to A5 can be easily carried out by setting the flash rate of 3 flashes per second. The next 3 second interval determines the timer setting procedure based on standby power consumption and user requirement where flash rate sets hour duration after which device's power is cut off.

E. Design of Smart Switch

Smart switch design involves the use of sensitive light detecting sensors, a microcontroller for process controlling and application of MOSFET & diode devices. The circuit for the Smart Switch is shown in Figure 1. The circuit consists of N-MOSFET, diode, pull-down resistor and relay. The functioning of various components used are-

- Relays are used for setting the duration of appliances connected to switch.
- The diode is used to prevent voltage spikes flowing in opposite direction. Fast action and load capacity decide the diode to be used in the circuit. For the protection of microcontroller, an optoisolator can withal be used between microcontroller and transistor.

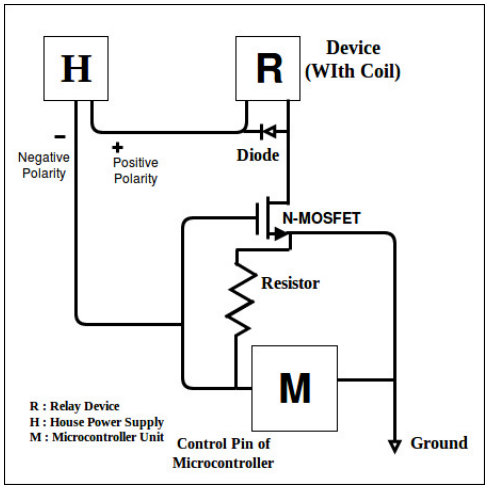

Fig. 1. Circuit Schematic of Smart Switch

- Pull down resistor is utilized for setting the gate electrode of the MOSFET low when no signal is sent by the microcontroller.
- MOSFET acts a switch it allows the flow of the current from source to drain when switched on.

F. Hybrid Mobile Application

A hybrid mobile application is designed for monitoring of energy utilized by various devices plugged in the switch and for setting the timer of the appliance connected to the switch. The application is provided with user registration and login page. It is connected to user's home via the Internet. The application displays the energy consumption rate and method to operate the switch.

G. Work flow Model

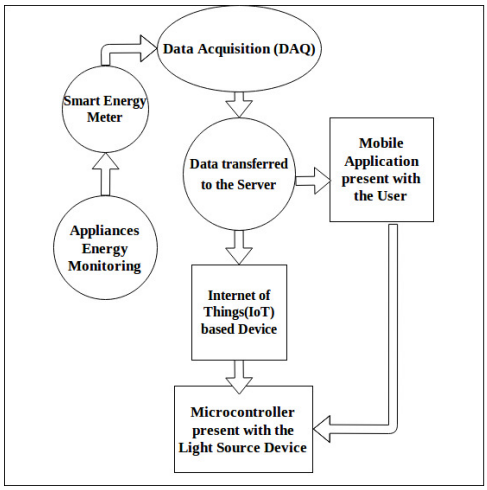

Fig. 2. Workflow Model of the proposed system

Figure 2 explains the workflow of the proposed model. Various devices and appliances are monitored for data consumption and standby power using smart energy meter. The data acquired is stored on a server. A mobile application monitors the data and connects to the light source present in a house via the Internet of things devices and communicates with the Smart Switch.

H. Smart Switch Circuit

Figure 1 displays the circuit schematic diagram of the smart switch. The circuit consists of NMOSFET device which acts as the switch and diode for the protection of device with a coil such as a Solid State Relay. The terminologies used in the figure are-R denotes Relay Device, H denotes House Power Supply and M denotes the Microcontroller unit. The gate terminal of the MOSFET device is connected to the microcontroller pin for operation. The microcontroller provides the signal to the MOSFET device for operation.

I. Predicted Energy Saving Calculation

Consider a light emitting source, for example, a 50-watt conventional bulb; the bulb is left on for approximately 5 hours a day beyond the time when it is needed. The energy wastage calculation-

- 50 x 5 = 250-watt-hour per day is wasted.
- 250-watt-hour x 30 days a month = 7,500-watt-hour or 7.5 kilowatt-hour a month.
- 7.5-kilowatt-hour x 5 rupees per kilowatt-hour = 37.5 rupees per month wasted or 450 rupees per year is wasted.

The calculation is summarized in Table 1. Thus the calculation shows how the standby wastage results in huge money loss over a long period of time. So with the presented system we can save electrical energy wastage and money loss [32].

TABLE I
ENERGY WASTAGE CALCULATION

Time Period	Energy Wastage
Daily	250-watt-hour
Monthly	7,500-watt-hour
Yearly	90,000-watt-hour

V. DISCUSSION

With the help of the proposed solution, the accessibility of home appliances can be improved and they can be remotely accessed from anywhere. The service duration of appliances can also be efficiently determined. With the help of a mobile application a user can view the overall calculated power consumption. The LED and light sources used for light communication are in direct control of the user and can be controlled when required. The LED source used in the communication has a small energy requirement for working when compared to the standby power loss. The proposed system is prone to hackers. If a hacker acquires the system then the data can be easily manipulated and the appliances connected via the Internet of thing devices can be accessed and misused. The system is only possible in smart cities and not everywhere due to the unavailability of Internet connectivity. Some useful application of the system is - Any required

electric appliance can be switched on remotely before the person reaches his/her home. Also, suppose if a mobile phone requires two hours for complete charging, it can be timed for that duration. This prevents the power wastage compared to the case when the socket is not timed and the charger is left idle without switching it off.

CONCLUSION

The research paper proposes an innovative solution for the reduction of standby power.Visible light communication is utilized along with Internet of Things technology and VLSI Devices. With an increasing scenario of power wastage in the modern day world, the system provides a solution for energy conservation.This system can further be upgraded to send the power consumption data directly to electricity department which will reduce the effort of electricity officials to manually note readings from the meter of individual houses. A detailed analysis of the power consumption data can be generated and it can be studied to get an idea of the power consumption during a particular period of time in a day. If the usage within this period of time is controlled, the overall power consumption cost can be reduced.

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