Arduino Based Automated Energy Saver in it and Domestic Load

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***Abstract*— The power consumption of electronic appliances are usually neglected in standby mode but it is very crucial to consider phantom loads like computer, TV for the efficient power usage. This proposed word presents a solution to detect and cutoff the phantom loads both in IT and domestic environment. In this paper, socket supplies the appliances with power when the user turns them on. When the user turns them off, our socket shuts the electric power off and reduces the standby power to zero. In this design, which uses Arduino, receives signals from a Passive Infrared (PIR) sensor which detects the user approaching the socket in domestic environment. A relay panel provides an Arduino to control the relay On/Off when used as an appliance switch for shutting off the standby power. The Arduino monitoring program provides both automatic detection of the user by the PIR sensor and detection of power consumption.**

Keywords—Phantom Load, Arduino, embedded C, sensor, Automation.

I. INTRODUCTION

Standby mode is defined as a mode, in which electronic devices wait in low load, expecting an external wake-up signal. This wake-up signal could be activated through remote control, network connection, keyboard and mouse. Recently, the standby mode is widely adopted for many applications as users require devices that are always available and can be remotely turned on and off. Electronic devices in the standby mode are always ON and consumes some energy required to supply the micro-controller and other standby circuitry. These days, standby power has become a growing concern in the international community. Standby power is the electric power consumed by the electrical appliances while they are turned off or in standby mode before operating their main functions. That is, the power is consumed even though the electrical appliances which are plugged in the sockets are not in use. Most of the electrical appliances have the standby power ranging from less than 1W to as much as 25 W. Over the last several decades many electrical appliances such as computers, televisions, refrigerators, printers, microwaves, various kinds of players, etc. have been used in houses and offices.

Arduino is an open source platform used for building projects. It does not need separate hardware to load new code onto the board. It is inexpensive and comes with free authoring platform, easy to use for beginners. Self-automated energy saver means the lights, fans and other appliances are controlled automatically to save energy. Domestic load can be defined as the total energy consumed by the electrical appliances in the household work. IT loads means the amount of energy consumed by servers and network equipment in server rooms. A phantom load is electrical power that is consumed by appliance while it is not performing their primary function, often waiting to be activated by remote controller. The power is consumed by remote control receivers, text or light displays, circuits energized when the device is plugged in even switched off, etc. Phantom loads are also known as standby loss, leakage electricity, waiting electricity, free running power, off mode power, energy vampires and standby power.

Two methods [1] are used. In method 1 the motion sensor checks for the user and turns ON the socket for 10 minutes. If not the sensor off the supply to the socket to 10 minutes. This repeats for every 10 minutes. In method 2 The user defines the turn ON period. Only in that duration the equipment gets turned ON and the rest of time it remains OFF [1]. The methodology [2] is that the PIR sensor detects whether the user is approaching or not. When the user is detected as he/she is approaching with the equipment the Solid State Relay (SSR) supplies the power to appliances, if the user is not detected then the relay cuts off the supply using power detector. The relays which are used are controlled by different controllers. Separate controllers are used for separate sockets to control each appliance which increases the cost.

We will be using single controller to sense different power detectors to detect the supply when the equipment is in sleep mode. And we will be using Arduino as a controller. And, the time which had been set by the user before that time the user will not get the supply to the socket and this will be rectified. The prime objective is to design Arduino based automated energy saver by detecting and cutting off the phantom load when appliances are in standby mode. When the device goes to standby mode the hall current sensor detects the power flow through the device and sends the signal to the Arduino and Arduino sends a command to the relay panel to cut off the power supply to the socket to which the appliance is plugged in. The sub objective to sense and switch off the supply when the user is not approaching near the electronic appliances.

The organization of this paper is as follows. In Section II block diagram has been presented, in section III components explanation has been given, In section IV the

working principle and operation, In section V the interfacing of module and in section VI expected results has been shown. In section VII conclusions are drawn.

II. SYSTEM DESIGN

The automatic energy saver can be designed by using Arduino with the aid of various sensors and relay panels. The block diagram of automatic energy saver is as shown in figure 1.

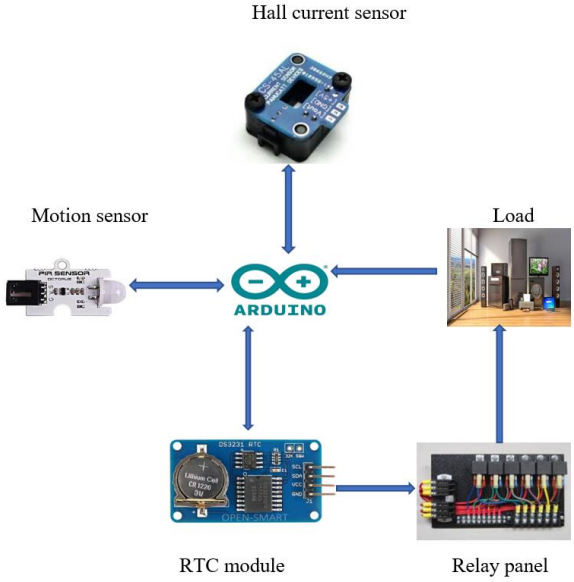

Fig 1. Block diagram

III. HARDWARE REQUIREMENTS

It consisting of Arduino, hall current sensor, motion sensor, rely panel, RTC module.

1.Atmega328P Microcontroller

ATmega-328 is basically an Advanced Virtual RISC (AVR) micro-controller. It supports the data up to eight (8) bits. ATmega-328 has 32KB internal built-in memory. ATmega 328 has 1KB Electrically Erasable Programmable Read Only Memory (EEPROM). This property shows if the electric supply supplied to the micro-controller is removed, even then it can store the data and can provide results after providing it with the electric supply.

ATmega-328 has 2KB Static Random-Access Memory (SRAM). It has 8 Pin for ADC operations, which all combines to form Port A (PA0 – PA7). It also has 3 built-in Timers, two of them are 8 Bit timers while the third one is 16-Bit Timer. It operates ranging from 3.3V to 5.5V but normally we use 5V as a standard. Its excellent features include the cost efficiency, low power dissipation, programming lock for security purposes, real timer counter with separate oscillator.

2. Motion Sensor (PIR Sensor)

The PIR Sensor module allows you to sense motion. It is almost always used to detect the motion of a human body within the sensor's range. It is often referred to used "PIR", "Pyroelectric", "Passive Infrared" and "IR Motion" sensor. The module has an on-board pyroelectric sensor, conditioning circuitry and a dome shaped Fresnel lens. The PIR sensor module provides an output "HIGH" when a human body is detected within its range and an automatic Delay "LOW" when the body leaves its range.

The delay time is adjustable using the potentiometer on-board. The minimum delay time that can be set is 5 seconds and maximum of 200 seconds.

3. Hall Current Sensor

ACS712 Current Sensor, how a Hall Effect based current sensor works and finally how to interface the ACS712 Current Sensor with Arduino. A Current Sensor is an important device in power calculation and management applications. It measures the current through a device or a circuit and generates an appropriate signal that is proportional to current measured. Usually, the output signal is an analog voltage.

4. Relay panel

A relay is an electrically operated switch that can be turned on or off, letting the current go through or not, and can be controlled with low voltages, like the 5 V provided by the Arduino pins.

5. RTC module

A RTC is a computer clock that keeps track of the current time. Although the term often refers to the devices in PCs, servers, and embedded systems. This handy module keeps accurate time for years using a tiny coin-cell, and is very simple to connect to Arduino. A driver library allows program to easily set or read the time and date.

An electrical load is a device or an electrical component that consumes electrical energy and convert it into another form of energy. Electric lamps, air conditioners, motors, resistors etc. are some of the examples of electrical loads

1. Industrial Load

Industrial load consists of load demand by various industries. It includes all electrical loads used in industries along with the employed machinery.

1. Domestic Load / Residential Load

Domestic load consists of lights, fans, home electric appliances (including TV, AC, refrigerators, heaters etc.), small motors for pumping water etc.

IV. WORKING PRINCIPLE

In IT Company the loads will be personal computer. We will be working with two modes of operation. One is automatic mode and the other is manual. In automatic mode, when the device goes to standby mode it is detected by the hall current sensor and gives the signal to the controller. And the controller sends the command to the relay panel to trip the supply to the socket. The RTC module checks for the pre-set value and relay panel cuts off the power supply to the circuit.

In second mode, there will be two delays. They are short time delay and long-time delay. If the user does not approach to the system within short time delay the long-time delay gets activated. If the time exceeds the long-time delay the controller will cut off the power supply to the socket.

DOMESTIC:

PIR sensor detects whether the person is available in the place or not. If it does not sense the person, the equipment automatically goes to the standby mode.

When the hall current sensor senses that the power flowing through it that it is less at that time than at the normal condition it sends the signal to the Arduino and the same process as explained for the personal computer. Arduino sends a command to the relay panel to trip the supply for which the TV is connected only for certain duration.

V. INTERFACE WITH THE MODULE

The steps included in interfacing the module with the Arduino includes:

Step 1: Designing a Programmer Shield

Step 2: Building the Shield

Step 3: Setting Up the Arduino IDE to Use the Programmer

After building the programming shield, connect it to an Arduino UNO, and connect the Arduino USB cable to the PC.

Open Arduino IDE
Select File - Examples – Arduino ISP
Upload the sketch to the Arduino.
The programmer shield LEDs should flash rapidly, where after the OK LED will fade on/off.
Select Tools - Board - Arduino UNO Select Tools - Programmer - Arduino as ISP

Step 4: Using the Programmer Shield

The same method can be used to program an AtMege328P in a stand-alone circuit (breadboard or PC board) using the programming cable. For stand-alone circuits, it is normally required that they are powered up via their own supply. If no supply is available, and the circuit does not require a lot of power, the circuit can be power from the programming shield by switching on the +5V.

VI. RESULTS AND DISCUSSION

Standby power consumption of an External modem for a computer:

1. Energy input (kWh) during the measured Time: 0.042kWh
2. Cost/Tariff (Set the tariff at the tariff rate for 1.55) : 0.062
3. Smallest Wattage: 1.0W
4. Highest Wattage: 7.2W
5. The amperage of the unit measured during on Time: 0.023A
6. The measured voltage measured: 225V
7. The actual kWh & Cost per year: 3.0W

Assume the modem is on standby for “a” hours and was on working for “b” hours.

a+b = 24 (Total number of hours over which kWh is recorded)
1a+7.2b = 42 Wh
1a+7.2(24-a) = 42 Wh
a=21 hours; b = 3 hours

The modem is working for 3 hours and was on standby for 21 hours. The power consumption would be
(7 Watts × 3 hours) + (1 Watt × 21 hours) = 42 Watt-hours
During standby mode, the modem is consuming 21 watt hours, the excess of electricity is consumed by keeping the external modem on standby mode instead of switching it off completely.
With reference to above calculation [6] The power consumed per hour in domestic loads like TV and refrigerator in standby mode of 83 and 110 watts respectively has been reduced to 0 watts. And the power consumed in IT loads per hour per modem and CPU of 7 and 108 watts has been totally deducted. Motion sensor is used in design used for domestic loads to get the user’s presence.

TABLE 1

Devices	Power consumed in standby mode (watts per hour)	Expected result
TV	83	0
REFRIGERATOR	110	0
MODEM	7	0
CPU	108	0

In table 1, it has been shown that by the implementation of this paper, the power drawn by the appliances has totally deducted to zero.

VII. CONCLUSION

Although the standby power of electric home appliances is not great, it affects the electricity bill in the long run. In this paper we propose a design which reduces the standby power substantially. Our design, the low standby socket, which consumes 0W, is easy to set up and is inexpensive. In the long term our design saves very much power. Furthermore, our design, which is equipped not only with power detector circuits and with an MCU to control both an relay panel and a PIR, is easily modified by programming

and can then be applied to a new generation of appliances to save more power.

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