Energy Management System for Office/Home Automation

Divyashree D A[1*]
Department of Electronics & Communication Engineering,
Malnad College of Engineering
Hassan, Karnataka.

Dr. B R Sujatha[2]
Department of Electronics & Communication Engineering,
Malnad College of Engineering
Hassan, Karnataka.

***Abstract*—Intrinsically in home and office, electrical appliances like lights and fans are controlled manually, which leads to power wastage most of the times. The key to saving energy in any organization is energy management. This needs a smart control of all the electrical appliances and electronic devices at home and in office. This smart control can be done considering the ambient temperature variations, the presence of people etc. We have designed an IOT based smart automated controlling system for appliances which can save power.**

Keywords–ARM-7 LPC2148 Microcontroller; RTC; LM35 Sensor; KeilmicroVision4 IDE.

I. INTRODUCTION

Energy consumption is the amount of energy or power used in order to maintain any electronic or electrical system. When we buy any electronic devices like desktop computers, laptop, tablet etc., electricity consumption is rarely considered as a cost factor. Most people use laptop, tablet and desktop without having the knowledge of how much power it consumes. Over consumption of energy reduces the life time of battery and other components, which makes the system less durable and reliable. For example, when a desktop computer should be ON for 24x7 and for 365 days, the lifetime of the battery gets reduced and energy consumption is increased.

Although there may be various factors that may be crucial for someone while shopping for a gadget, power consumption is the most crucial factor for the gadget to operate in an efficient manner. Power control is seen in several electronic equipment specifically copiers, computer systems, CPUs, GPUs and PC peripherals including monitors and printers that turns OFF the power or switches the system to a low energy state. In the present environment it is termed as the PC power management and is designed as ACPI standard. For instance, in the previous decade, computers were consuming 175watts of electricity. But with the ACPI power management with Advanced Configuration and Power Interface (ACPI) power management method, the energy consumption is reduced to 60watts.

Thus, ACPI is an enterprise specification for the efficient handling of power consumption in laptops and cellular computers. ACPI specifies how a computer's primary input/output devices, running machine, and peripheral devices communicate with each different component about power utilization. Although it may not be obvious, there is an instantaneous connection among energy utilization and the surroundings. In any case, the observing and results-driven methodology utilized by professional energy managers is similarly as compelling in the home for what it's worth in large buildings. Even though there are numerous commercial energy effective products that are helpful in energy saving for particular appliances, it is still difficult to find a comprehensive solution to effectively reduce energy consumption in the appliances. Thus, the importance of power saving and need of a smart system arises. With the reduced power consumed, the quantity of toxic fumes released from electrical and electronic appliances and in electricity plants can be reduced, which in turn preserve the Earth's atmosphere from destruction.

Energy management systems are being designed and used in several fields. Also considerable amount of literature is available with regard to smart energy saving.

CH. Madhuri Devi et.al [1] have proposed a paper that presents a detail view of modern power management system. Wireless verbal exchange is implemented, so that the data on energy statistics can be transmitted to a centralized tracking station through a FM transmitter & FM receiver.

A Lachi Reddy et.al [2] have proposed a modem Energy Management System using Smart Meter and Web Server. The assignment includes three portions: the electricity meter (modern-day, voltage sensors), the microcontroller, and the Ethernet chip that's used to connect to a LAN.

Madhu M S et.al [3] have proposed a Smart Power Saving System for Home Automation. By designing a smart computerized controlling system for appliances they have shown that energy consumption can be reduced.

Grenville J. Croll [4] have proposed the use of computer and allied technologies to improve the energy efficiency of the system. The report is divided into shipping, industrial, commercial and domestic sections which correspond to the most important electricity sectors of the economy.

The rest of the paper is organised as follows, Section II provides the system description and design followed by Section III that details the implementation of the work. Section IV discusses the outcome of the wok followed by conclusion.

II. SYSTEM DESIGN

The system block diagram is as shown in fig. 1 which consists of hardware peripherals like ARM-7 LPC2148 Microcontroller, RTC (Real Time Clock), EEPROM, Relay, LCD Display, Buzzer, LM35 Sensor, power supply.

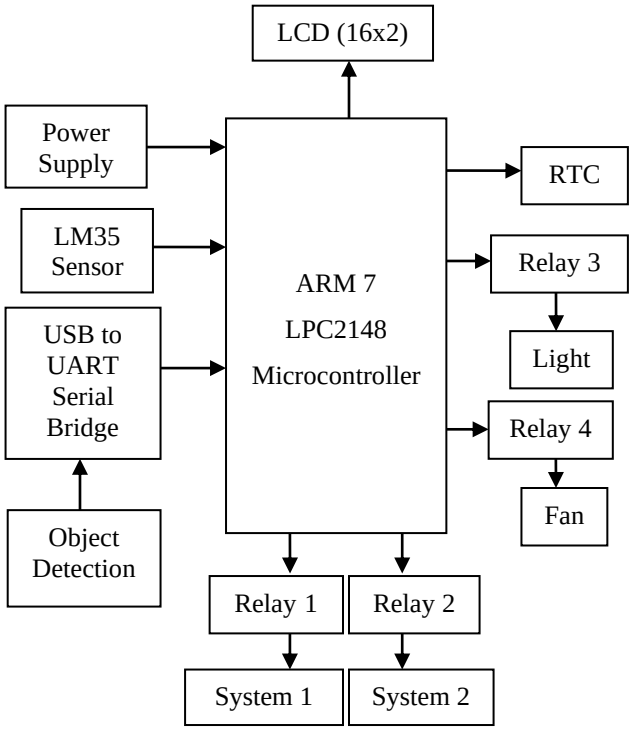

Fig 1. Block diagram of the system

A. ARM-7 LPC2148 Microcontrollers

ARM normally known as Advanced RISC Machine. It is a Reduced Instruction Set Computer (RISC) instruction set architecture (ISA) developed by way of British organization ARM Holdings. The most broadly used structure is 32-bit instruction set structure. LPC2148 microcontroller is arranged by Philips (NXP Semiconductor) with not many inbuilt features and peripherals. In view of these reasons, it will make continuously solid just as successful option for an application engineer. LPC2148 is a 16-piece/bit or 32-piece microcontroller reliant on ARM-7 family. Features of ARM-7 LPC2148 Microcontroller:

- The LPC2148 is a 16-bit or 32-bit ARM7 family based microcontroller.
- ON Chip RAM is 40KB.
- 512KB of Flash Memory.
- 60MHz of oscillator frequency/ clock frequency.
- It contains 2 ADC that is 8-bit and 10-bit.
- In this two 32-bit timers are present.
- 2 UARTs they are UART0 and UART1.
- Operation voltage of 3.3v.
- For this board, the input voltage is 12v.
- It is a 32-bit IC. It contains two ports that are port 0 and port 1. Port 0 is from 0 to 31 which are available pins and port 1 is from 16 to 31 are available pins and 0 to 15 are reserved pins. The total available pins are 48.

B. RTC

It gives a time counter which provides the counts continuously in real time. By using the RTC we get the present date and time details. It is clocked continuously for tracking the current time by using separate oscillator that is 32.768 KHz. LPC2148 RTC can be timed by a different 32.768 KHz oscillator or by a programmable presale divider dependent on the APC clock. It keeps up a schedule and clock and gives seconds, minutes, hours, month, year, and day of week, day of month and day of year. It has power supply pin that can be associated with a battery or to the primary 3.3 v. To program the RTC one should use the registers.

C. LM35 Sensor

It is a precession Integrated circuit Temperature sensor, the output voltage varies based on the surrounding temperature. It is a small and reasonably IC in this we can measure the temperature from -55°C to one hundred fifty°C. it is interfaced with microcontroller which contains ADC characteristics. Power the IC by means of giving a supply of 5v and the ground pin will be grounded.

D. LCD Display

LCD (Liquid crystal display) screen is an electronic display module and has a wide scope of application. A 16x2 LCD display implies it can display 16 characters for each line and there are 2 such lines like 80 – 8F and C0 - CF. In this LCD each character is shown in 5x7 pixel matrix.

E. Relay

Relay is one of the most simplistic component but they are also one of the most important because relays are the link between low power digital electronics and high power digital electronics. Relays allow the digital circuits and digital microcontrollers to switch high powered devices ON and OFF. Relay consists of a coil which builds the magnetic field when current is passed through it. When power flows via the primary circuit, it activates the electromagnet, generating a magnetic discipline that attracts a contact and activates the secondary circuit. When the power is switched off, a spring pulls the contact lower back as much as its original function, switching the secondary circuit off once more.

F. USB to UART Serial Bridge

USB to UART converters are the serial port to PC and send the information over the wires serially. When the two devices communicating with UART then there is 3 connection is done. One is Common ground. Another is the transmitting pin (Tx) of one device is connected to the receiving pin (Rx) of the other device. Similarly, Rx is connected to Tx.

III. SYSTEM DESIGN AND IMPLEMENTATION

When a system should be ON for 24x7, then the life time of the battery reduces and the system becomes less durable and reliable. So, to overcome this problem in this work we have using two systems.

The two critical system needs to be switched for every one Hour instantaneously without delay. For this purpose, we use RTC (real time clock). Initially RTC (Real Time Clock) is started from zero and the system will switch exactly for every 1 Hour after 59 minutes to system 2 automatically and after 1 hour 59 minutes it will switch back to system 1 automatically. When the power goes down then the RTC will be running continuously. In this the relay is used to switch the system and LCD display is used to convey

manually to the user about the critical switching of the system. By using this system some amount of energy can be saved which leads to energy conservation. The overview of energy management system is shown in fig. 2.

In this system, depending on the room temperature the amount of power delivered to the fan is controlled, the room temperature is measured using LM35 sensor. Initially the camera will capture the image and the people inside image is counted and the count of the people will be sent to the LPC2148 using USB to UART Serial bridge. The light intensity is also controlled based on the number of people inside the office. When any person enters the office premises, it detects the presences of person using the object detection and automatically the light and fan gets turned ON and OFF accordingly. By using the object detection, one can take the count of the person inside the office.

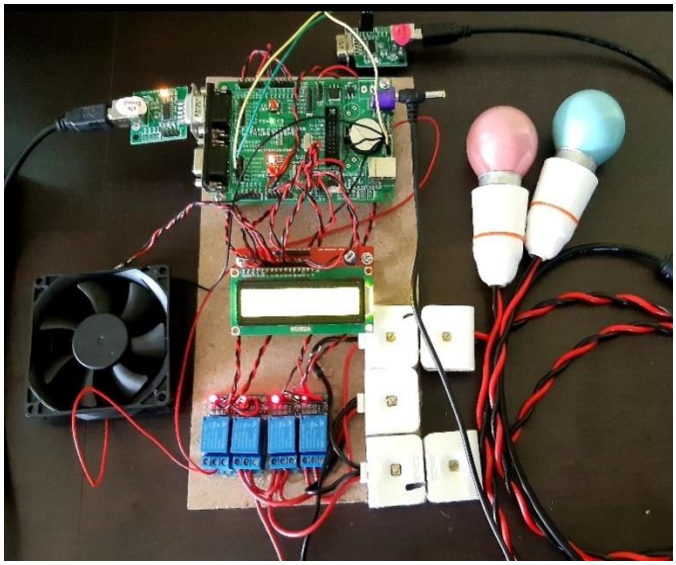

Fig 2. Overview of Energy Management System

Object detection is the way toward discovering real word object occurrences like car, bike, TV, flowers, humans in still image or videos. By utilizing the AI models which are capable of identifying and localizing numerous items in the single picture. For the object detection, the programming is done in python language using spyder. In this the data will be sent to the ARM-7 LPC2148 using USB to UART Converter. Based on the number of person the light will be turned ON and OFF. Opencv_python, cvlib, matplotlib, tensorflow these are the libraries that should be installed to perform the object detection for images or live images. Image is converted into an umpire array in the tensor flow OD so that the computation can be made easy. The Tensorflow which contains the record of the image along with the tags such as person tag, bulb tag, hostage. These tags are just label which are provided in the input data.

IV. SOFTWARE REQUIREMENT

A. KeilmicroVision4 IDE

The µvision IDE joins project management, run-time environment, build facilities, source code, editing, and program debugging in a single incredible condition. µvision is easy-to-use. With the µvision project manager and run-time environment you make programming application utilizing pre-fabricate programming parts and gadget support from software packs. The product part contains libraries, source modules, design records, source code layouts, and documentation. Programming segments can be nonexclusive to help a wide scope of gadgets and applications.

B. Philips flash utility (LPC2000)

Philips flash utility is used to upload the file to the microcontroller. The sets to upload the file is given below

- Open the Philips flash utility after completing the program.
- Select the appropriate COM port, for which the microcontroller is connected.
- Set the baud rate to 19200
- Select the appropriate file to upload to the microcontroller. The file name will be end with .hex extension.
- The use DTR/RTS for reset and boot loader selection is ticked.
- To establish the communication with the microcontroller “Read Device ID” button is pressed. Then “Read Part ID is successfully” message will be displayed on the left side of the flash utility window.
- To upload the file with .hex extension to the flash memory “Upload to Flash” button is pressed. Then “File upload is successfully completed” will be displayed in the left side of the flash utility window when the file upload is completed.

C. Embedded C

Embedded C is the most popular and commonly used programming language in the development of embedded systems. For programming embedded systems the most popular language used is embedded C. There are many popular programming languages like C++, Python, and basic C etc.

V. RESULTS AND DISCUSSIONS

The time control of operation of computing system can be achieved. Also energy consumption is controlled by smart turning ON and OFF of electrical devices. Concept of IOT will be used for smart energy management.

A. Critical switching of the system

The switching of the system is done for every 1 minute. Initially the RTC is started from zero and after 59 seconds the system 1 (bulb) will be turned OFF and the system 2 (bulb) will be turned ON automatically as shown in the fig. 3. Similarly, the switching process will continue and for every 1 minute which is controlled by inbuilt RTC. The change in time will be displayed on LCD display as show in the fig. 4.

When desktop is being used it uses minimum of 200 W/hour. When a computer is ON for eight hours a day then it uses almost 600 kWh and emits 175 kg of carbon dioxide per year. Similarly, when a laptop is ON for eight hours a day then it uses between 150 and 300 kWh and emits between 44 and 88

kg of carbon dioxide per year. When we use the laptop for one hour then it consumes a lot less energy that is approximately 30 to 70 watts per hour. So by switching the system we can save the energy and the life time of the battery will also increases and the cost of the electricity is also less.

B. Automatic Control of Fan

In this the fan is controlled based on the temperature and it is turned ON and OFF automatically based on the presence of the person inside the room. When the room temperature will be greater than 30°C then the fan will be turned ON automatically and when it is below 30°C then fan will be in OFF condition. The changes in temperature value will be displayed on LCD display. For example the power consumption of fan for 3 hours is 75 watts. When the fan is controlled based on the temperature than the power consumption is less than 75 watts and the cost of the electricity is also less.

C. Automatic Control of Lights

In this the light is automatically controlled based on the presence of the people inside the office. Here by using the concept of object dection we will get the count of the people inside the office. The data will be transferred from python, spyder IDE to the microcontroller by using USB to UART converter. If the count is greater than zero light remains turned ON and when the count becomes zero light gets turned OFF as shown in the fig. 5 and fig. 6.

The power consumption for the bulb will vary according to the different types of the bulb based on watts for example 30w, 40w, 100w etc. For example, a 100w light bulb operating for 10 hours would use one kilowatt-hour. So by using this we can manage the power consumption in both lights and fans.

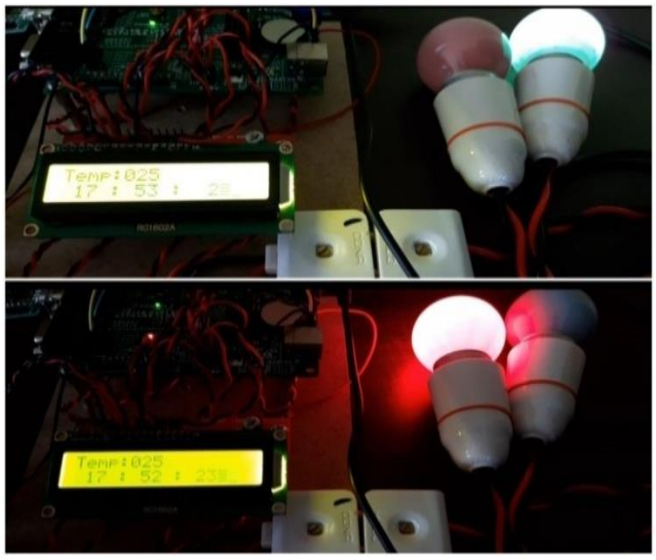

Fig 3. Snap shot of critical switching of the system (bulb)

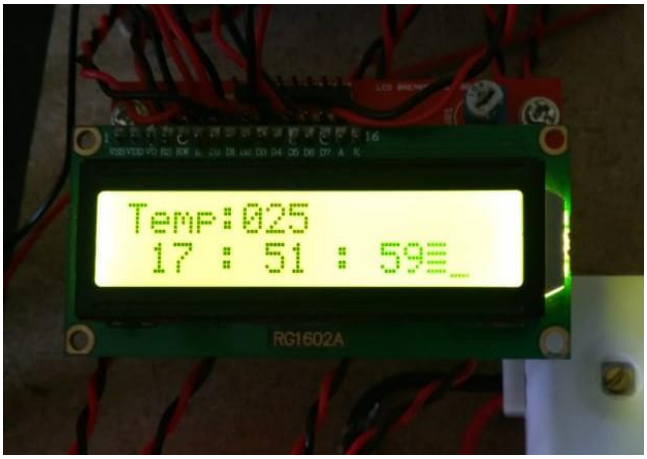

Fig 4. RTC timing displayed on LCD display

Fig 5. Output consol window of spyder with light is tuned ON

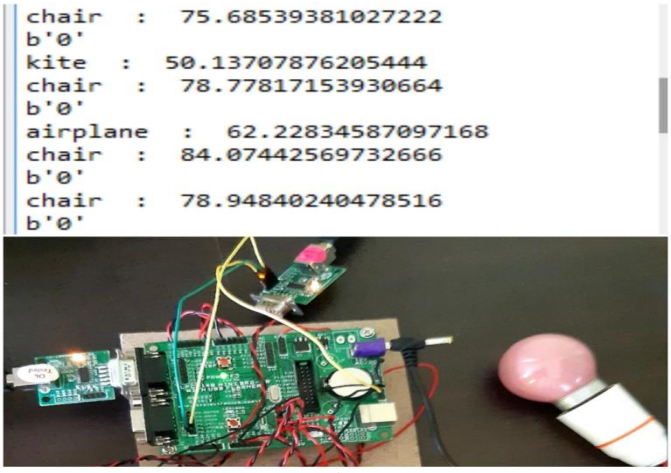

Fig 6. Output console window of spyder with light is tuned OFF

VI. CONCLUSION

Using this smart IOT based system; consumption of energy can be reduced. In this model we are using the machine learning concept for object detection to determine the presence of people inside the office to control the electrical appliances. This system can be used in several applications including home and office automation etc.

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