

DESIGN AND CONSTRUCTION OF ENERGY SAVING SYSTEM USING AUTOMATIC ROOM LIGHT CONTROLLER (A CASE STUDY OF DEPARTMENT OF COMPUTER SCIENCE, OYO STATE COLLEGE OF AGRICULTURE AND TECHNOLOGY, IGBOORA)

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Abstract

The demand for electrical energy is steadily increasing, and the buildings sector represents one of the largest energy end use. The larger amount of that energy is wasted due to unnecessary heating and cooling. Several studies have shown that the major reason for this behaviour lies in poor controls and the lack of feedback information. This paper presents the design and construction of a digital bidirectional visitor counter with automatic room light controller. The bidirectional visitor counter is a reliable circuit that takes over the task of counting number of persons or visitors in the room very accurately and turn ON the room light when there is at least a person in the room; otherwise, the light goes off. It can also be configured to beep a warning alarm when the number of visitors exceeds the capacity limit of the space be it room, hall and what a few. The counter increments and decrements by value of 1 by the sensor. The sensor operates on bidirectional and is operated under the control of embedded programming code which is stored in Read Only Memory (ROM) of the microcontroller. The total number of persons inside the room is displayed on the Liquid Crystal Display (LCD). The microcontroller detects an entry or exit action and computing the figures (addition and subtraction) to acquire accurate results. The principal work of this system is based on measure the temperatures of several rooms in the smart home, and then send this information wirelessly to main control device which employing better controls and feedback information to turns on only one air condition in one room at each time to save the electrical energy. The simple measurement shows that using the suggested system can save the electricity cost for every test case.

Keywords: Energy, Saving; Counter; Timer; Controller

Introduction

Energy conservation is the effort to lessen energy consumption by reducing the number of services used or by using energy more efficiently. Conserving electricity gives numerous benefits to the consumer, nation and the environment. Energy-saving strategies can help save energy and money, improve our economy, and help stop global warming. One of the easiest ways to help reduce energy consumption is to use electronic products only when necessary. Energy costs are a huge part of the school's expenditures. Hence, the school administrators are tracking the energy usage and imploring everyone to do their share of conserving energy like using the air-conditioned units only from 11:00AM to 4:00PM; turning off lights in unoccupied rooms; turning off computers when not in use; and incorporating energy-efficient equipment. Making behavioural and operational changes in school has resulted in some energy savings. Changing a user's daily habits in using electricity has

a good impact in day-to-day life and to the environment. However, some people cannot simply turn the lights and fans off before leaving a room. The reminders and stickers saying to do this seem invisible to those who do not care. This misuse of electricity sees the need for an intervention or solution to minimize energy consumption.

A timer is a specialized type of clock for measuring time intervals. By function timers can be categorized into two main types. A timer which counts upwards from zero for measuring elapsed time is often called a stopwatch; a device which counts down from a specified time interval is more usually called a timer or a countdown timer.

Due to the menace of oil and gas pipeline vandalism in recent times by bandits and terrorists, Nigeria as a country experienced a massive drop in generated power by 1000Mw bringing the current generated power in the country to about 2,500Mw as against the peak demand of 12,800Mw. This development, in addition to the ever increasing tariff of electricity

consumption has necessitated the need for an intelligent energy saving system that will efficiently regulate power consumption in Nigerian homes. The conventional way of switching OFF lights for a period of time in order to save cost, comes with some sort of discomfort. This intelligent device can make smart decision based on data gathered or obtained from the environment. It will check the intensity of illumination within the designated area coupled with human presence, and then, decides whether to turn light ON or OFF. Many research works in the literature have presented different models aimed at addressing similar challenges. In his work, (Arun, 2013), a Light Controlled System (LCS) was presented which can minimize the energy consumed for lighting a room. In furtherance to this, our paper has taken into account other electrical and electronics office appliances where energy can as well be saved. These appliances include electric fan system, air conditioning system, and water heater among others. Using appropriate sensor networks, the environmental conditions where these appliances are used will be continuously monitored and the data sent to a microcontroller unit which in turn uses these data as a basis for either switching ON or OFF of the appliances.

Statement of the problem

Energy costs are a huge part of the school's expenditures. Hence, the school administrators are tracking the energy usage and imploring everyone to do their share of conserving energy like using the air-conditioned units only from 10:00AM to 4:00PM; turning off lights in unoccupied rooms; turning off computers when not in use; and incorporating energy-efficient equipment. Making behavioral and operational changes in school has resulted in some energy savings. Changing a user's daily habits in using electricity has a good impact in day-to-day life and to the environment. However, some people are not cultured in managing the consumption of power supply of home appliances, they find it stressful to turn the lights and fans off before leaving a room. Some employees and guest in organization settings do not care about the reminders and stickers conveying messages. This misuse of electricity sees the need for an intervention or solution to minimize energy consumption.

Aim and objectives of the study

The aim of the study is to design and implement an energy saving system using timer and the objectives are to:

- i. design energy saving system

- ii. develop energy saving system using timer sensor
- iii. validate the developed energy saving system

1.1 Justification of the study

Power wastages have most commonly occurred in schools and colleges where the fans and lights are kept ON even if there is nobody in the classroom due to the carelessness or negligence of the students and staffs. As more and more electronic products are developed and installed, the need for power is increasing rapidly to overcome the problem of the wastage in electricity and to increase energy awareness. This study is needed in the reduction of the misuse of electricity.

Literature review

Visitor counter

In the digital world, there is a need for every possible thing around us to be automatic which reduces human efforts. This brings about a sense of urgency for developing systems that would ease the complexity of life due to the increase in standard of living (Winfred, George and Hilary, 2016). The process of measuring visitor traffic entering and leaving a place such as seminar and auditorium halls, conference rooms, etc. is known as visitor counting. The count is incremented by one only when someone enters into the room and decremented by one only when someone leaves, and the room light will only be turned on where there is at least one person in the room; otherwise, it will be off (Ogherohwo *et al.*, 2018).

Microcontroller

A microcontroller is a computer present in a single integrated circuit which is dedicated to perform one task and execute one specific application. It contains memory, programmable input/output peripherals as well a processor. Microcontrollers are mostly designed for embedded applications and are heavily used in automatically controlled electronic devices such as cellphones, cameras, microwave ovens, washing machines, etc. Microcontrollers are now single-chip microcomputers (SOCs) that can perform all kinds of functions on all electronic systems and those that are often prepared are the leading 8- and 16-bit, due to their low cost and ease of implementation.

Sensor

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a

signal that is converted to a human-readable display at the sensor location or transmitted electronically over a network for reading or further processing. A sensor receives a signal and sends the signal to the microcontroller; the signal is then operated under the control of a program stored in the ROM and finally produces an output (Ogherohwo, *et al.*, 2018).

Analogue sensor

Analogue Sensors produce a continuous output signal or voltage which is generally proportional to the quantity being measured. Physical quantities such as Temperature, Speed, Pressure, Displacement, Strain, etc. are all analogue quantities as they tend to be continuous in nature. For example, the temperature of a liquid can be measured using a thermometer or thermocouple which continuously responds to temperature changes as the liquid is heated up or cooled down. The microcontroller has an Analog-to-Digital Converter (ADC) which provides a digital output extracted from the voltage or current difference between sensor and reference (Gelijon *et al.*, 2009).

Sensor interfacing

Sensor interfacing is a mixture of amplification, filtering, and other signal conditioning as well as analog-to-digital conversion. Connection to the microcontroller is simplified if the sensor itself contains in-built signal conditioning, such that the output is linear, reasonably large, conveniently scaled and pre-calibrated.

According to Ferran (2012), a classical sensor interfacing comprises 4 steps; first, the sensor transforms a signal from a given energy domain to the electrical domain by changing—for example—its capacitance or electrical resistance. After, the signal conditioning circuit, which generally relies on Operational Amplifiers (OpAmp), performs some or all of the following tasks in the analogue domain: amplification, sensor output-to-voltage conversion, filtering, linearization and demodulation. The resulting analogue signal is then digitized through an analogue-to-digital converter (ADC). Finally, a digital system (for example, a Micro Controller) acquires, stores, processes, controls, communicates (to other devices or systems) and displays the digital value with information about the measurand. An example of a sensor that is of note in interfacing is the ultrasonic sensor.

Liquid crystal display

LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LCDs were a big leap in terms of the

technology they replaced, which include light-emitting diode (LED) and gas-plasma displays. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it. Where an LED emits light, the liquid crystals in an LCD produce an image using a backlight. LCDs at present represent the leading flat panel display technology and seem certain to maintain this dominance for the foreseeable future.

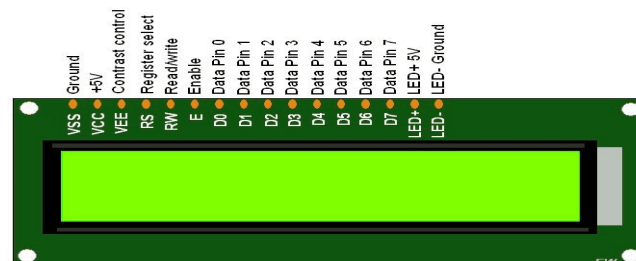


Fig 2.1: Liquid crystal display

Alternate Current (AC) and Direct Current (DC) Relays

AC and DC relays are both somewhat different in construction but works on the same principle as electromagnetic induction and also depends on the uses for which these relays are selected. AC relays use laminated cores to prevent eddy current losses while DC relays are made with a freewheeling diode to de-energize the coil. Also, the power supply to the DC relay must be direct current.

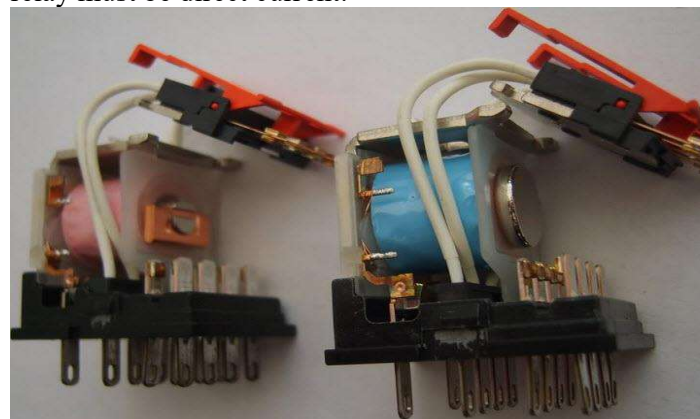


Figure 2.2: AC and DC Relays

Power supply unit

The Power Supply unit converts the main supply (240AC at 50Hz) to a lower direct current voltage that is suitable for Powering Low power devices. The user can either choose to use an AC to DC adapter or 5V-12V battery to power the circuit. A higher input voltage is 12V. The ultrasonic sensor will generate some heat at 12V. There are two types of power connector for the circuit: DC plug (Jumper) and Power connector. Normally, an AC to DC adapter can be plugged to the Jumper connection. Power supply

consists of the rectifier, transformer, voltage regulator, and the filter capacitor. The 5V power supply must have the following characteristics:

- Accurate voltage
- Sufficient current
- Low noise and ripples

Materials and method

The flow of execution of the proposed model is shown below in the figure 3.1. Micro Controller refers to the Arduino UNO.

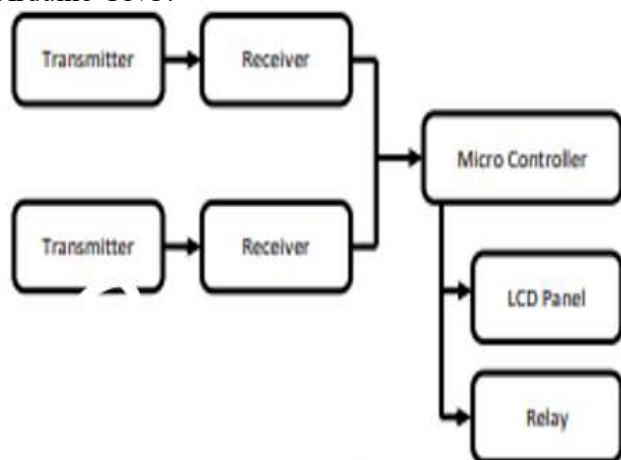


Fig 3.1: Flow of Execution

Model working

The Infrared (IR) sensors are placed at the entrance of the door. They are positioned in such a way that the counter sensor increments the object that crosses it while the light sensor tests if there is no object in the room. The logic behind the working of the counting process is simple, when the person crosses the sensor near the door and then to the sensor away, it recognizes motion and there is an increment in counter. If the person crosses the sensor placed away from the door and then sensor near the door, then it will be decremented. Increment in the sense that person enters the room whereas decrement denotes the person leaving the room. It is to be noted that both IR sensors should be placed apart from each other at the entrance region. The LCD board gets refreshed at every instance as the time delay kept is very small in few milliseconds so that the count display should not be lagged at any instance. Potentiometer is connected to the LCD so as to adjust the contrast of the LCD display board. Lights and fans can be connected to the relay such that they can start working once the relay switch gets closed. The opening and closing of the relay is controlled by the Arduino UNO board. If the count in the room is equal to zero then the relay switch is in open mode. The relay gets closed at once the count is raised greater than 1, that is, an object is

present in the room. To avoid of discrepancies in counting, a condition can be set in the algorithm such that the count should not precede the limit zero. If count goes less than zero, then set the counting variable to zero again. Mahmud Hossain Jewel, JahidHasan, Nazmul Islam used the smoke sensors additionally to detect the gas leakage. The digital pins of the Arduino UNO are connected to the LCD display board. IR sensors are connected to analogue ports of the Arduino UNO. Video of the working model is given as sample in this reference which will be useful for further conclusions about the physical structure and the working nature.

Code

The Arduino UNO microcontroller if fed up with a code in a special type of embedded C programming language made especially for Arduino UNO. Basic syntax to code the arduino board and to fix its configuration at the reference site will be useful. The code guides the Arduino UNO microcontroller about where to get input from and where to give output signals and instructions related to interpreting the sequence of inputs into entry or exit of a person. It also guides the Arduino UNO to display the output in the LCD panel according to the number of persons in the room. There are two main parts in an Arduino UNO code namely, the setup () part and the loop () part. Explanation of the code for this proposed model can be verified as a sample from the website as mentioned.

A. Setup ():

The setup () part gives all the initial set-ups for the process to begin such as defining the input and output pins and creation of the necessary input variables for processing. This part is executed only once every time the Arduino UNO is booted.

B. Loop ():

The loop () part gives all the necessary instructions to the Arduino UNO that is to be executed repeatedly throughout the working of the Arduino UNO board. The loop () part of the program is executed repeatedly every 0.6 micro seconds. Inside the loop () part, the instructions such as receiving inputs are mentioned

C. Psuedocode for loop part:

The psuedocode printed below is with proper indents

```

If ((sensor 1) and not (sensor 2))
  ## person crosses the sensor 1 and standing before
  sensor 2
  If (sensor 2)
    ## person crosses the sensor 2 after crossing the
    sensor 1
    Count=count+1
  ## As the person crosses both sensors, count rises to 1
  
```

```

End if
Else if ((sensor 2) and not (sensor 1))
##person crosses the sensor 2 and standing before
sensor 1
If (sensor1)
##person crosses the sensor 1 after crossing sensor 2
Count = count-1
##person moves out, count decrease
end if
end if
led.print (count)
## display the count in LCD display

```

Flow Chart

The Complete flow of working is given in the flow chart below in the figure 3.2. It completely gives a clear cut idea of the working and the code. It explains the case conditions for the LCD display.

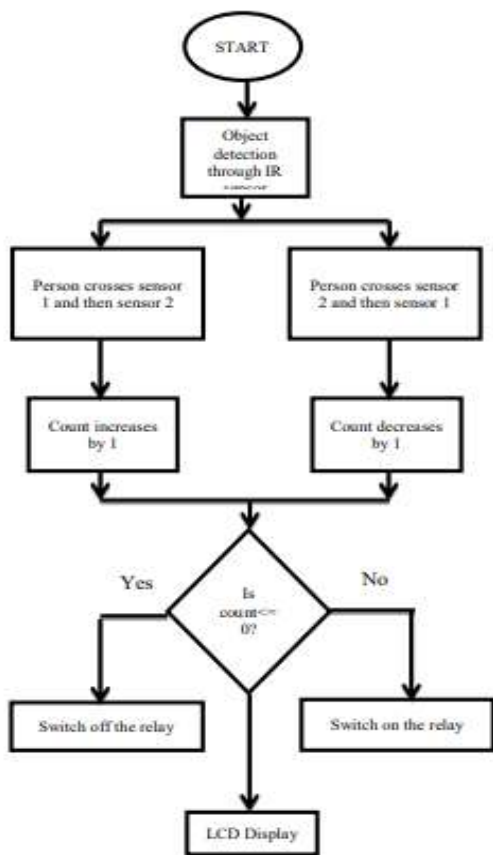


Fig 3.2: Sequential Execution of Code

Results and discussion

This system is tested and experimented with a model, where the working is based on the Infrared (IR) sensor in the following cases:

- A. Case (i): The room appliances are in off state, if there is nobody in the room which implies that energy is getting conserved instead of wasting. The figure 4.1 gives a pictorial representation of the circuit connection and the

figure 4.2 gives the external appearance with the LCD display.

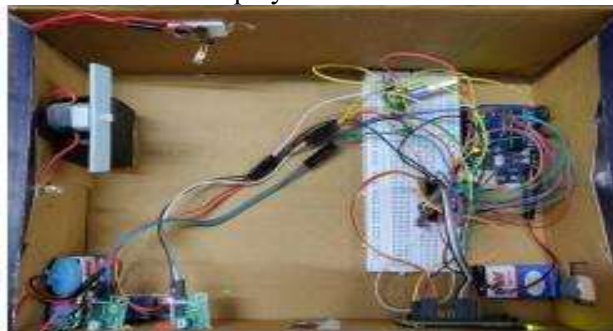


Fig 4.1: Circuit Connection when relay is Off



Fig 4.2: LCD Display when the count is Zero(0)

Hardware requirements

The system mainly uses Arduino UNO board for the process of monitoring, Relay for the process of external switching of the circuit, LCD Display board displays the person in the room and finally the IR Sensors. The lists of the components used to build the model are listed below along its perfect model number:

Arduino – UNO, LCD Display, 5V Relay Module, Infrared Sensors, Potentiometer, Bread Board, Jumpers, Led lights, 5V DC motor (as fan), Power Source, Resistors and a Laptop.

A. Arduino UNO:- Arduino UNO is an interactive board which receive various signals as input, it operates different operations based the signal given to Arduino UNO. It has 13 digital pins and 6 analogue pins. A typical Arduino UNO is given in the figure 1. Digital pins are connected to the digital output and the analogue pins are used to get basic input signals. It has a 32kb of flash memory to store the program that is coded for the operation. It is connected to the system using a B-type cable. The software used to code is Arduino UNO 1.8.8 as the latest version.



Fig 4.3: Arduino UNO

B. LCD – display board:- Liquid Crystal Display board of dimension 16x2 where it can display of 32 characters in two lines each of 16 characters. It has 16 external holes for connections as shown in the figure 4.4. These output holes can be connected to the bread board with the help of male to male breakable pins. It seeks a voltage of 5V from the source provided to the Arduino UNO board. It has three ground connections.



Fig 4.4: LCD Display Board

C. 5v – relay module:- Relay module is a magnetically operated switch which closes the external circuit based on signal received from the Arduino UNO board. The relay seeks voltage from the source to induce a magnetic field which attracts a metal strip and closes the external circuit; at once it receives the positive signal from the Arduino UNO.

There are three external pins available in the relay module to connect to the external circuit as given in the figure 4.5. The middle point is always the ground, the positive line of the external circuit can be to the either of the two pins based on the normally open and normally closed.



Fig 4.5: Relay Module

D. Infrared sensors:-

Obstacle detection sensor generates a signal when any object encounters it. It has transmitter and receiver at its end. They send analogue signals to the Arduino UNO for processing. It has two extrapolation facing outwards they are receiver and transmitter as shown in the figure 4.6. Black coloured knob is the transmitter whereas the white coloured is receiver. It has three pins to get connected they are for ground, Vcc and sending output signal.



Fig 4.6: Infrared Sensors

E. Power Source:- Power source for the working of Arduino UNO can be given through the 9V DC battery with the help of power cord whereas the alternative one is the connection of Arduino UNO to the laptop using B type cable. During developing stages it will be easier to connect with B type cable, but as an end product it advised to use DC battery. It requires a maximum of 5V, in the real time model the power can be given from the AC socket by transforming it to pulsating DC and rectifying to DC.

F. Potentiometer:- It is the device which is used to provide variable resistance to the circuit. In the LCD board, the third pin is facilitated for contrast adjustment by providing the necessary resistance to it along with the input voltage. It has three external pins to get connected to the circuit, one pin to the resistor terminal and other two pins are connected to both ground and Vcc.

Circuit diagram

The circuit diagram of the system is shown in the figure 4.7. The coloured lines specify the wires connecting the circuit elements. To connect various elements in a single port, bread board is used.

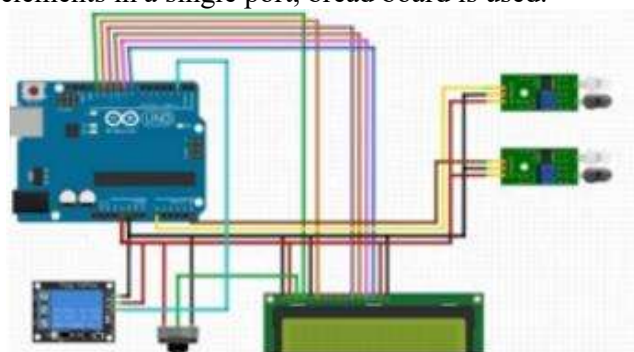


Fig 4.7: Circuit Connection of the Timer

Conclusion

Many times we need to monitor the persons visiting places like seminar hall, conference room or shopping mall or temple. This project can be used to count and display the number of visitors entering inside any conference room or seminar hall. ARM_VC can be implemented in developing countries which are useful for transformation of homes to smart homes. To supersede the old practice of counting the number of people entry and leaving the room one by one. It was concluded in the study that object detection system can be design and implemented using body counter censor

Recommendation

This study recommends that, body counters using Timer should be deployed to ensure that the power consumption at various homes is drastically reduced. Also, the effective functioning of the system of body counter censor should be ensured using an 8bit microcontroller, Infrared Led (IRLED) phototransistor circuits and is powered by a 9V Power Pack 3 (PP3) battery.

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