OPTIMUM ENERGY MANAGEMENT SYSTEM FOR THE HOME

Automatic light and fan controller based on the environment

[1]Tanya Chauhan, [2]Syed Zabiulla Faizan, [3]Sukanya R, [4]Kavyashree H M, [5]Rachana M Hullamani
[1]Student, [2]Student, [3]Student, [4]Student, [5]Assistant Professor
[1]Department of Electrical and Electronics Engineering
[1]DSCE, Bangalore, India

Abstract: In some countries high loads at peak hours have led to blackouts in the past. India has faced a similar blackout in August 2012 which left around 650 million people without electricity. Each such blackout cost millions of loss to the industries this in turn affects the GDP of the country. Huge investment are being made in the supply side by generating energy from alternative source in order to reduce carbon emission and avoid any further situation of blackout. So this generation of energy has to be balanced by increasing the efficiency of energy consumption on the demand side, which can be done by using electronic circuits which will make our surrounding automatic and further people can be made aware of their energy consumption by receiving information of their usage. This project is very useful for such problems as it takes into consideration the home energy management system which includes both energy consumption and generation simultaneously to minimize the energy cost.

Keywords – **Arduino, IR Sensor, LDR, Servo motor, DHT11, PWM, TL494, Carbon printing, Renewable Energy, Energy Optimization.**

I. Introduction

In country like INDIA, which has faced problems like blackouts in the past, limited energy available in rural areas, power cuts in some parts of urban areas, wastage of energy available, increase in carbon footprint due to thermal generation of the electricity and the rapid depleting rate of the non-renewable sources of energy. It has become important to use renewable sources of energy for generation of the electricity which is a clean for the environment and it could be used for hundreds of years. Apart from generation, it is important and necessary to use the available power efficiently and optimally so the losses can be reduced and within the limited power available appliances could work for a longer time and consumption will also reduce which will eventually reduce the electricity bill.

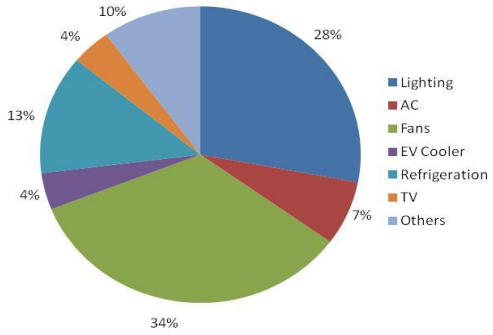

Figure 1- Domestic usage

In the total energy consumption of INDIA, industries forms the 45% of the energy consumption and after that residential comes with a percentage of 22%. Going in more detail with the energy consumption of the residential area, it can be seen from the given pie chart that lightings and fans forms more than 60% together for the energy consumption. Therefore a circuit has been built up which is used to reduce the extra consumption of the energy by reducing the wastage of energy when it is not needed. The lighting circuit has used sensors for counting number of people and other sensor is used to sense the illumination present outside and according to the two given condition the lightings of the house are controlled by either allowing daylight coming to the house or by lights. The fan and the heating circuit works depending upon the people present in the room and temperature which is sensed by the temperature sensor. According to the two conditions, the fan circuit will perform its operation and as the temperature reduces the heating of the coil will increase.

The generation part of electricity takes into account the solar power-renewable energy. Statistics have shown that power generation in INDIA is based on coal and that accounts to 57%. Generation of electricity by renewable sources forms 20% of the total energy production, in renewable power capacity of INDIA, wind power accounts to 50% and after that solar comes which accounts to 31%. Analysis has shown that solar power generation is going to increase by a greater percentage by 2022 and this is because of high solar insolation. Increase in the solar power generation is shown in the table.

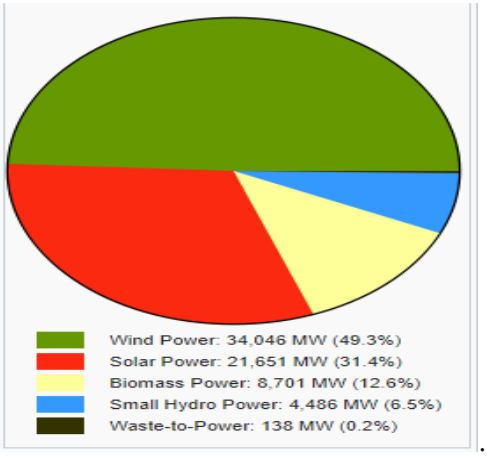

Figure 2- Usage of renewable energy

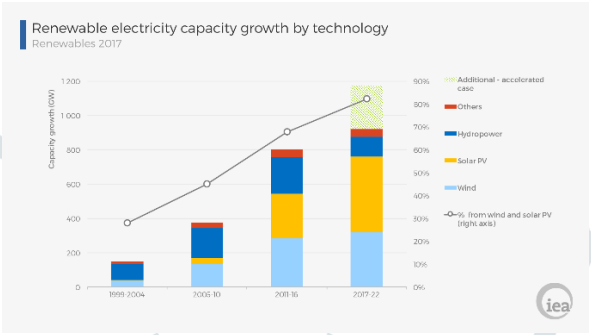

Figure 3- future increase of solar generation

II. Circuit Details

1. Lighting Circuit

The first part of optimum energy management focuses on **automatic lights control using IR sensors, LDR and counter logic.** The project has the goal to manage the room lights efficiently. The microcontroller works based on the people count and turns on /off the lights and increases/decreases the illumination based on the density of people and the presence of the natural light.

1.1 Circuit Description

As per the circuit diagram shown in Figure 5, the circuit is divided into four sections namely**: sensor section, control section, display section & driver section.**

The **sensor section** senses the interruptions and send the signals to the CPU (Arduino board). The **IR sensor** senses an interruption by transmits an IR wave and the wave hits the target and bounces back reaching the receiver of the module. A **Photoconductive light sensor** changes its physical properties (resistance) when subjected to light energy. The resistance of LDR when unilluminated (dark resistance) is about 10MΩ and when fully illuminated (light resistance) it is 100 Ω. The output of voltage divider circuit using LDR and 100k resistor is feed to the analog pin of the Arduino. The analog Pin senses the voltage and gives some analog value to Arduino. The analog value changes according to the resistance of LDR.

Control section does the work of controlling the lights and moving of the curtains and this is done by the microprocessor after receiving the data from the sensors.

Display section basically displays the data on the LCD, whether the lights are on or not and how many people are present inside for the moment.

Driver section is used to drive the relay which is used as a switch for controlling the lights. Transistor is used to amplify the voltage which is used to drive the relay.

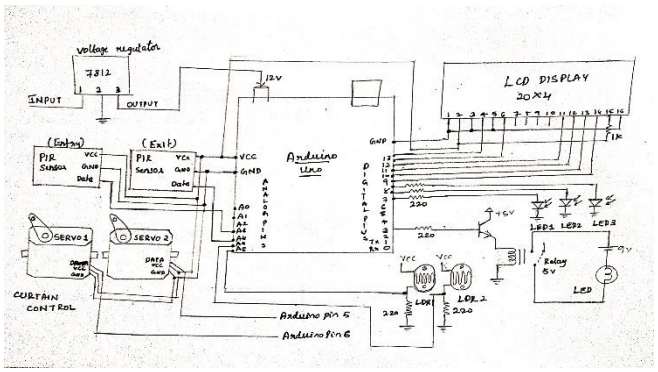

Figure 4- Circuit diagram of lighting and curtain control

1.2 Working

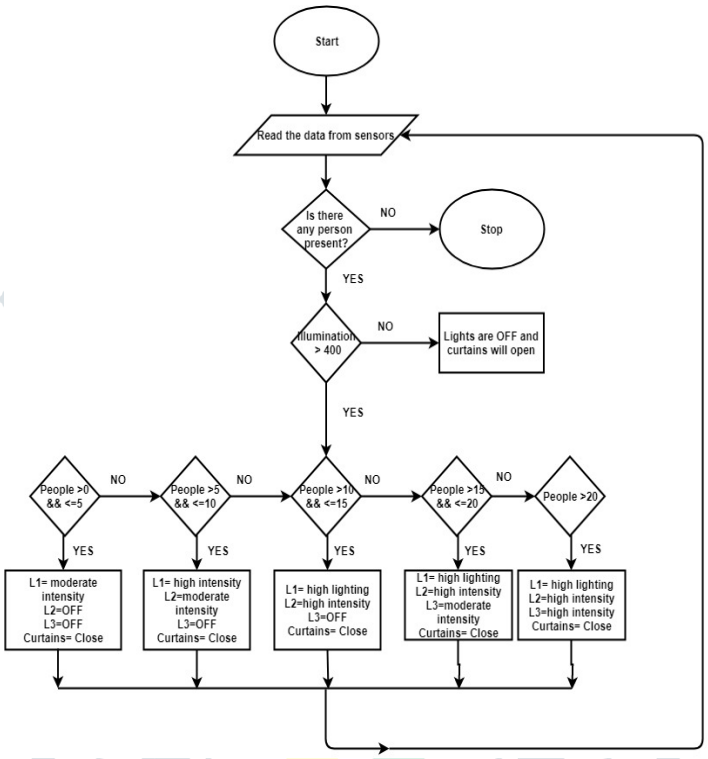

Figure 5-Flowchart for working of lighting circuit

Two modules of sensors are used, one for sensing the entry and the other for sensing the exit. Both works independently but are linked to each other via the count increment and decrement, Entry sensor is operating by incrementing the count the exit sensor is operating by decrementing the count. The extension of the above part includes **interface between the LDR and the lights and automate the curtains**. Here we make use of light dependent resistor (LDR) which is the representation of the sun light and gives the illumination value. This LDR values is linked to the servo motor through the microcontroller which is programmed for opening the closing of curtains.

How energy is optimally managed here? The main role is played by the LDR and the PIR sensors combined, the microcontroller is programmed such that only when the human presence is detected the whole of the module works i.e., even when the human count=0 the module doesn't work and saves energy. The whole working is controlled by the IR sensor i.e. for the human count and energy optimisation

As explained by the flowchart in figure 5, when count =0 (no human present in room) the curtains and lights does not function even if its morning or night conditions and the whole module stays in stand by condition.

If there are people inside the room and outside the illumination is >400(as we have considered), it indicates morning to evening condition and the lights in the room are automatically turned off to use the natural lights using servo motor to automate the curtains (opening of curtains) there by reducing energy consumption and during sunset to night time the illumination value is taken as <400 and room lights are turned on and servo motor is used to close the curtain. Depending upon the number of people present in the room the intensity of lighting and number of lighting lamps are controlled such as if count is 10 then two lights one of moderate intensity and other one of high intensity are on and if the count is 15 same two lights are on with higher intensity and if the count is 20 three lights are on with high intensity and so on.

2. Fan circuit

Like the lighting circuit, fan is also controlled based on number of people inside the room and if no one is there then the fan will be off. Along with the fan, heater is also included.

2.1 Circuit Description

The connection diagram of the circuit is shown in figure 6, in which the inputs to the arduino is temperature sensor and outputs are to the motor, LCD and LED.

The circuit uses DHT11 sensor for measuring of the temperature. DHT11 sensor has the temperature range of 0-50˚C with an accuracy of ±2%. IR sensor is used to detecting the number of people present in the room.

Dht11 sensor senses the temperature and displays the output on the LCD. Fan is represented by dc motor which has an operating voltage of 9V. We are going to control DC fan speed according to the room temperature and show these parameter changes on a 16x2 LCD display. It is accomplished by the data communications between Arduino, LCD, DHT11 sensor module and DC fan that is controlled by using PWM as shown in Table 1. PWM is a technique by which we can control voltage given to the motor.

Heaters are represented by the use of LEDs. Working capacity of the heater is indicated by the glowing of the LEDs. Four LEDs are used in the circuit to represent the 25%, 50%, 75% or 100% working capacities of the heater.

2.2 Working

Number of person in the room is sensed by IR sensor and displays the output on LCD. Depending upon if anyone is there in the room, fan or heater will start to operate as shown in figure 7. Depending upon the temperature of the surrounding, the fan speed will be adjusted according the instructions given to the microcontroller. If the temperature detected is less than 26˚C then fan will be in OFF condition. When temperature is 26˚C then fan speed will be 20% and so on till the temperature is greater than 29˚C at which the fan speed is 100%. If the temperature is low the fan will not work and that time heater will work depending upon the present temperature. If the temperature is below 10˚C then one LED will glow indicating the 25% of working capacity of heater and when the temperature is 0˚C or less then all four LEDs will glow indicating that the heater is working at its full capacity.

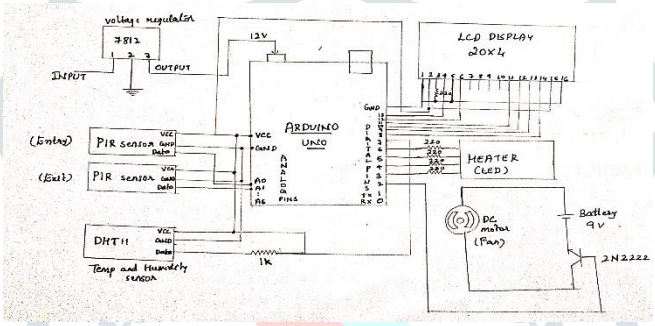

Figure 6- Circuit diagram of fan and heater

Table 1- PWM values and fan speed

Temperature	PWM Value	Fan Speed
<26 ˚C	0	OFF
26 ˚C	51	20%
27 ˚C	102	40%
28 ˚C	153	60%
29 ˚C	204	80%
>29 ˚C	255	100%

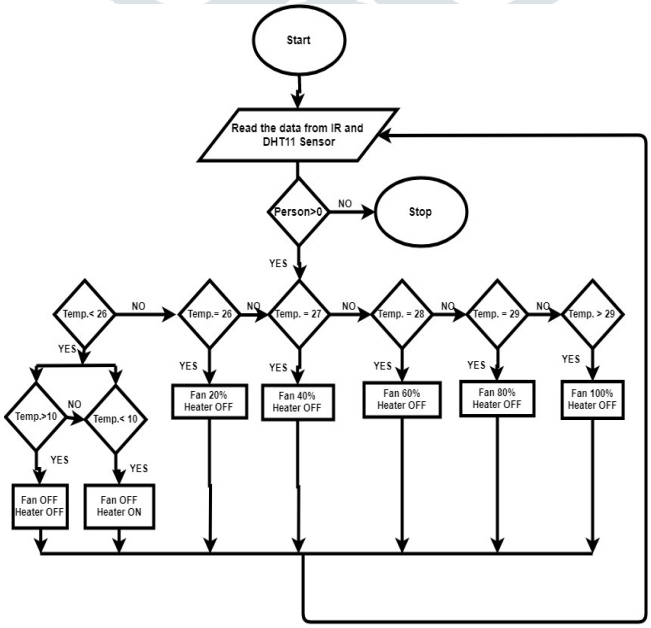

Figure 7- Flowchart for working of Fan circuit

3. Solar circuit

The next part is the generation part and final part of this project as mentioned the energy is generated from the solar through one of the most effective methods at lesser cost and high reliability though there are several costly equipment's in market. Solar charge controller charges the battery the power output from the batteries could be controlled to deliver the power in adequate quantity to the above mentioned circuits and devices.

3.1 Circuit Description

The circuit is shown in the figure 8, is the dc-dc buck convertor which steps down the input voltage of the solar panel (22V) to the battery voltage (12V). The buck convertor has a PWM control circuit which measures the different parameters for the safe working of the charge controller. The whole circuit works for constant voltage and constant current. IRF9540N mosfet is used as a switching device. TL494 is a PWM control circuit which controls and the charging of battery according to the parameters inputted to it. LM358 op amp is used as a current sensing element and amplifies the output which is used for the controlling of the charging current. TL431 is used as an overvoltage protection circuit.

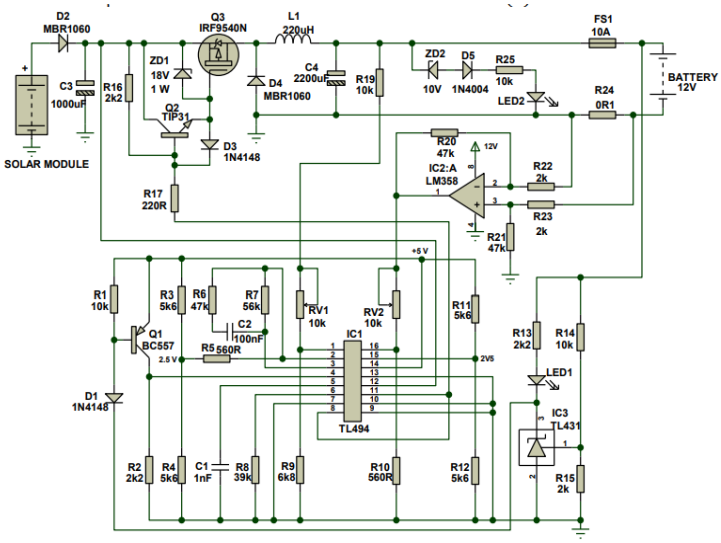

Figure 8- Circuit Diagram of Solar Charger

3.2 Working

From the solar module the current will flow through diode (D2) to the transistor Q3. Turning ON/OFF of Q3 is controlled by its gate which is controlled by the outputs of TL494. From mosfet the current goes to inductor and then to the battery. The energy is stored in the inductor and when mosfet is off it is used to provide energy to battery and capacitor (C4). The output voltage is maintained at a constant value by comparing the output voltage (pin 1 of TL494) with the reference voltage set up with the help of voltage divider (Pin 2 of TL494) and if pin1 voltage rises about the pin2 voltage then the output of TL494 id reduced and charging decreases and vice versa. As the battery is being charged, the differential voltage appearing between pins 2 and 3 of LM358 is amplified by the op amp. The voltage is adjusted to 2.5V when battery is fully charged at Pin 16. A reference voltage of 2.5 V is set up by the voltage divider at pin 15 of the TL494. When the battery is fully charged then the voltage across both the pins are same and this reduces the output pulses and thus the charging current reduces. TL431 shunt regulator is the sensing element, the reference node is set up to 2.5V and when overvoltage condition is there the output pulses of TL494 is reduced.

III. Results

Lighting circuit works efficiently as per the given condition. It senses the number of people and the daylight present and switches on or off the leds based on it. Fan and heater circuit works with efficacy by sensing the number of people and the surrounding temperature.

Charging of the battery with the help of solar panel gives the constant output voltage of 12V when the input is sensed as 22V. The voltage is remained constant for the whole charging period. As the input voltage decreases the output voltage also decreases.

Output graphs:

Figure 9-output across TL494 and MOSFET

Table 2- different outputs at different solar radiation levels

Input voltage (in V)	Output voltage (in V)
5.5	6.22
7.8	6.22
10.3	6.24
15.4	9.65
21.4	11.15
22.3	12.10

IV Conclusion

The presented circuit does efficient use of available power and reduction in the electricity bills and reduction in the power produced by the non-renewable sources which will lead to less carbon emission. This circuit can be of efficient use for power in schools, homes, colleges, rural electricity.

V Future Scope

For further continuation of the project, GPS can be used to transfer the data to the user present in any location, provide the graphical data of usage of energy from first to last day of the month. Android applications can be used to control the room lights and other appliances by body gestures and control home appliances via phone, iPad or tablet alongwith the sensors used.

References

[1] Automatic Lighting Using Arduino and PIR Sensor Karthikeyan.R.A , Saran Sriram.K , Piyush.D

[2] 2015 IEEE International Symposium on Robotics and Intelligent Sensors (IEEE IRIS20I5) Optimal Light Power Consumption Using LDR Sensor

[3] Development of Light Control and Motor Speed Control by Smart Phone

[4] 2013, IEEE Green House Monitoring and Controlling Using Android Mobile Application

[5] IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 10, Issue 5 Ver. II (Sep – Oct. 2015), A Cost Effective Solar Charge Controller and Load Driver for DC Home Appliances A.A. Willoughby1, O.A. Babalola2 1 Department of Physics, Covenant University, Ota, Ogun State, Nigeria 2 Department of Physics, University of Ilorin, Ilorin, Kwara State, Nigeria

[6] 2016, IEEE Automatic Lighting And Control System For Classroom

[7]International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056Volume: 04 Paper on Implementation Of MPPT Charge Controller Based Buck Boost Converter Vikas R.Gurav1, Sunil S.patil2, Akshay S.Salokhe3, Mr.P.V.Kothawale4

[8]https://www.elprocus.com/ldr-light-dependent-resistor-circuit-and-working/

[9]https://cdn-learn.adafruit.com/downloads/pdf/pir-passive-infrared-proximity-motion-sensor.pdf

[10]https://components101.com/servo-motor-basics-pinout-datasheet