ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 4, Issue 11, November 2017

Development of an Energy Controller for Smart Home by Developing an Automatic system

[1] Dr. Manoj priyatham M, [2] Keerthana H, [3] Madhu J,
[1][2] Department of Electronics and Communication,
R R Institute of Technology, Chikkabanavara, Bangalore-560090

Abstract: - **This paper presents the development of an energy Controller in a Building Automatic system, based on the availability of natural light and thermal comfort. The system consists of an energy conservation circuit which helps in reducing the energy consumption of household appliances such as fans and lights. This circuit includes an occupancy level detector, environmental thermal comfort temperature level detectors and illumination detector. The PIR sensors are used for the occupancy detection. A pair of temperature sensors is used to detect thermal comfort temperature and Light dependent resistors are used to detect illumination. These sensor outputs are fed to a Microcontroller. The Microcontroller has the task of controlling the lights and fans, according to ANSI/ASHRAE Standard 55.**

Keywords — **Temperature sensors LM35, PIR, Thermal comfort (ANSI/ASHRAE Standard 55), LDR sensors, Microcontroller.**

I. INTRODUCTION

Worldwide the energy consumption is more than the energy production. This has lead to an insufficient and overpriced of energy. Energy Conservation is the only course of action made to reduce the consumption of energy by using less of an energy service. Rational use of energy be equipped in normal buildings. These systems will directly work on the home appliances and provide easy operation and control of the devices. A smart home is a convenient home where appliances and devices can be automatically controlled remotely from anywhere in the world using mobile phones. This smart home control system provides both low expensive home environment, as well as a great level of flexibility and control for the administrators and great comfort for the occupants. Now-a-days the demand for home automation systems in homes and offices is high.

II. WASTAGE OF POWER

The electrical appliances like lighting and fan consume a worldwide part of electrical energy. In homes and offices about 20 percent to 50 percent of energy is consumed by fans and lights. Most importantly, for some buildings over 90 percent of lighting energy is consumed can be an unnecessary expense. According to the UN Environment Program or global environment facility (GNF) en. lighting initiative, by simply replacing all incandescent lamps with efficient energy control system globally, 409TWh per year will be saved, which is approximately 2.5% of global electricity consumption. Thus lighting represents a critical component of energy use today, especially in large office buildings. According to McD Built Environment Research Laboratory, a regular air conditioner consumes 1.5kWh of energy.While the comfort is also achieved by ceiling fan which works with David Humthrey thermal comfort consumes 0.075kWh, which can save global up to 20MWh per year.

III. PROBLEM DEFINITION

Home power consumption is the largest power consumption in the world. When it comes to having a power-efficient electrical installation, the most important thing to be a user is minimized power losses while keeping capital expenditures on target. The amount of electricity used by the HVAC system has to be reduced by installing the most relevant control devices. The electrical installation must be upgraded to meet the new standards. The electricity bills should be reduced. Lighting and ceiling fan or AC unit is one of the easiest ways to save on energy costs. The main purpose of this paper is to develop a much cleaner, cost effective way of power saving by designing a lighting controller using natural light and building occupation, Ceiling fan or AC unit controller with adaptive thermal comfort and ambient conditions as required. Also the thermal shock should be eliminated in the system

IV. OVERVIEW OF THE SYSTEM

In this paper, we present the comparison of indoor and outdoor temperatures to calculate the David Humthrey thermal comfort by using a temperature sensor. This circuit also constitutes Light Dependent resistors, PIR sensor, Zigbee Transceiver and Microcontroller [2]. We provide a DC power supply to microcontroller and AC power supply to light fan or AC unit. Fig. 1 shows the architecture of our energy controller

a. Operation

The system consists of a Microcontroller which is interfaced with the LCD and sensors. The inputs to the microcontroller are obtained from the Light sensor, PIR sensor, Temperature sensor and a Zigbee module (for wireless monitoring of the temperature). The outputs from the microcontroller are transferred to Light, Fan or AC unit. The Energy Measurement Modules implemented on the microcontroller are used to monitor and measure the energy consumption of the device. Fig. 2 shows the flow of the control in the microcontroller.

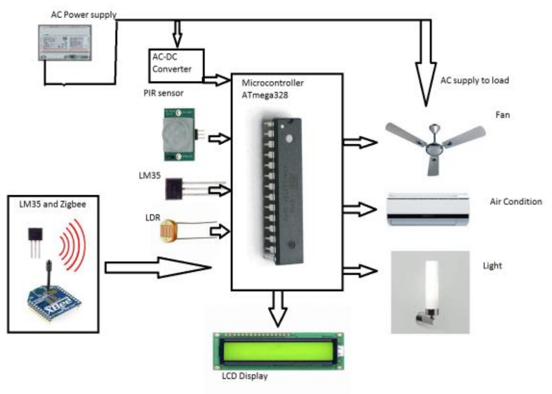


Fig.1 Architecture of Efficient Energy Controller for an Building Automatic system

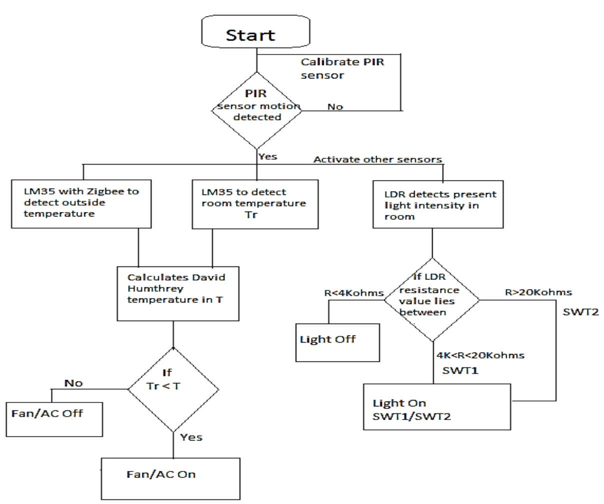


Fig. 2 Control flowchart of the Program running on the microcontroller

In this system first we use a PIR sensor to check the occupancy level and send this information to the microcontroller. If yes, it results in activation of the other sensors for further processing else other sensors are switched off till motion is detected by the PIR sensor. The system is further divided into two sections of sensing and controlling. The Light Dependent Resister and Temperature sensor's routines are shown in flow chart. The LDR detects the environment illumination and sends signal to the microcontroller which controls the intensity of light depending on LDR's illumination value. At temperature sensors side, we have two temperature sensors to calculate the temperature of indoor and outdoor temperature. The microcontroller receives this signal and gives thermal comfort ambient temperature value to control the ceiling fan or AC unit.

b. Thermal comfort

Thermal comfort is the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation (ANSI/ASHRAE Standard 55). Maintaining this standard of thermal comfort for occupants of buildings or other enclosures is one of the important goals of HVAC (heating, ventilation and air conditioning) design engineers. Thermal comfort is maintained when the heat generated by human metabolism is allowed to dissipate, thus maintaining thermal equilibrium with the surroundings. The main factors that influence thermal comfort are those that determine heat gain and loss, namely metabolic rate, clothing insulation, air temperature, mean radiant temperature, air speed and relative humidity.

V. HARDWARE COMPONENTS

A. Microcontroller-ATmega328

The ATmega328 is a microcontroller board (the chip is shown in Fig. 3). This chip has 28 "legs", 14 Digital IO pins (pins 0–13) which can be inputs or outputs and are specified by the sketch that we create in the IDE. 6 Analogue In pins (pins 0–5) are dedicated analogue input pins that take analogue values (which can be the voltage readings from a sensor) and convert them into a number between 0 and 1023. 6 Analogue Output pins (pins 3, 5, 6, 9, 10, and 11) which are originally digital pins that can be reprogrammed for analogue output using the sketch that we create in the IDE.

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 4, Issue 11, November 2017

Fig. 3 Microcontroller ATmega328

B. Sensors

1) Light sensor - LDR NSL 19M51: Light Dependent Resistor (schematic shown in Fig.4) is used as the light sensor for sensing the requirement of light for the surroundings and passes the information to the microcontroller. The resistance of the LDR decreases with an increase in the light intensity. It has a wide spectral response and is suitable for different ambient temperature conditions. It is of low cost and hence is used in many applications which involve automatic lighting control. The operating temperature range is -60 deg C to +75 deg C.

Fig. 4 LDR NSL 19M51

2) PIR sensor - LDR NSL 19M51: PIR sensors (shown in Fig. 6) sense the motion of the human, animals or other objects which varies the infrared radiation impinging on it. When a object such as human has moved in or out of the sensors range at that point the temperature changes from room temperature to body temperature. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection(motion is detected). They are small, inexpensive, low-power, easy to use and don't wear out. Hence they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

Fig. 6 PIR sensor top view

The sensor in a motion detector is actually split in two halves. The reason for that is that we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low. Along with the pyroelectic sensor is a bunch of supporting circuitry, resistors and capacitors. It seems that most small hobbyist sensors use the BISS0001 ("Micro Power PIR Motion Detector IC")[8], undoubtedly a very inexpensive chip. This chip takes the output of the sensor and does some minor processing on it to emit a digital output pulse from the analog sensor as shown in Fig. 7.

Some of the typical features of the PIR sensors are:
Size: Rectangular.
Output: Digital pulse high (3V) when triggered (motion detected) digital low when idle (no motion detected). Pulse lengths are determined by resistors and capacitors on the PCB and differ from sensor to sensor.
Sensitivity range: up to 20 feet (6 meters) 110° x 70° detection range
Power supply: 3V-9V input voltage, but 5V is ideal.

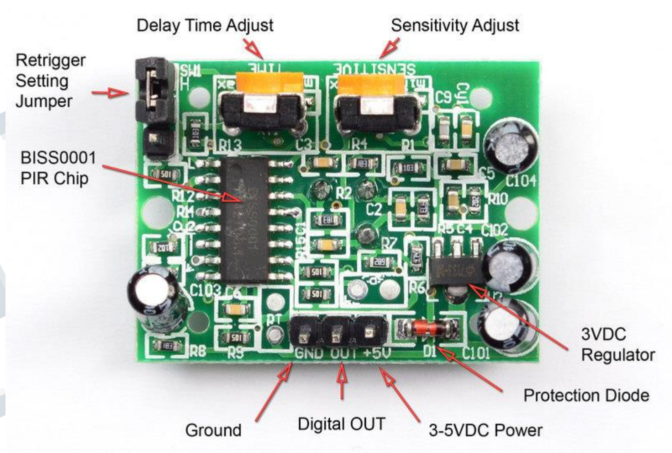


Fig.7 PIR sensor with supporting circuitry

3) Temperature sensor – LM35:

LM35 is a precision Integrated circuit temperature sensor whose output proportional to the temperature (in oC). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With LM35, temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 oC temperature rise in still air.

Features of LM35 Temperature Sensor:

- ±1/4˚C of typical nonlinearity
- Calibrated directly in ˚ Celsius (Centigrade)
- Rated for full −55˚ to +150˚C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Low self-heating,
- Low output impedance

IFERP connecting engineers... developing research

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 4, Issue 11, November 2017

Thus the LM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The low output impedance, linear output, and precise inherent calibration of the LM35 make interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 draws only 60 µA from the supply, it has very low self-heating of less than 0.1°C in still air. A typical view of the LM35 is shown in Fig. 8

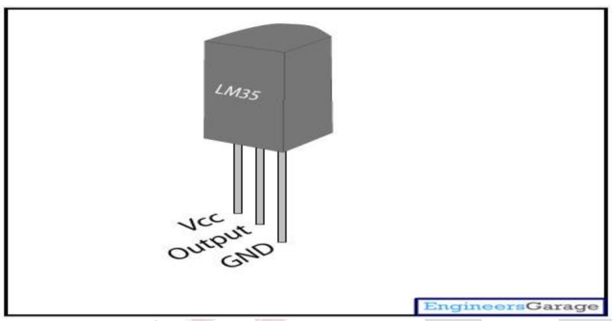


Fig. 8 Temperature sensor LM35

C. communication

We use Xbee Pro 2.5 ZNet (shown in Fig. 9) in our system. The XBee Pro module is compliant to the IEEE 802.15.4 standard. It is a series-2 version which supports mesh networking, fixes the address to 64 bits, and has 20 pins.

Fig. 9 XBee pro 2.5ZNet

VI. SOFTWARE

Arduino IDE is used as a code editor and code burner for programming the microcontroller. The IDE (Integrated Development Environment) is a special program running on computer that allows writing sketches for the Arduino board in a simple language and uploaded to microcontroller. A typical layout is shown in Fig. 10.

VII. TESTING

Every sensor is tested on the proto board which is connected to the Arduino analog input pin as shown in Fig. 11 and 12 for temperature and LDR sensors. We observe the sampled values in the range 0-1023 to check for the working of the sensors.

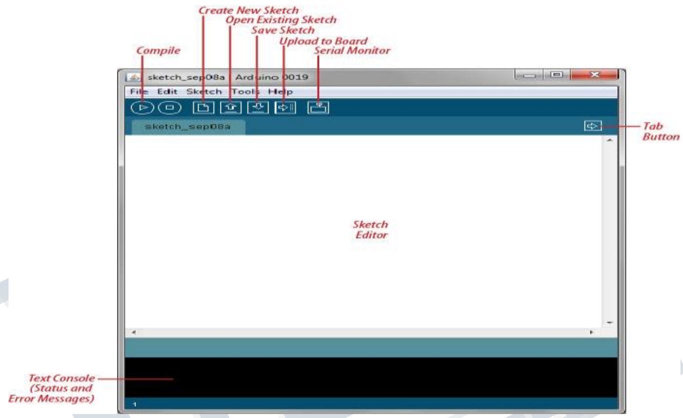


Fig. 10 Arduino IDE edit window

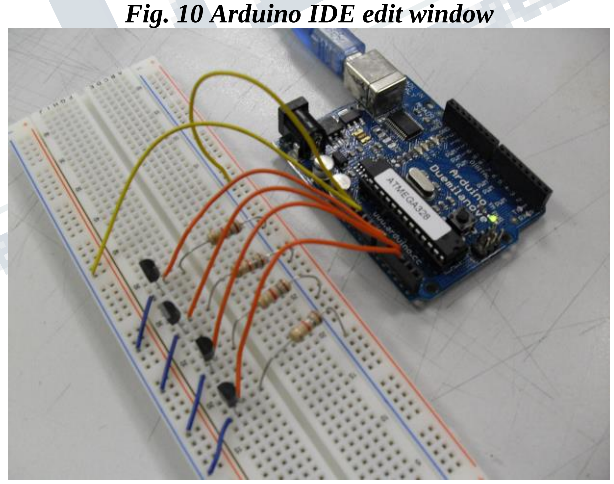
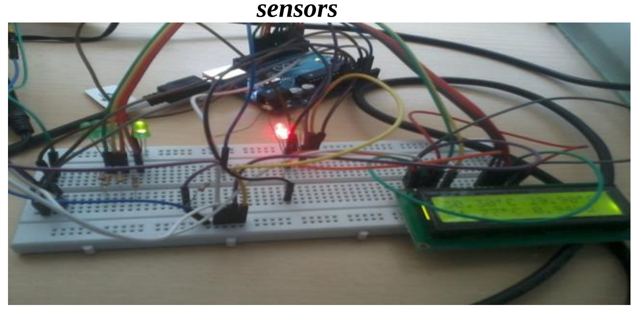


Fig. 11 Accuracy and Stability Testing of Temperature sensors



ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 4, Issue 11, November 2017

Fig. 12 Accuracy and Stability Testing of Light sensors

VIII. RESULTS

Our prototype has been implemented for a green house. Some sample LCD readings are shown in Fig. 13.

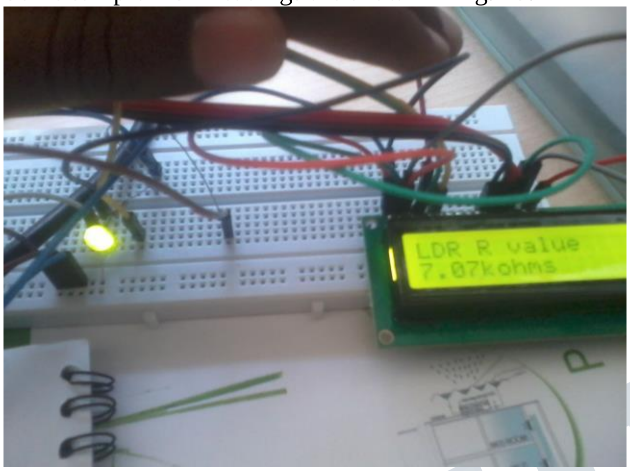


Fig. 13 Sample LDR sensor result displayed on the LCD by the microcontroller

IX. CONCLUSION

In this paper, we have built a prototype of an embedded automation control system using sensors and microcontroller. This system conserves energy by calculating the energy requirement for a particular room by sensing the personnel availability. The overall reduction in consumption and costs are to be computed on a test basis for actual buildings and for different number of users.

REFERENCES

1. Alheraish, “Design and implementation of home automation system,” IEEE Transactions on Consumer Electronics, vol. 50, no. 4, pp.1087-1092, Nov. 2004

2. Changseok Bae, Jinho Yoo, Kyuchang Kang, Yoonsik Choe, and Jeunwoo Lee, “Home server for home digital service environments”, IEEE International Conference on Consumer Electronics, 2003, vol 49, pp. 1129-1135, Nov. 2003

3. Dhiren Tejani, Ali Mohammed A. H. Al-Kuwari, “Energy Conservation in Smart Home”, 5th IEEE International Conference on Digital Ecosystems and Technologies, Daejeon, Korea, May 2011.

4. Jian Li, Jae Yoon Chung, Jin Xiao, “On Design And Implementation of a Home Energy Management System”, published in IEEE,2011.

5. National Semiconductor (2000, November) Precision Centigrade Temperature Sensors. Retrieved October 25, 2009, from National Semiconductor. www.ti.comNo Internet Sharing

6. Smart Lighting http://www.rpi.edu/research/magazine/summer04/futurechips_1.html

7. Lighting - Occupancy Sensors, http://www.doi.gov/greening/energy/occupy.html

8. www.wikipedia.com