Islamic University of Technology

Intelligent Energy Efficient Embedded Home Automation System

A Thesis Presented to

The Academic Faculty

by

Rakib Islam (112416)

Rahbar Haque (112448)

Muntasir Mahmud (112451)

In Partial Fulfillment

Of the Requirement for the Degree

Bachelor of Science in Electrical and Electronic Engineering

Academic Year: 2014-2015

Submitted By

Rakibul Islam(112416)	Rahbar Haque(112448)	Muntasir Mahmud(112451)

Approved By

Dr. Md. Shahid Ullah
Head of the Department & Professor
Department of EEE, IUT

Dr. Khandokar Habibul Kabir
Thesis Supervisor & Assistant Professor
Department of EEE, IUT

Abstract

Automation is the technique, method or system of operating or controlling a process by highly automatic means, as by electronic devices, reducing human intervention to a minimum. An automated home appears "intelligent" because its computer systems can monitor so many aspects of daily living. We are living in the era where automation is playing important role in human life. Home automation allows us to control household appliances like light, door, window, fan etc. Home automation not only refers to reduce human efforts but also energy efficiency and time saving. The main objective of home automation is to help handicapped and old aged people which will enable them to control home appliances and alert them in critical situations.

This paper put forwards the design of home automation system using simple components like Arduino uno and conventional sensors. The design is based on a standalone embedded system at home. The home appliances are connected to the embedded system and their status is controlled by arduino. We would develop an authenticated system to control the home appliances. Scalable energy usage and less modification is much important. It presents the design and implementation of automation system.

Keywords-Home Automation; Arduino uno; Embedded Systems; Sensors; Motors.

Preface

The undergraduate thesis, "**Intelligent Energy Efficient Embedded Home Automation System**" has been written for the completion of Bachelor of Science degree at Islamic University of Technology (IUT). This thesis work and writing has been done during the year 2014 under the supervision of Dr. Khandokar Habibul Kabir, Asst. Professor of the department of Electrical and Electronic Engineering, IUT.

We would like to show our gratitude towards our thesis supervisor Dr. Khandokar Habibul Kabir to give us the opportunity to work under his guidance. We would also like to thank our respected faculty members to help us to make our project experience effective and fruitful.

Table of Contents

1

INTRODUCTION

With the technological advancement, our necessity increases. As we are in a 3rd world country, the difference of demand and supply of energy is an obvious obstacle. The supply and demand of electrical energy is challenged within the context of environmental awareness and national security. As the electrical energy is an intangible necessity, it plays a critical role in our life. We have a limited amount of power supply and that actually doesn't match our gross need. Again, to cope up with the modern world and to have a comfortable life, we have to have a system that can manage the goal. Home automation is a wonderful solution to this problem which can reduce the energy wastage and can also give us an easy comfortable lifestyle. In this thesis paper we attempt to simulate some real home appliances to be automated to save energy usage in easy way using arduino and some usual sensors. As the title says, it's an energy efficient smart home system with low cost that meets our necessity.

1.2 Overview

Our home automation system consists of several types of sensors placed in particular areas to fulfill our required demand. All the sensors are connected to the arduino where all the data processing is done. The arduino gives the command to particular mechanical devices to show the result as asked. The final result that we see is the automatic control over home appliances.

1.2.1 Assumption

We have considered a usual Bangladeshi classroom with some natural problems that people have to face in their day to day life. We have taken in account the possibility that teachers need to check the attendance of the students again and again and most importantly the lights and fans are often misused. So we thought of making a low cost device which will show the attendance in the classroom and it must reduce the misuse of the electricity.

1.2.2 Project selection

We have chosen some basic projects in home automation to fulfill our destination. Understanding how the energy is spent and knowing how to monitor and control it is the prerequisites of our work. We can reduce energy wastage and also save our time by making the home appliances automated. Then it will be in operation only when it's needed and otherwise it

will be off. As most people of Bangladesh have financial problems, keeping that in mind we have selected this project that can save their money by limiting energy usage (only that much to meet their needs) and also can make their life easy and comfortable.

1.3 Motivation

Our primary motivation is based on some basic aspects as following:

- Demand of people, especially for Bangladesh.
- To keep pace with the modern world.
- Geographical and climate convenience.
- Making life easier.
- Making user friendly systems that can be controlled easily even by a person who isn't much familiar to technology.

So, our target was to make a classroom automation that can reduce the misuse of the electricity of our country with an easy and comfortable process and try to make it connected to the available technological advancements.

1.4 Major challenges

In this project work, we had to consider several major challenges that we had to overcome. The top most prior problem was to make the system qualified for our very own Bangladeshi people who have financial problems also. Then the consideration was on fulfilling the need of energy efficiency. Basically we faced the following challenges in way to accomplish our goal:

- Making a low cost device that's available to everyone.
- Using very usual and common equipment.
- Programming the device in a simple and understandable method.
- Keeping in mind the basic need of energy efficiency.
- To make it preferable over the available devices.
- Make it such a way that it can be easily used in the classrooms of Bangladesh.

2

THEORY

2.1 Home Automation

The phrase “Home Automation” is used to encompass so much stuff that it’s not possible to elaborate it shortly. Basically it’s a system that can be controlled by low power device to have a control on overall basic functions and operations of a home. Home automation can include the scheduling and automatic operation of lighting, window coverings, heating and air conditioning and other home appliances. Home automation may also allow vital home functions to be controlled remotely from anywhere in the world using a computer connected to the Internet.

The fundamental components of a well-designed home automation system include a low power computer (or computers) with the appropriate programming, the various devices and systems to be controlled, interconnecting cables or wireless links, an emergency backup power source, its peripherals, and the essential home systems.

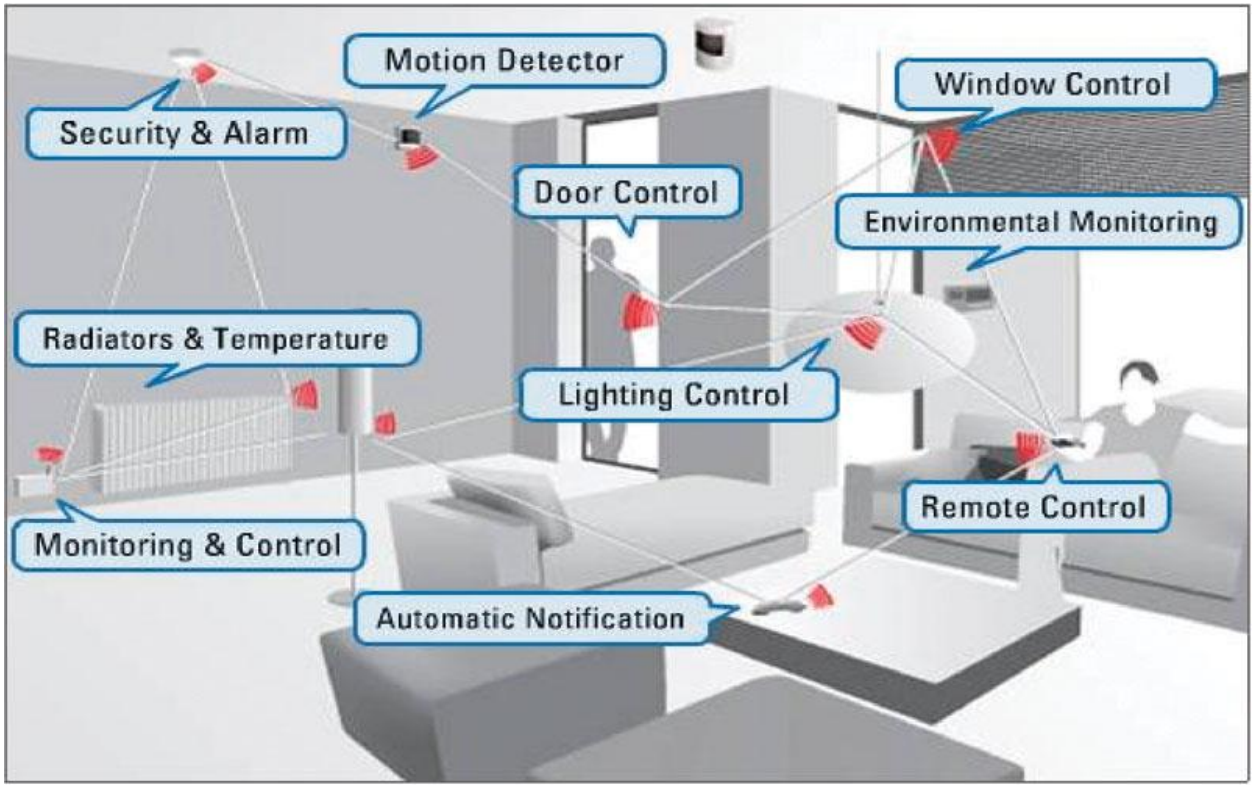


Fig: Home Automation

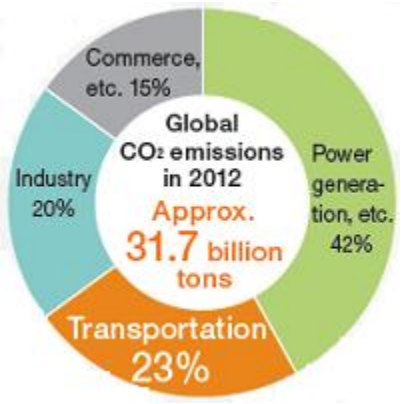
2.2 Why we need electricity saving

At a time when global climate is changing at alarming and extreme rates, governments and organizations are calling on everyone to do their share of preserving the planet. This is not only to prevent calamities brought about by the abuse we have done to Mother Nature, but also to make sure that future generations will still be able to enjoy the beauty and gifts that this world has to offer. And what better way to help than to start saving electricity at home.

How can this contribute in preserving Mother Earth?

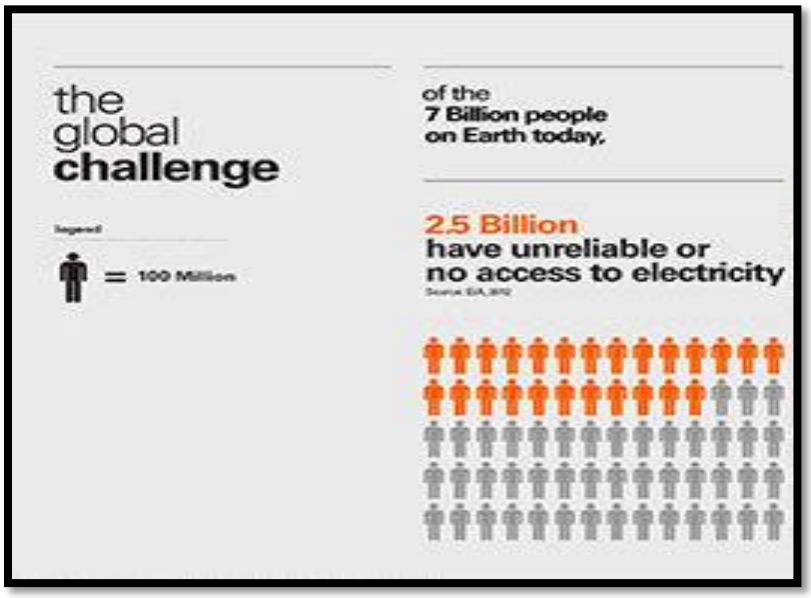
1. It helps conserve natural resources. Every citizen in the world is aware that electricity prices are constantly increasing. What a lot of people may not know is the reason for these hikes. Well, one of the most compelling causes is the depletion of the sources of electricity, including coal, oil, and gas.

2. It reduces carbon footprint. By opting to limit your home's or office's use of fossil products and utilizing solar, geothermal, or hydro power instead, you are not only saving electrical energy, but also reducing greenhouse emission in the environment. As a result, there is less pollution.

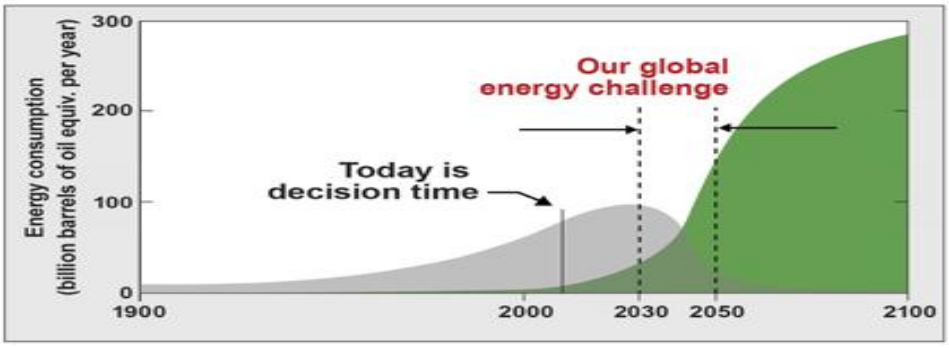


The figure shows the CO_2 emission from the generation and use of electricity. Worldwide CO_2 emissions amounted to approximately 31.7 billion tons in 2012,* 42% of which derived from power generation. So the generation of electricity and the use of it in different machines emit approximately 13.3 billion tons CO_2.

There is also electricity crisis in the developing countries in the world. The backbone of the development of any country's economy during this technological age is availability of ELECTRICITY/ENERGY and so a reason why any country which is willing or is eager to develop has to not just have it but do so in abundance. But in the developing countries, the generation of electricity in not equal to the electricity demand. There is a shortage in the electricity supply in many countries.



Providing for the world's energy demands is one of the most urgent—and difficult—challenges facing our society. Even with likely improvements in efficiency and energy conservation, there is a critical need to rebalance electricity supply away from fossil fuels to ensure long-term sustainability of natural resources, reduce carbon emissions over the next half-century, and stabilize greenhouse gas concentrations thereafter. The projected electrification of transport further increases this need, as does our increasing reliance on products fabricated from the very same natural resources that are currently being burned to create electricity.



In the near future, home automation systems may be linked to the electricity utility in a number of ways. Home automation will be very effective in solving the electricity crisis of the world. The utility may communicate variations in electricity prices to a 'smart' electricity meter, which interfaces with the home automation controller. Householders can then program appliances to reduce power, save energy or switch off altogether during high price periods.

Alternatively householders could enter a supply contract that allows the electricity supplier to send a signal to equipment controlled by the home automation system (such as air conditioners) to turn off certain equipment for short periods.

The householder may choose to participate and obtain lower electricity prices or other financial incentives as a trade-off for allowing the electricity supplier to have this control.

Scenario in our country:

In a 3rd world country like Bangladesh, amount of energy is limited. Moreover, we have a huge amount of energy wastage due to lack of control over them. So, it's very important for our people to have energy efficient system that can be implemented easily. Again, most of our people don't have much money, so the system should also be cost effective.

Hence, to account for the aforementioned drawbacks of the present condition, a home automated system needs to be deployed which will allow reduction in energy wastage with a good control over them. This is obtained by using the sensors with appropriate protocol.

2.3 Smart Classroom

An automated classroom is sometimes called a smart classroom. A *smart classroom* is a classroom that has highly advanced automatic systems for lighting, window and door operations, temperature control, and many other functions. Basically we are making the classroom enable to be self-organized which can take care of itself. Thus, an automated classroom appears "intelligent" because it can monitor so many aspects:

- Lighting control of our room.
- Controlling the fans of our room.
- Counting people in a room and so on.

The ultimate smart classroom automation is done by making the electronic components and systems work automatically depending on the need. By integrating the whole system, we can enhance our life and work with added comfort, savings, convenience and peace of mind.

2.3.1 Importance of Home Automation

The concept of Smart Homes plays an important role in the planning of future housing-based models of care. In today's life, we need home automation for many reasons, such as:

- Tasks that are repetitive in nature can be accomplished automatically
- We can save money by limiting our energy usage and reduce wastage.
- Home automation can increase home safety.
- It saves our time by sharing our responsibilities.
- By using this system we can keep pace with the modern world and can make our life easier.
- Sudden geographical and weather change can be handled well.

2.4 Components for Home Automation

The basic components that are used in home automation system can be categorized as following:

2.4.1 Controlled Devices

Controlled devices include the tremendous range of equipment that a home automation system is capable of controlling. They include household appliances, lighting systems, door openers, power door locks, HVAC systems, power drapes, security systems, telephone systems, intercoms, messaging systems, information systems, and many other types of equipment.

2.4.2 Sensing Devices

Sensing devices can report values, such as light intensity, temperature, humidity, sound levels, etc. or states (such as on, off, open, closed, etc.). The signals sent by sensors are converted into data that can be displayed to the user or used by a controller program to make informed decisions based on certain conditions. The signals can also be converted at the sensor itself. This data is a form of feedback.

2.4.3 Controllers

Controllers provide the intelligent control functions in a home automation system. They can range from a simple lamp timer unit to a smart keypad to a powerful computer. Controllers include any intelligent device capable of sending commands that are understood by the controlled devices.

The control functions may be contained in a single central controller, or there may be other controllers besides the central controller that have a limited subset of control functions.

All controllers must have sufficient data in order to control the controlled devices. Data can come from user input, sensor input, a timer, a control program, or some combination of these. To obtain user input, the system must have one or more user interfaces.

2.4.4 I/0 Interface Devices

I/O (input/output) interface devices provide the logical communication link between the controller(s) and the controlled devices in a system. They are the means of making various devices compatible with the physical and logical structure of the system. Most I/O interface devices provide one-way communications from the controller(s) to the controlled devices. An I/O interface device can serve several communications functions, including: Converting analog signals to digital signals that can be used by the controller.

2.4.5 System Network

The system network includes all of the controllers, sensors, wires, cables, RF (radio frequency) links, IR (infrared) links, adapters, connectors, junction boxes, dimmers, ballasts, power supplies, etc. that connect the various system components. In many systems, this is the area that requires the most planning and can be the most labor-intensive part of a total system installation.

2.4.6 Programming Computer

Some system controllers allow the user to program the system with the system's own user interface(s). Other systems require the use of a separate computer (typically a PC) to program the system controller. Still others may allow certain functions to be programmed with the system's own user interface(s), but require a separate computer to program the more advanced functions or change certain basic operating parameters.

2.5 Limitations of Home Automation

Many researchers are currently engaged in developing home automation system integrated with wireless embedded networking. household chores are being more complex and congested day by day. Human beings have been making things for many thousands of years. Originally most products were made on an individual as-needed basis. But complexity arises with the changes. Though home automation plays an important role in our day to day life, it has some limitations as well. The following points are most prominent.

2.5.1 Installation Costs

It is not a secret that installing a home automation system can be quite costly. But, it all depends on the equipment we wish to have installed. The more advanced system you wish to have in your home the more expensive it will be. This is the most common issue that most homeowners address through automation and remote control. In fact, there are many "starter kits" with pricing less which can provide the owner with several transmitters, a receiver and even options for dialing into the system through a cell phone or PDA. But for reliable home automation system the cost will be higher. For installing a smart home we need sensors, chip, controller etc. The aggregated cost of these equipments is high. Moreover, dedicated home automation specialists are usually being used by the home owners in the present days. The home automation specialists will charge a very high upfront fee to install the system. So the overall cost increases more.

2.5.2 Technological limitations:

Current technology is unable to automate all desired tasks. Some tasks cannot be easily automated, such as the production or assembly of products with inconsistent component sizes or in tasks where manual dexterity is required. Again, Different home should have different types of automation. So the shape and size of the product should be varied for different home. So while producing home automated devices industrially we have to look into these aspects. Sometimes we do not have the same need for same issue. For example, a person who is sick may not need switching the fan on while entering to the room. But the automated home cannot sense it. Here home automation system is increasing work. So fully automated home is not desirable and convenient. There are some things that are best left to human assembly and manipulation.

.

2.5.3 Human Error:

Human error is a deviation from intention, expectation or desirability. From a design perspective the engineer or designer produces a piece of equipment or a system with intentions to function in a certain way. When it doesn't function that way (it breaks, catches on fire, messes up its output or is befallen of some other mishap) they try to find the root cause. If the equipment is not handled & installed safely, this can lead to the equipment being damaged and the risk of the system crashing is high. If the human does not handle the kit safely or if he/she does not use the correct keys to perform the operations, human errors may occur.

Human error includes:

- Failing to perform or omitting a task
- Performing the task incorrectly
- Performing an extra or non-required task
- Performing tasks out of sequence
- Failing to perform the task within the time limit associated with it
- Failing to respond adequately to a contingency

If a switch malfunctions when the operator uses it that is not human error it is a malfunction there is an ongoing debate between ergonomic centered designers and engineering minded designers about human error and design deficiency. On one side is the belief that almost all human error is related to design deficiency because a good design should take into account human behavior and design out those possibilities while on the other side they believe people make mistakes and no matter what you give them they will find a way to break them. Human errors also lead to destructions of the machine. Then there will be a huge system crash.

2.5.4 Reliability:

This occurs on a very rare occasions, depending on the age of the equipment it can have an effect on the system, but otherwise the technology in the home automation systems are all up to date. There has been an increasing interest in home automation over the last few years. In particular, an application such as intelligent illumination, heating, and ventilation which allow reducing the overall energy consumption and improve comfort in our everyday lives mostly depends on the reliability of the product. If there is any damage due to rupturing of cables or the fibers the entire system gets crashed. Here there will be a problem of signal receiving. The wiring of the system results in crash in most of the systems. the reliability of the home-

automated devices decreases. It depends mostly on the technology used and the advancements being done.

2.6 Formation of Home automation system:

Heating, lighting, ventilation and air conditioning are often controlled via home automation systems, sometimes with excellent energy-saving benefits. Homeowners can regulate temperatures in their entire homes or even in individual rooms or zones. In addition, they can implement a temperature calendar and schedule based on weather predictions, usage patterns or other factors related to HVAC system usage patterns.

At the highest level, home automation systems integrate electrical devices with each other. There are various systems used in home automation, which may be controlled wirelessly or by a hard-wired system connected to the home's electrical grid (this implementation is often present in older systems). In newer home automation schemes, the various systems are often connected to the home or businesses' computer network, allowing them to be controlled remotely from computers or mobile devices.

There are a number of steps we can take to improve the efficiency of your home and reduce the cost of operations and they're all available via today's highly sophisticated home automation and control systems. The pricing tiers and levels of complexity for individual systems or whole-house installations vary greatly.

2.6.1 Advantages of home automation:

Convenience

Convenience is one of the biggest reasons that people build and purchase smart homes. These homes give users remote access to systems including heating and cooling systems, intercoms, music and multimedia devices throughout the home. Integrated hard drives allow homeowners to watch video or listen to audio in any room; video intercoms make it easy to communicate with others in the home or visitors at the door. All of these smart home technologies streamline common tasks. We can manage our home…whether we are actually at home or not! This means we can turn alarms on or off from our smartphone or control multiple audio and video devices with one button. If we want something less hands-on, we can easily set timers to turn lights on or off, turn the temperature up or down…or virtually anything else we can think of. For instance – imagine arriving home every evening to complete comfort. The thermostat has already been adjusted to complement the cool night

temperatures perfectly. We sit down and touch one button on an advanced remote that turns on your satellite TV, activates your favorite channel and launches your most used audio preset on your surround sound system.

Security

Smart homes include advanced security systems with cameras, motion sensors and a link to the local police station or a private security company. Smart homes may also use key cards or fingerprint identification in place of conventional locks, making it harder for someone to break in-home automation security systems make this all possible and easy.

Energy efficiency

Smart homes offer enhanced energy-efficiency. Lights can shut off automatically when no one is in a room, and the thermostat can be set to let the indoor temperature drop during the day before returning it to a more comfortable level just before residents arrive in the evening. All of these automated tasks, along with modern, energy-efficient appliances, combine to save on electricity, water and natural gas, thereby reducing the strain on natural resources. Home automation can pay off, literally, in terms of efficiency and energy savings.

Flexible and future-oriented

A surprising advantage of home automation is that the system is very flexible and future-oriented. The functions of the Bits & Bytes Home System can easily be adapted to the stage of life**..** For instance, a family with young children has other needs than a family where the children are living in digs during the week and as a consequence doesn’t need to heat those bedrooms.

3

OUR PROJECT

3.1 Objective

The main objective of this project is to create a classroom automation device based on Arduino uno. Our target is to create an automation system which is user friendly, mordern and fullfills the demand of our country. The Arduino Uno is a microcontroller board based on the ATmega328. These modules are placed in between the target device's electrical plug and the electrical outlet. The modules are then able to control the flow of electricity to the attached device enabling us to turn them on, off lights, amongst other things.

3.1.1 Efficient Energy Use

Efficient energy use, sometimes simply called **energy efficiency**, is the goal to reduce the amount of energy required to provide products and services. For example, insulating a home allows a building to use less heating and cooling energy to achieve and maintain a comfortable temperature. Installing fluorescent lights, LED lights or natural skylights reduces the amount of energy required to attain the same level of illumination compared with using traditional incandescent light bulbs. Compact fluorescent lights use one-third the energy of incandescent lights and may last from 6 to 10 times longer. Improvements in energy efficiency are generally achieved by adopting a more efficient technology or production processes or by application of commonly accepted methods to reduce energy losses.

There are many motivations to improve energy efficiency. Reducing energy use reduces energy costs and may result in a financial cost saving to consumers if the energy savings offset any additional costs of implementing an energy efficient technology. Reducing energy use is also seen as a solution to the problem of reducing carbon dioxide emissions. According to the International Energy Agency, improved energy efficiency in buildings, industrial processes and transportation could reduce the world's energy needs in 2050 by one third, and help control global emissions of greenhouse gases.

Energy efficiency and renewable energy are said to be the *twin pillars* of sustainable energy policy and are high priorities in the sustainable energy hierarchy. In many countries energy efficiency is also seen to have a national security benefit because it can be used to reduce the level of energy imports from foreign countries and may slow down the rate at which domestic energy resources are depleted.

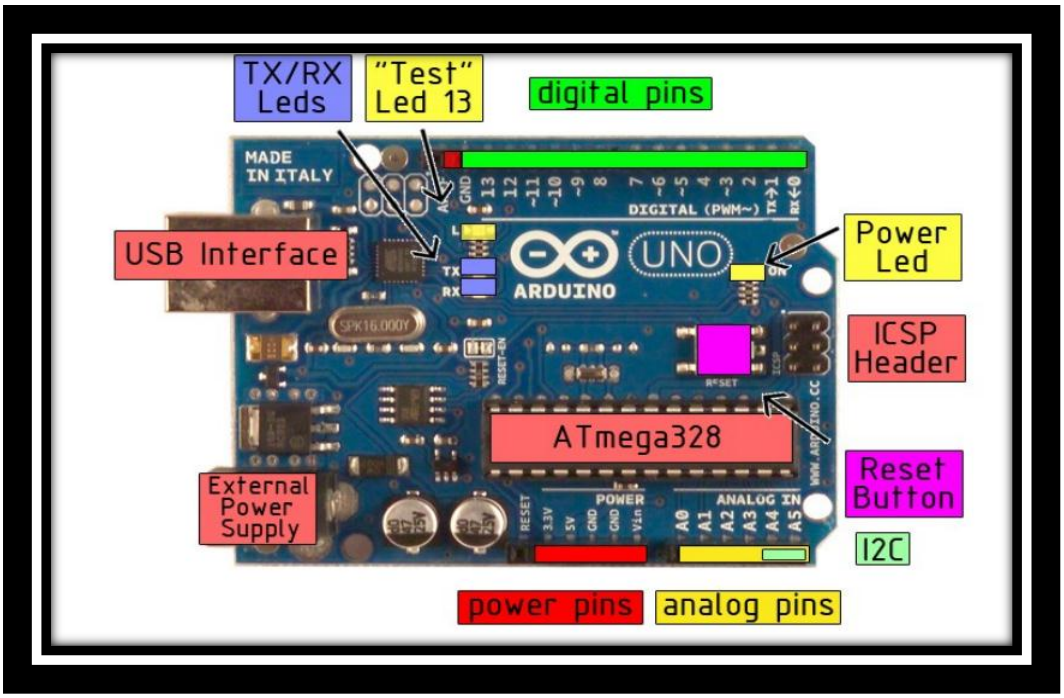
3.2 Automatic switching of fans and light

Most people leave the fan and lights on when they leave the room. Wasting electricity is caused by leaving things on when they are not being used. This means leaving on lights when we're not in the room outlet plugged into the main socket will draw electricity, so it is the best interest of the household to leave electronics turned off, or unplugged, until it needs to be used. Even leaving an entire house's lights on when only using one room can waste five times as much energy than if you're using all the sockets in only one room. As well as needing to be replaced three times as much as any other electric component, lights use more than twice as much energy to run daily. To keep the same amount of light entering a room without using energy, one could try keeping the curtains open in certain rooms, to allow natural light to enter the house. This is both free, and is better for your eyes, reducing the strain on the iris to focus on things in low-light conditions. So, we are going to implement an automation system to stop the wastage of electricity.

3.2.1 Components required

1. Arduino-uno:

Microcontroller	**ATmega328**
Operating Voltage	**5V**
Input Voltage	**7-12V**
Input Voltage (limits)	**6-20V**
Digital I/O Pins	**14 (of which 6 provide PWM output)**
Analog Input Pins	**6**
DC Current per I/O Pin	**40 mA**
DC Current for 3.3V Pin	**50 mA**
Flash Memory	**32 KB of which 0.5 KB used by bootloader**
SRAM	**2 KB**
EEPROM	**1 KB**
Clock Speed	**16 MHz**



2. Infrared Emitters and Detectors

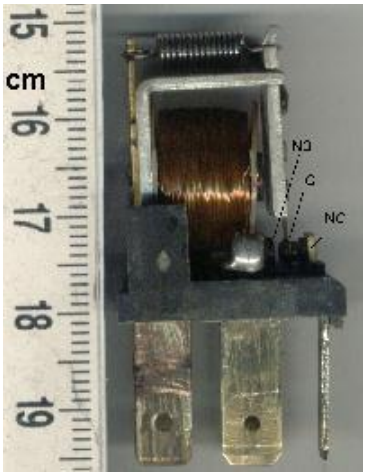
Infrared Emitters and IR Detectors simple devices operate at 940nm and work well for generic IR systems including remote control and touch-less object sensing. Using a simple ADC on any microcontroller will allow variable readings to be collected from the detector. The emitter is driven up to 50mA with a current limiting resistor as with any LED device. The detection is a NPN transistor that is biased by incoming IR light.

Fig: IR emitter & receiver

3. Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

Here, we will use the relay as a switching device. When the room will be vacant the relay will open the circuit by its operation. Again, it will switch on when someone enters into the room.



4. Resistors

5. Wires

3.2.2 Software based Implementation:

We are using arduino-uno to implement the automatic switching of lights and switches. Here, fig3.1 shows that someone is entering through the door, thus the Infrared is interfered. But we have to notice wheather she is entering or leaving. So, We are using two layers of IR. One IR is at the outer side of the door denoted as IR1 and another is at the inner side of the door denoted as IR2.

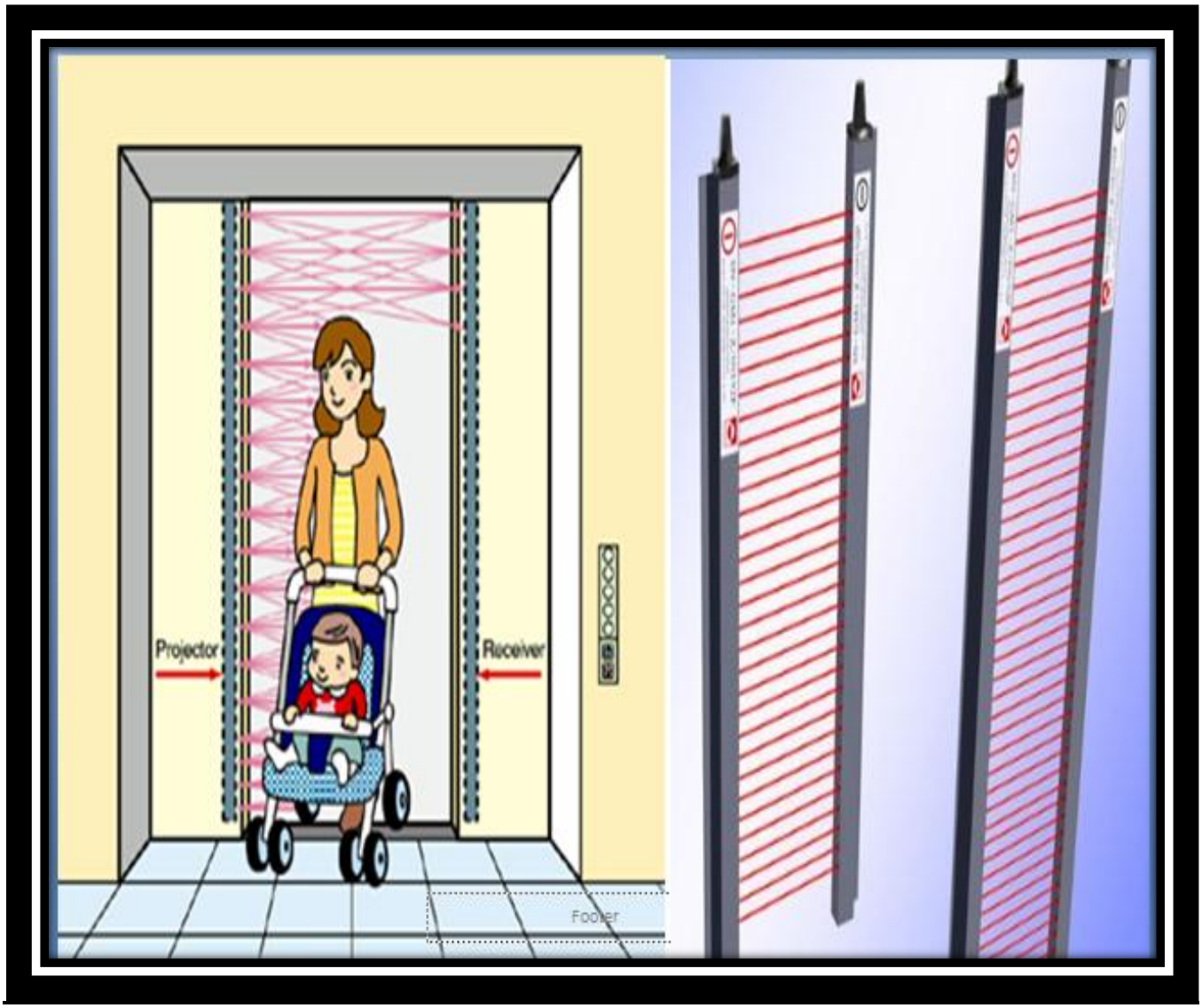


Fig: 3.1

If IR1 is interfared first, someone is entering into the room. If IR2 is interfared first, someone is leaving.

The fig.3.2 shows the flow chart of automatic switching control depending on number of persons in the room.

FLOW CHART

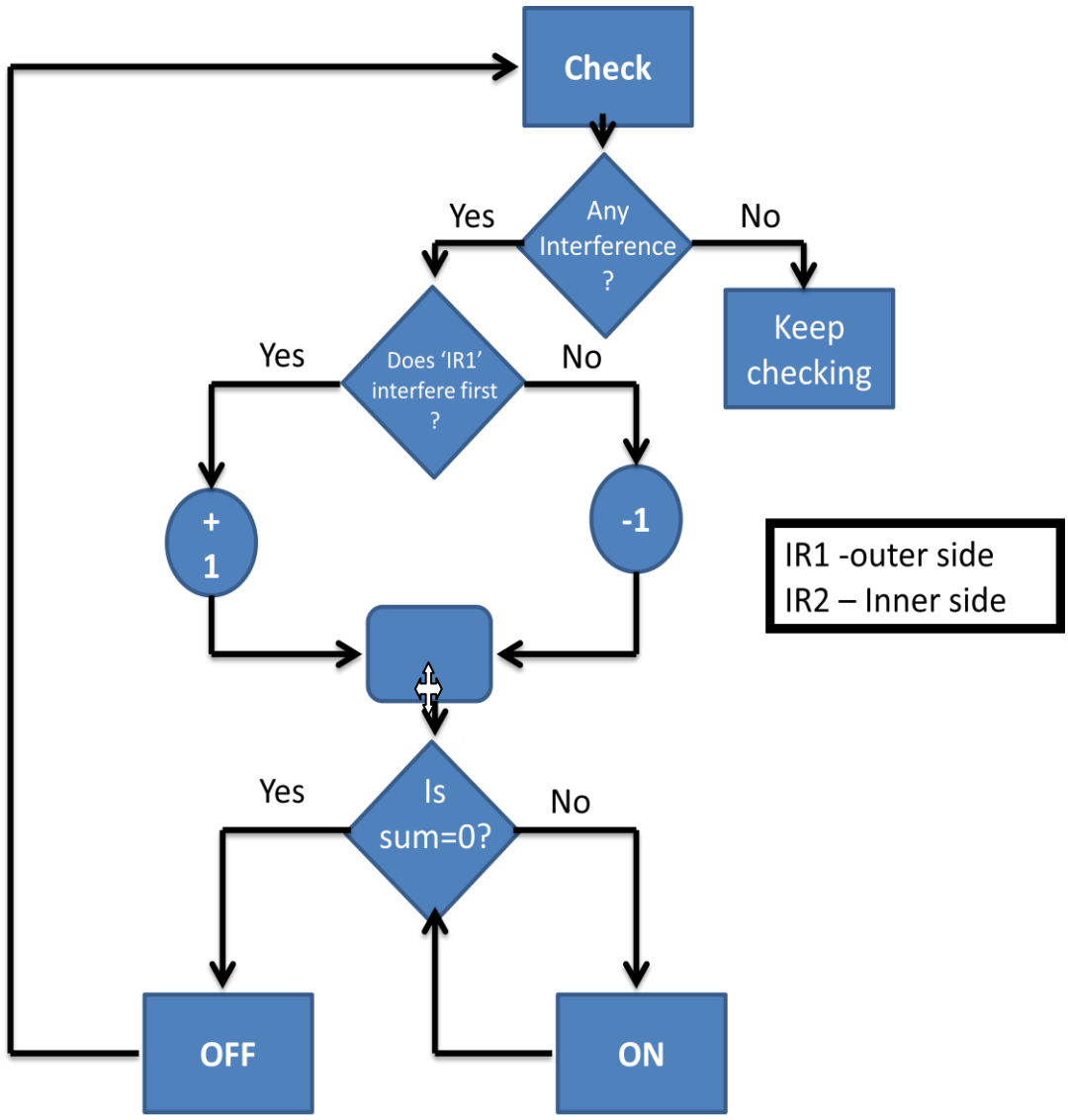


Fig: 3.2

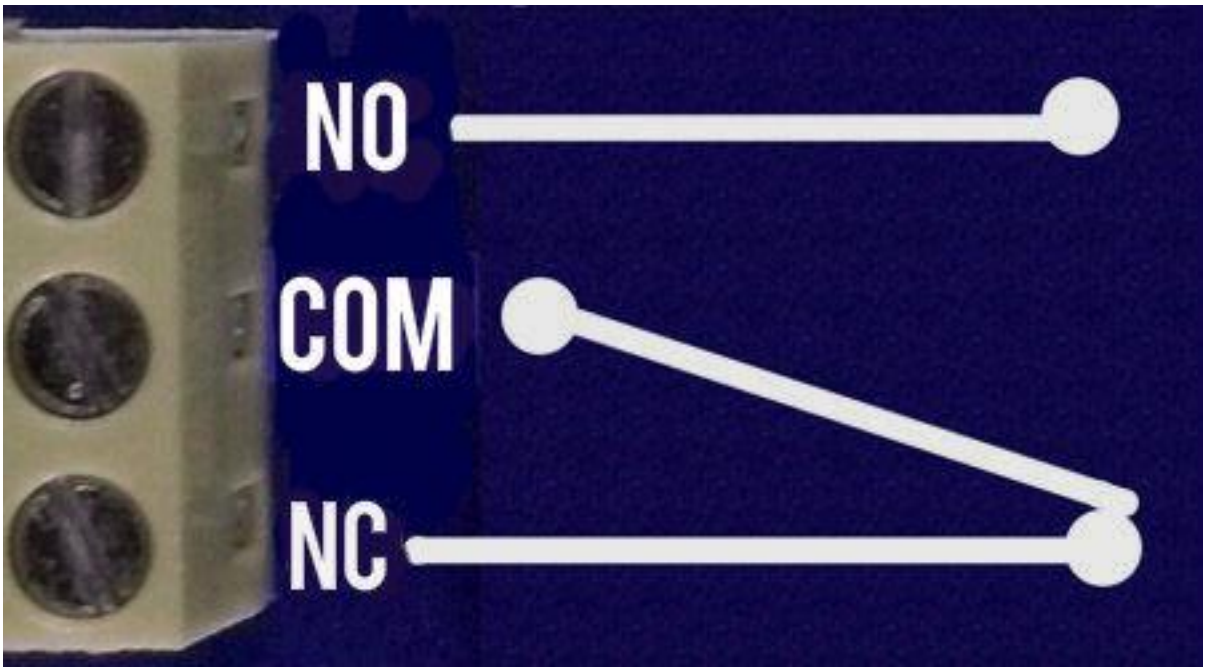
Explanation:

- At first Arduino will continue to check whether there is any interference or not.
- If there is any interference, it will check whether IR1 is interfered first or not.
- If IR1 is interfered first, someone is entering. So, it will count +1
- If IR2 is interfered first, someone is leaving. So, it will count -1
- If sum is not zero, room is not vacant. Switch of the lights and fans will be ON.
- If sum is zero, room is not empty. Switch of the lights and fans will be OFF.
- Again, it will continue to check.

- We are considering 2 row based classroom where 1st row lights can cover upto 9 students and when the count is 10 and above the lights of the 2nd row will be on automatically.

Controlling AC light using Arduino with relay module:

Step: NC COM NO of Relay



COM - Common connection--> it is the center terminal, It is hot as power to the load is connected at this terminal.

NO Normally open ---> It acts like a switch, since it is open - there will be no contact between COM and NO, When we trigger the relay module, it connects to COM by the electromagnet inside the relay and supply to the load is provided, which powers up the light. Thus the circuit is closed until we trigger the state to low in relay.

NC Normally closed---->It is always in contact with COM, even when relay is not powered.when we trigger the relay it opens the circuit, so the connection is lost. it behaves just opposite to NO.

im using NO connection, but here in this type of relay "HIGH" state in code turns off the relay(opens the circuit). "LOW" state in code turns on the relay.

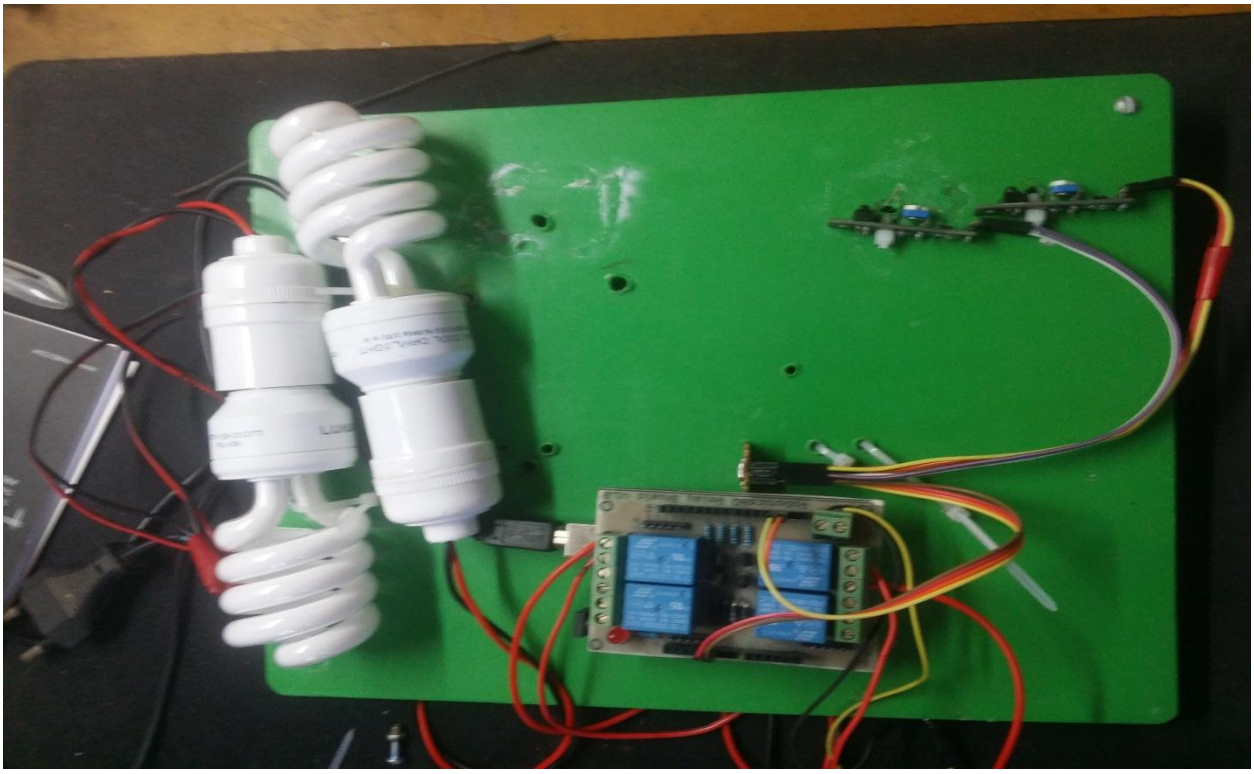
Code:

```
int count=0;
int sen0=A0;
int sen1=A1;
int sen0_s;
int sen1_s;
int rel1=10;
int rel2=9;
int rel3=8;
int rel4=7;



void setup()
{
        pinMode(sen0, INPUT);    //set pin as an input mode
        pinMode(sen1, INPUT);   //set pin as an input mode
        pinMode(rel1, OUTPUT); //set pin as an output mode
        pinMode(rel2, OUTPUT); //set pin as an output mode
        pinMode(rel3, OUTPUT); //set pin as an output mode
        pinMode(rel4, OUTPUT);  //set pin as an output mode

 Serial.begin(9600);                  //selecting baud-rate 9600
}

void loop()
 {
       Sen0_s = analogRead(sen0);
       sen1_s= analogRead(sen1);

                 if (sen0_s == LOW)
                {
                          count = (count+1);
  Serial.println(count);
                delay(1000);
                 }

                 if (sen1_s == LOW)
                {
```

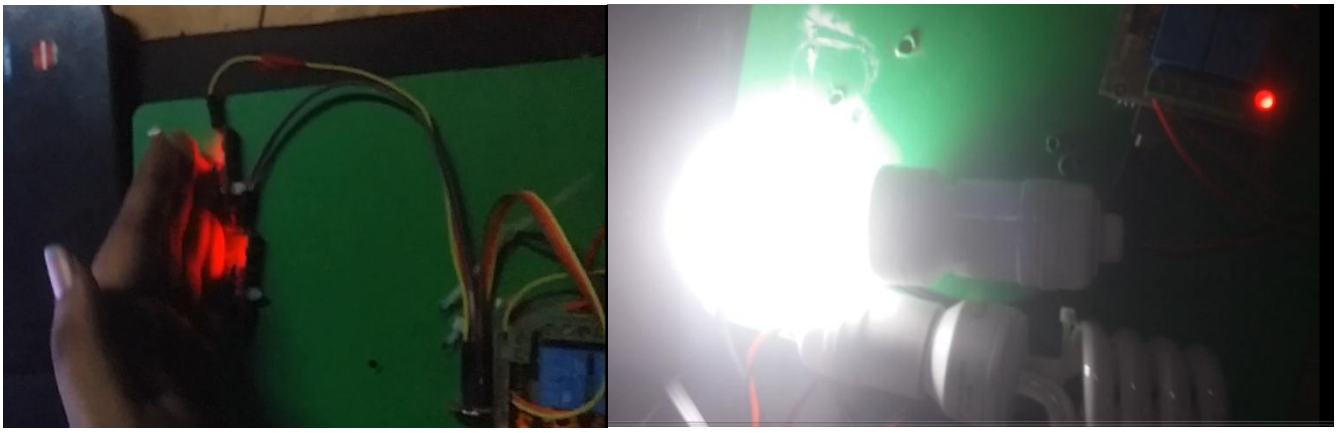
```
                    count = (count-1);
Serial.println(count);
            delay(1000);
              }

             if (count >0)

             {

                    digitalWrite(rel1, HIGH);
                    digitalWrite(rel2, HIGH);
             }

              if (count <=1)
             {
                    digitalWrite(rel1, LOW);
                    digitalWrite(rel2, LOW);
              }


               if (count >5)

             {
                    digitalWrite(rel3, HIGH);
                    digitalWrite(rel4, HIGH);
             }
             if (count <=5)
             {
                    digitalWrite(rel3, LOW);
                    digitalWrite(rel4, LOW);
              }
      }
```

Hardware implementation

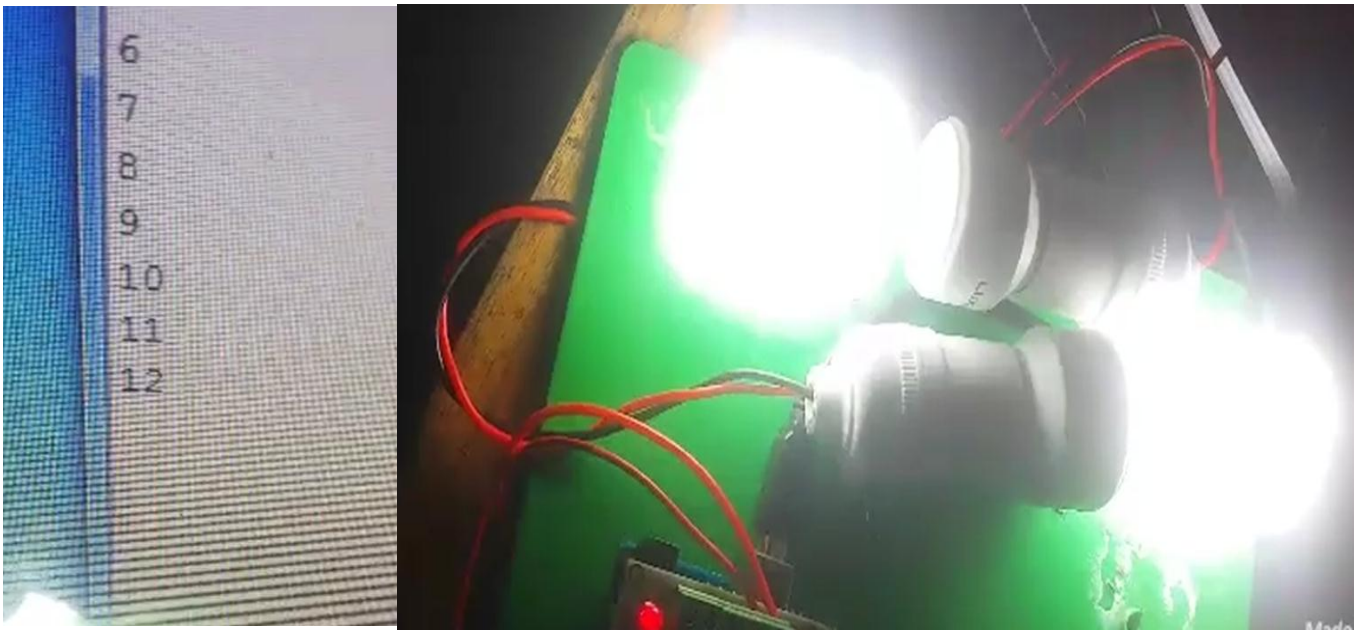
We used a board and implemented our idea and made our project as it is captured in the next page:



Initially the light is off



When the first person enters, lights on



When 10 people enter, 2nd light become on

3.3 Counting the number of people in the room

Two laser beams are used to count the number of persons entering or leaving the room.

Advantages

- The number of persons entering or leaving can be monitored automatically.
- Without counting manually we can have an accurate calculation of number of people of any place like classroom etc.
- The counting information can be used in automatic switching.
- If the counting is zero, then cutting the power off, we can save usage of energy.

Components

1. Arduino-uno
2. LCD display
3. Laser

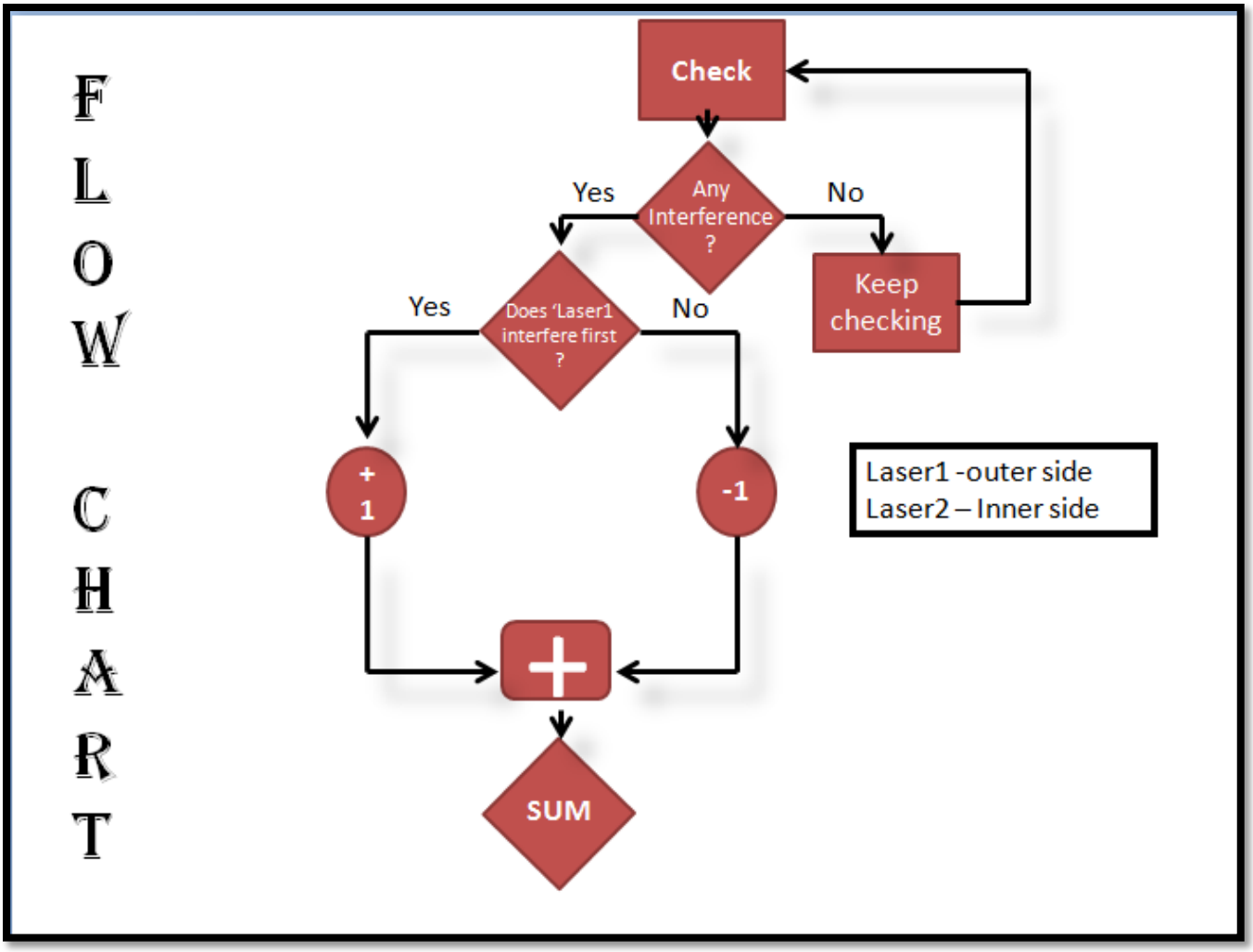


Fig: counting the number of people

Explanation:

- At first Arduino will continue to check whether there is any interference or not.
- If there is any interference, it will check whether Laser 1 is interfered first or not.
- If Laser 1 is interfered first, someone is entering. So, it will count +1
- If Laser 2 is interfered first, someone is leaving. So, it will count -1
- If sum is not zero, room is not vacant.
- If sum is zero, room is vacant.
- It will give the reading to the LCD display.

4

FUTURE OF THIS PROJECT

4.1 More possibilities

Technological advancement has made the implementation of embedded systems within home appliances possible. Now a day, most of the people are in touch with web or mobile communication. This has added new capabilities and features in the field of home automation. However, most of the time, the implementations are proprietary and networking is not always possible due to some problems. Yet there is an increasing demand for smart homes, where appliances react automatically to changing environmental conditions and can be easily controlled through one common device. We can show a possible solution whereby the user can control devices easily by employing an embedded system to which the devices and sensors are interfaced. This results in a simple, cost effective, and flexible system, making it a good candidate for future smart home solutions.

Home automation can include following ways to control the home appliances.

- Global system for mobile communication (GSM)
- Remote controller
- Web enabled controller and so on

4.2 Home Automation System using GSM module

Today, mobile phone is an important part of our life. So it's best possible way if we can interconnect our home appliances with mobile based control. GSM is the most popular standard for mobile phones in the world. GSM controlled home automation systems are widely used in the world. Our basic home appliances can be easily controlled via GSM network. But the main thing is to cope up with the cost. That is why, it's best to use our own GSM module to integrate with our required appliances. Main components that can be used are:

- GSM module
- DTMF (dual tone multi frequency) signaling
- DTMF decoder

- Arduino
- Relay
- Required complete circuit

DTMF is used in telecommunication between handset and other communication devices. To match the arduino low power with the high power real network, relay is used. As GSM module has built in RS232 chip, it can easily communicate with the controller arduino. The whole setup is in such a way that it contains proper atmosphere and safe instrumentation. Thus, the system presents a mobile controller and user friendly approach to the home automation system.

Advantages

- GSM is easy to access and use, portable, and has a global range.
- It can make our life easier.
- Home appliances can be controlled from far distance.
- Portability
- Low power consumption
- SMS (short message service) can be used as command.

Disadvantages

- No feedback is provided
- If the main chip/device fails, it leads to a catastrophe.

4.3 Home Automation using Remote Controller

Wireless technologies represent a rapidly emerging area of growth and importance for providing ubiquitous access to the network. Remote controller is a good way to use as a control device for home automation system. Many types of remote controllers can be used here; such as

- TV remote
- IR remote etc.

4.3.1 HAS using IR remote

A completely automated smart home system can be implemented by using an unused remote controller. In this case, control head receives an IR signal using an IR receiver chip. Here, remote controller is used to send signals and it senses the necessity by sensing the signals sent from remote instead of using sensor inputs. To implement the whole system, a remote controller with numerical buttons can be chosen. Then an IR receiver is needed to be integrated with the main chip with the ability of decoding 35 KHz to 40 KHz IR signals. Once implemented, we can use the controller to control home automation system from a distance manually.

A normal TV remote can also be used to control the automated home. As TV remote has built in IR sensors in it, it can be easily used with the same principle as previous section.

4.4 HAS using Bluetooth

As people have easy access to Bluetooth because of their smart phones, it's preferable to use Bluetooth rather than using remotes in home automation also. Main advantages of using Bluetooth are:

- Easy access and use
- More secured
- Works in short distance range (10m max)
- Anyone can find free Bluetooth in their smart phones.

So, if we want to have a simple system with reliable control then using Bluetooth is a better option.

Basic components that can be used here are:

- HC-05 Bluetooth module
- Power supply
- Arduino
- Smart phone (android)
- Resistors, Capacitors

The Module that can be used here is a Serial Port Protocol (SPP) module designed for a transparent serial connection setup. Using potentiometer, we can get the required output for the Bluetooth module.

Basic algorithm can be as such:

The system simply receives instructions from Bluetooth enabled smart phone using the module and pass it to the arduino which does the main processing part. When the arduino gets the input signal via Bluetooth, it switches ON or OFF the relay and relay works as a switching device for the AC appliances. Thus, we can control our automation via Bluetooth using a smart phone.

4.5 HAS using web interface

We can integrate the automation system using web browser as well. We can check out the home appliances using web browser and even can command it to do something form a distant place.

The basic idea is to turn a normal router as a home automation server. It will allow us to send out serial commands remotely. The simple principle is to send command using a web browser to the router. Upon getting the command, the router will send specific input signal to the receiver and thus the control arduino will do as commanded. Basic components that are needed on this purpose are:

- OpenWRT compatible router with serial header
- Actuators like RF switches outlets
- Arduino
- RF receiver
- Particularly designed webpage (optional)

After pushing a button on the web page the router sends out a serial command, we process this with arduino which converts it to RF protocol, injects it into the RF remote, which controls the RF outlets.

There are some disadvantages too. Such as:

- Comparatively unsecured
- It requires several internet protocol and user information etc.

In contrast to devices controlled from a web browser these are designed to be simple. Arduino based devices that are capable of talking to each other bi-directionally. It's possible to have local Device/Relay combinations to control Mains socket power to the appliances. Practically, it is a good idea to have one device per room.

4.6 Interconnected System

Home automation is an interconnected system that includes every home appliance. After being able to control all rooms in a house automatically, we can take all of them under the command of a master device. This master device can have ultimate control over all the arduino at a time. The total system can be integrated by using: one arduino for each room, a master arduino (may be arduino MEGA) to take over all other arduinos, jumper wires and related circuits. Only the main arduino will be connected to the main power supply of the house and others will be connected individually to power line specified to each room. Then every room is controlled by one arduino and all of them will be answerable to the master arduino which will make the ultimate decision.

4.7 Security incorporated in System

As it is said, there is no substitute for peace of mind. The first prior thing comes in our mind is security of ourselves. And a secured home is essential for that. In that case, we have opportunity to include security automation to our home automation system. Security automation will provide us the possibility to make our home both comfortable and secured. For that purpose, we have to add two things in our system. We can either take already burned arduino chip that contains security program for our home or we can extend our own system to security level such as adding a digital coded lock in our automated doors and windows. We can also add this system to our following home appliances:

- Door lock
- Fire alarm
- Smoke detector and so on

We have to incorporate it with our system by using another arduino connected with/without wire and have to monitor the security system by using a computer or smart phone alarm.

4.8 Making Own Device/Product

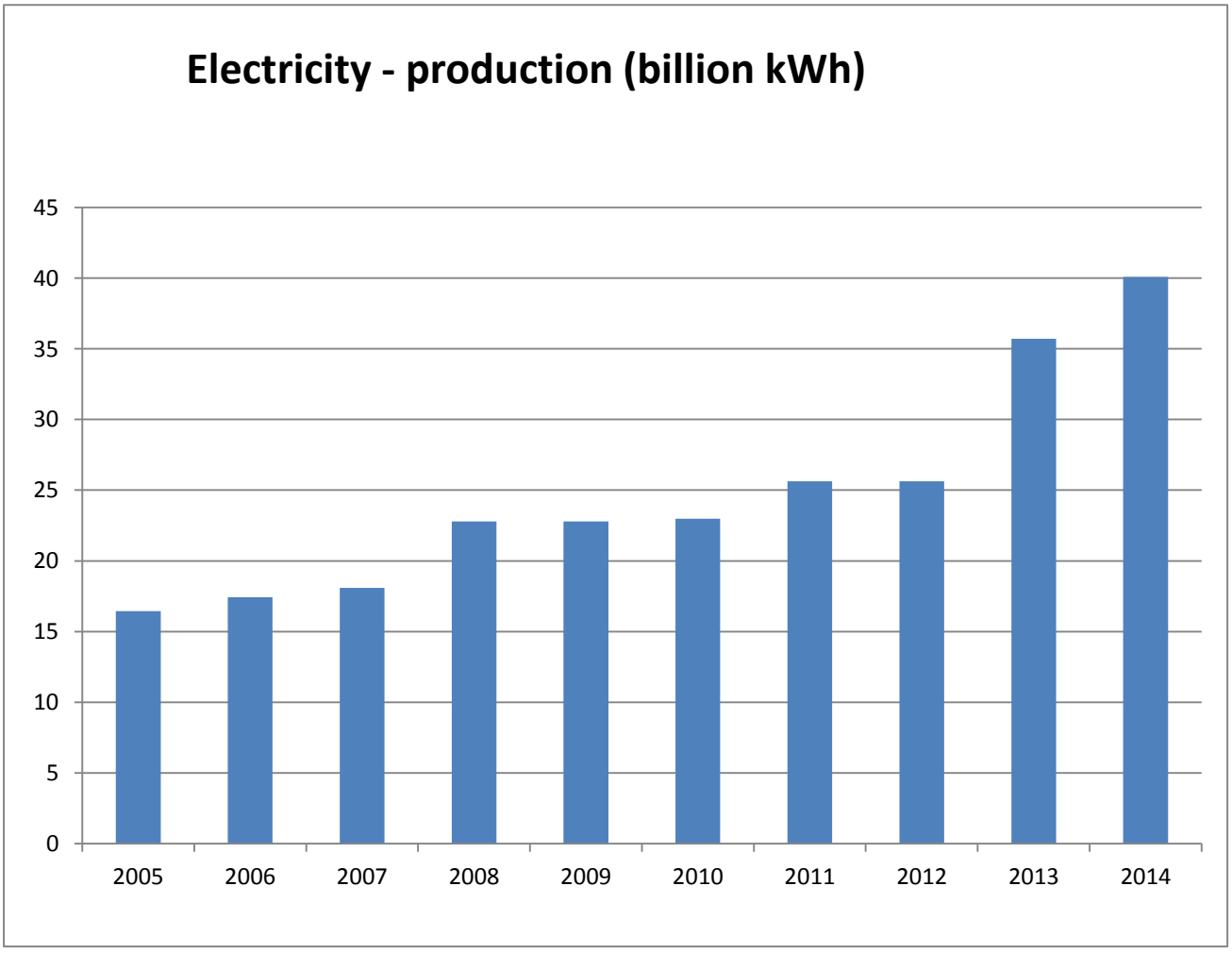
If we can design all the required appliances, we can take the burned chip and use it to make a small device. We can make the PCB design and implement it in a PCB board. Then it's very easy to connect to the whole system in a house. And thus we can make a cheap, effective home automation device

5

ANALYSIS

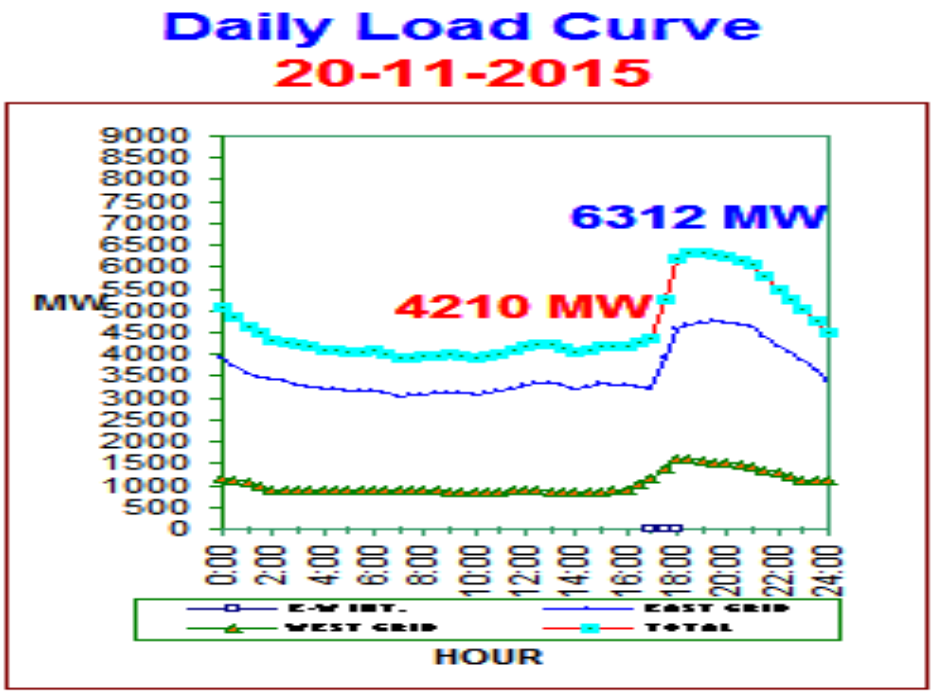
5.1 Electricity - production and demand in Bangladesh:

Bangladesh's installed electric generation capacity was 10289 MW in January, 2014; only three-fourth of which is considered to be ‘available’. Only 62% of the population has access to electricity with a per capita availability of 321 kWh per annum. Problems in the Bangladesh's electric power sector include corruption in administration, high system losses, delays in completion of new plants, low plant efficiencies, erratic power supply, electricity theft, blackouts, and shortages of funds for power plant maintenance. Overall, the country's generation plants have been unable to meet system demand over the past decade.



5.2 Load Curve

The load curve of Bangladesh is not ideal because the supply of electricity and the demand in not equal. So the load shedding occurs and thus the load curve is suppressed.



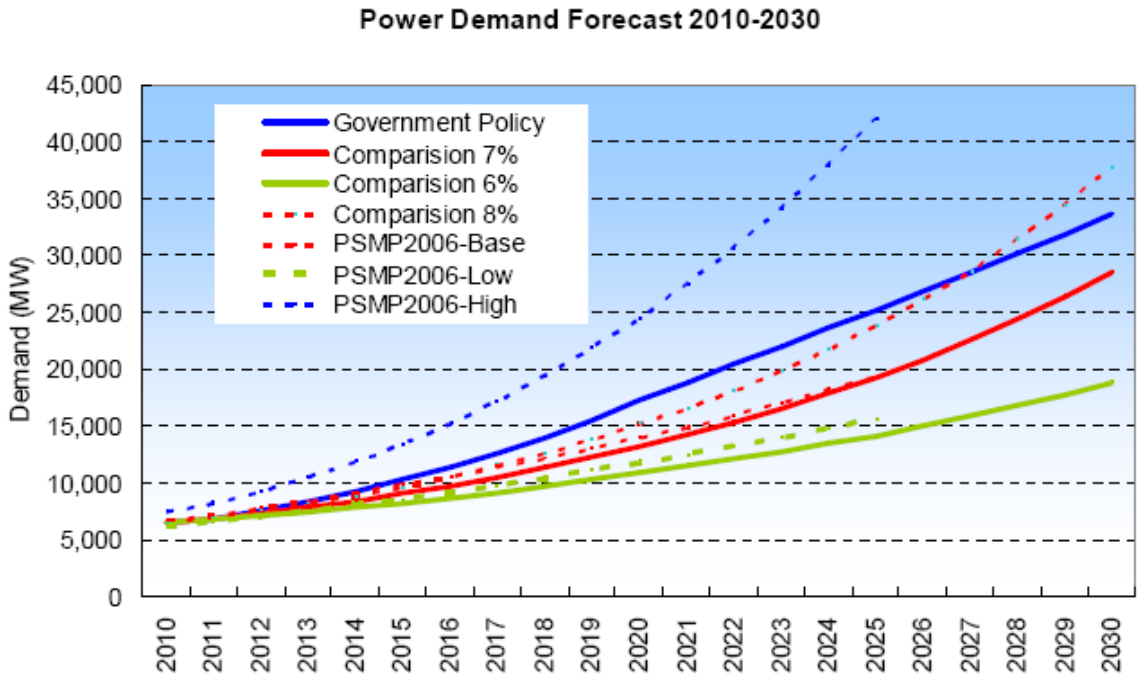
5.3 Projected Demand for Electricity

In Bangladesh, the power supply has constantly remained strained in peak hours. Potential demands have not been met, and rotational outage has frequently occurred. The actual recorded maximum power has not included these potential demands. To estimate the maximum power that includes potential demands, PSMP 2006 adopts a method for calculating the generated power energy with which a compound daily load curve is produced by adding the evening peak demand for lighting, calculated from a daily load curve with no rotational outage on weekends and holidays in winter, to a daily load curve suppressed by rotational outage on weekdays in summer. By regressively analyzing the relation between the generated power energy calculated this way and the economic level indicated by the actual GDP and setting the load factor from a load curve that includes potential demands, PSMP 2006 estimates the maximum power energy. The following table shows the result of the forecast of power demands indicated in PSMP 2006.

	Base Case		High Case		Low Case		Projected Load Factor
Fiscal Year	Net Generation (GWh)	Net Peak Load (MW)	Net Generation (GWh)	Net Peak Load (MW)	Net Generation (GWh)	Net Peak Load (MW)	
2005	21,964	4,308	22,336	4,381	21,964	4,308	58.2%
2006	23,945	4,693	24,692	4,839	23,611	4,627	58.2%
2007	26,106	5,112	27,297	5,345	25,382	4,970	58.3%
2008	28,461	5,569	30,177	5,904	27,286	5,339	58.3%
2009	31,028	6,066	33,592	6,567	29,333	5,734	58.4%
2010	33,828	6,608	37,652	7,355	31,533	6,160	58.4%
2011	36,622	7,148	42,202	8,237	33,659	6,569	58.5%
2012	39,647	7,732	47,627	9,288	35,928	7,007	58.5%
2013	42,922	8,364	53,749	10,473	38,351	7,473	58.6%
2014	46,467	9,047	60,659	11,810	40,937	7,970	58.6%
2015	50,306	9,786	68,924	13,408	43,697	8,501	58.7%
2016	54,079	10,512	78,316	15,223	46,643	9,066	58.7%
2017	58,135	11,291	88,384	17,166	49,788	9,670	58.8%
2018	62,496	12,128	99,746	19,357	53,145	10,313	58.8%
2019	67,183	13,027	112,568	21,827	56,728	11,000	58.9%
2020	72,222	13,993	126,172	24,445	60,553	11,732	58.9%
2021	77,092	14,924	141,419	27,377	64,178	12,424	59.0%
2022	82,290	15,917	158,510	30,661	68,020	13,157	59.0%
2023	87,839	16,977	176,448	34,103	72,092	13,934	59.1%
2024	93,761	18,107	196,415	37,931	76,408	14,756	59.1%
2025	100,083	19,312	217,137	41,899	80,982	15,626	59.2%

The demand of electricity is increasing day by day. But the rate of the increase in the electricity generation is not meeting up that rate. In order to decrease the rate of electricity consumption per capita in developing countries like Bangladesh home automation can play an effective role.

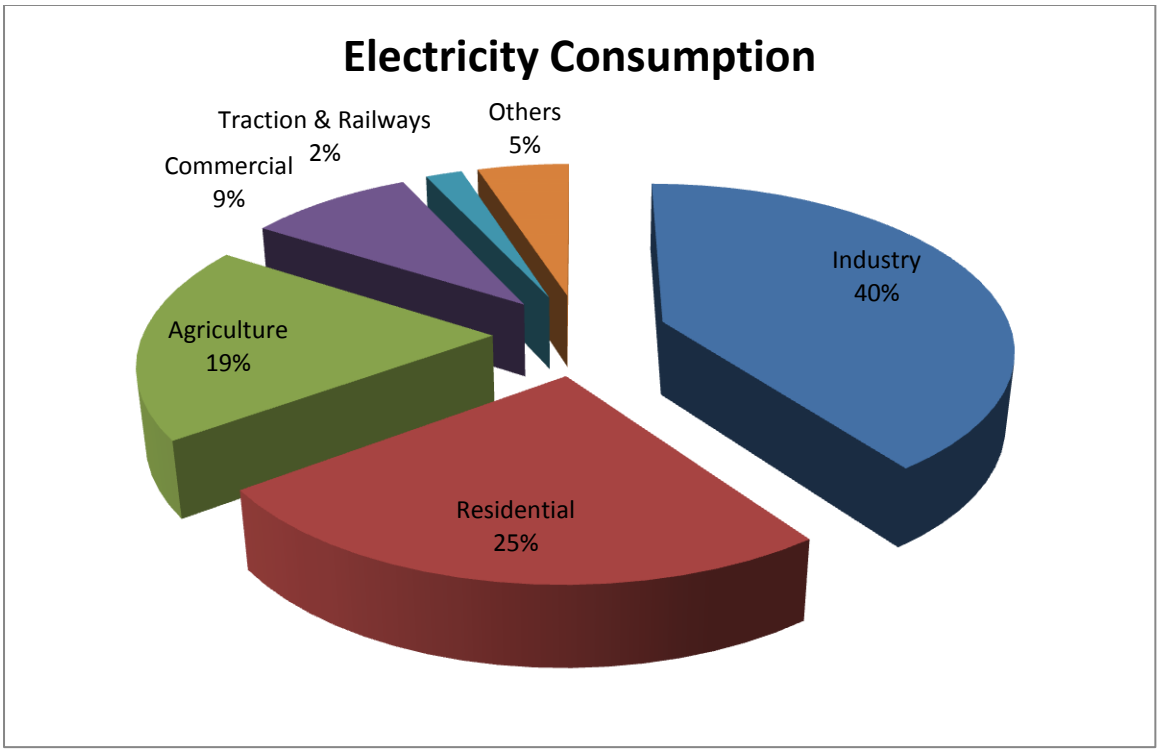
The adoption scenarios of the power demand forecast in this MP are as shown in the figure below. The figure indicates three scenarios; (i) GDP 7% scenario and (ii) GDP 6% scenario, based on energy intensity method, and (iii) government policy scenario.



Source: JICA Study Team

5.4 Home Automation & Energy Saving:

A significant amount of energy used in home. Approximately 25% of the total electricity consumption occurs in home. In 2014, the average annual electricity consumption for a Metropolitan residential utility customer was 40,932 kilowatt hours (kWh), an average of 911 kWh per month. Dhaka had the highest annual consumption at 35,497 kWh per residential customer, and Banderbuns had the lowest at 1,077 kWh per residential customer.

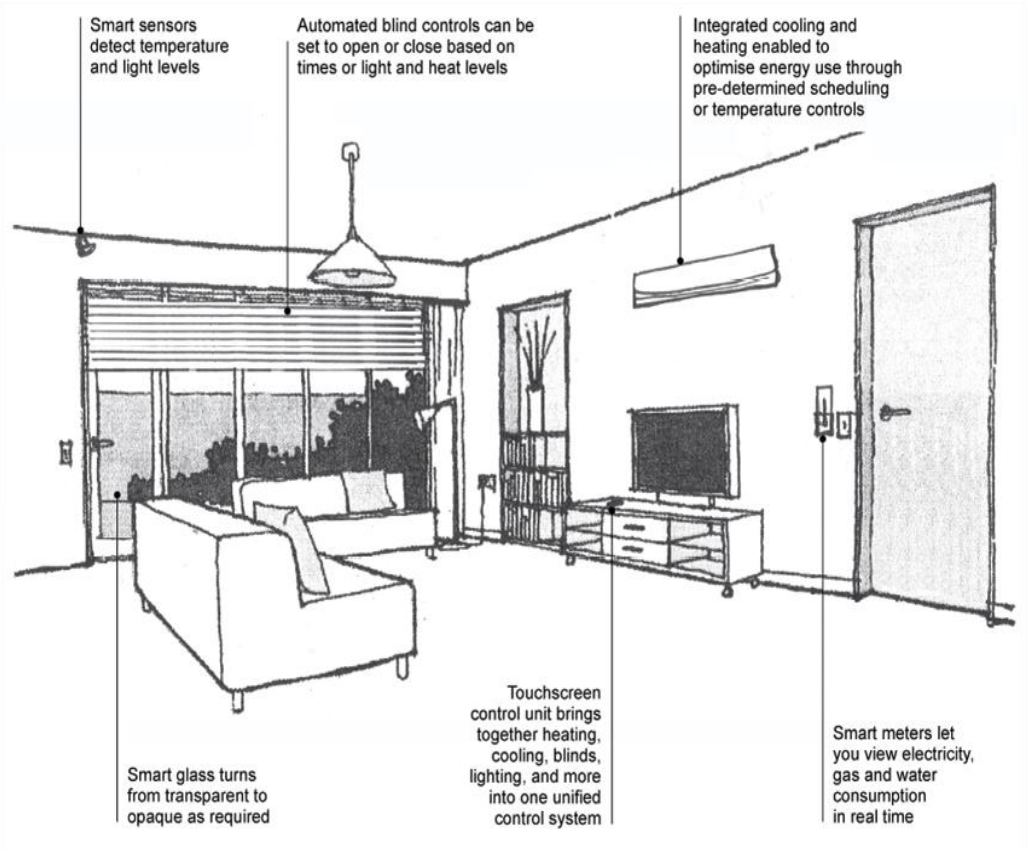


In the Home Automation System, appliances and equipment can be controlled automatically and remotely. Automated controls can turn equipment on or off, or adjust operating settings at predetermined times; they can be triggered on site or remotely; they can adjust equipment operation in response to changes, such as temperature, in the home environment. Homes using these techniques, which may also integrate broadband communications, are sometimes called smart homes or smart houses.

Home automation can either be centralized and programmable, or consist of decentralized and isolated sensors and controls. Systems range from sophisticated electronic programmable controls for lighting, heating, cooling and entertainment devices using special wiring or wireless, to just a few isolated, automated systems, such as motion sensors to control lights.

Home automation systems can improve the energy efficiency of your home only if they are designed for this purpose. Automated systems use energy, so they produce energy savings only if they save more energy than they use. They are typically expensive, so take a significant time to 'pay back' the savings from reduced energy costs.

Make designing an energy efficient home, and installing high energy efficient appliances and lighting, your first priority. Then, design home automation systems to reduce the time that energy-using equipment operates or the need for operating equipment.



Automated systems use an electrical signal to switch equipment — usually a light, a motor or heating/cooling appliance — on or off. Lights can be turned on or off on demand or based on timers or sensors. Motors can open and shut blinds, windows and vents; they operate fans, dampers, valves and pumps. Valves and dampers can allow water or air to flow under the influence of the fans and pumps. Motors and heating/cooling appliances can be triggered by timers, sensors or thermostats. Relays are more sophisticated switches that can activate any electrical or electronic device. Computers or specific controllers can automate all of these devices.

Automation system saves energy by saving the electricity from misuse. There will be no light or fan on while there is no one in the room. In this project number of light and fan on depends on the number of students present in the classroom. Thus there will be no misuse of energy.

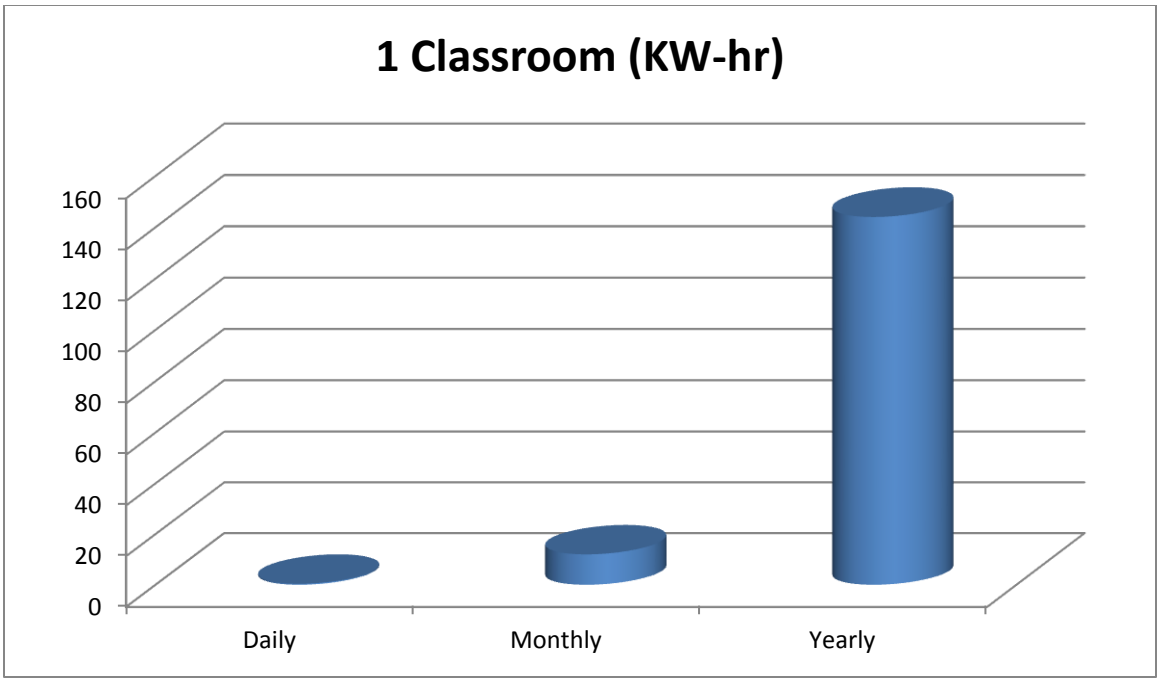
5.5 Calculations of our project:

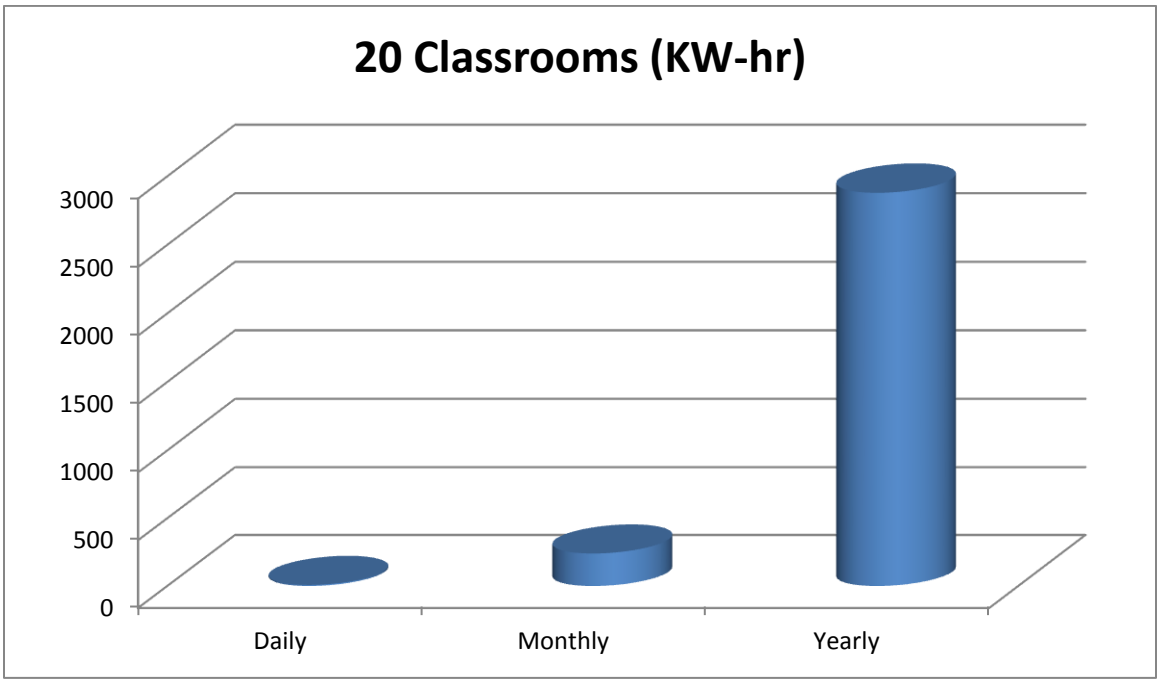
The misuse Energy in one classroom

Time Period	2 Lights (40 W each)	2 Fans (60 W each)	Total
Misuse Time	2 hours	2 hours	2 hours
Daily	(80 x 2) = 160 W	(120 x 2) = 240 W	400 W
Monthly	(160 x 30) = 4800 W	(240 x 30) = 7200 W	12000 W
Yearly	(4800 x 12)= 57600 W	(7200 x 12)= 86400 W	144000 W
Total Kilowatt-hour unit	57.6 KW-hr	86.4 KW-hr	144 KW-hr

Consider 20 classrooms in the university. Here considering only two lights and two fans is misuse for only two hours. Daily, monthly and yearly savings of electricity shows below –

Time period	2 lights & 2 fans	Total
Misuse Time	2 hours	2 hours
Daily	(400 x 20)	8 KW
Monthly	(12000 x 20)	240 KW
Yearly	(144000 x 20)	2880 KW





Automation system saves energy in the long run. Home automation makes the home "smart." It allows the devices like a lamp to intelligently perform actions based on conditions set. According to the American Lighting Association, household lighting accounts for 12-15% of our household utility bill.

Furthermore, studies suggest that a whopping 50% of the electricity used for lighting in the U.S. is wasted! This is due to inefficient lighting sources or lights that are on in unoccupied rooms.

By setting up a home-automated system, the money can be saved by conserving energy. Programming the thermostats or air cooler according to schedule so that there is no misuse. Home automation systems offer centralized control over not only residential lighting and heating, ventilation, and air conditioning (HVAC) units, but also smaller home appliances and security systems, thereby making life simpler and more convenient throughout the home. Although these products come with an initial cost, they are designed to save the money as well as the energy and time of the consumer.

The price unit for 1 KW-hr is 3.33 TK. Money can be saved by prevent the lights, fans, other cooling or heating system from misuse. Here considering only two light and two fans preventing misuse for two hours.

For one classroom -

Daily money saving = (0.4 x 3.33) = 1.33 TK

Monthly money saving = (12 x 3.33) = 40 TK

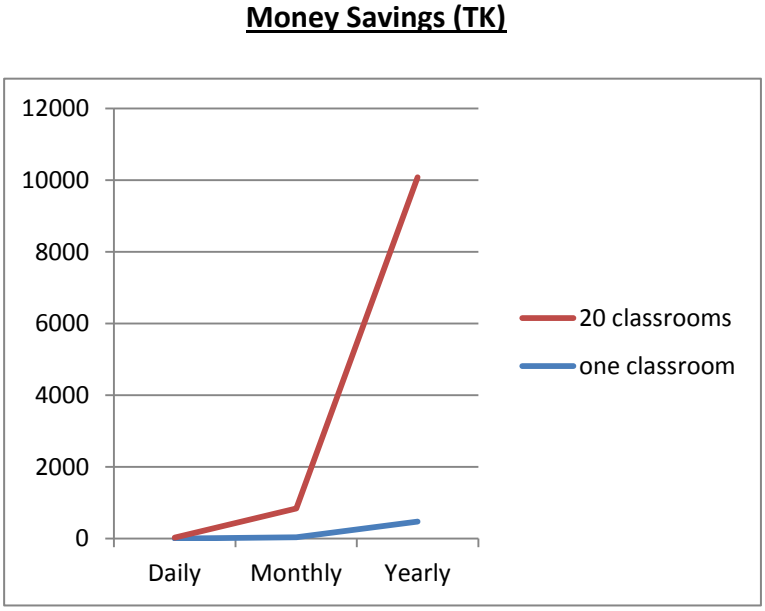
Yearly money saving = (144 x 3.33) = 480 TK

For all the classrooms (considering 20 classrooms) -

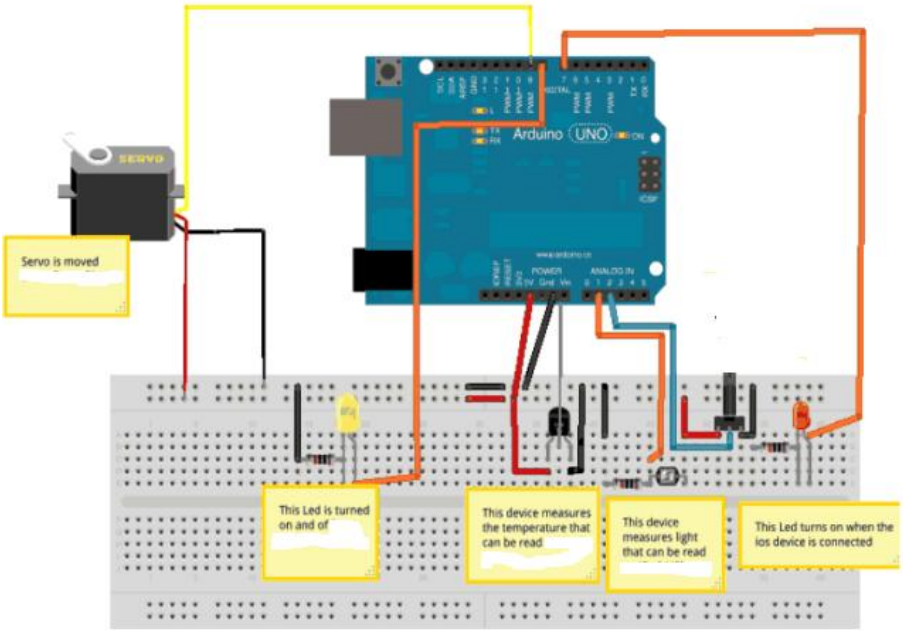
Daily money saving = (8 x 3.33) = 26.64 TK

Monthly money saving = (240 x 3.33) = 800 TK

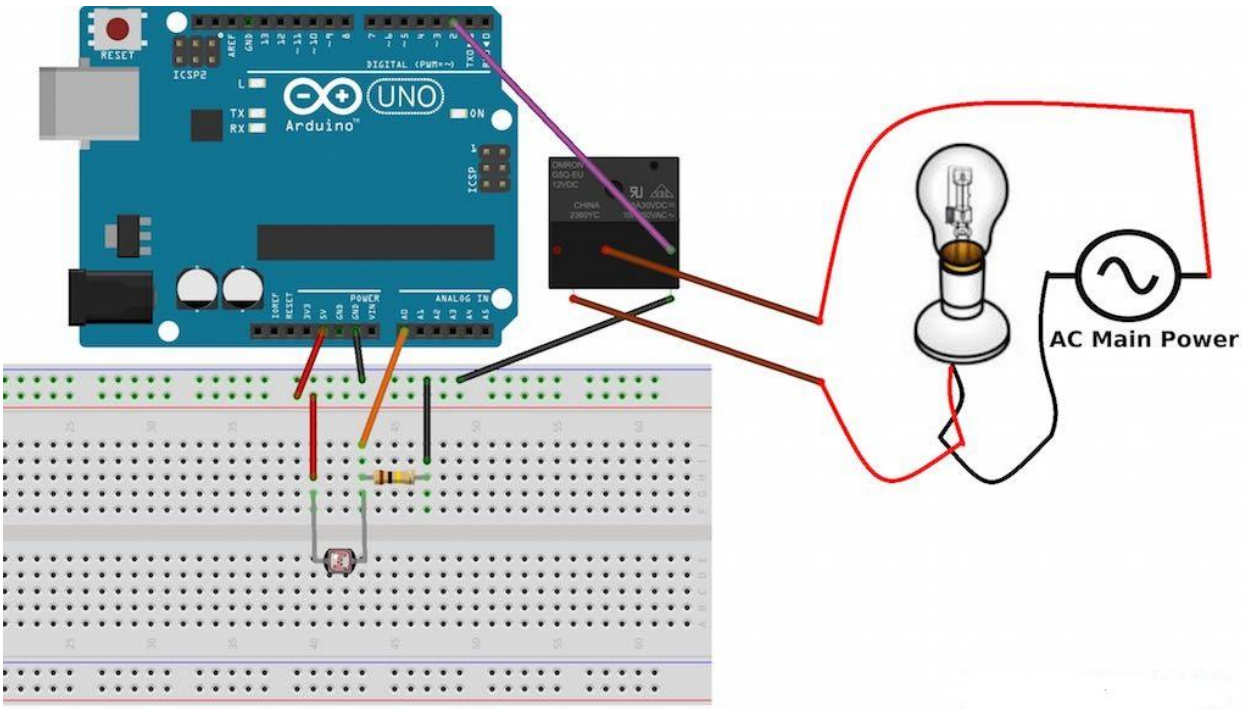
Yearly money saving = (2880 x 3.33) = 9600 TK



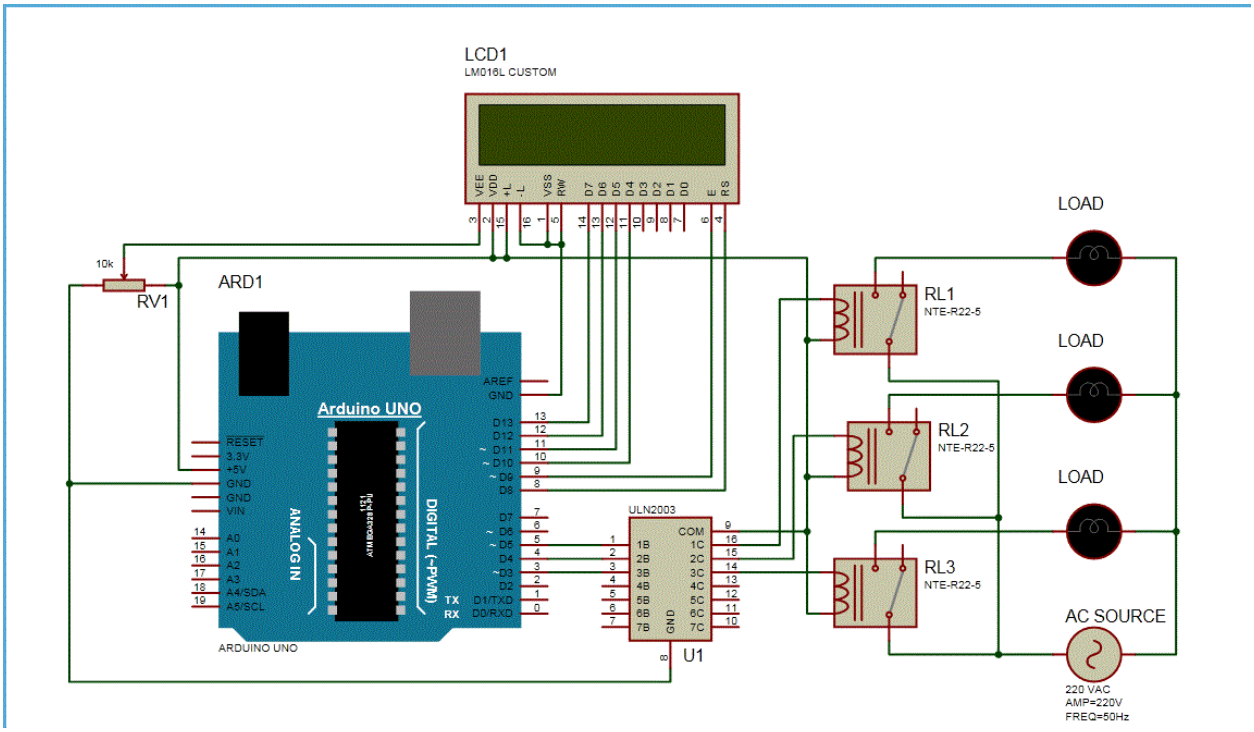
5.6 Using the Servo Motor



5.7 Using the Relay:



5.8 Using the LCD:



Conclusion

Home automation is a technical system that isn't very familiar to people in our country. A home automation system integrates electrical devices in a house with each other. The techniques employed in home automation include those in building automation as well as the control of domestic activities. As the number of controllable devices in the home rises, interconnection and communication becomes a useful and desirable feature. Home automation can also provide a remote interface to home appliances or the automation system itself, to provide control and monitoring on a smartphone or web browser. Home automation technologies are viewed as integral additions to the smart grid. Communication between a home automation system and the grid would allow applications like load shedding during system peaks or would allow the homeowner to automatically defer energy use to periods of low grid cost. The whole system can be incorporated with GSM, Universal access of appliances in smart home with energy usage limit where applicable.

In modern construction in industrialized nations, most homes have been wired for electrical power, telephones, TV outlets (cable or antenna), and a doorbell. Many household tasks were automated by the development of specialized automated appliances. In this thesis work, our target was to accomplish the goal to take simple home appliances under automated control and the whole system to be integrated. However, we have done the projects and found the way to incorporate with it in future.

Furthermore, we tried to reach the optimum point of operation integrating all the projects together so that we can control the whole system with only one arduino.

References:

1. International Energy Agency 2014 report.

2. Bangladesh Power Development Board.

3. World Bank

4. http://www.indexmundi.com

5. CIA World Fact book

6. PSMP 2006, Bangladesh