SMART IOT BASED ENERGY SAVER HOME AUTOMATION SYSTEM BY MEASURING RELATIVE DISTANCE AND POWER CONSUMPTION

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This Report Presented in Partial Fulfilment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "**Smart IoT Based Energy Saver Home Automation System by Measuring Relative Distance and Power Consumption**", submitted by Md. Rakib Hossain, ID: 161-15-950, Md. Ahosan Habib, ID: 161-15-974 and Sadia Afrin Setu, ID: 161-15-982 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfilment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 26/11/19.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Saif Mahmud Parvez, Lecturer, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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Abstract

Smart energy consumption and power measurement are some of the most important concerns in the recent era. Here an IoT based solution is provided to redeem the concept of over-power consumption. The main purpose of this paper is to focus on devising an intelligent energy-efficient home automation technology that can detect human presence. By detecting the presence of a person, it can turn on or off any of the lights and fans. Here, the distance between the human and the object is taken into concern. According to the distance, only the closest light fan will turn on automatically and others will remain off. The reduction in energy costs is the most important part of this paper. The total amount of energy is calculated on a daily basis. If the cost is more than the expectation, the device automatically turns off a certain fan or light for a certain time. Also, the temperature is taken into a concern to control the electrical devices. The amount of energy can be easily compared which is spent in a month by using this device and without using this device.

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Introduction

1.1 Introduction

The Internet of Things (IOT) describes the concept of remotely linking and manipulating real world objects (things) via the Internet. After coming it to our house, this idea makes our life smarter, safer and automated. Domestic mechanization includes consolidation of unavoidable computing methods to be connected with the electro powered devices and its surrounding environments. This interactive communication among human and machines is encouraged either by the utilization of a sensory device or by joining distinctive modalities of interaction including examination of human discourse [1], motion diversity[2], computer-vision[3] and behavior of human[4]. Smart home automation is not so popular yet because of nontechnical person and high cost. But our project is user friendly and less expensive. Everyone can use this because the functionality is totally automated. We use Arduino for the measurement of daily energy cost. We also show how much energy we can save per month.

This project is classified into two part there are

• Hardware

• Software

In hardware section has shown the energy cost of daily basis by using Arduino. And the software section has the automation functionality developed by the python and Image processing.

1.2 Motivation

Now this time, the uses of technology is increasing day by day. People are very much dependent on the technology therefore till now there are many new technology has been invented. For example- they can control light, fan, TV, AC through a single remote and device. There is no technology has been discovered which can control a room by detect the human presence and depend on nearest distance. Means only closest fan or light will be turned on-off by human presence. If it is calculated how much energy can save end of the month then it’s very much helpful for people and the system will be much better.

1.3 Objectives

The main objective of this project is to measure how much current can save by using this method. This project is able to switch the light-fan automatically by detecting human presence, it can turn on only the closest fan or light when human are presents in the room. Of-course it can save more current. This document helps to gather a basic concept how can control a room automatically by using a device. It also helps to find out how can it solve day to day life problem through a simple device.

1.4 Expected Outcome

It is completely an IOT base project.

It can be calculated how much current can save end of the month

It can find out the distance between human and object. Also object can switch(on-off) automatically according to the closest distance of human.

It can detect the human. By detecting the presence of human light-fan will turn on automatically and similarly it will turn off when the human left.

1.5 Report Layout

This project has five part. The introduction section depicts presentation, motivation, expected final result and so on.

The second section describe related work, comparison of the project with others problem that venture face and overall summery of the project.

The third section describe structure and segment description of the task.

The fourth section portrays experimental result discussion and descriptive analysis of this project.

The fifth section describe the usage and testing. The conclusion and the future spread of the project.

Chapter 2

Background

2.1 Introduction

Energy preservation is the effort which is made to reduce the consumption of energy by using less energy service. Day by day the invention of technology is increasing more and more. Every day human being are introduced with new technology. The main purpose of inventing new technology is for human favor. This paper is also like this. It helps human to reduce their time and cost.

As this project focused on saving the cost of energy, it helps people to reduce their daily cost. Energy can be preserved by reducing wastage and losses, improving efficiency through technological upgrades and improved operation and maintenance.

In this chapter, it is discussed about the related work of this project, how much work were completed till now and 'why this project is exceptional than others' details about this and the main purpose of this project, problems and challenges are also included here.

2.2 Related Works

First, The Internet of Things (IOT) explicates the idea that real world objects (things) are remotely connected and controlled via the Internet. After coming it to our house, this idea makes our life smarter, safer and automated. Home automation includes the use of omnipresent computational technologies to communicate with electrical appliances and their surrounding nature. The interface among these devices and humans is achieved either by using a sensor or by integrating various interaction modalities involving human speech analysis [1], locomotive movement interaction [2], computer vision [3], and behavioral pattern of human [4]. On that paper they built a smart home automation system for the comfort and protect human. That system has a house network. The system was able to getting information from environment by using a sensor and according to the information the system used an actuator for controlling. To communicate between user and android application they used Arduino [5]. By the means of software processes and locomotive movement tracking sensors, it is now possible to create automated home and building to save and energy and improve functionality. The Software incorporates an adaptive algorithms which is controlled by signals from the presence and activity tracking sensors.

It continuously detect and store systematic and stochastic behavior of at least one person in a room and in multiple rooms. It also includes a second configurable deterministic algorithms. They are used to adapt as well as trigger installation actuators or groups of installations. The algorithms are combined into a third algorithm with external parameters to optimize the entire automation system and adjust the first and second algorithms through feedback [6]. On that paper they have reported an effective use of IoT for environment condition monitoring and controlling home. That

system detected fault and correction in any device and correct fault automatically. That system predicted to find out require solution if any problem occurs in any device connected. [7] An intelligence system based on vision monitoring is described in this paper to identify the toggling state of widely utilized household appliances like fan, lamp, TV. The system uses machine intelligence based on vision to perceive the status of various devices without relying on the total number of them. A new home automation system is devised in this paper which operates by sensing the state of the appliances. The smart home interface platform has many distinctions over commonly used residence mechanization solutions which allows the usage of different sensory modules. By monitoring the system using the vision of the home and facilitating an autonomous switch to toggle the devices without sending images turns the overall process towards home automation to bimodal approach which also satisfies the privacy concerns. [8] For acquiring better residence management and consumer satisfaction, a system has been devised where the network has wireless built-in sensors and actuators which enables controlling and monitoring facilities. Research study of this paper is the major existing and emerging technology. It is used in Z-Wave as well as base software for Zigbee, INSTEON, and IP. [9] For future generation this paper built a smart home automation technology. In this paper, it is focused on the uses survey and residence mechanization systems for cost effective use of energy. For the future generations the system paves the way for cleaner and greener environment. In Advance Metering Infrastructure (AMI), smart survey and automated home, remarkable work is going on throughout the world [10]. In this proposed automation method, the home is totally control remotely via Wi-Fi or internet connection. The controlling system is remote by smart phone. It has been a user interface to control all the electronics devices. The smart phone are connect with the embedded system via internet, user can be on or off any devices using smart phone's app interface. The client will trigger the power control remotely, so the primary goal of the proposed method is to reduce the waste of energy. Through remotely giving the user access to the power management, users can use electricity to meet their needs. [11] This process control electric devices remotely via Bluetooth or WAN connection depend on temperature. In here used end to end connection, it also control by android app. Sensor can be detect the room or building condition. [12] In this proposed

method monitoring the energy consuming rate and control this remotely by app. It monitor every devices consuming energy. It also measure the cost of energy. [13] Here used Bluetooth based controlling system. Where Arduino and android app connect via Bluetooth. Here just control the devices via app and Arduino. It is proposed to user comfortably, not any automated system. [14] On that proposed method Arduino was controlled via android app, the main point is voice controlling system. The android app process the natural language and send

command to Arduino microcontroller to switch on/off any devices. [15] This method are present image processing to give security. Monitoring home via GSM technology. Face recognition is used here to give security, it is also control and monitoring via GSM home and aboard. [16] On that paper focused on face recognition. Where the system recognize a face and detect a person. The proposed method correspond to isolated features like eye, ear and nose. [17] A method for rapid object detection is proposed in this paper. Here, 15 frames per second is being detected to recognize a face in real time. The learning algorithm based on Adaboost algorithm. [18] This proposed method is based on image processing. It run on Linux operating system. The system detect all the faces and count the number of person. It also communicate via GSM module, if any person turn out from the room it notify by SMS and system turn on video recorder. If any person do not exist on the room it will be turn off all the electric devices in this room. [19] In this proposed method system can be detect moving people and count also. [20] On that proposed method Distance Transforms based matching. The system method with brute force technique. It can be detect real time traffic signal and correlation with hardware by the realm of the computer [21]. From those papers we got the motivation to make a home automation system that could save energy and also can be control automatically.

2.2 Comparative Studies

In this time human being are totally depend on technology. Therefor every day manufacturer is trying to invent new technology for better and easier life. Nowadays IOT based project is very popular. Many projects have been done till now. This project is also based on IOT which saves energy on daily basis. It also be tried to build new thing from others and here describes why our project is different from others.

In their project [5] they built a system for programmed control of a home and building automation system and saving energy and improving comfort with the process being performed by means of software and presence and activity monitoring sensors. In their project they detect systematic and stochastic behavior of at least one person in a room. According the behavior of person their project worked. But here it is tried to build a project

which is totally different. This project is able to detect the distance between person and object and the closest light/fan will turn on automatically and others fan/light are remains close.

On that paper they consist a system for automated home used a network system and appliance actuators for getting information from environment and according that information it controls a house automatically [6]. There used Arduino microcontroller that communicates with an Android application for user interface. In this system, Arduino is used for measuring the cost of electricity, detect the temperature condition and control relay module. This device can calculate the monthly cost and determine how much electricity can save the end of the month. Using database for storing data and display the cost of current.

2.4 Scope of Problem

As this project is built on IOT (Internet of Things) it can be divided into two parts- hardware and software. In hardware section measure electricity cost in daily basis, so the system need to connect with electricity line which is very risky for us. Arduino and other hardware devices are difficult to carry. To create data set for object detection, the system huge amount of data to collect which was not so easy. To run this code, it need to high configure computer

Chapter 3

Research Methodology

3.1 Introduction

This chapter is included description of various type of equipment that are utilized in this project. This section described procedure of data collection, required equipment for implementation that are used this project. Here presenting the feature of components and why these are used this project. Describe the research subject and instruments of the project.

3.2 Methodology

The idea behind this methodology is designed to an electronic device by using embedded system which observe environment and detect the human. Base on the human presence it can turn on the closest fan or light. The system observed the room temperature. According to temperature the electricity will turn off/on for certain time. System also measure the daily cost of current. In this project measurement of current is very important part because the main focus is to calculate the amount of saving energy end of the month. Here used many building function to run that calculation and making the comparison of the given default and coming output. The design of the system flow chat is given in figure 3.2.1

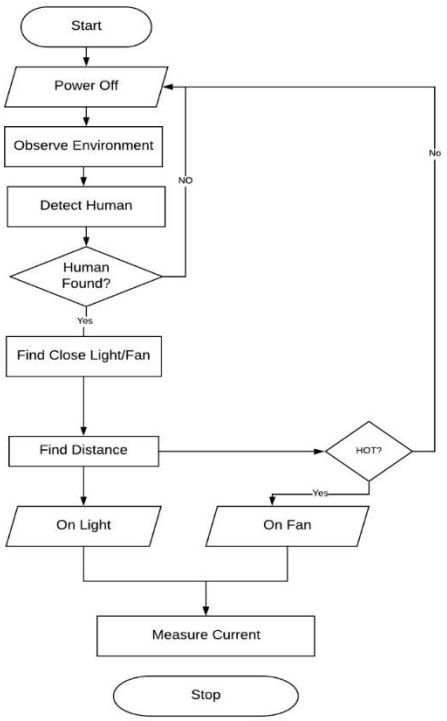

Figure 3.2.1: Flowchart of the system.

Use case diagram is dynamic diagram in UML. This model is the functionality of a system using actors and use case.

The use case diagram show that the system has three actors one is camera, Software system and Arduino. The actor camera which observe the environment and detect the objects. System Software which get the information from the actor camera and it process for the further information. It find out distance and send this information to the arduino. Arduino control the sensors, light/fan and Measure current.

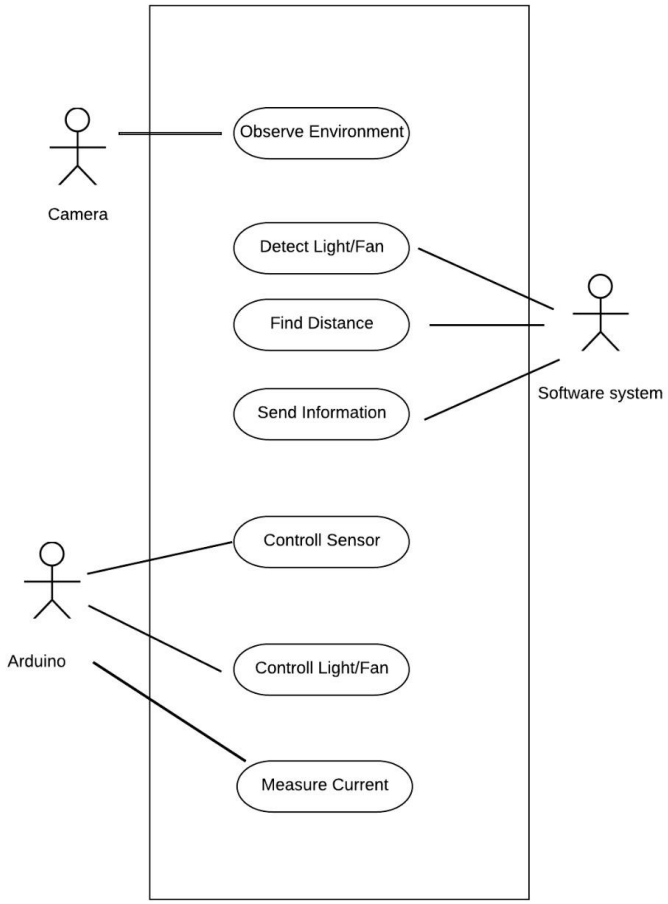

Figure 3.2.2: Use Case Diagram of System

3.3 System Design & Implementation

In this circuit diagram used an Arduino UNO for measure temperature, detect lighting conditions and control relay. Here used two relay module one is for control light and another one control fan. For detect the lighting condition here used LDR. One pin is connected with voltage and another one is connect with Analog (A1) and connect with ground pin with resistance for taking input. For measure temperature here used LM35 sensor. The sensor has three pin one is connect with voltage, the middle pin connected with Analog (A0) pin and another one is connect GND. The Bluetooth module connected with Arduino by pin RX and TX for receive information from processed image and send to Arduino. One pin is connected with GND and another pin with VCC for power to Bluetooth module. Current sensor ACS712 measure the whole used current instantly, VCC pin is connected to power, GND pin connected GND pin and VOUT pin is connected to A0 pin of Node MCU. Node MCU used for sending energy information to server and showing by web browser. The node MCU is powered by 5V power adapter, it is connected by Wi-Fi to server for sending data.

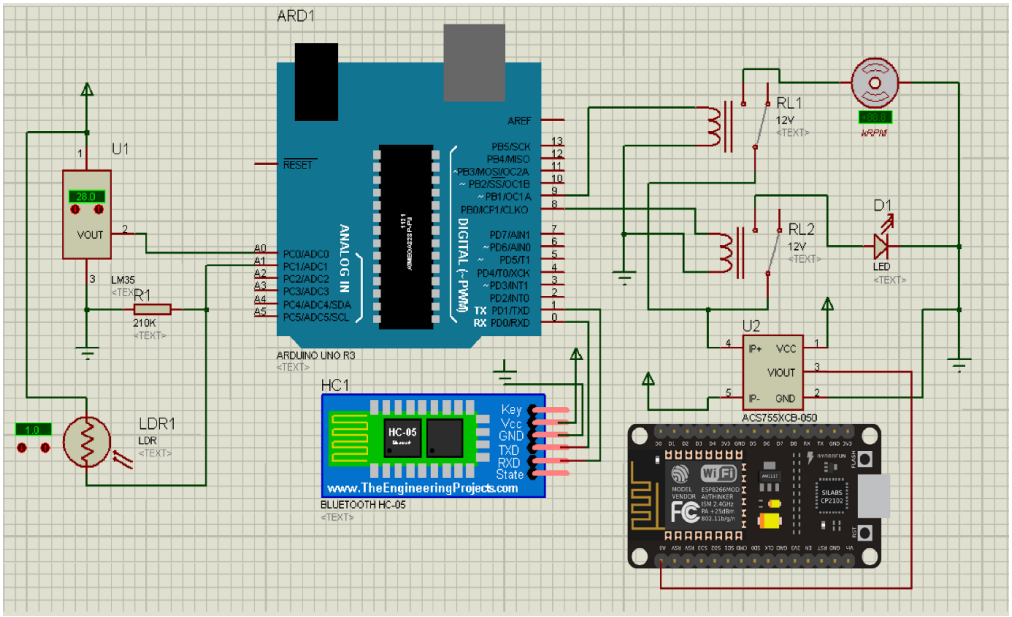

Figure 3.3: Circuit Diagram of system

3.4 Implementation Requirements

The name of the components that are used in this project are given bellow and what are the amount of the components

Table 3.1: List of components used in circuit

No	Component Name	Quantity	Used
1.	Arduino	1	Used for measure temperature, detect
2.	Relay Module	2	Used to control light & fan
3.	LDR	1	LDR used to detect light
4.	LM35 Temperature Sensor	1	LM35 temperature sensor used for measure temperature
5.	Node MCU Epson Wi-Fi Module	1	Node MCU for sending used energy information to server and showing
6.	ASC712 Current Sensor	1	Used to measure current and send to node MCU

7.	Bluetooth Module HC-05	1	Used for getting data from image processing and send that data to Arduino.

3.4.1 Arduino Uno

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and Analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 Analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "Uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software The Uno board is the first in a series of USB-based Arduino boards; it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases. The ATmega328 on the board comes pre-programmed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

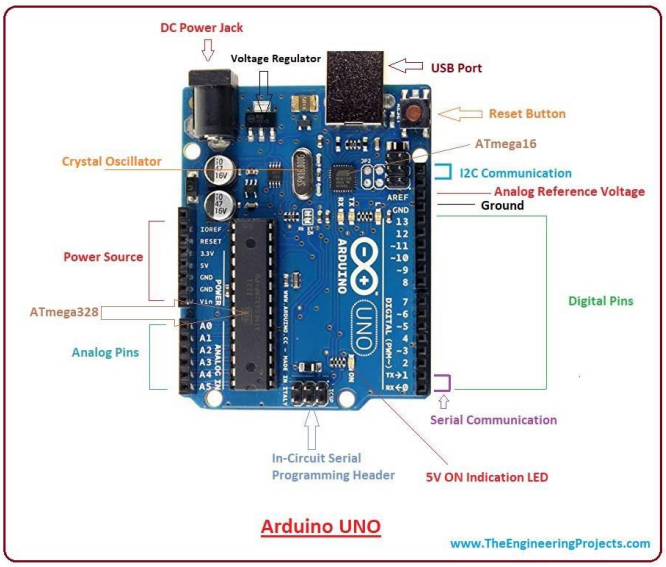

Figure 3.4.1: Arduino Uno

3.4.2 Relay Module

A relay is basically a switch which is operated by an electromagnet. The electromagnet requires a small voltage to get activated which we will give from the Arduino and once it is activated, it will pull the contact to make the high voltage circuit [8].

Figure 3.4.2: Relay Module

3.4.3 LDR

A Light Dependent Resistor (LDR) is also called a photo resistor or a cadmium sulphide (CdS) cell. It is basically a photocell that works on the principle of photoconductivity. The passive component is basically a resistor whose resistance value decreases when the intensity of light decreases [9].

Working Principle of LDR. These devices depend on the light, when light falls on the LDR then the resistance decreases, and increases in the dark. When a LDR is kept in the dark place, its resistance is high and, when the LDR is kept in the light its resistance will decrease [10].

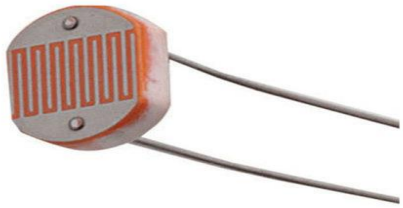

Figure 3.4.3: LDR (Light Dependent sensor)

3.4.4 LM35 Temperature Sensor

LM35 is a temperature measuring device having an Analog output voltage proportional to the temperature.

It provides output voltage in Centigrade (Celsius). It does not require any external calibration circuitry.

The sensitivity of LM35 is 10 mV/degree Celsius. As temperature increases, output voltage also increases. E.g. 250 mV means 25°C.

It is a 3-terminal sensor used to measure surrounding temperature ranging from -55 °C to 150 °C.

LM35 gives temperature output which is more precise than thermistor output [11].

Pin Description

VCC: Supply Voltage (4V – 30V)

Out: It gives Analog output voltage which is proportional to the temperature (in degree Celsius).

GND: Ground

Application Set-up

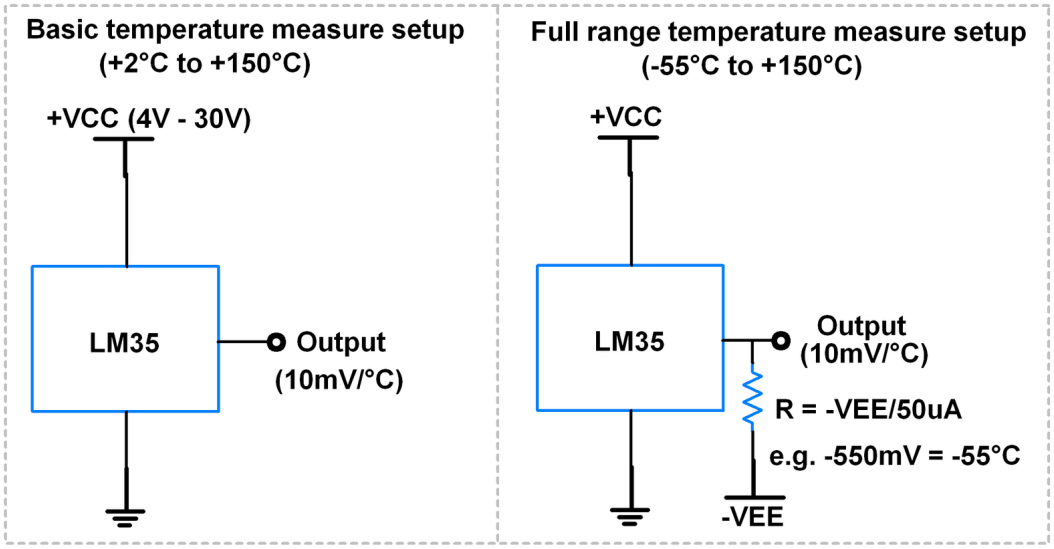

Figure 3.4.4: Application Set-up of LM35 sensor

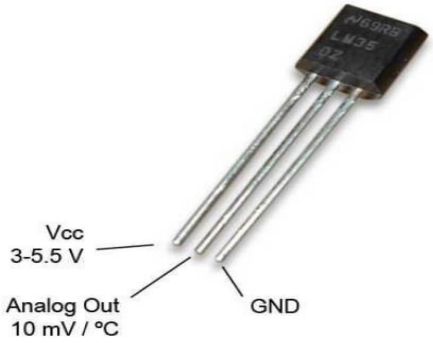

Figure 3.4.4.1: LM35 Temperature sensor

3.4.5 NodeMCU Epson Wi-Fi Module

NodeMCU is an open source development board and firmware based in the widely used ESP8266 -12E Wi-Fi module. It allows you to program the ESP8266 Wi-Fi module with the simple and powerful LUA programming language or Arduino IDE.

With just a few lines of code you can establish a Wi-Fi connection and define input/output pins according to your needs exactly like Arduino, turning your ESP8266 into a web server and a lot more. It is the Wi-Fi equivalent of Ethernet module. Now you have internet of things (IOT) real tool.

With its USB-TTL, the nodeMCU Dev board supports directly flashing from USB port. It combines features of WIFI access point and station + microcontroller. These features make the Node MCU extremely powerful tool for Wi-Fi networking. It can be used as access point and/or station, host a webserver or connect to internet to fetch or upload data [12].

Features

- Finally, programmable Wi-Fi module.
- Arduino-like (software defined) hardware IO.
- Can be programmed with the simple and powerful Lua programming language or Arduino IDE.
- USB-TTL included, plug & play.
- 10 GPIOs D0-D10, PWM functionality, IIC and SPI communication, 1-Wire and ADC A0 etc. all in one board.

- Wi-Fi networking (can be used as access point and/or station, host a web server), connect to internet to fetch or upload data.
- Event-driven API for network applications.
- PCB antenna.

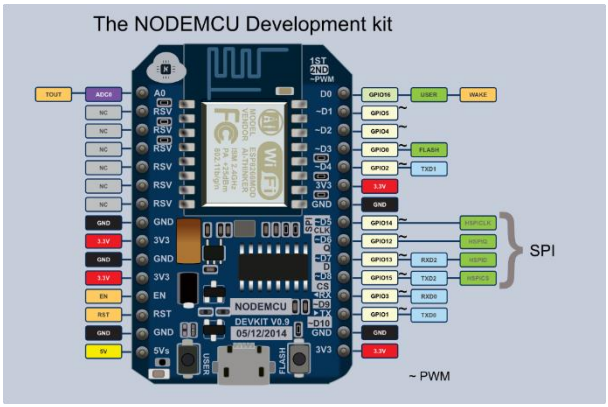

Figure 3.4.5: NodeMCU Epson Wi-Fi Module

3.4.6 ASC712 Current Sensor

The ACS712 Current Sensor is a product of Allegro Micro-Systems that can be used for precise measurement of both AC and DC currents. Coming to the output of the ACS712 Current Sensor, it produces an Analog voltage that is proportional to AC or DC currents (whichever is being sensed) [13].

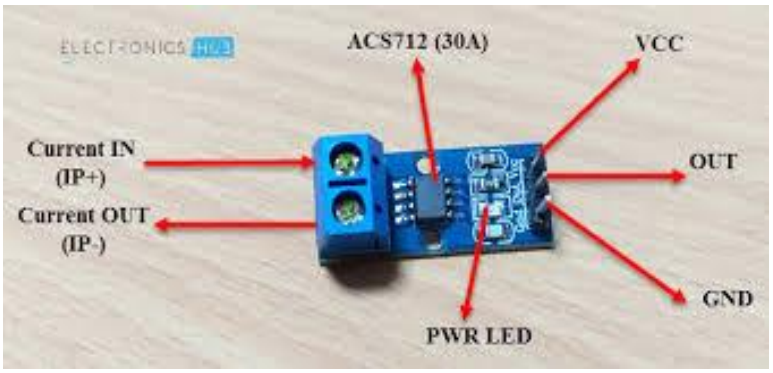

Figure 3.4.6: ASC712 Current Sensor

3.4.7 Bluetooth Module HC-05

HC-05 Technical Specifications

- Serial Bluetooth module for Arduino and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800 [14].

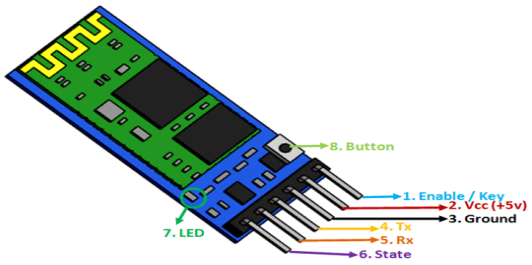

Figure 3.4.7: Bluetooth Module HC-05

Chapter 4

Experimental Result and Discussion

4.1 Introduction

The main focus to build a smart home is to save time and safe from trouble. A home automation system can control light, switching fan and other equipment. This project representing an automated home with saving energy. In this section the task is to be characterized as the execution based. In here the execution of the project are also expand. It is also discussed about the operation of the device.

4.2 Descriptive Analysis

A home automation system is a technological solution that able to automate mass of electronic, electrical and technology-based task within home. It builds the combination of hardware and software technology that can control over appliances and devices within home.

4.2.1 Hardware

IOT based energy saving smart home automation is able to switch the current action automatically. The hardware section used Arduino for measure temperature and detecting the lighting condition and control relay. The main feature of the project is calculated the closest distance between human and object and after find out the distance, the system is able to turn on light/fan automatically. To control the fan and light, here used relay module. For measuring the distance between human and object used Bluetooth module that detect the human first then calculate the distance between them and send this value to Arduino. This project is mainly built for saving energy. The system calculated by using this how much energy save ultimately. For monitoring the daily energy cost used current sensor ASC712 and send the value to node MCU. The node MCU for sending energy information to server showing. Temperature effect is also included here. Depends on the room temperature the system is able to switch the current action. For measure the room temperature used LM35 temperature sensor.

Figure 4.2.1: Arduino IDE Screenshot

4.2.2 Software

This system is developed by python language using anaconda platform. To take an action, the system needs to detect the human presence. For detecting the presence of human it used image processing. Used Open-CV for detecting the face, features and shape. It's a library of python language.

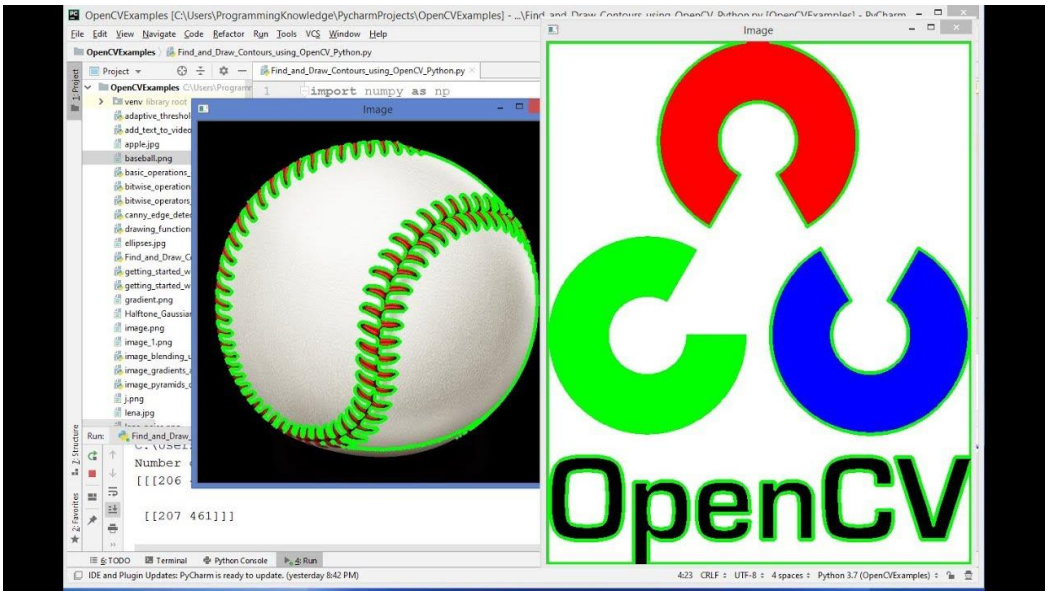

Figure 4.2.2: Open-CV screenshot

4.3 Experimental Result

4.3.1 Distance Calculation Output

The distance measure between object and human. When a face is detected and also the other object there is a coordinate value for the detect items. First of all when we take a picture of a room it becomes a 2D surface. From a 2D surface we can calculate the distance by using the formula (1) which shown below. In order to do that we need the coordinates (X,Y). To do that we create a box around a detected object and find the middle of that box and then find out the distance between those middle point of that box from human to object.

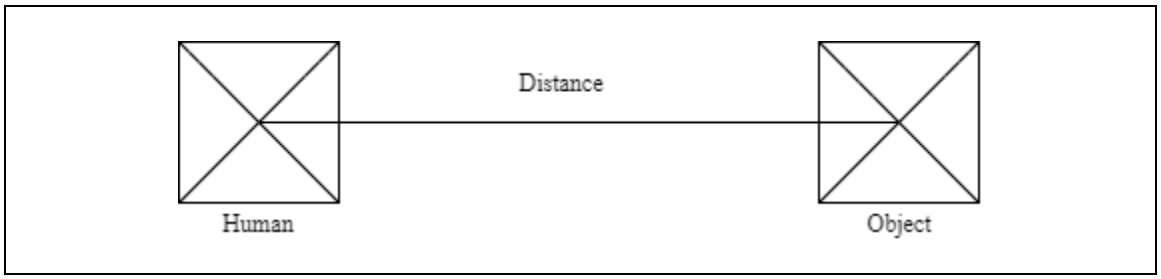

Figure 4.3.1: Finding coordinate

By applying the rule of finding distance between two coordinate this system is able to find out the distance.

$$Distance = \sqrt{((X_2 - X_1)^2 + (Y_2 - Y_1)^2)} \quad (1)$$

```
40 print("fan x{}",fan_x)
41 print("fan y{}",fan_y)
42
43 #Distance
44 distance = math.sqrt((face_b - face_a)*(face_b - face_a) + (fan_y - fan_x)*(fan_y - fan_x))
45 print("Distance {}",distance)
```

Figure 4.3.2: Distance Measurement

```
In [2]: runfile('F:/Python/final
project/complete.py', wdir='F:/
Python/final project')
Number of faces found {} 1
face a{} 130
face b{} 159
Number of fan found {} 1
fan x{} 419
fan y{} 16
Distance {} 404.04207701673846
```

Figure 4.3.3: Distance Measurement Output

4.3.2 Current Calculation Output

To get the consumption result of system need to monitor daily energy cost. In order to find the current use in a day this system uses current sensor where it find out current and then it calculate this current into power using the law of power

$$Power = V \times I \text{ (watt)}$$

```
double adcVoltage = (read / 1024.0) * 5000;
double currentValue = ((adcVoltage - 2500) / 66);
int sensorvalue= currentValue*220;  //Read Analog
sensorValueSend = String(sensorvalue);   //String
```

Figure 4.3.4: Calculation of Current sensor reading

By the reading of current sensor, it find out the value of I and then calcite the power using the above rule.

4.3.3 Temperature Output

Using Temperature sensor it find out the temperature of the environment. To find out the temperature it uses this above rule:

```
float milivolt = (value*5000)/1024;
int temp = milivolt/10;
```

Figure 4.3.5: Calculation of temperature sensor

4.4 Statistical Analysis

In this section we have shown the benefit of our device by comparison. We have taken the reading of the current for whole day with our device and without our device then we calculation an average value of power consumption that show in the graph.

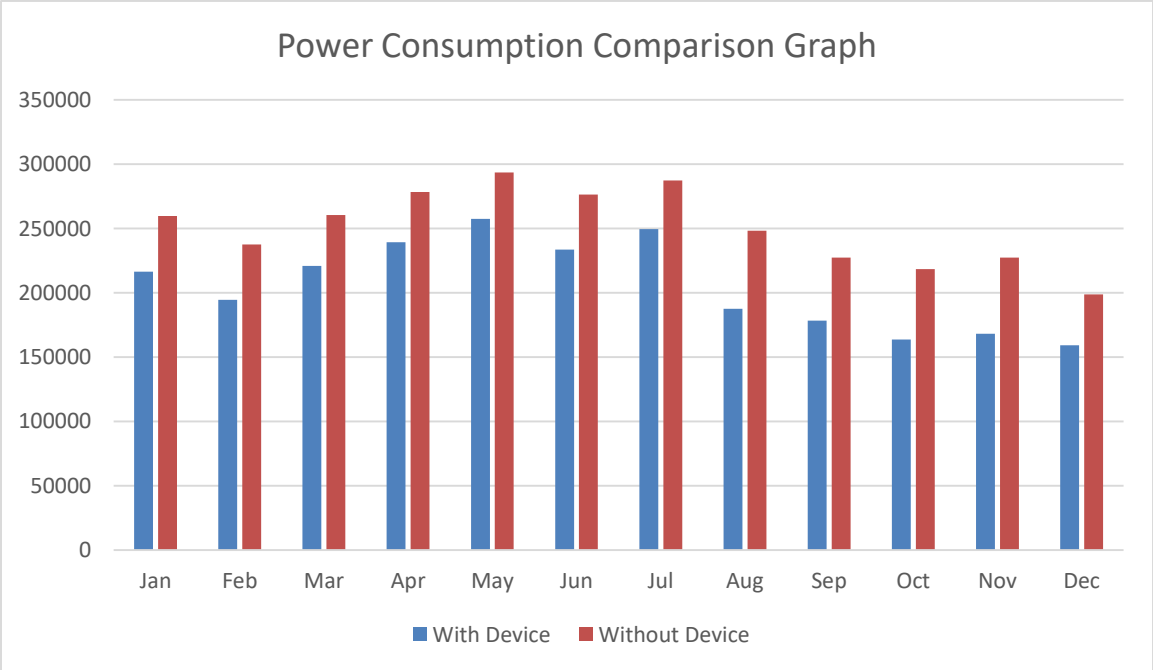

Figure 4.3.6: Graph of Power Consumption comparison

Chapter 5

Conclusion & Future Work

5.1 Summary of Study

After analyzing this complete project, it can be said that, 'This is a smart IoT based energy server home automation system because the functionality is totally automated. System is also measuring relative distance and power consumption. This system is detecting human by a camera. Bluetooth module detect the human presence whether he belongs within the range or not. Here temperature effect is also being used to control the system. Finally, here is presented the cost comparison between by using this system and without using this system and how much power the system can consume ultimately.

5.2 Conclusion

Nowadays the uses of technology spread extensively. But yet in rural people are still nontechnical. They are not familiar with advance technology. We proposed a very user friendly and efficient energy saving smart home automation system that makes human life easier than before. The functionality of this system is totally automated. Every person even nontechnical person can use it easily. This project first detected the human in the room and find out the closest distance between human and object. After calculating the distance it's automatically turn on the light/fan. Behind building the system, the main aim is to calculated the saving cost of current in full month. And by using this system how much current it can save ultimately. The system has another option which is temperature effect. Depending on the temperature it switching the present situation.

5.3 Recommendations

We have worked with less data and objects for this project. In this project we have used light and fan to measure energy consumption. We are able to find out satisfactory result by this. If anyone want to work with this, we recommend to add more devices to this project so that it can be implemented in the real life scenario.

5.4 Implementation for Further Study

This system can measure distance between human and object but It's not completely an accurate distance value. We assume an approximate value. In future, we will work for getting an accurate value.

This system can turn on automatically only the light and fan. In future we will includes other appliances.

The human face detection which can be used as security purpose like open the door.

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