Design & Implementation of IoT based SMART HOME SYSTEM

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Declaration

It is declared hereby that this thesis paper or any part of it has not been submitted to anywhere else for the award of any degree.

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This is to certify that this project entitled "**Design & Implementation of IoT based SMART HOME SYSTEM**" is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, **Sonargaon University (SU)** in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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ABSTRACT

Recent advances in smartphones and affordable open-source hardware platforms have enabled the development of low-cost architectures for Internet-of-Things (IoT)-enabled home automation and security systems. These systems usually consist of sensing and actuating layer that is made up of sensors such as passive infrared sensors, also known as motion sensors; temperature sensors; smoke sensors, and web cameras for security surveillance. These sensors, smart electrical appliances, and other IoT devices connect to the Bluetooth through a home gateway. The proposed architecture uses an Arduino microcontroller board along with Bluetooth Modules for communicating with the sensors that implements arestful application. Several programming languages are used in the implementation and further applications of the door sensor are discussed as well as some of its shortcomings such as possible interference from other radio frequency devices.

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LIST OF ABBREVIATIONS

DC	Direct Current
IoT	Internet Of Things
AC	Alternating Current.
LCD	Liquid Crystal Display
LDR	Light Dependent Resistor
LED	Light Emitting Diode
PCB	Printed Circuit Board
LCD	Liquid Crystal Display

CHAPTER I

INTRODUCTION

1.1 Introduction

The need for automation systems in day to day life is rapidly growing because of their numerous advantages like comfort, convenience, centralized control of appliances, cost reduction, energy-saving, security, and safety. A home automation system provides improved quality of life for users, especially for the elderly and differently-abled persons. Smart home technology can play an important role to increase energy efficiency. Commonly, home appliances remain switched 'ON', due to the laziness or due to human negligence. Many times the home users leave the room without turning off the lights, fans, Air conditioners. Smart home automation systems can automatically 'switch OFF' home appliances without human intervention.

1.2 Background Study

The utility electricity sector in Bangladesh has one national grid with an installed capacity of **21,419 MW** as of September 2019. Bangladesh's energy sector is booming Hence, the per capita energy consumption in Bangladesh is considered low (95%) (source- https://energypedia.info). Bangladesh has small reserves of oil and coal, but very large natural gas resources. Primary consumed energy is calculated as 62% of biomass, 25% of natural gas, 12% of imported oil, and 1% for both coal and hydropower. Still the power is not according to the demand of overall generated power. One of the main reason for this is for weasting of electrical energy.

1.3 Objectives

The main objective of this system is to introduce a automated smart control system with microcontroller technology. The supplementary objectives of this project are as follows:

To control & maintain all the home appliences along with the security system in much easier way by using automation system & customized software.

1.4 Project Organization

In this report, Chapter one covers introduction, background, objectives. Chapter two represents theory, description of the components. Chapter three describes and working principle of the project. In chapter four we have discussed result and discussion, cost estimation, future modification, conclusion.

CHAPTER II

THEORY OF THE PROJECT

2.1 Introduction

This chapter includes the total over view of the device. Here we can know that the total system overview of the projects. And we will also know that how the equipment are working with each other.

2.2 Theory

We've developed the system that can handle this critical switching situation perfectly. Our system has several voltage, and sensors to measure required illumination. Based on those circumstances our system manages that power source switching. For example in daylight light loads are less required so use the minimum level of light loads to operate to consume less power. It also can provide monitoring on security system. For safety purpose gas sensor is being used to detect harmful gas & create a safe operation.

2.2.1 Arduino Uno

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language and the Arduino Software (IDE), based on Processing.

Arduino Uno is one kind of ATmega328P based microcontroller board. It includes the whole thing required to hold up the microcontroller; just attach it to a PC with the help of a USB cable, and give the supply using AC-DC adapter or a battery to get started. The term Uno means "one" in the language of "Italian" and was selected for marking the release of Arduino's IDE 1.0 software. Arduino board and IDE software are the reference versions of Arduino and currently progressed to new releases. The Uno-board is the primary in a sequence of USB-Arduino boards, & the reference model designed for the Arduino platform.

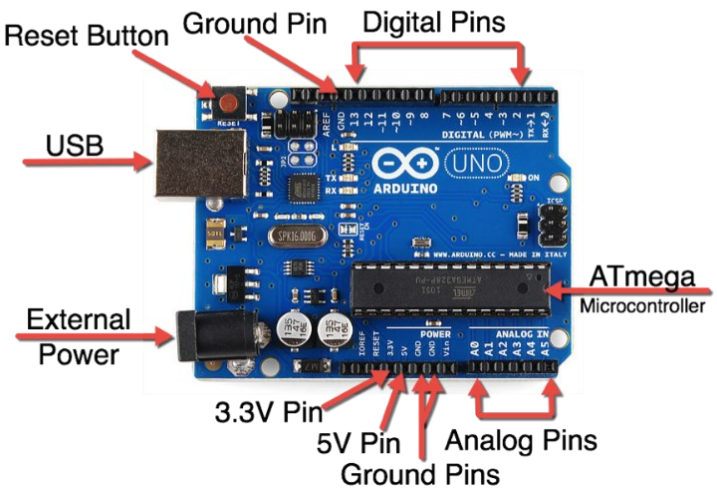


Fig: 2.2.1.1 Arduino UNO Pin Diagram

Technical specifications:

Table 2.1: Technical specifications of Arduino UNO

SL	Specification
1	It is an ATmega328P based Microcontroller
2	The Operating Voltage of the Arduino is 5V
3	The recommended input voltage ranges from 7V to 12V
4	The i/p voltage (limit) is 6V to 20V
5	Digital input and output pins-14
6	Digital input & output pins (PWM)-6
7	Analog i/p pins are 6
8	DC Current for each I/O Pin is 20 mA
9	DC Current used for 3.3V Pin is 50 mA
10	Flash Memory -32 KB, and 0.5 KB memory is used by the boot loader
11	SRAM is 2 KB
12	EEPROM is 1 KB
13	The speed of the CLK is 16 MHz
14	In Built LED
15	Length and width of the Arduino are 68.6 mm X 53.4 mm
16	The weight of the Arduino board is 25 g

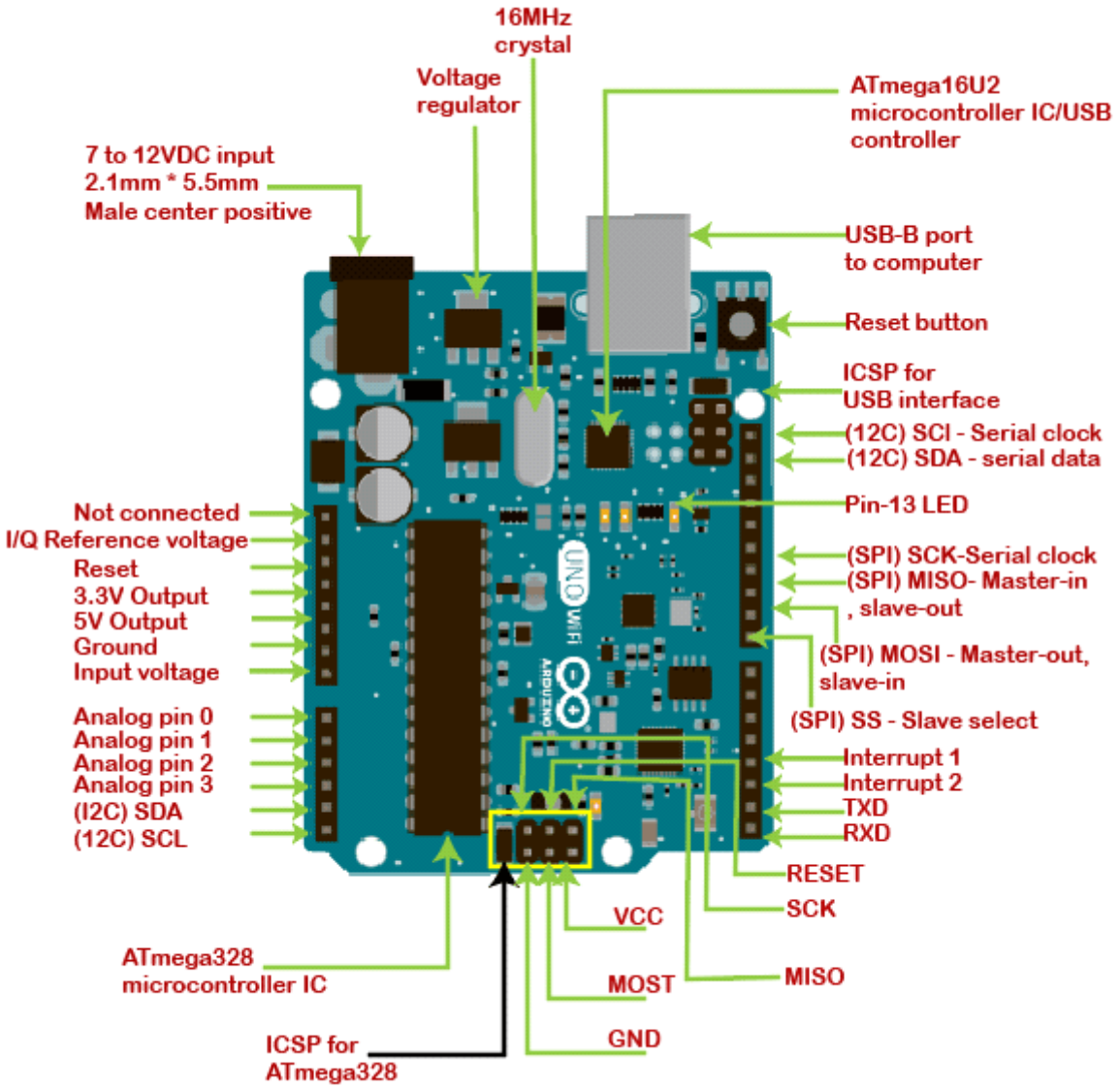


Fig: 2.2.1.2 Arduino UNO specified Pin Diagram

2.2.2 Microcontroller ATMEGA328P

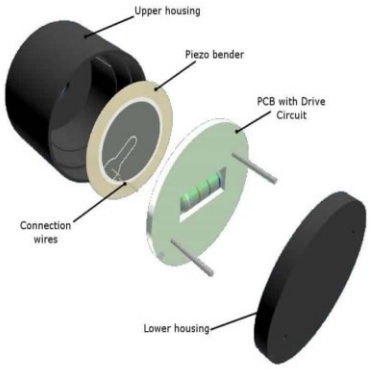
The Atmel® picoPower® ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR® enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328/P achieves throughputs close to 1MIPS per MHz. This empowers system designer to optimize the device for power consumption versus processing speed.
The Atmel AVR® core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers. The ATmega328/P provides the following features: 32Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 1Kbytes EEPROM, 2Kbytes SRAM, 23 general purpose I/O lines, 32 general

purpose working registers, Real Time Counter (RTC), three flexible Timer/Counters with compare modes and PWM, 1 serial programmable USARTs , 1 byte-oriented 2-wire Serial Interface (I2C), a 6- channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages) , a programmable Watchdog Timer with internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption. In Extended Standby mode, both the main oscillator and the asynchronous timer continue to run. Atmel offers the QTouch® library for embedding capacitive touch buttons, sliders and wheels functionality into AVR microcontrollers. The patented charge-transfer signal acquisition offers robust sensing and includes fully debounced reporting of touch keys and includes Adjacent Key Suppression® (AKS™) technology for unambiguous detection of key events. The easy-to-use QTouch Suite toolchain allows you to explore, develop and debug your own touch applications. The device is manufactured using Atmel's high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an On-chip Boot program running on the AVR core. The Boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega328/P is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications. The ATmega328/P is supported with a full suite of program and system development tools including: C Compilers, Macro Assemblers, Program Debugger/Simulators, In-Circuit Emulators, and Evaluation kits.

2.2.3 PIEZOELECTRIC BUZZER

In simplest terms, a piezo buzzer is a type of electronic device that's used to produce a tone, alarm or sound. It's lightweight with a simple construction, and it's typically a low-cost product. Yet at the same time, depending on the piezo ceramic buzzer specifications, it's also reliable and can be constructed in a wide range of sizes that work across varying frequencies to produce different sound outputs. So when certain piezoelectric materials are subjected to an alternating field of electricity, the piezo buzzer element — often a manmade piezo ceramic material — stretches and compresses in sequence with the frequency of the current. As a result, it produces an audible sound.

Unlike magnetic buzzers that have a narrow operating voltage of somewhere between one and 16 volts, piezo buzzers can typically operate anywhere between three and 250 volts. In addition, magnetic buzzers have a higher power consumption of 30 to 100 mill amperes, while piezo buzzers normally consume less than 30 mill amperes — even at higher rate frequencies. And although piezo buzzers require a larger footprint than magnetic buzzers, they produce a higher sound pressure level.



Piezo Buzzer Construction

Fig: 2.2.3.1: Piezo Buzzer

2.2.4 GAS/SMOKE SENSOR

MQ2 is one of the commonly used gas sensors in MQ sensor series. It is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as Chemiresistors as the detection is based upon change of resistance of the sensing material when the Gas comes in contact with the material. Using a simple voltage divider network, concentrations of gas can be detected.

This is a robust Gas sensor suitable for sensing-

LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentrations in the air.

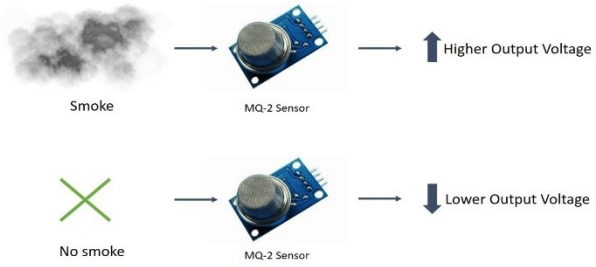


Fig: 2.2.4.1: Gas/Smoke sensor

2.2.5 RELAY

Relays are the switches which aim at closing and opening the circuits electronically as well as electromechanically. It controls the opening and closing of the circuit contacts of an electronic circuit. When the relay contact is open (NO), the relay isn't energize with the open contact. However, if it is closed (NC), the relay isn't energize given the closed contact. However, when energy (electricity or charge) is supplied, the states are prone to change.

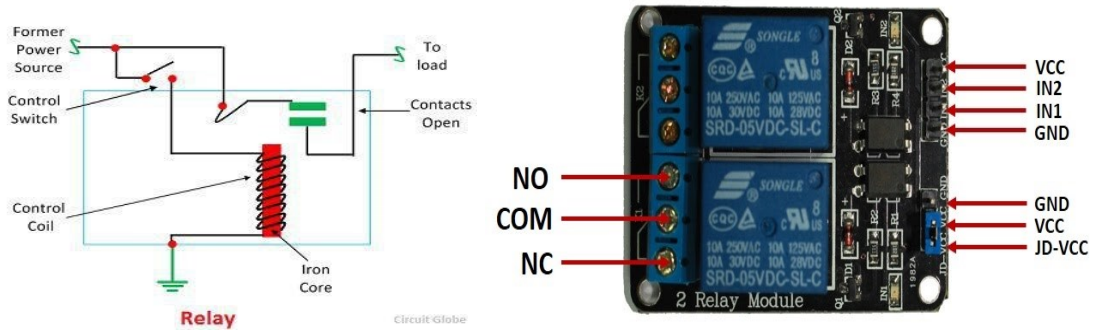


Fig: 2.2.5.1: Relay

2.2.6 BLUETOOTH INTERFACE CIRCUIT

Bluetooth interface circuit is a very popular open wireless standard for short range communication. The range is typically about 50 feet, although this can be significantly increased with the use of a range extender circuit that either increases the sensitivity or increases the transmission power or both at the same time.

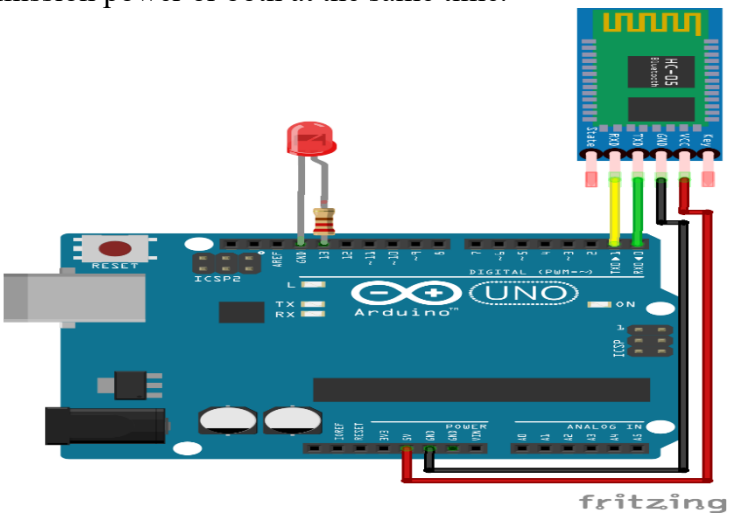


Fig: 2.2.6.1: Bluetooth Circuit

CHAPTER III

STRUCTURE & IMPLEMENTATION

3.1 Introduction

In this chapter fully cover with discuss design and fabrication of this project. Here we will discuss about developed block diagram and briefly describe about the circuit description and also learn about working principle. Total project flow chart is also available in this chapter.

3.2 Block Diagram

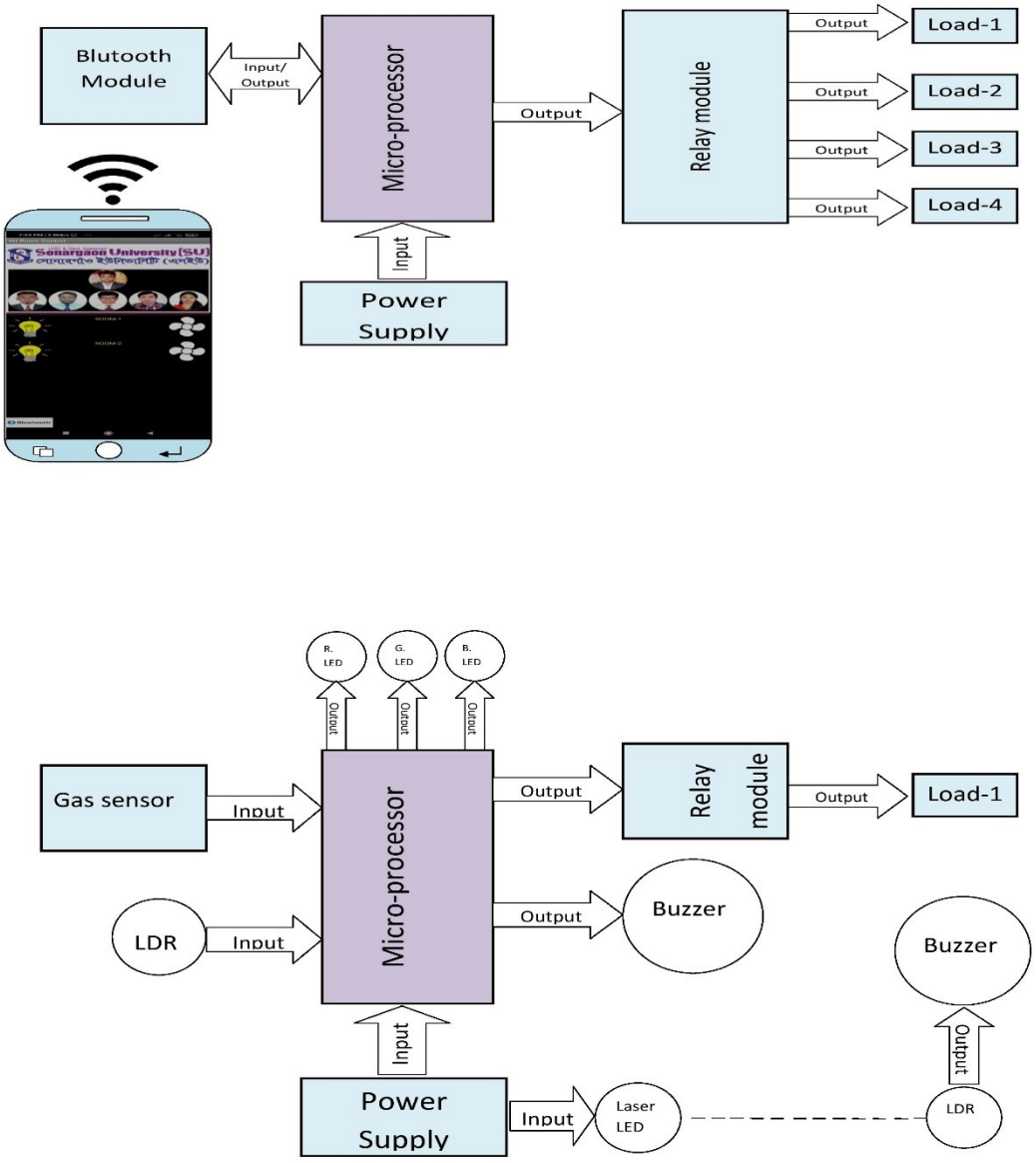


Fig: 3.2.1.1: Block diagram of project

Here's the block diagram of our system. We can clearly describe the working process through this block diagram. Firstly we have the bluetooth module connected directly with the

microprocessor. Here loads are connected with the relay modules. The total operation are being controlled by the application.

3.3 Circuit Description

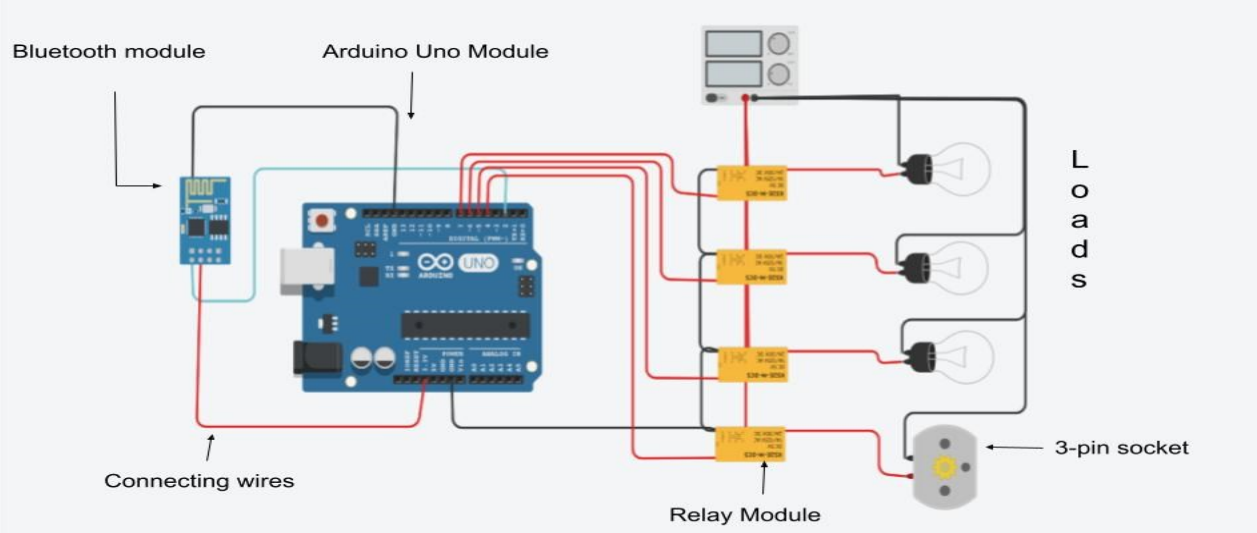


Fig: 3.3.1.1: Circuit diagram of project

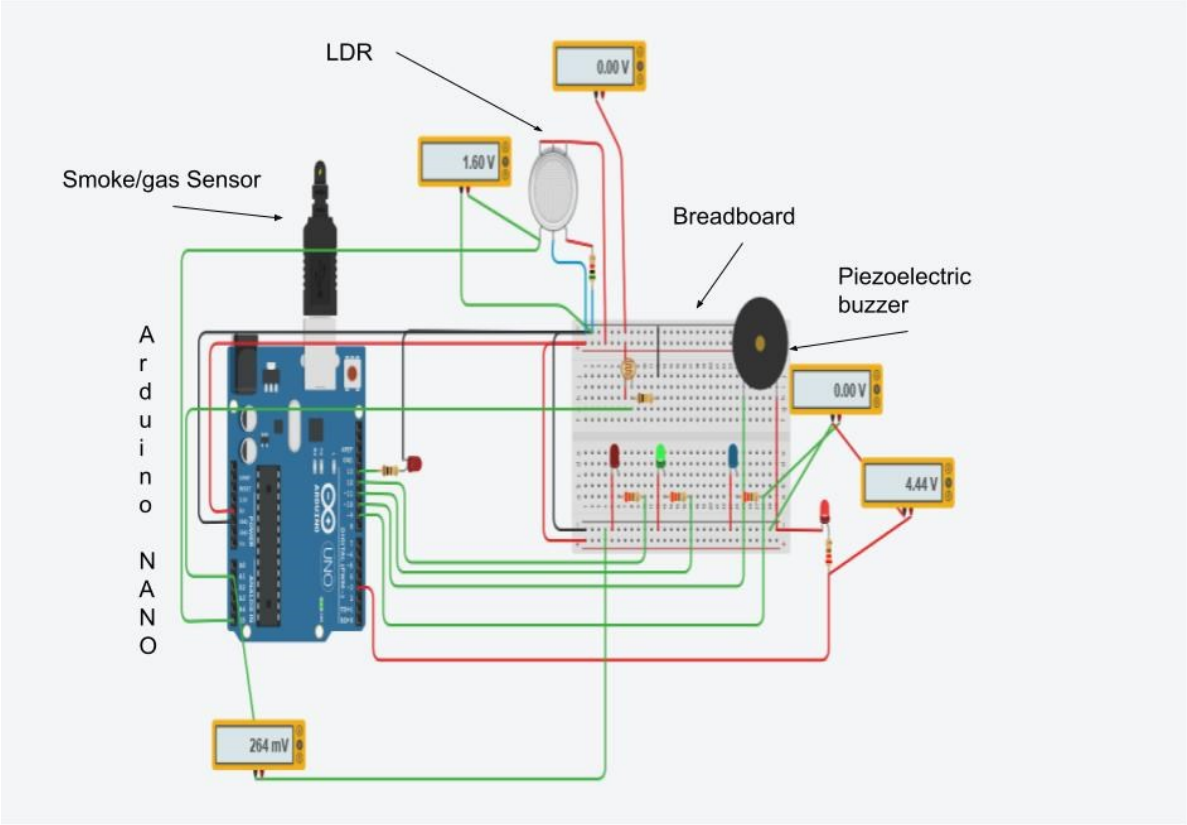


Fig: 3.3.1.2: Circuit diagram of project

For this project of Smart Home Automation System, open source android platform is used. Android application from any mobile devices connects to the Bluetooth module HC-06 and controls the home appliance devices such as rooms lighting, water pump motor and garage motor. For the safety purpose of this project, Bluetooth connection of application and Bluetooth device need password when paring for authorized using. After that confirm message for Bluetooth connection is successful and then list on available devices in android application can control as remote devices. This project also monitor CO2 content in the house by MQ-2 gas sensor and make alarm sound by speaker when the certain amount of smoke detected in the house. Block Diagram of the implemented project shown in below fig our proposed project consists of the following three sections.

- Input from Bluetooth module via android application and gas sensor
- Arduino UNO microcontroller processing
- Output of process indication and alarm

First development of our project, all the component modules are made Hardware components simulation of this project consists of Arduino UNO, Bluetooth module, motors, output of gas sensor and rooms lighting by LDR & android app control.

3.4 Overview of IoT based Smart home system

Smart home automation is an application area of IoT for remote home control, comfortable and healthy living, energy efficiency, safety, security, and social benefits. IoT technologies have made it possible for home occupants to remotely have total control over their homes, appliances, environmental conditions, and activities in their homes and their surroundings, regardless of the current location of the home occupant. Several commercial products such as Amazon Echo, Google Nest Hub, Wink Hub2, Samsung SmartThings, and Apple Home Kit have been developed, tested, implemented, and used for the intelligent control of a home. Different approaches have been proposed and presented in the previously by several researchers. However, interoperability, security of data, data analytics, security of communication, and the home remain prominent challenges in smart home automation. To address some of these existing challenges in smart home automation, we present an intelligent home automation system,

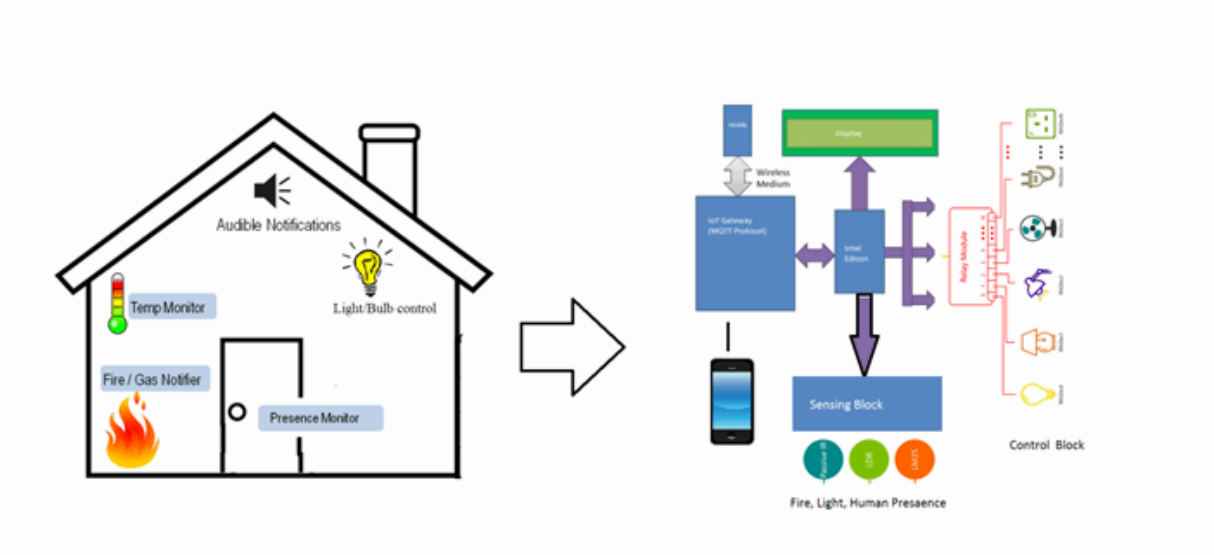


Fig: 3.4.1.1: Overview of IoT based Smart home System.

3.5 Working Principle

The picture below are the actual demo project we've made. Now let's take a look at the step by step working process.

After powering up everything these two lights and other loads remains on off status. First needs to open the room control app and pair with the Bluetooth module. After connecting the app interface will display the load icons as per the below fig: 3.5.1.

Loads are controllable by the app. LDR detects the daylight and can turn the light on /off as per the required illumination for the room.

Gas/smoke detector detects the harmful gas in room if it gets high then sends signal through buzzer & relay dislocates the circuit.

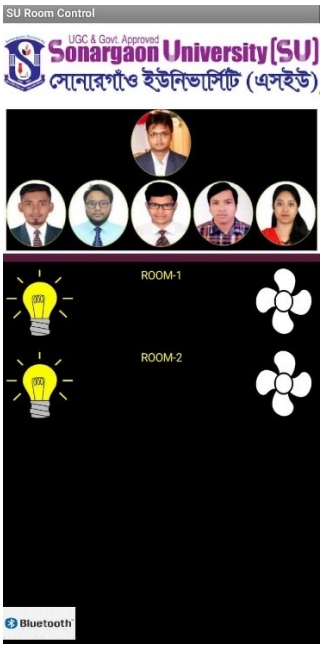
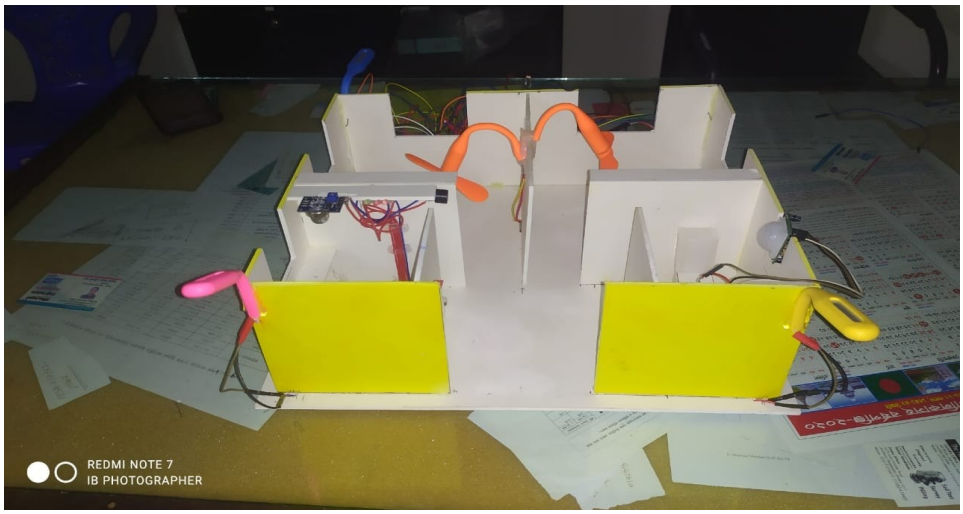


Fig: 3.5.1.1: Overview of IoT based Smart home System App interface

3.6 Real Image of the Project



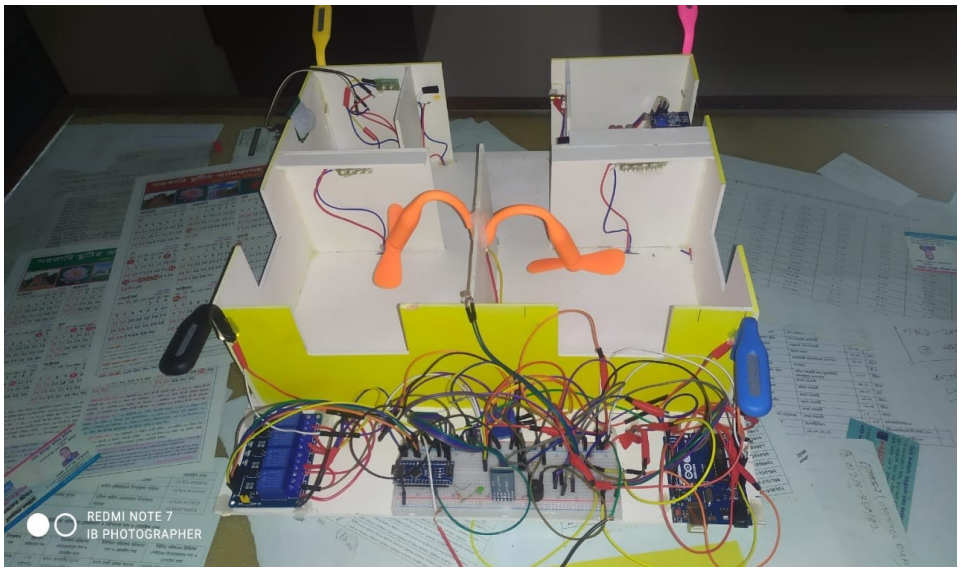


Fig: 3.6.1.1: Real image of the project

3.7 Flow Chart

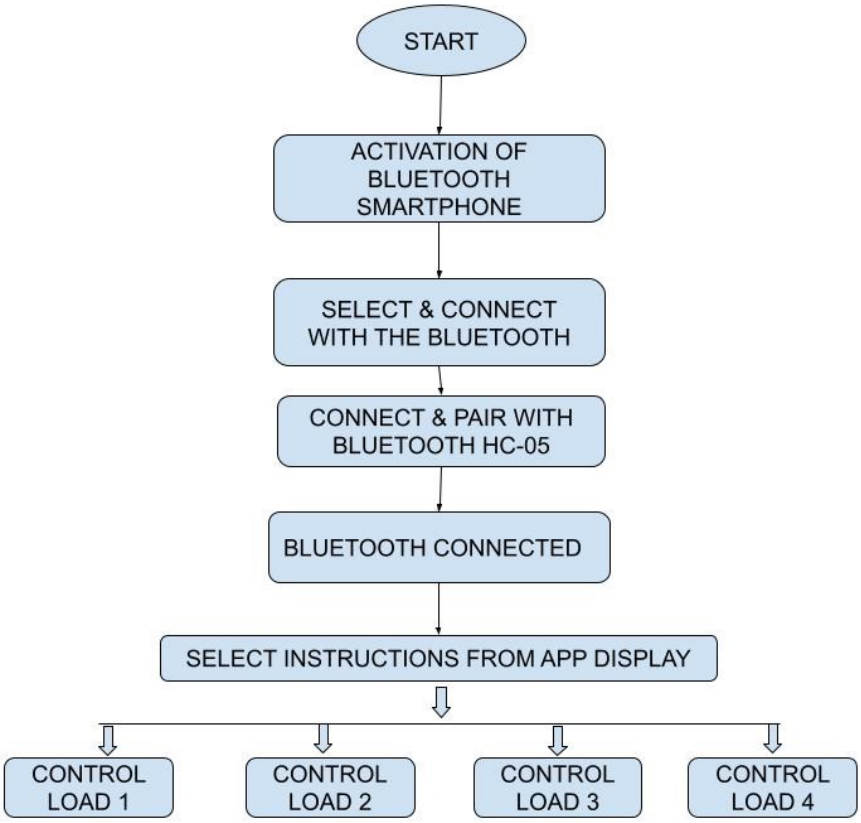


Fig: 3.7.1.1: Flow chart of the project

In this flowchart we can easily determine the working process of our system. At initiate point needs to activate the bluetooth in smartphone/android, then connect with the bluetooth module by parining with it bluetooth conncted prompt will display then loads are controllable by selecting icons on app display.

Autometic actions are for LDR & Gas/Smoke detectors, where detecting room illumination (Lumen) and turn on/off by itself & sense/detect flammable gas/smoke which activates the piezoelectric buzzer & relay operates itself to protect the circuit.

3.8 Used Materials

Table 3.8.1

SL	Name of components	Count
1	Microcontroller (Arduino Uno & Nano)	2
2	Bluetooth Module (HC-05)	1
3	Smoke/gas sensor	1
4	Motion sensor	1

5	Relay module	1
6	Presentation board	1
7	Arduino Pin	1
8	PCB	1
9	Male to male cable	1
10	Male to Female cable	1
11	LED	1
12	Power supply	1
13	USB LED	4
14	USB Fan	2
15	Laser light	2
16	LDR	2
17	Diode	5
18	RANG	-
19	LED(3:1)	-
20	Buzzer	2
21	Anti-cutter	1
22	Resistor(220Ω)	1
23	Resistor(100KΩ)	1
24	Resistor(100Ω)	1
25	Resistor(6.8KΩ)	1
26	BC-547	5
27	2N7000 Transistor	3
28	Connecting wire	-
29	PVC sheet	-
30	Spray Paint	1

3.9 Conclusion

In this chapter we have discussed the block diagram,circuit discription, working principle, flow chart also show the real image of the project and others. In the later part of this paper we discussed the result & discussion of the project to make the concept clear to anyone.

Chapter IV

DISCUSSIONS PROS & CONS

4.1 Introduction

This chapter contains the discussion & advantages/disadvantages about the project. We have also covered discussions about advantages, disadvantages and limitation of current version of the protection system.

4.2 Advantags of Smart Home

- Control and Monitoring. The IoT significantly improves the way we can control and monitor all the processes taking place at our home.
- Takes minimum time to use and get habituated with it.
- Cost and Energy Savings.
- Environment Impact.
- Better Security.
- Comfort to use of all ages works

4.3 Disadvantages of Smart Home

- Significant installation costs
- Technological problems in connected homes
- Helplessness if technology fails
- Maintenance and repair issues
- Compatibility problems between devices
- Surges are possible
- Smart home technology not suitable for all houses.

4.4 Discussion

By implementing above systems there are various benefits.

- By continuously monitoring the status of load, we can control the selection of power sources.

- Conservation of labor: Since the systems are automatic, they do not require continuous monitoring by labor.
- The design is low cost, small size, robust and highly versatile.
- This system use microcontroller which make it more convenient than conventional system.
- The main advantage is that the system's action can be changed according to the situation (high/Low power consumption of load).

4.5 Cost Estimation

Table 4.5.1

SL	Particulars	Count	Cost
1	Microcontroller (Arduino Uno & Nano)	2	750
2	Bluetooth Module (HC-05)	1	200
3	Smoke/gas sensor	1	150
4	Motion sensor	1	150
5	Relay module	1	100
6	Presentation board	1	150
7	Arduino Pin	1	40
8	PCB	1	40
9	Male to male cable	1	140
10	Male to Female cable	1	140
11	LED	1	50
12	Power supply	1	600
13	USB LED	4	200
14	USB Fan	2	200
15	Laser light	2	200
16	LDR	2	40
17	Diode	5	30
18	RANG	-	200
19	LED(3:1)	-	40
20	Buzzer	2	80
21	Anti-cutter	1	50
22	Resistor(220Ω)	1	20
23	Resistor(100KΩ)	1	20
24	Resistor(100Ω)	1	20

25	Resistor(6.8KΩ)	1	20
26	BC-547	5	40
27	2N7000 Transistor	3	60
28	Connecting wire	-	50
29	PVC sheet	-	600
30	Spray Paint	1	400
31	Travelling & other costs	-	500
Grand Total			5280

Table:4.5.1: Cost Estimation

4.6 Applications

The areas where we can see mostly applications of **HOME AUTOMATION LED IOT-ENABLED CONNECTIVITY** nowadays are:

- **LIGHTING**
- **DOORS**
- **THERMOSTAT (Air conditioning)**
- **GARDENS**
- **HOME ROUTINES ETC.**

4.7 Conclusion

This IOT based **SMART HOME SYSTEM** provides advantages like comfort, convinince, centralized control of appliences, cost reductive, energy saving, safe & security. A home automation system provides improved quality of life for users, specificaly for the elderly & differently abled persons. It plays an important role to increase energy efficiency. Commonly, home appliances remain switched ”ON” due to the laziness or due to human negligence. Many times the home users leave the room without turning off the appliences. Smart home automation system can autometically switch off easyly by smart phone. Which can contribute to save a significant amount of electrical energy for household users.

Chapter V

CONCLUSION

5.1 Conclusion

This project can be usefull for industrial automation that will help people to balance the production & energy consumption. It mainly helps the household controlling system which is in very small & individual application. For greater control & security, proper control

5.2 Future Work

These days, there is a vast range of devices powered by IoT. These include thermostats, refrigerators, security systems and even dryers and kettles. With the passage of time, more devices are sure to be added with smarter features.

Some of the areas where our future plan is to add to see home automation connectivity are:

- LIGHTING CONTROL
- MOTION AND THERMAL DETECTOR
- IMPROVED HOME SAFETY AND SECURITY
- HOME AIR QUALITY AND WATER QUALITY MONITORING
- NATURAL LANGUAGE-BASED VOICE ASSISTANTS
- SMART SWITCHES
- SMART LOCKS
- SMART ENERGY METERS

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Appendix

Code: