Home Automation and Security incorporating Electricity Conservation

Dissertation/ Project report submitted in partial fulfilment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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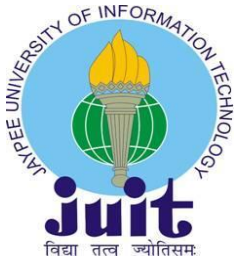
UNDER THE GUIDANCE OF

Ass. Prof. Munish Sood



Department Of Electronics and Communication Engineering

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

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DECLARATION BY THE SCHOLAR

I hereby declare that the work reported in the B-Tech thesis entitled **"Home Automation and Security incorporating Electricity Conservation"** submitted at **Jaypee University of Information Technology, Waknaghat India,** is an authentic record of my work carried out under the supervision of **Ass. Prof. Munish Sood**. I have not submitted this work elsewhere for any other degree or diploma.

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Sumesh Mahajan

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Jaypee University of Information Technology, Waknaghat, India
Date:-

SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the B-Tech. thesis entitled "**Home Automation and Security incorporating Electricity Conservation**", submitted by **Jasmeet Chhabra, Shubhender Singh and Sumesh Mahajan** at **Jaypee University of Information Technology, Waknaghat, India** is a bonafide record of his / her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree or diploma.

(Signature of Supervisor)

Mr Munish Sood

Assistant Professor

Date:-

Acknowledgement

We take this opportunity to express our gratitude and regards to our guide Mr Munish Sood for his consistent guidance and constant encouragement throughout the course of this project. The guidance and help given by him in the course of this project didn't just benefit us for this project but also taught us my priceless lessons which will definitely be very helpful to us throughout our lives.

The in-time facilities provided by the department of Electronics and Communication throughout the project development are also equally acknowledgeable.

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Date: 28-04-2017

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Abstract

The project illustrates an Ethernet based smart home intelligent system which supervises the energy consumption of the electrical appliances or devices in our daily use by tracking their real time working at home .The project makes use of INTEL GALILEO 2ND generation development board which is portable enough that it can be used in houses and colonies. The project keeps a track of the appliances being used or not and it also provides us with a feature to control them remotely by merely the use of verbal instruction which is made possible by the use of the android based app in our project.

The project uses various sensor to keep a track of the devices whether they are working or not and it also provides security to the home by keeping a check on the presence of any unexpected person. The project remotely monitors and controls the working of the appliances by using the android app which can be provided connectivity either by internet or intranet. The project helps the user to check any surplus usage of any appliance hence cutting a substantial amount of electricity bill on yearly bases .Apart from this the project also helps the user to manage his home security by keeping a check on any intrusion at his home or any unexpected event like fire ,etc. when the user is not there.

With the help of this security feature of the project the user can take counter measures on time to prevent any potential disaster at his home quite easily. Apart from reducing the surplus usage of any appliance and providing security to the home the project also provides the user with an environment where all his daily tasks can be completed with ease and with lesser consumption of time as it provides the user with an option of activating or deactivating a device by using his voice or simple toggle touch on their smartphone and last but most importantly track the operation so as to conserve the limited natural resources by reducing electricity consumption.

CHAPTER 1
INTRODUCTION

1.1 INTERNET OF THINGS (IoT)

Internet of Things is means by which objects, animals or people are given a specific identity and the capability of transferring data over a network without requiring human-human or human-computer interaction. Evolvement of IOT is due to the occurrence of wireless technologies, micro-electromechanical systems (MEMS) and the Internet.

It pertains to the network of physical bodies that characterise an IP address for internet connectivity

Figure 1: Introduction to Internet of things

It extends internet connectivity beyond conventional devices like desktop and laptop computers, smartphones and tablets which has in turn diversified range of devices and everyday things that utilize embedded technology to communicate and interact with the external environment through the Internet.

Examples of such objects include thermostats, cars, connected security systems, electronic appliances, and lights in household and commercial environments, alarm clocks, vending machines, speaker systems and many more.

As far as the reach of the IoT is concerned, there are more than 12 billion devices that can currently connect to the Internet, and it is estimated to grow by 26 times by the researchers at IDC estimate that in 2020.

1.1.1 Vision defining the Internet of Things

Internet of Things conceptually incorporates futuristic visions of automating the detail of our lives. IoT will ultimately optimize every aspect of our lives like morning routine, which would include preferences for shower temperature, coffee timing, food preparation, etc. The travel arrangements would be made cleverly, using up-to-the-minute traffic and weather data. It shall be able redefine our workflows, simply by prioritizing tasks and projects based on on-going flow in real time keeping in mind as to what is happening throughout our organization

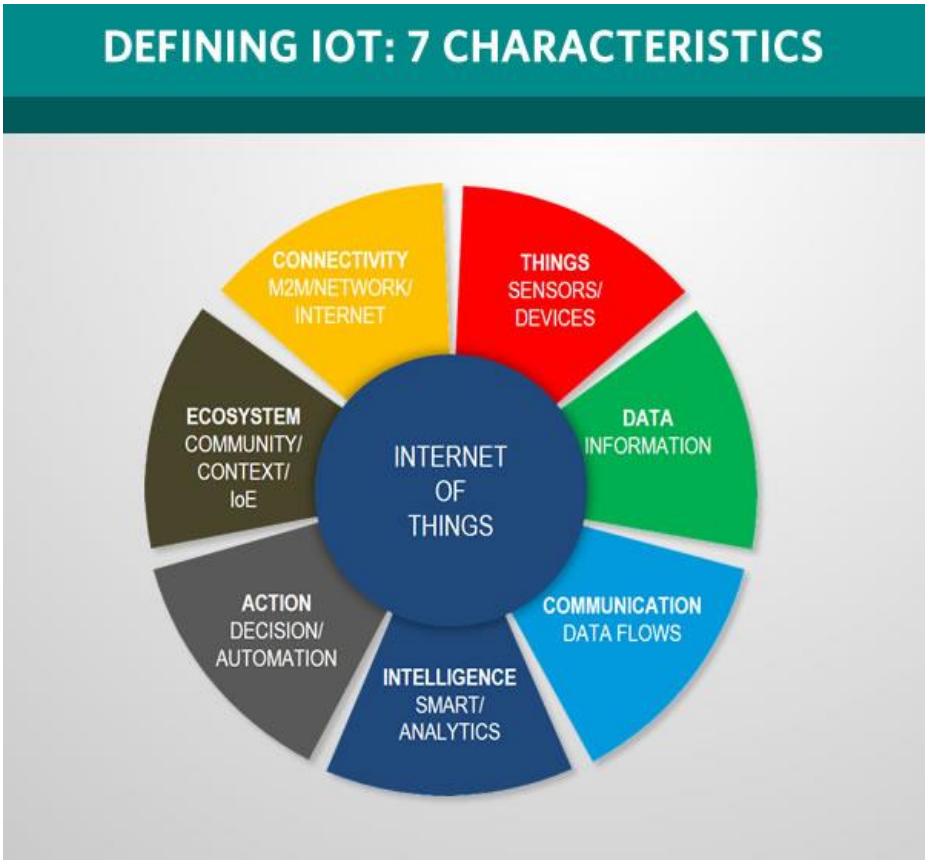

Figure 1.1: Vision of IoT

1.1.2 Intel IoT Platform

Internet of Things has huge potential to drive social change and economic value. The industry has yet to tap IoT's enormous potential as 80% of things are still unconnected.

The Intel IoT Platform can overcome these hurdles by providing an end-to-end platform for connecting the unconnected—allowing data from billions of devices, sensors, and databases to be securely gathered, exchanged, stored, and analysed across multiple industries.

1.1.3 Key Benefits of the Intel IoT Platform

Security: Transmit data with an integration of hardware and software based on security that starts where data is most prone to attack

Interoperability: Employ technologies so as it communicate to one another, help accelerate time to market, and reduce the cost of deploying and maintaining IoT solutions

Scalability: Achieve scalable compute from edge to cloud with processors based devices, gateways, and data centres solutions

Manageability: Get advanced data management and analytics from sensor to data centre.

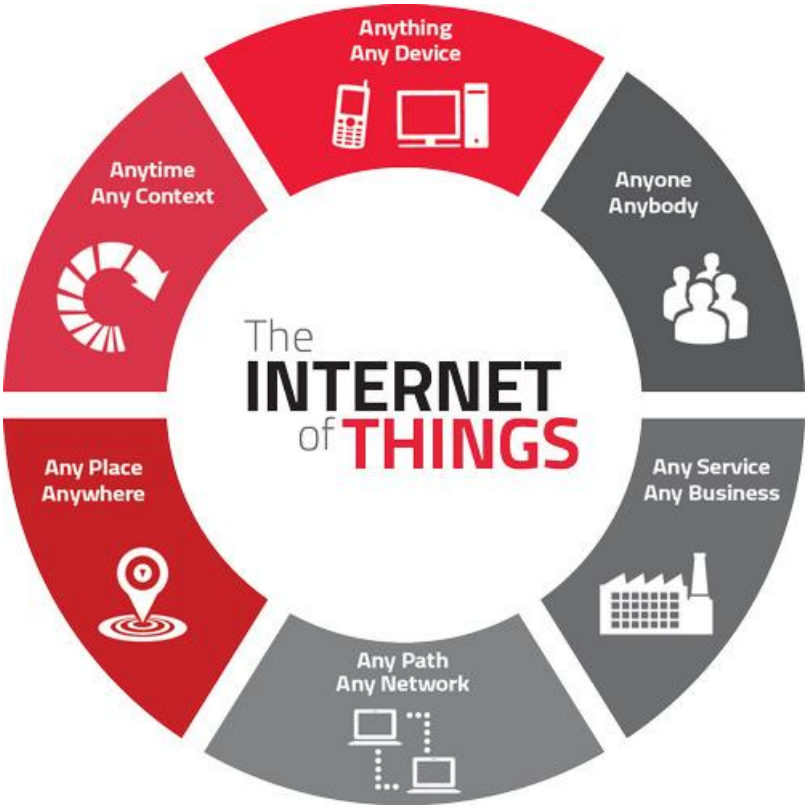

Figure 2: Accessibility of Internet of things

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1.2 AUTOMATION

We define automation as "the invention and application of technology to administer and control the production and delivery of products and services."

From the above definition, the automation profession includes "everyone involved in the invention and application of technology to monitor and control the production and delivery of products and services"; and the automation professional is "any individual involved in the creation and application of technology to monitor and control the production and delivery of products and services."

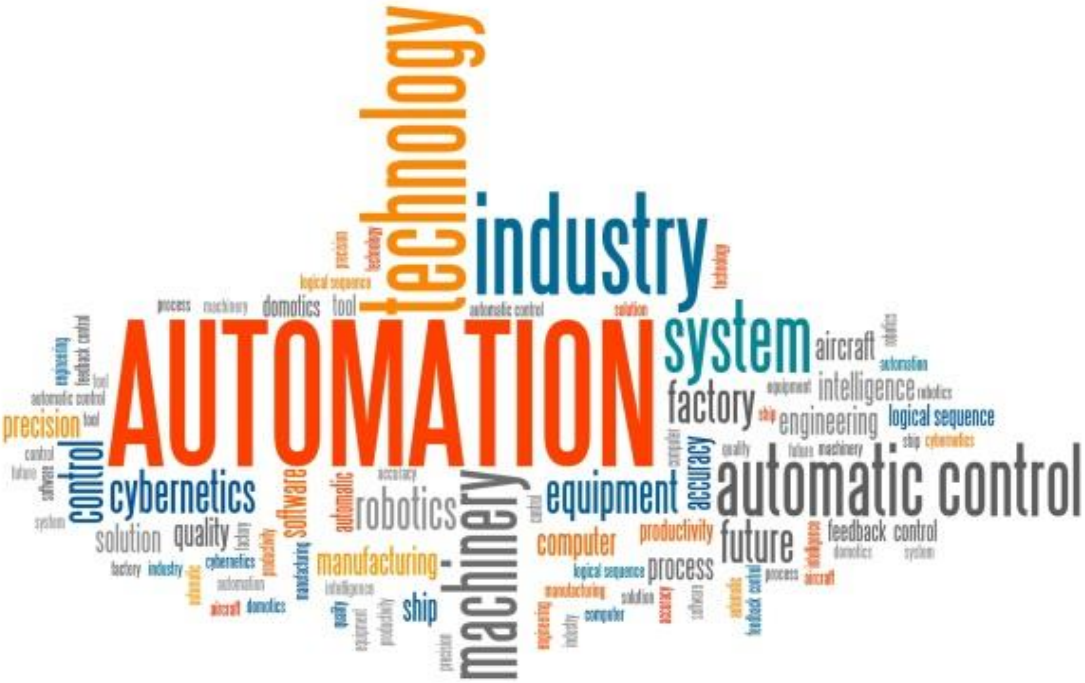

Figure 3: Introduction to Automation

Automation is the use of various technologies to optimize productivity in the production of goods and delivery of services. Automation helps in increasing the productivity, and/or quality beyond that possible with current human labour levels so as to realize economies of scale, and/or realize predictable quality levels. Automation involves using control systems for operating equipment like machinery, processes in factories, and heat treating ovens, boilers, switching in telephone networks, aircraft and other applications with minimal or reduced human intervention. Some of these processes have been fully automated.

The most important advantage of using automation is that it saves labour, energy and materials and improves quality, accuracy and precision.

Automation provides following benefits:

Manufacturing, including chemical and petroleum, food and pharmaceutical, pulp and paper.

Transportation including rail, automotive and aerospace

Utilities, including oil and gas, water and wastewater, electric power, and telecommunications

Facility operations, including energy management, security, environmental control, safety, and other building automation

Automation covers almost all functions within industry including installation, integration, and maintenance to design, procurement, and management. Automation has also reached the marketing and sales functions of industries.

Automation includes vast range of technologies including robotics, telemetry and communications, Cyber security, expert systems, process measurement and control, sensors, wireless applications, electro-optics, systems integration, test measurement, and many more.

1.2.1 Automation Tools

Engineers can now have numerical control over automated devices. This results in rapidly spreading range of applications and human activities. Computer driven technologies provides a platform for organizational and mathematical tools used to create complex systems.

IT along with machinery and processes can help in the design, implementation, and monitoring of control systems. Programmable logic controller (PLC) is one example of an industrial control system. Programmable logic controller is specialized computers frequently used to synchronize the flow of inputs from sensors and events with the flow of outputs to actuators and events.

1.3 ARTIFICIAL INTELLIGENCE

"Artificial intelligence, or **AI**, is the field that studies *the synthesis and analysis of computational agents that act intelligently."*

An **agent** is the one that acts in an environment including worms, dogs, thermostats, airplanes, robots, humans, companies, and countries.

An agent acts **intelligently** when whatever it is doing is appropriate for its circumstances and its goals, it is flexible to any change in the environments and goals, it learns from its experience, and it makes appropriate choices.

An agent cannot observe the state of the world directly as it has only limited memory and it does not have unlimited time to act.

Artificial intelligence (AI) is the intelligence which a machines or software can show. It is the study which focuses on creating decision making power or intelligence in machines. John McCarthy, who introduced the term in 1955, defines it as "*the science and engineering of making intelligent machines*".

It can have applications in business to boost work processes and improve the processing of work systems. Artificial intelligence refers to the ways in which the programs in consideration are used to help companies and organizations carry out a variety of operations and transactions.

1.4 Difference between Automation, Robotics and Artificial Intelligence

Automation and Robotics are very closely connected to each other.

Tasks which are performed by human efforts are a manual operation. Automation is the reduction of human effort. For example, a semi-automatic washing machine needs human engagement for drying of the clothes while a fully-automatic washing machine needs no human engagement.

Robotics is used for some specific kind of routine jobs. For example, painting a car in manufacturing takes help of robotics for automating the task.

Artificial intelligence is the higher version of Automation & Robotics. It is an area where intelligence like humans can be developed in machines/processors. Humans intervene Intelligence by learning, studying, making mistakes, remembering the mistakes made, discussing with friends, implementing. Artificial intelligence is means of giving instructions to the machines for what to do, we make them capable enough to learn the things on their own like we do.

In AI a machine is able to collect information about the outside world and apply that information to best perform its function. Automation and robotics treat this information differently. Automated machines cannot collect information and can't be programmed with any form of intelligence. Robots can be made with intelligence and they are able to learn from mistakes; this allows the robot to fix problems.

1.5 EMBEDDED SYSTEMS

An embedded system is a device that contains both hardware and software components to perform a single function and is expected to work with minimal or no human interaction.

Embedded systems need real time operations and multitasking capabilities. Most embedded systems make decisions based on the inputs and move directly with processes or the environment. It is important for the system to be reactive, responding in real time to process inputs to guarantee proper operation. These systems operate in restricted environments where memory, computing power, and power supply are limited. Multitasking is the ability to perform various tasks simultaneously or in a quasi-simultaneous manner. The embedded controller is liable of monitoring several aspects of the embedded system.

Figure 4: Introduction to Embedded System

The concept of embedded system precedes the concept of a general purpose computer. The earliest forms of computing devices match better to the definition of an embedded system than to that of a general purpose computer.

Embedded systems are seen in many common electronic devices, such as consumer electronics, digital cameras and calculators, home appliances such as microwaves ovens, answering machines, office automation such as fax machines, printers, scanners and automobiles etc. As the embedded system is focused to specific tasks, its design can be optimized, reducing the size and cost of the product, or increasing the reliability and performance.

1.6 INTEL GALILEO 2nd Generation Development Board

Intel Galileo second generation board renders a single board controller for manufacturer community, students and professional developers. It is a 32-bit Intel Pentium processor- class system on a chip that provides fully featured applications. It is Arduino-certificated and designed to be software, hardware and pin compatible. The processor details and the other details are mentioned in the table below:

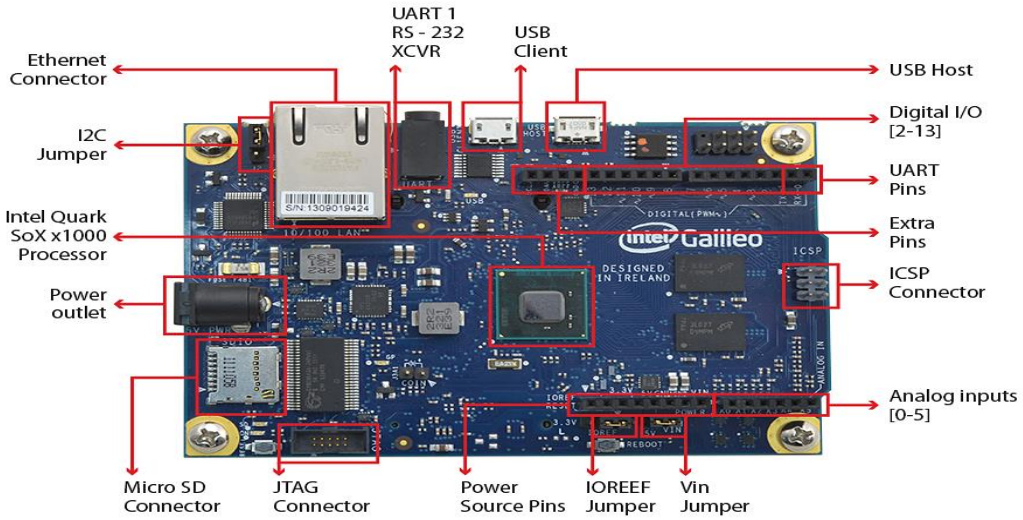

Figure 5: Top-view of Intel Galileo Board

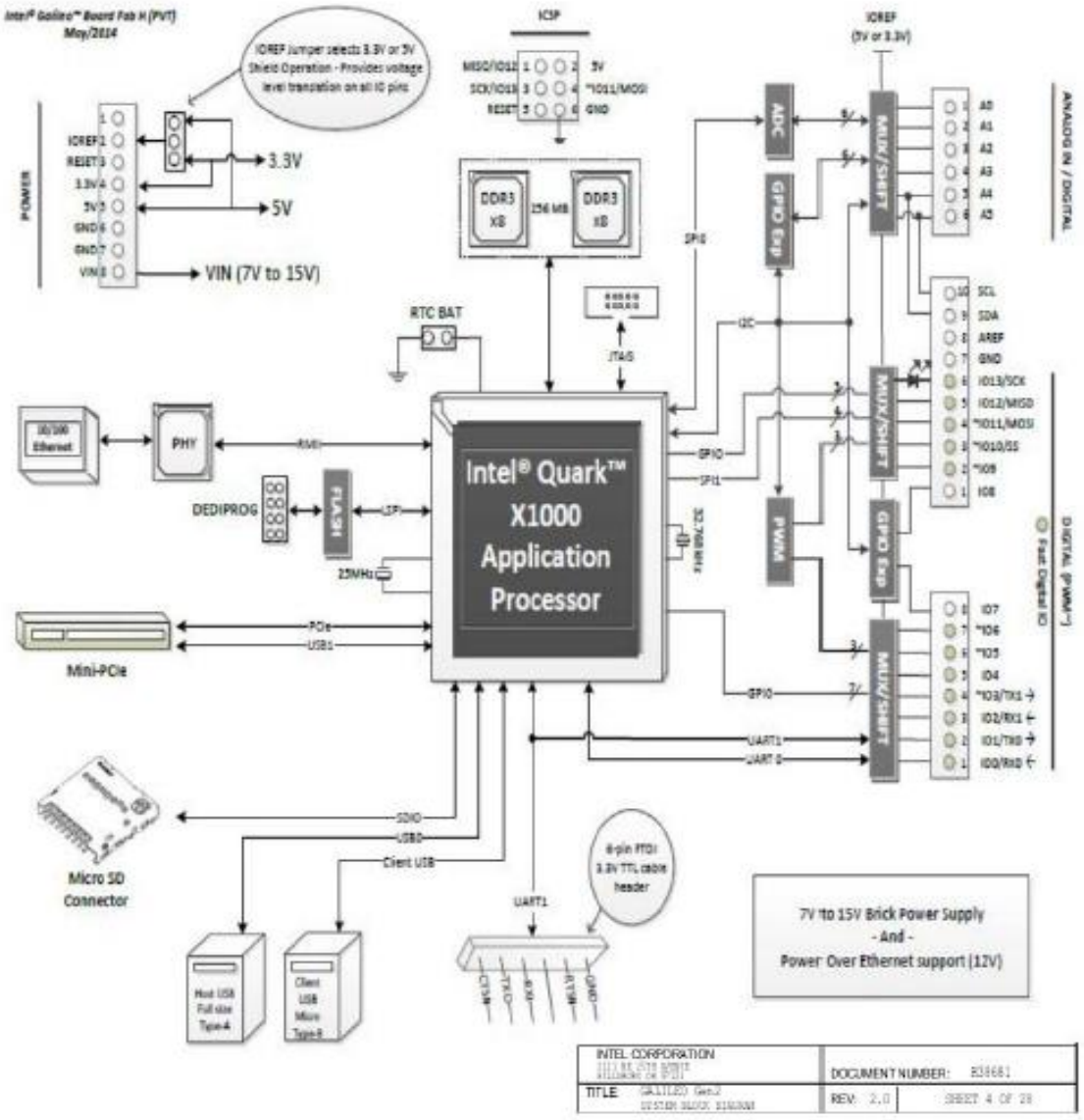

Figure 6: Pin configuration of Intel Galileo Board

1.6.1 General Characteristics of Intel Galileo 2nd Generation Board

1.6.2.1 Specifications

DIMENSIONS	123.8 mm(L) x 72.0 mm(W)
ATTACHMENTS	Four screw holes 4mm (diameter) Arduino compatible headers containing: • 20 digital I/O • 6 analog inputs • 6 PWMs with 12-bit resolution • 1 SPI master • 2 URATs (1 shared with console URAT) • 1 I^2C master
CONNECTORS	6-pin console URAT (compatible with FTDI USB converters) 6-pin ICSP 10-pin JTAG for debugging RJ45 Ethernet, Power over Ethernet capable USB 2.0 Host(Standard Type A) USB 2.0 Client(micro- USB Type A) Mini-PCI Express 1x slot
POWER	Jack with increased range (7 to 15 V) Supports Power-over-Ethernet (requires PoE module installation) Header for RTC power
BUTTONS	Reset for sketch and attached shield resets 10/100 Mbps Ethernet Reboot to reset the Intel Quark SoC X1000

Table 1: General Specifications

1.6.2.2 Processor Specifications

MODEL	Intel Quark SoC X1000
SPEED	400 MHz
CORES/ THREADS	1/1
INSTRUCTION SET ARCHITECTURE (ISA)	32-bit Intel Pentium processor compatible ISA
L1 CACHE	16 Kb
SRAM	512 Kb on- die, embedded
PACKAGING	15 mm x 15 mm BGA ACPI- compatible with CPU sleep states
TECHNOLOGIES SUPPORTED	Integrated real time clock (RTC) Optional 3 V coin cell battery for operation between turn on cycles

Table 2: Processor Specifications

1.6.2.3 Storage Specifications

FIRMWARE/ BOOT LOADER	8 MB NOR Flash
DRAM	256 MB DDR3, 800 MT/s
SD CARD (OPTIONAL)	Up to 32 GB
USB	Compatible with any USB 2.0 storage device (USB drive/ stick)
EEPROM	8 KB (programmed via the EEPROM library)

Table 3: Storage Specifications

1.6.3 Enhancements

The 2nd Generation Intel Galileo board is known to deliver unique features and different functionalities of which below are some of them:

- It has 12 GPIOs which has great communication speed and drive strength
- 12-bit PWM pins which are used for modulation techniques for the control of servos
- High speed 12 V Ethernet connectivity
- Various communication protocols like URAT, serial compatible with FTDI USB converters.

1.6.4 Key Component Description

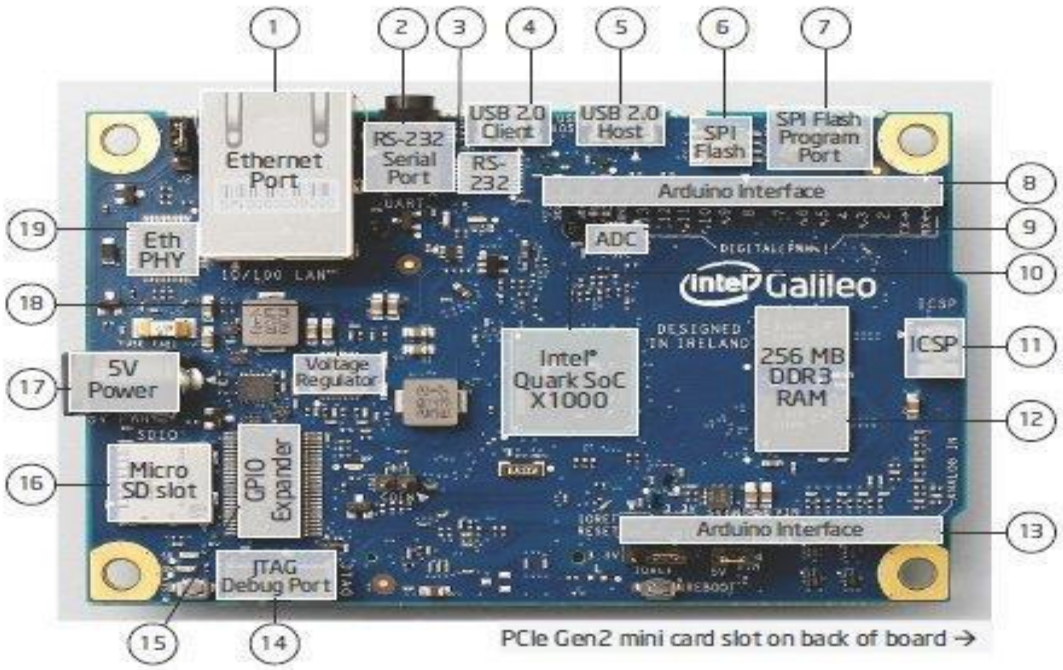

Figure 7: Top view of Galileo Board with Component Specifications

Number	Component	Description
1	Ethernet Port	10/100 Ethernet connector
2	RS-232 Serial Port	3-pin 3.5 mm jack
3	RS-232	RS-232 transceiver
4	USB 2.0 Client	A fully compliant USB 2.0 Device controller, for programming
5	USB 2.0 Host	Supports up to 128 USB end point devices
6	SPI Flash	To store the bootloader and the latest sketch
7	SPI Flash Program Port	7-pin header for Serial Peripheral Interface (SPI) programming Defaults to 4 MHz to support Arduino Uno shields. Programmable up to 25 MHz.
8	Shield Interface	Complies with Arduino Uno Revision 3 shield pin out.
9	ADC	Analog to Digital Converter
10	Intel Quark SoC X1000	400 MHz 32-bit Intel Pentium instruction set architecture (ISA)-compatible processor
11	ICSP	6-pin in-circuit serial programming (ICSP) header. These pins support SPI communication using the SPI library.
12	256 MB DDR3 RAM	Enabled by the firmware by default.
13	Arduino Interface	Complies with Arduino Uno Revision 3 pinout.
14	JTAG Debug Port	10-pin standard JTAG header for debugging
15	GPIO Expander	GPIO pulse width modulation provided by a single I^2C I/O expander
16	Micro SD slot	Supports micro SD card up to 32 GB
17	5V Power	The board is powered via an AC-to-DC adapter, connected by plugging a 2.1 mm center-positive plug into the board's power jack, output rating of the power adapter is 5V at up to 3A.

Table 4: Key Component Description

CHAPTER 2
LITERATURE REVIEW

As part of the literature review, here we have reviewed and analysed the various existing technologies and the products and services based on them systems for energy. Here we have specially focussed on Home Automation Systems which aim to conserve energy and automate device control in homes, and the various products recently developed or available in the market which can be easily deployed.

2.1 Z-HOME

Z-HOME is a home based automation solution. It enables customer's wireless solutions who want the best of Automation and Security along with service quality.

It is a wireless communication protocol made for remote control applications in residential and commercial areas. It requires a low-power radio frequency radio embedded in electronic devices and systems, such as household appliances, access controls, entertainment systems and lighting.

Z-Home allows customers to start small and enhance on the go. They offer packages to customers which are priced low. The initial kit is simple way to start home automation now. The kits have been made to fulfill the requirements of home owners. The initial kit comes with lighting and basic security features whereas the premium kit offers lot more like curtain control, AV integration and advanced security features. The premium kit also requires additional labor hours for installation.

Figure 8: Z HOME Dimmer & Switch **Figure 9: Z HOME Retrofit Solution**

2.2 SYNCO LIVING

Synco Living Home automation and control system offers comforting and superior energy efficiency via smart home automation. This system offers favourable control and switching of HVAC systems and lights.

It provides a convenient home where one can save energy costs with a suitable room climate, and eliminating the threat on any breach as it is always supervised.

Single system for complete home

Synco living makes your house secure and energy efficient. It is good enough to think by it controlling things in the background, including the room temperature and ventilation. Synco living monitors a person's presence by switching on lamps, provide information about water damage and administer doors and windows.

Comfortable and secure

Synco living's helps in minimizing the consumption of the energy also making living area comfortable. Most of the functions run by themselves and you don't have to think about them or take action. This not only eradicates daily tasks but also benefit

from the system's reliability and dependability. Major components are related to Siemens' which has experience in building automation.

Adjusting to users demands.

It provides a high level of flexibility. For example, if you figure out that other arrangements are more suitable, then one can optimize it to the new demands by programming new scenes or by reprogramming existing ones.

CHAPTER 3

PROBLEM STATEMENT

Most of the tasks which took a lot of time in earlier days are now done within a blink of an eye and all this is made possible due to the technical advancements in the recent years. If we look around us then we can see that our life style nowadays is highly dependent on the electronics around us for all the good reasons. From escalators to launching satellites electronics has reduced the need for human efforts by a great amount.

Now by our project we are aiming to amalgamate the electronics to our lifestyle so as to have home automation to achieve a faster and easier lifestyle along with sustained usage of electricity.

The problem statement of our project can be summaries as the following statements:-

- The need for energy efficiency and conservation of resources.
- The need to automate everyday tasks so as to reduce human efforts.
- The need to reduce the time for our daily chores so as to adapt to the fast lifestyle of today's world.
- The need to avoid potential disastrous situations at our home like thief intrusions, fire, etc.
- The need to reduce hefty electricity bills at our home due to surplus usage of appliances.

CHAPTER 4

PROPOSED MODEL

Looking upon the proposed model of our project, this project proposes to develop an intelligent smart home which uses automation and voice control to control the power and security of the home. This system is used for conserving the electrical energy which can be also be implemented in the large industries and organizations. This system will work on automation in which the electrical devices can be controlled remotely using android app and Bluetooth and can be controlled using voice control.

4.1 PHASES FOR THE PROPOSED MODEL

This project has been divided into two phases.

PHASE I consists of the following modules :

- Formulation of the project idea keeping in mind the requirements
- Survey of the existing models of home automation
- Planning out a schematic approach and defining the proposed model
- Software and Hardware Requirements gathering
- Controlling the 220v appliances from the app according to the human input
- Interfacing the sensors including the PIR sensors, Fire sensor and the relay module.

PHASE II consists of the following modules:

- Setting up the communication between the hardware unit and the mobile
- Customising the Android app
- Connecting the hardware unit with the app using Bluetooth
- Installation of complete setup
- Analysis of energy efficiency after installation

4.2 BLOCK SCHEMA

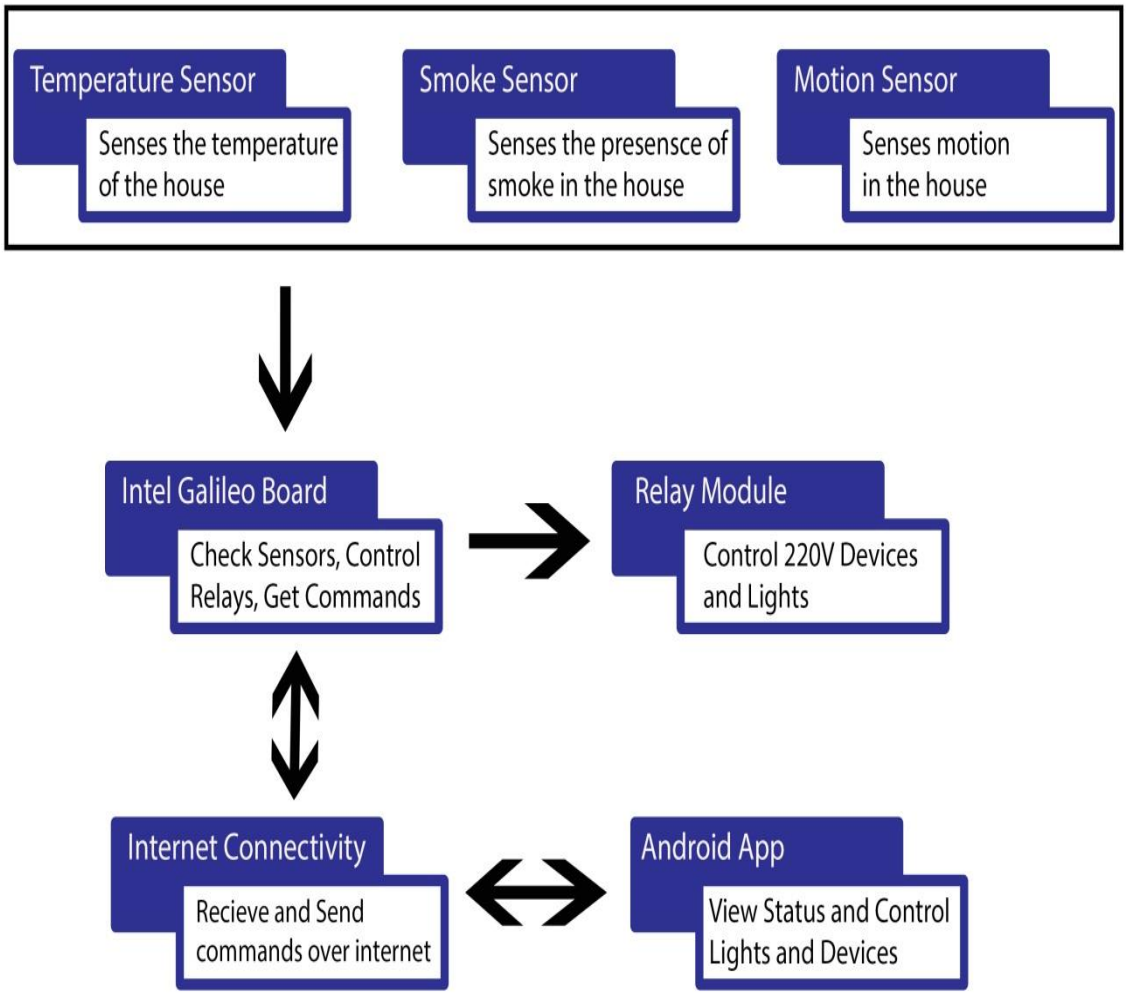

Figure 10: Block Schema of the Proposed Model

4.3 Description and Working of the Proposed Model

Overview:

In this model, a Wireless based (Bluetooth or Internet) system is developed which will enable the user to control all the electrical appliances for example lights, fans etc. through an android mobile app. The appliances can also be controlled using the voice

of the user through the app. Also, our model is automated based model which will switch off the specific appliances and in case of absence of the user. The model also has fire protection and security feature which will uses different type of sensors to measure the and look out for any fire or the unwanted intrusion in the home and also for the fire detection. The system is connected to the android app using Bluetooth and internet connectivity for efficient and reliable communication. The interface is user friendly which includes both- tap-to-toggle as well as voice control feature.

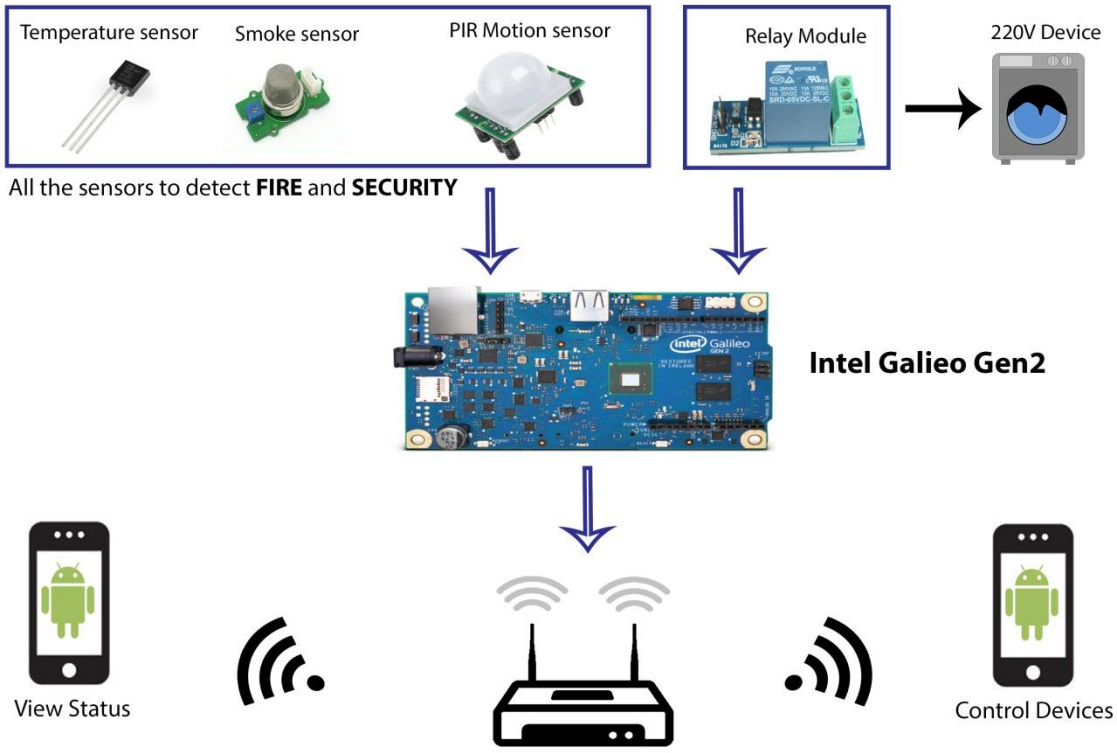

Figure 11: Architecture design of the Prototype

Hardware Model:

Briefing about the hardware part of the model, there is a LM35 temperature sensor which gives the temperature measurement of the house ranging from the value -35 degree Celsius to 50 degree Celsius, which in combination with the MQ5 smoke sensor will detect the presence of fire in the home and switch on the buzzer alarm. For the security purpose we have the PIR motion sensor which will automatically get on when the user leaves the house and will switch on the burglar alarm in case any

human motion is detected. For the switching part we have relay modules through which the appliances will be controlled and monitored by the Intel Galileo. The main working CPU of our system is the 2nd gen Intel Galileo board which enables us to connect to it various sensors and other output devices likes relay etc. It is the single development board based on the Intel Quark SoCX1000. The system contains a 32-bit Intel Pentium processor. The board is Arduino compatible and has a large variety of shields and devices to be connected to.

Software Model:

On the software side of our model, there is an android based mobile app which enables the user to toggle the appliances and control them using tap-to-toggle system or else using the voice mode. The system may also be programmed to generate the alerts in case of security breach or fire. The android app is connected to the hardware unit using Bluetooth and internet. It connects to the Intel Galileo/Arduino over the Bluetooth and lets the users toggle the current switching position of the appliances. The voice recognition is done through the Google API speech recognition tool. The app has also the feature to manually control the fire and security sensors in case of emergencies.

4.4 SOFTWARE REQUIREMENTS

For the software part of the model, it requires an environment to interact and code the microcontroller which is Arduino **IDE software** to upload various program codes for the hardware).

4.4.1 Introduction to the Arduino IDE

The Arduino Integrated Environment is a java based open source platform independent application which derives from the IDE for wiring projects and processing programming language. It is built to introduce programming to armatures and the people who have not used any programming language before but are willing to use it for their projects. It has a code editor which has features like brace matching; syntax

highlighting and it can also load and compile the program on the board with just a click of a button. The code for arduino is known as a sketch.

Arduino programs uses languages like C or C++. The IDE contains a software library called Wiring for the actual wiring project with which we can easy do the normal input output operations. Users only need define two functions to make a runnable cyclic executive program, a setup( ) function that run once at the start of a program to initialize settings and a loop( ) function that is called repeatedly until the board powers off

The IDE uploads the program on the board by using avrdude and it compiles the program using the GNU tool chain and avr libc.

We have used Arduino version 1.6.4 which is compatible with the Intel Galileo Gen 2 board and it can be used for the environments like Windows, Linux or Mac.**4.5**

HARDWARE REQUIREMENTS

As proposed in the block schema, the system intends to use the **Intel Galileo 2nd Generation Development Board/ Arduino board** as its main brain or the hardware processing unit.

In addition to that, the system requires:

- relay module
- few LEDs, 220v bulb to check the proper functioning
- Bluetooth module
- Temperature sensor
- Smoke sensor
- PIR motion sensor
- few resistors and switches
- buzzer alarm

CHAPTER 5

IMPLEMENTATION

Software Implementation:

5.1 Sketch 1 : Blink.ino

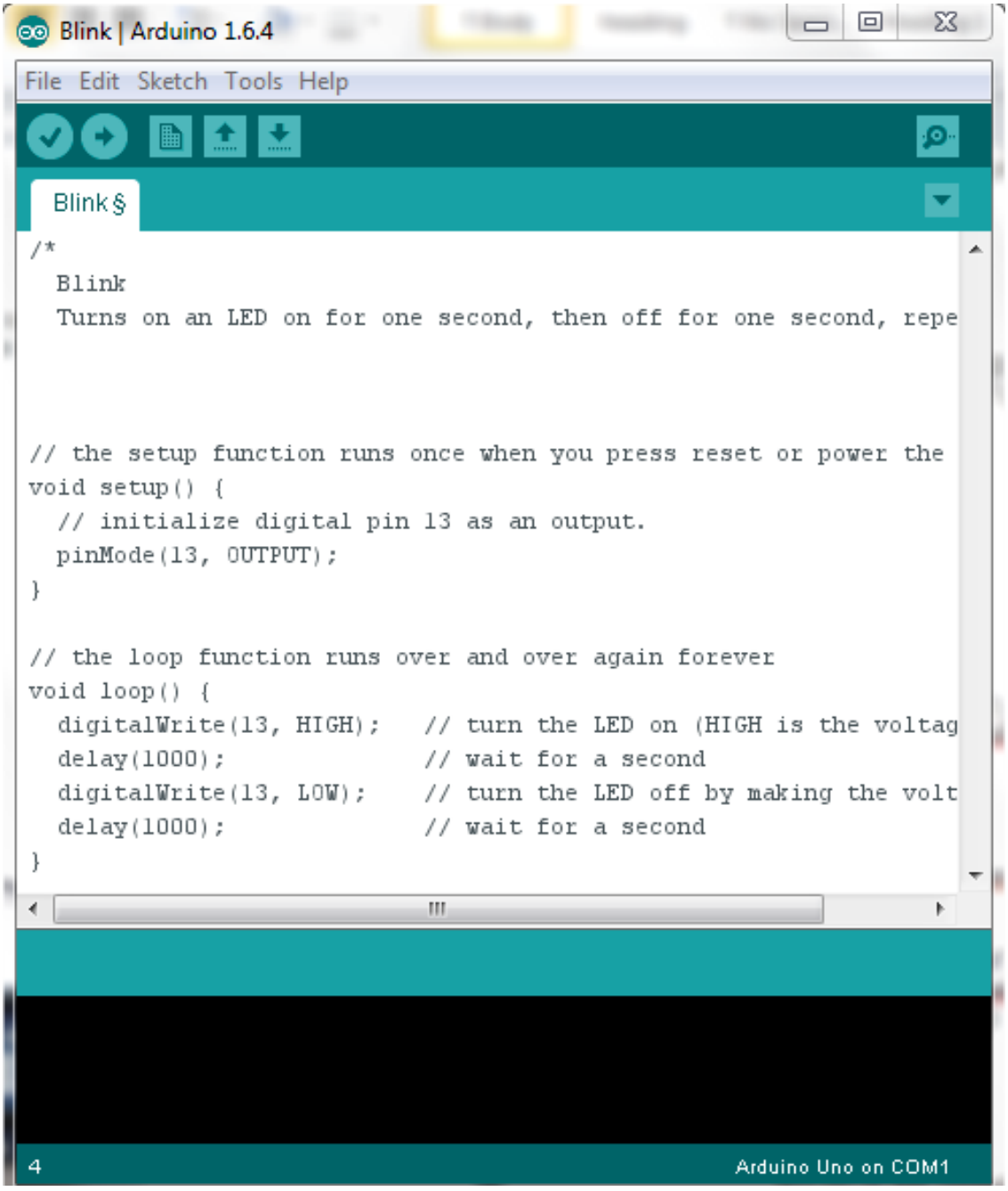

Figure 12: Screenshot of 'Blink code'

5.2 **Sketch 2 :** Web Server.ino

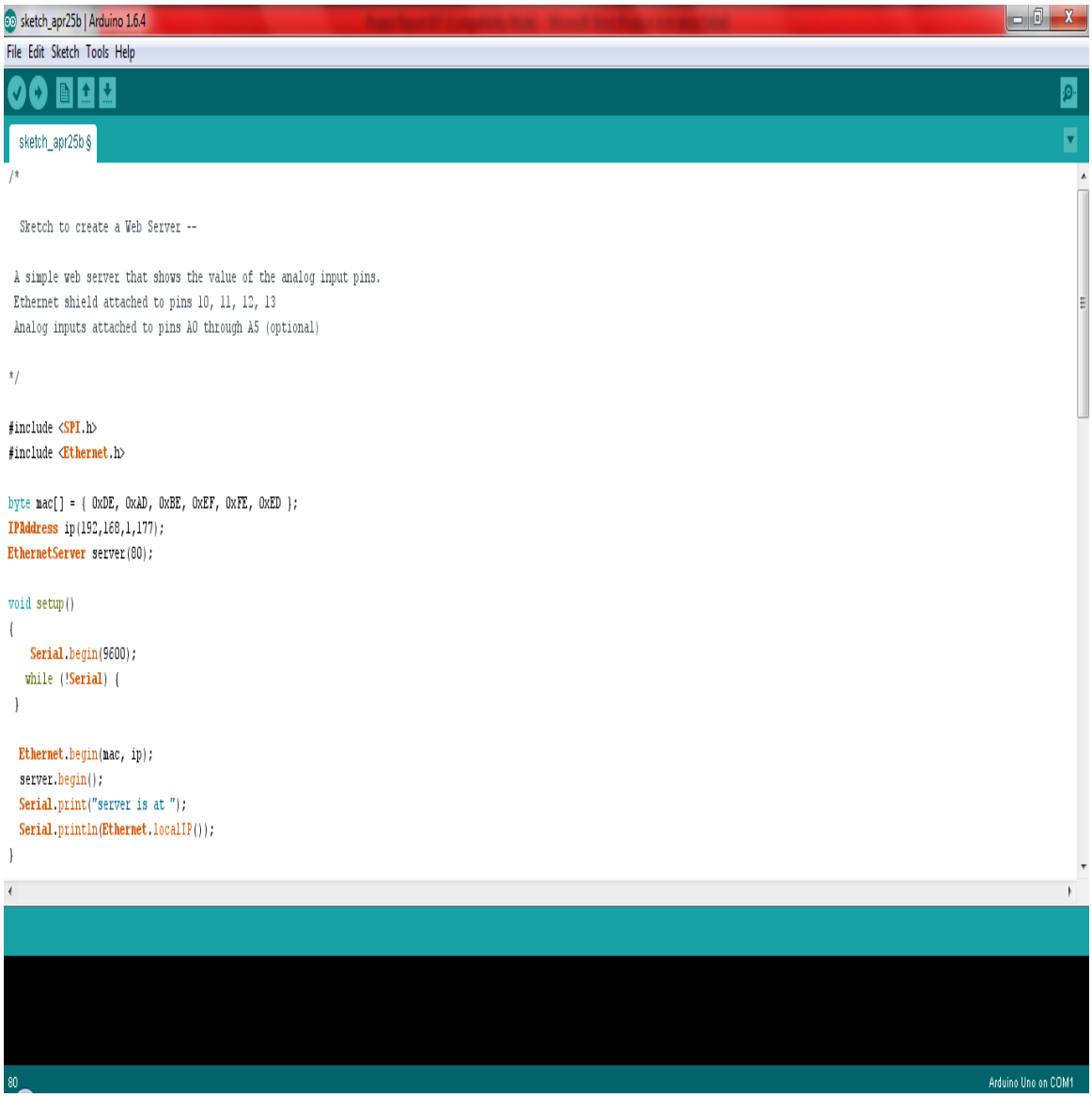

Figure 13: Screenshot of 'Web server code 1'

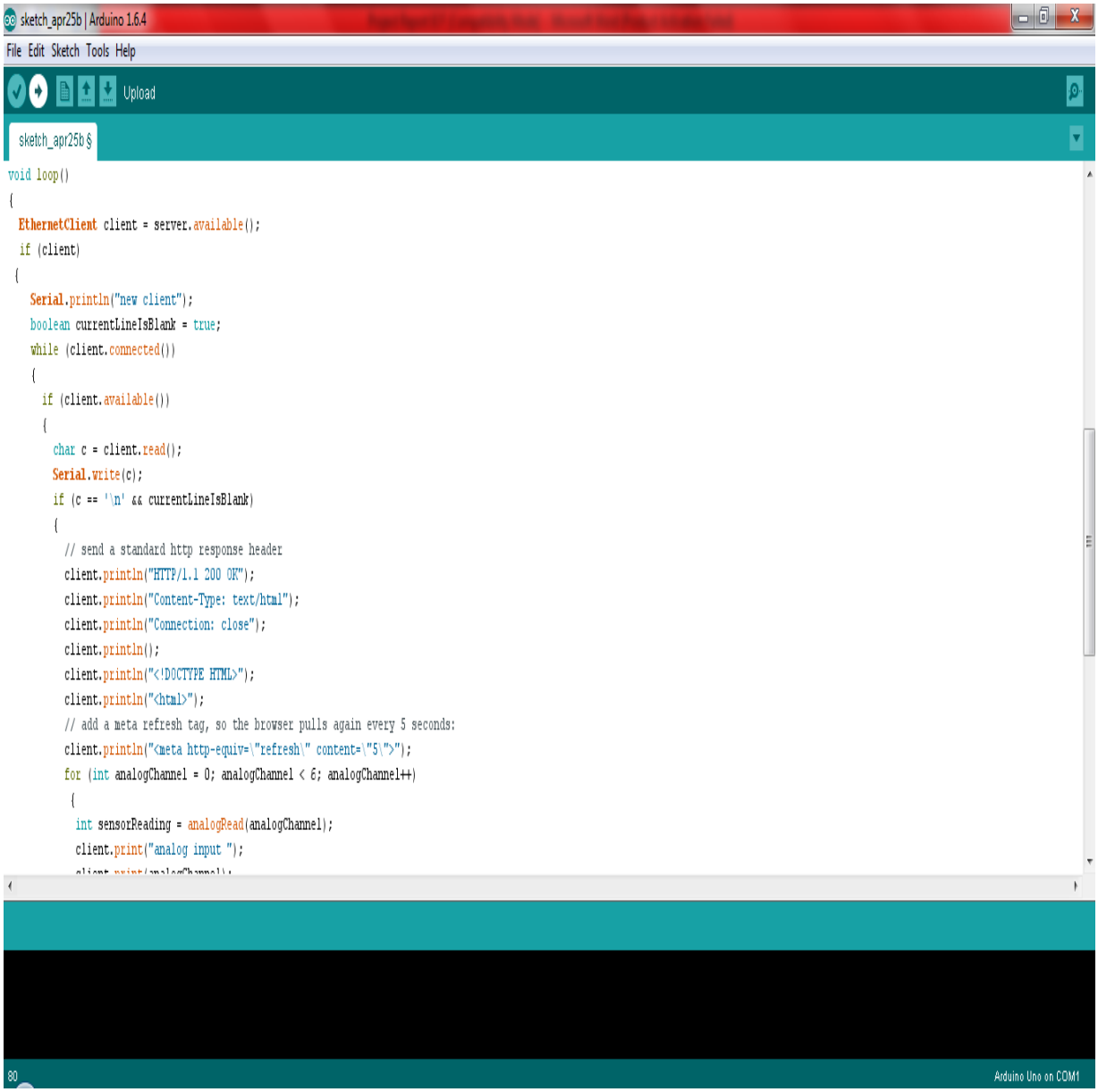

Figure 14: Screenshot of 'Web server code 2'

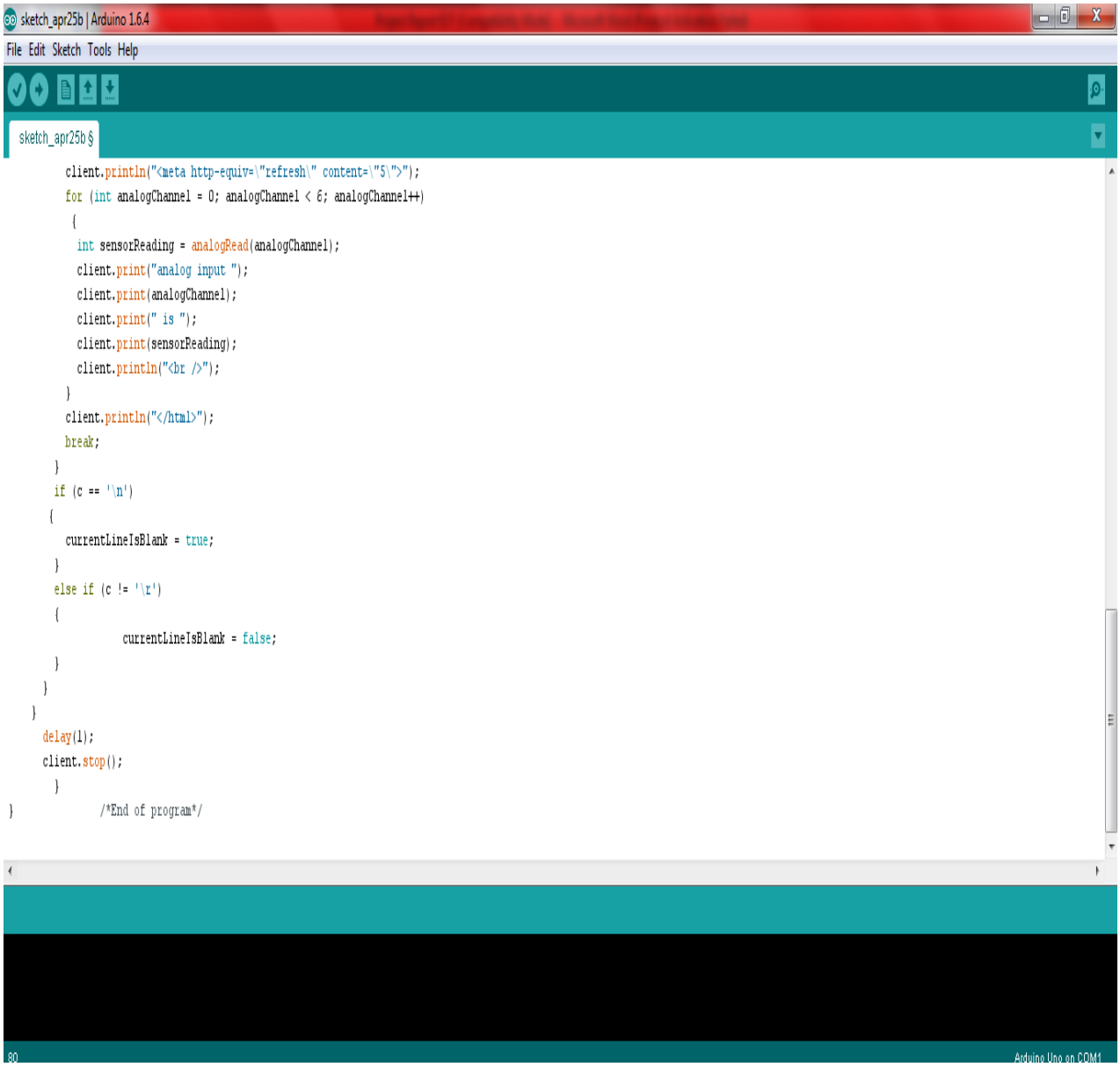

Figure 15: Screenshot of 'Web server code 3'

5.3 Sketch 3: The main final program

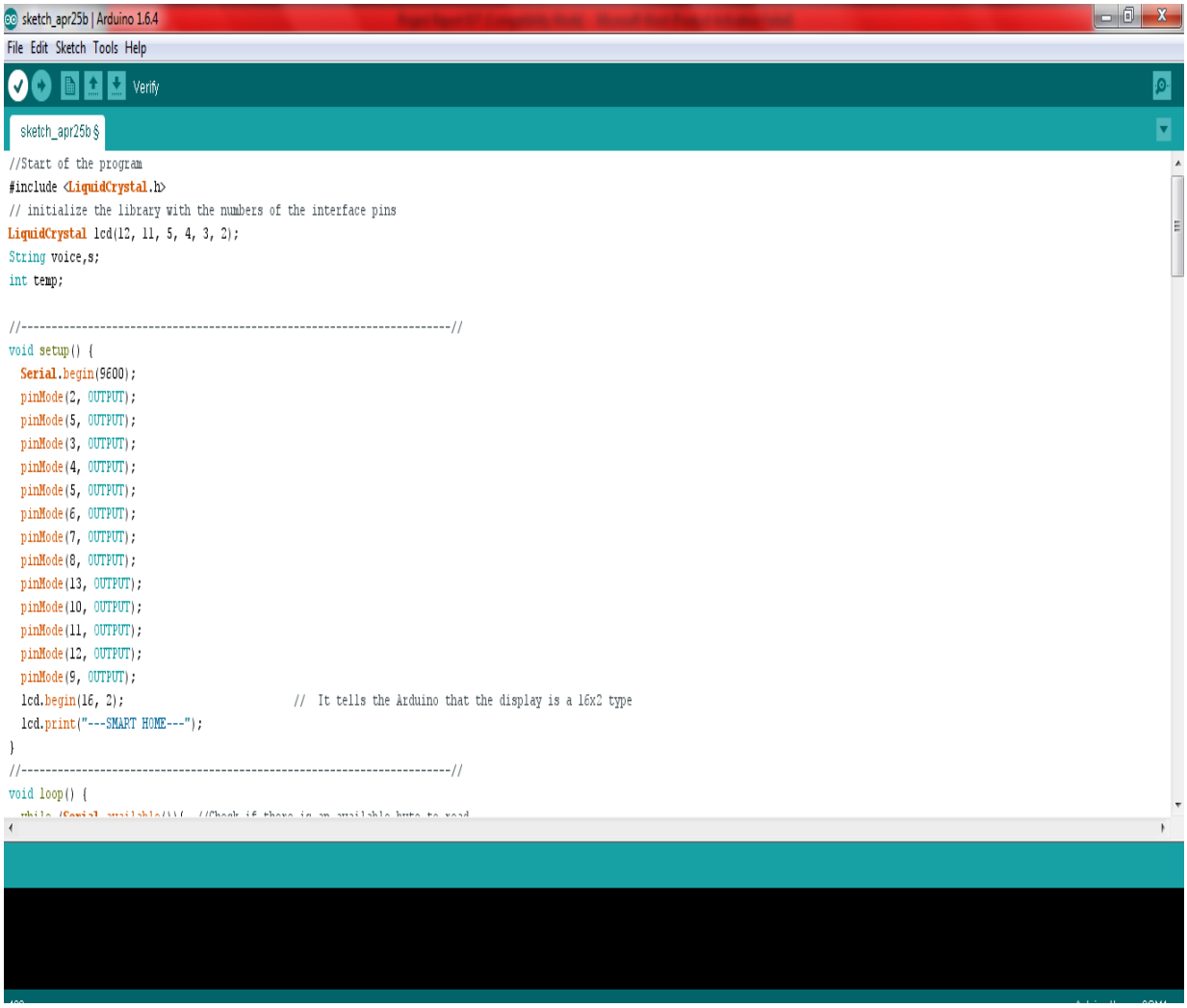

Figure 16: Screenshot of 'Final code 1'

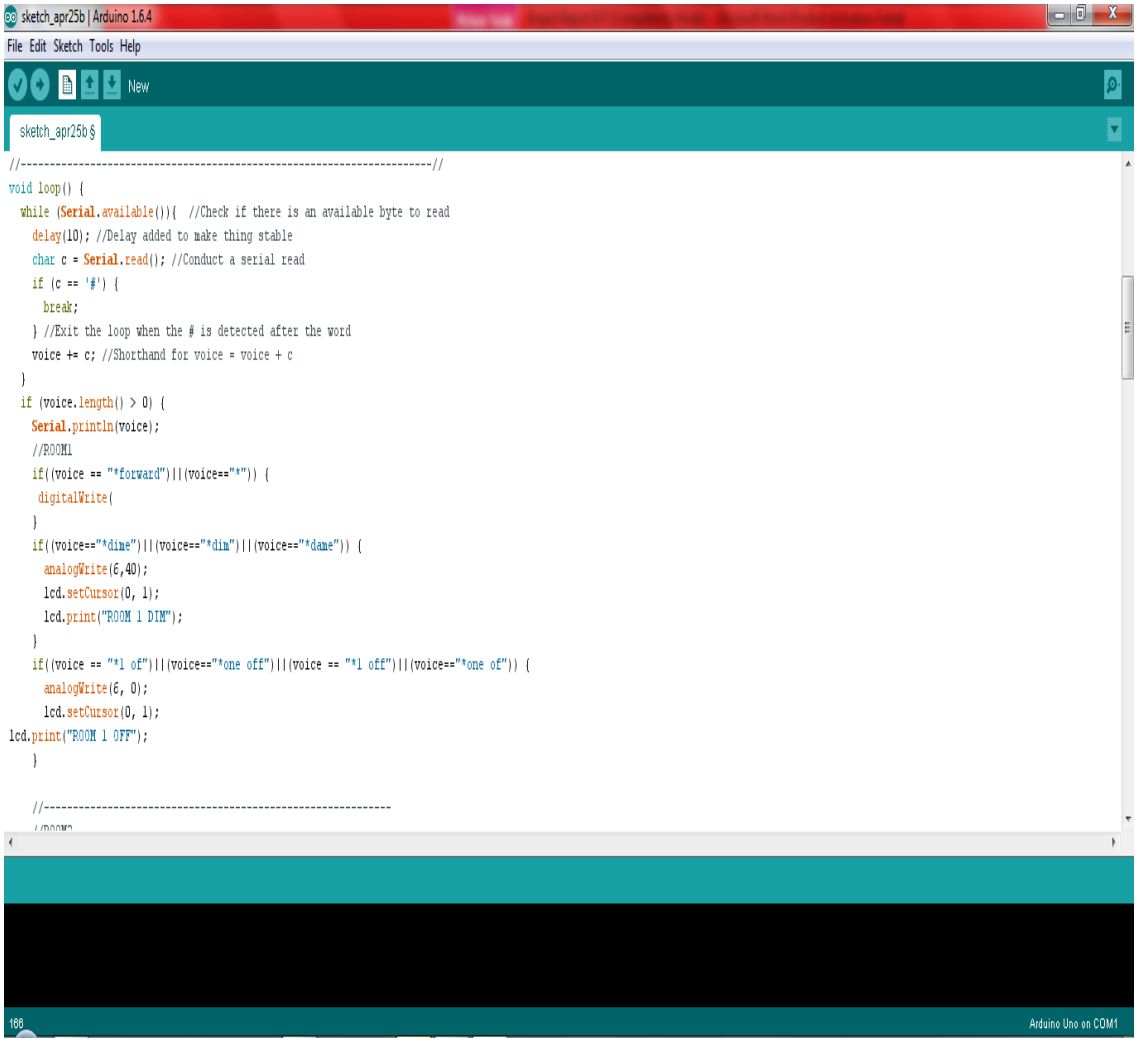

Figure 17: Screenshot of 'Final code 2'

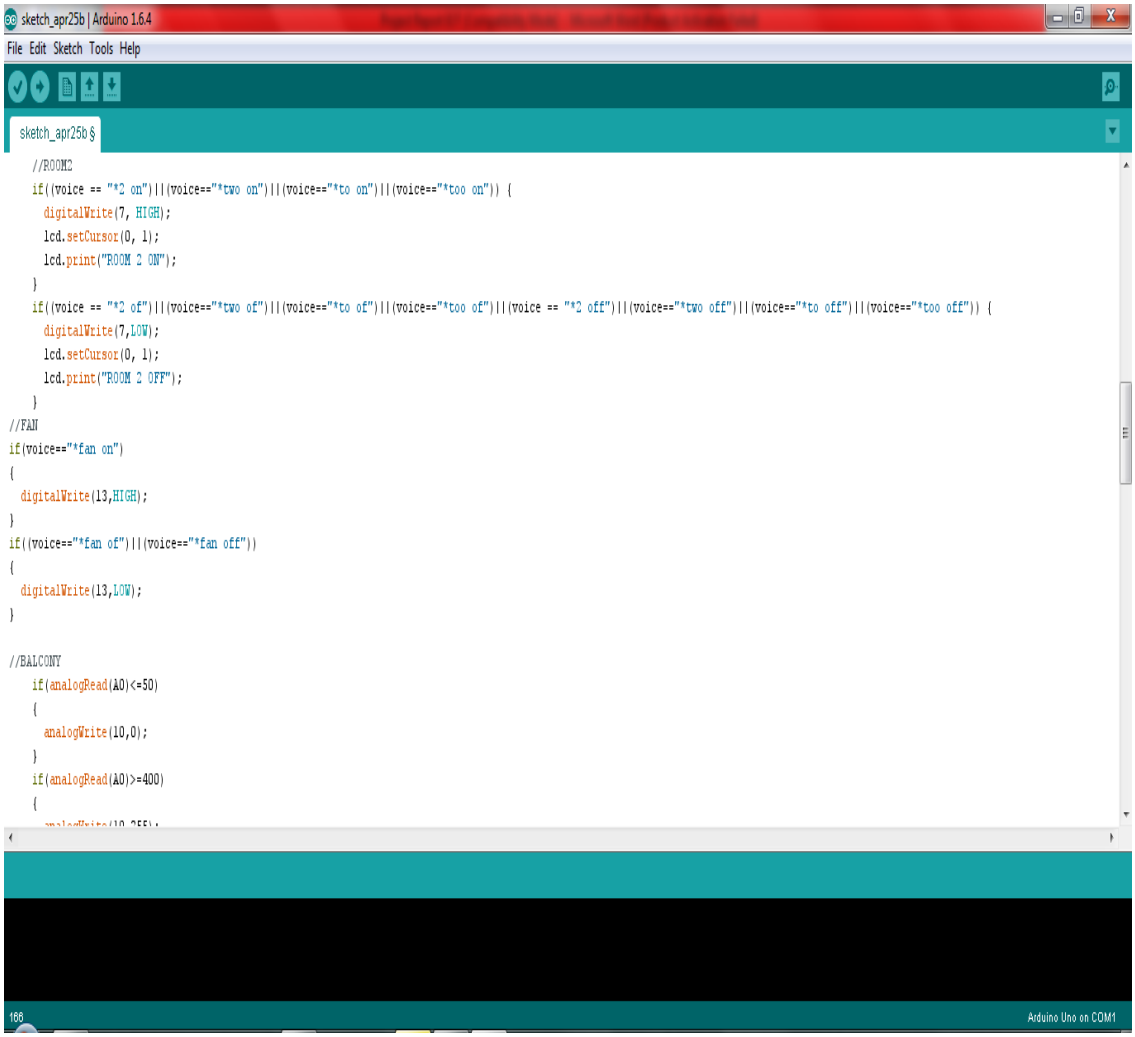

Figure 18: Screenshot of 'Final code 3'

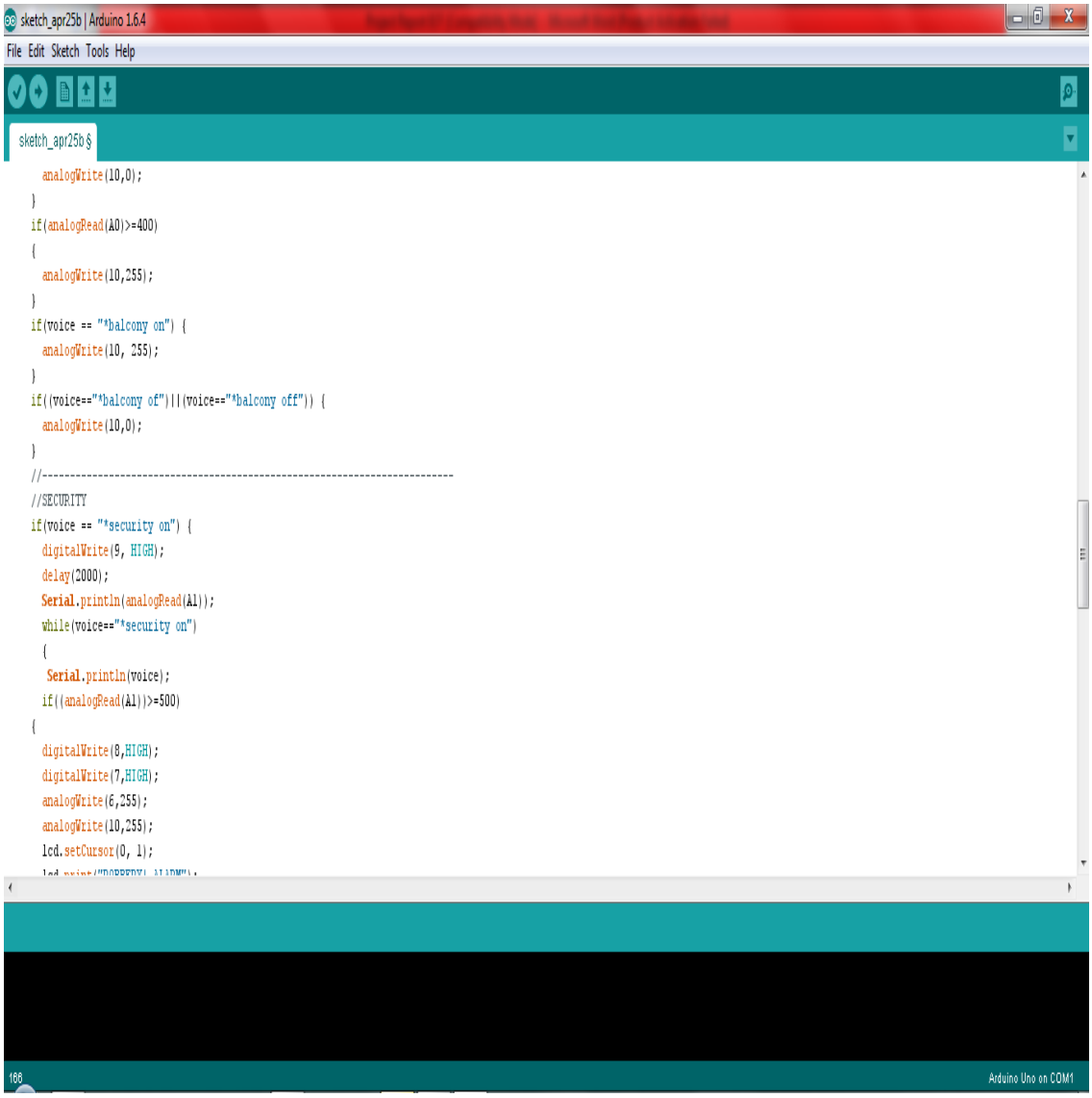

Figure 19: Screenshot of 'Final code 4'

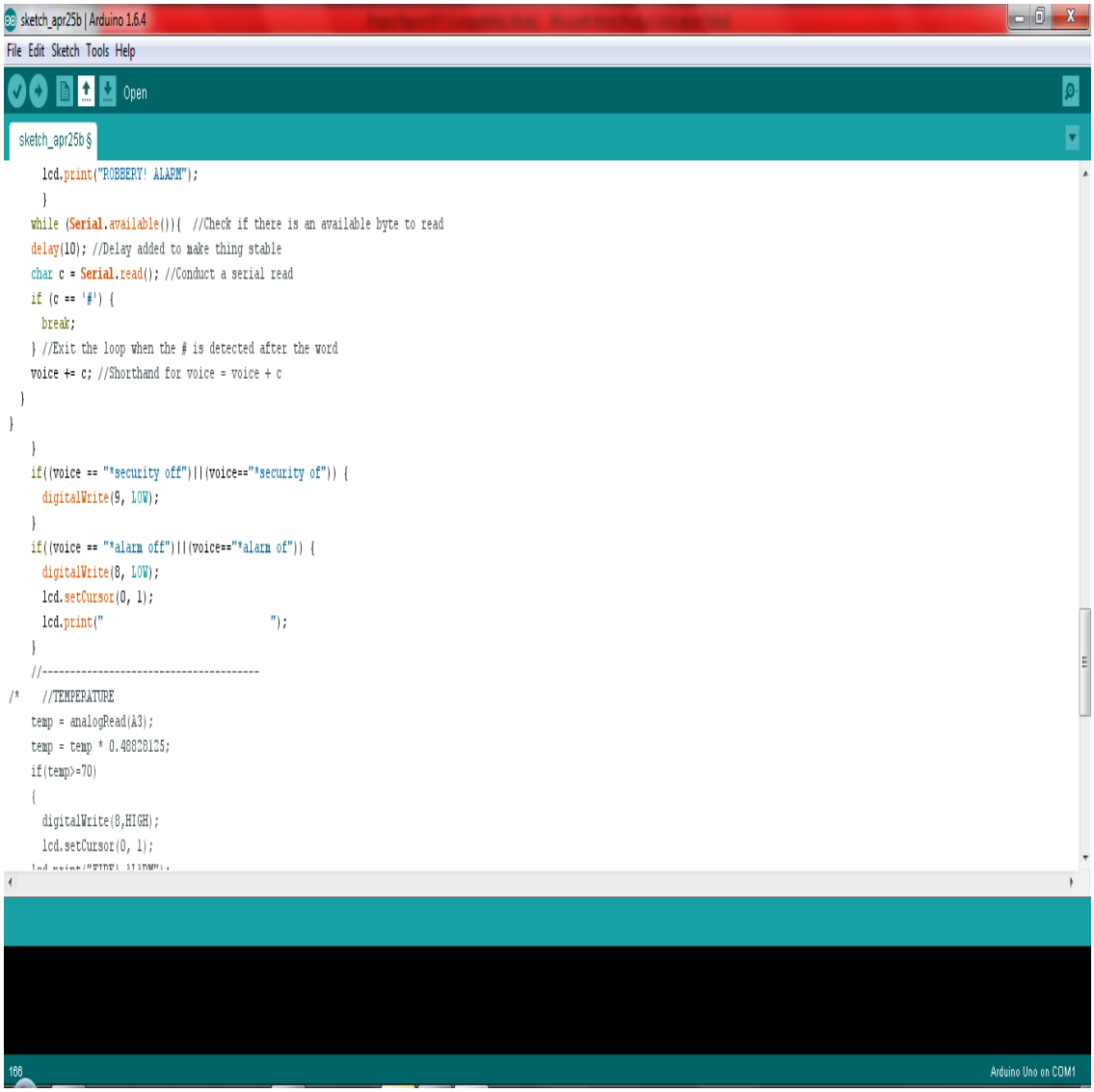

Figure 20: Screenshot of 'Final code 5'

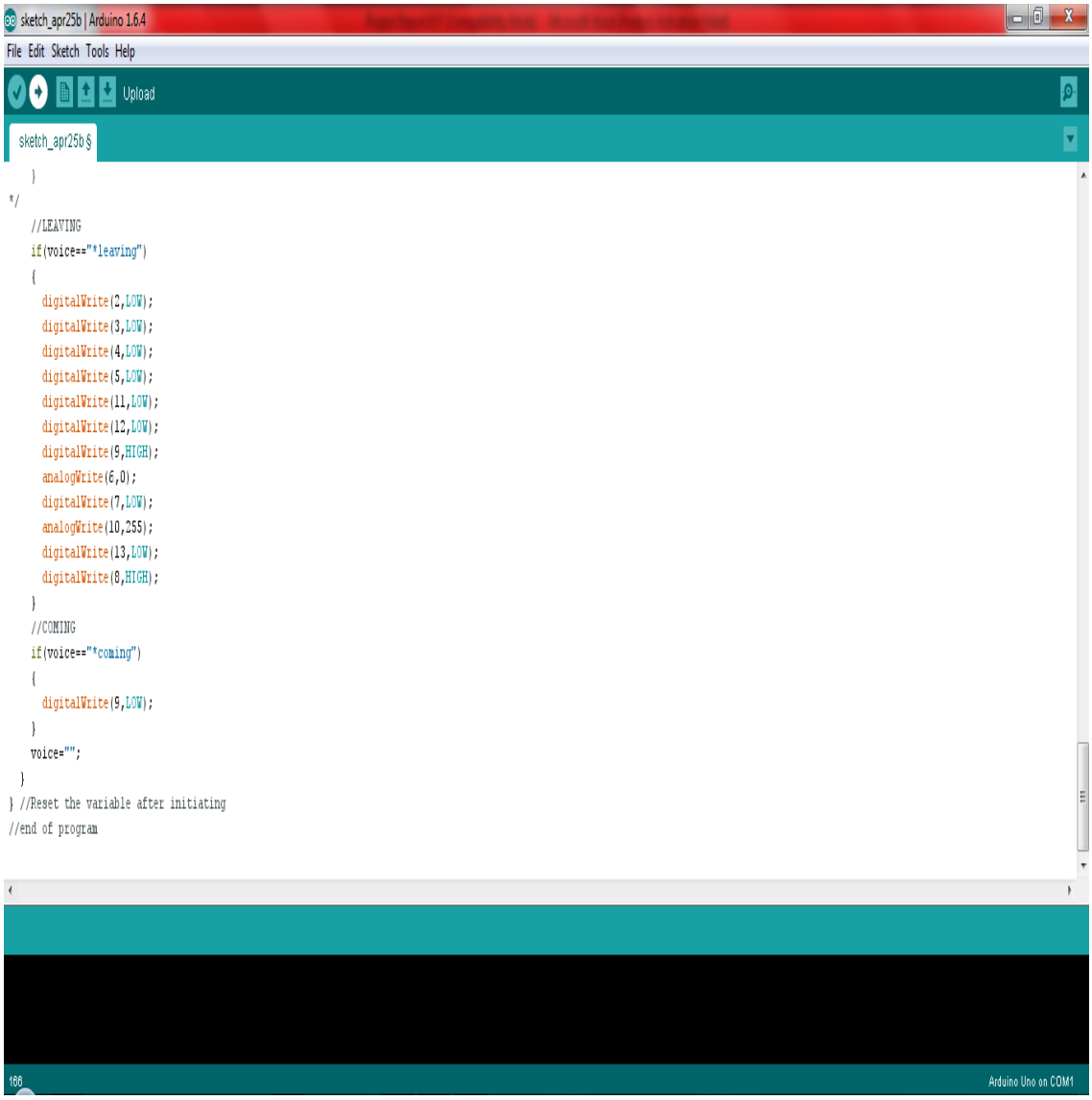

Figure 21: Screenshot of 'Final code 6'

5.4 Snapshots of Hardware and Software

Hardware Implementation:

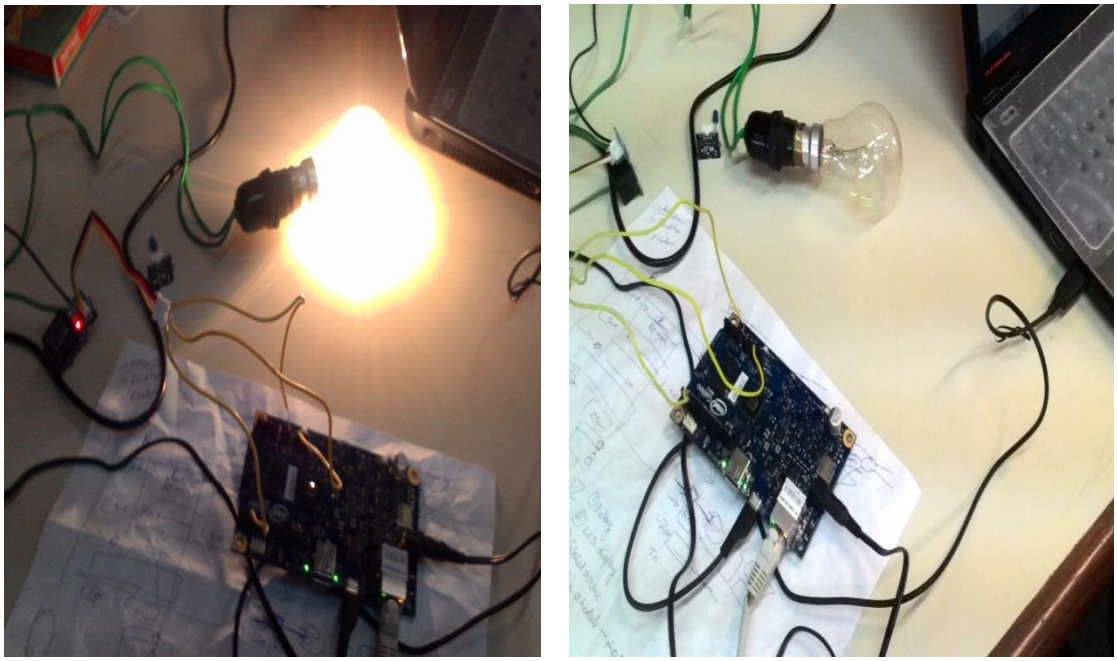

Figure 22: Interfacing of the 220v light bulb

Figure 23: Interfacing of the PIR motion sensor

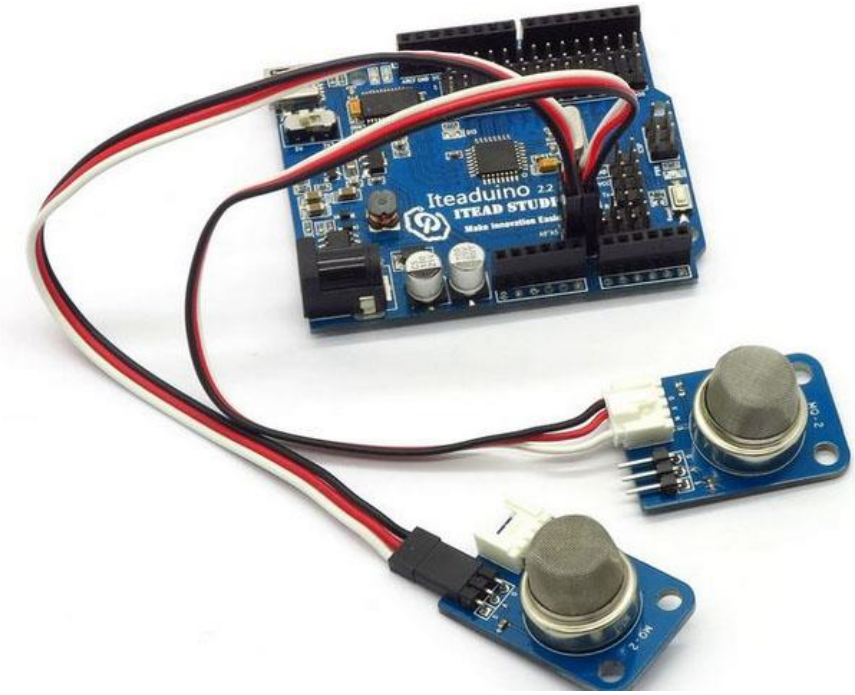

Figure 24: Interfacing of the Fire sensor

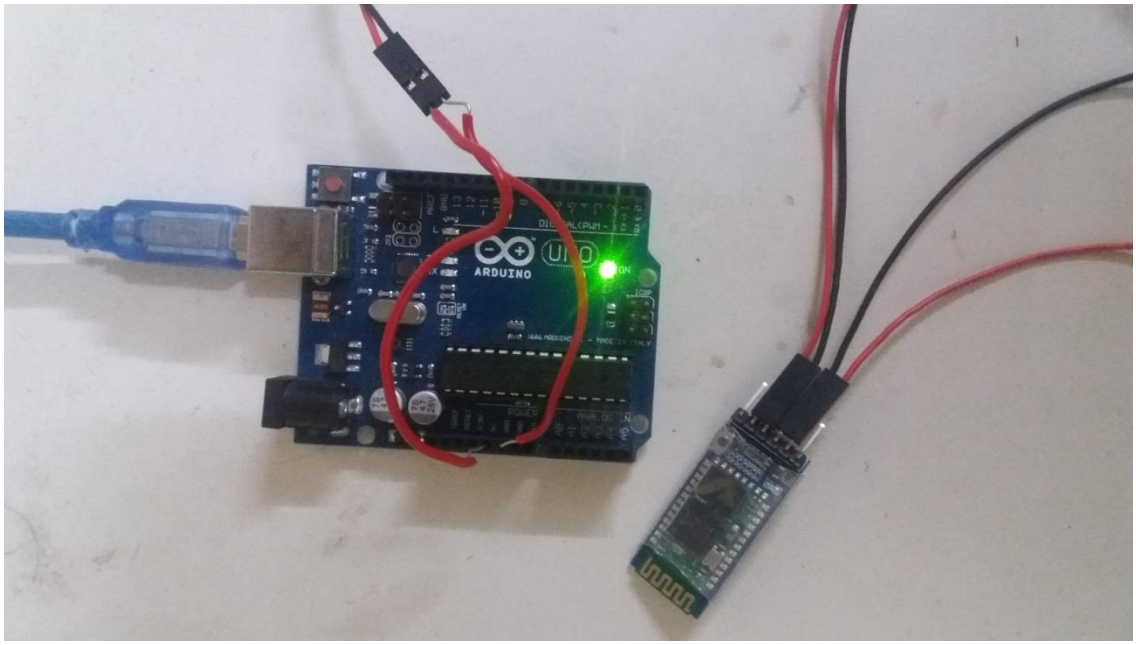

Figure 25: Interfacing with Bluetooth module

Android App Implementation:

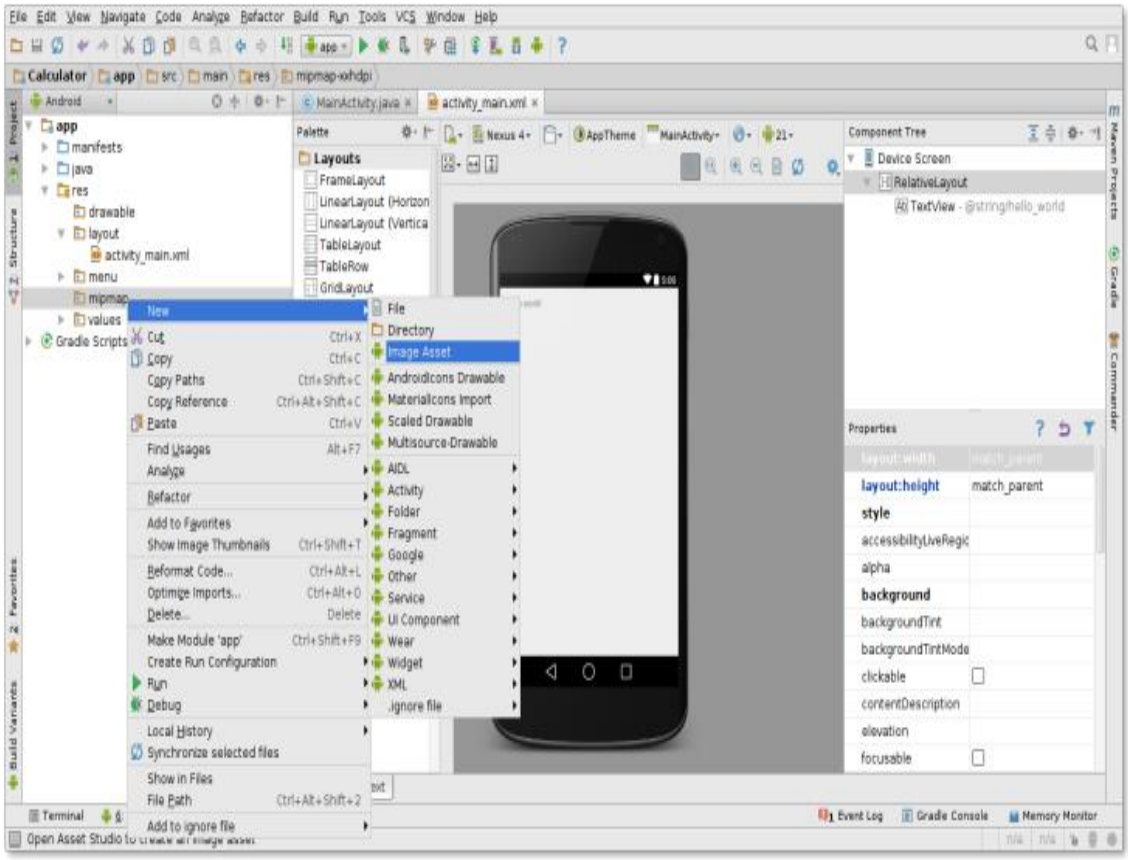

Figure 26: Application development in Android SDK

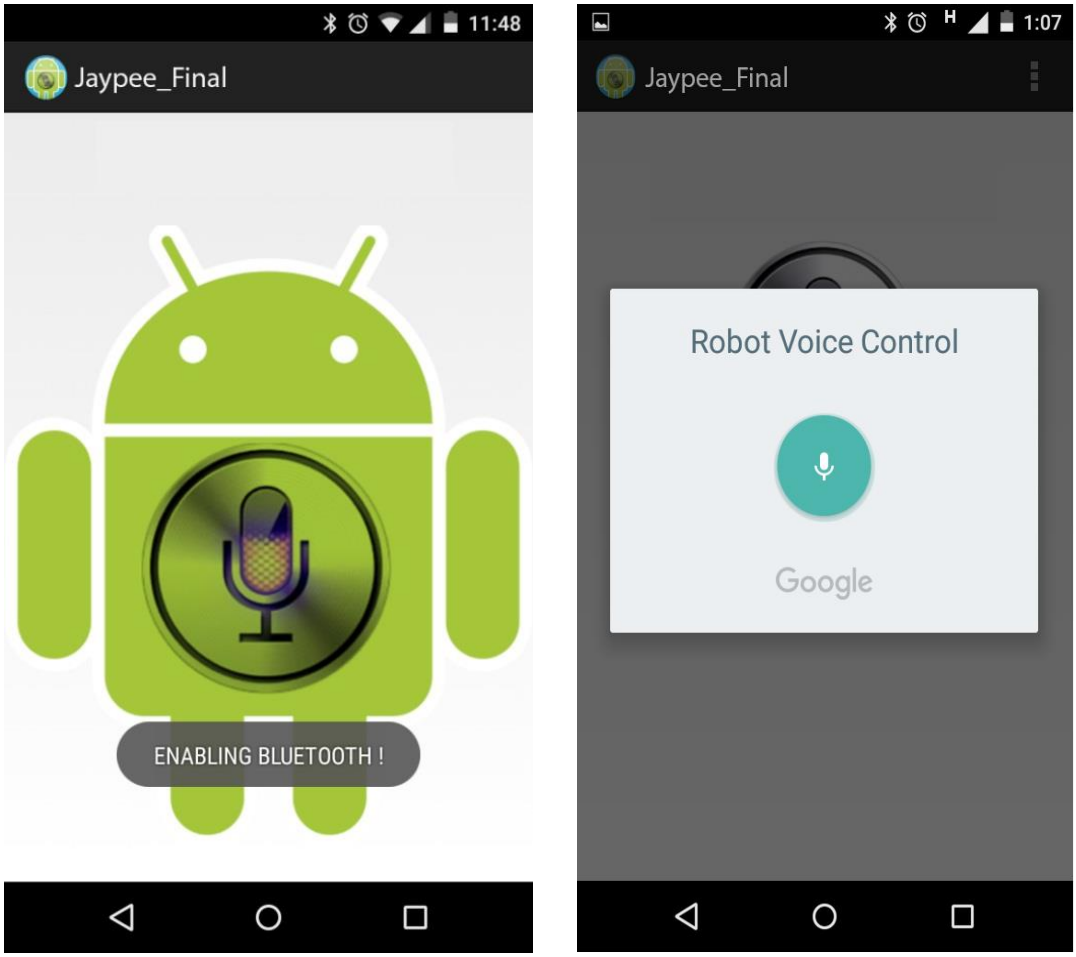

Figure 27: Application user Interface

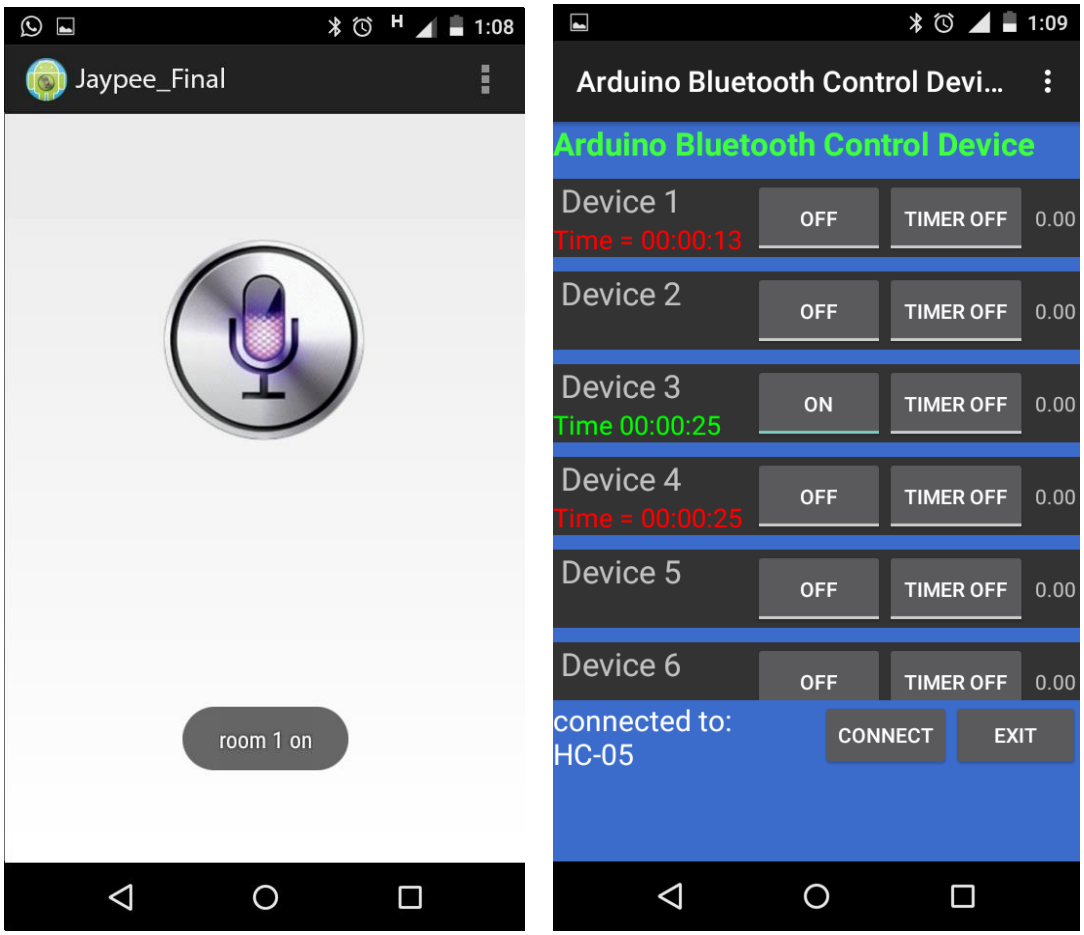

Figure 28: Application voice mode and touch mode

CHAPTER 6

Results and Future works

The proposed model to develop an intelligent automated system for conserving electrical energy that can be implemented in the hotel room has been prototyped and its **Phase I** has been completed. Various sketches have been executed using the Galileo hardware unit, and the communication with the micro controller to toggle the lights.

Further, the **Phase II** of the proposed model has been completed with creating a customized app and the tap-to-toggle and voice modes are implemented.

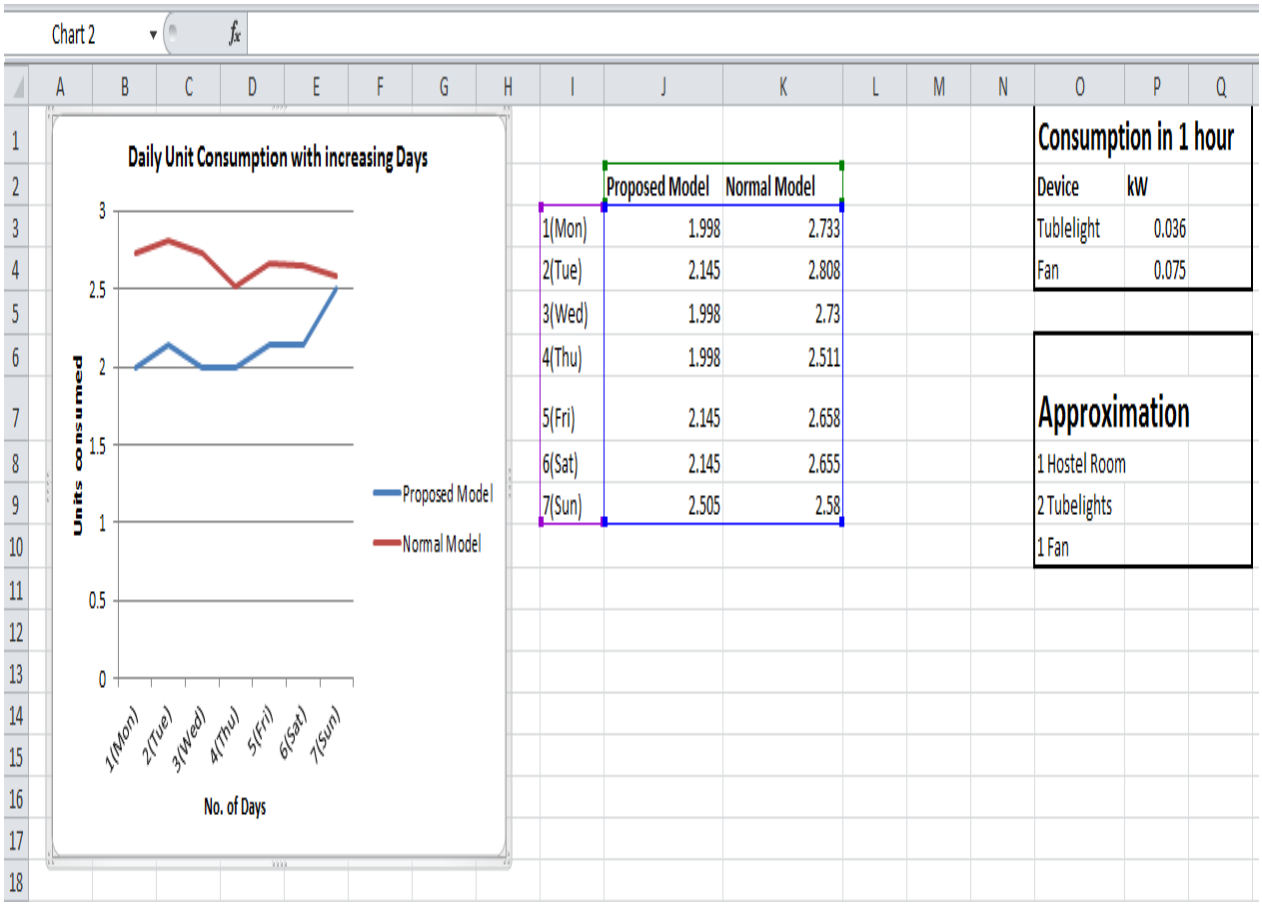

Figure 29: Graph comparison of Proposed model vs. Normal model

The proposed system prototype can be extended to be accessed through an Internet access server through smartphones and other web devices to view the current status and also monitor the usage power and time of each appliance

It is also proposed to work on another criteria of energy saving, which involves real-time sensing of the external environment, like weather, temperature and amount of sunlight entering the room, to decide the required amount of light actually needed and thus control the number of lights needed or the requires voltage.

CHAPTER 7

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