Economical Approach for Home Automation and Security

Thesis submitted in partial fulfillment of the requirements for the award of degree of

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Submitted By

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Certificate

I hereby certify that the work which is being presented in the thesis entitled,"*Economical Approach for Home Automation and Security*", in partial fulfillment of the requirements for the award of degree of Master of Technology in Software Engineering submitted in Computer *Science and Engineering Department* of Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of Dr. Vinod Kumar Bhalla and refers other researcher's work which are duly listed in the reference section. The matter presented in the thesis has not been submitted for the award of any other degree of this or any other University.

(Abhishek Singh)

This is to certify that the above statement made by the candidate is correct and true to the best of my knowledge.

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(Abhishek Singh)

Abstract

Home automation is primarily done to improve the comfort level of the users. But, its use for improving the safety and the security from intruders can't be over looked. It has been observed in this paper that home automation can be used as a great tool to improve security scenario. The work focuses on concept of home security by sending user notification on their smartphones in case user is miles away from house and raising various alarms when user is around. Home automation system and technologies considered here includes central controller arduino or raspberry pi , Wi-Fi camera, sensors network and GSM shield.

Consumers also may have certain reservations in using smart home systems viz. cost, performance, data security, privacy, ease of use, installation configuration of the system, management and maintenance etc. but, through constant work on each of these smart home technologies can be made more economical, user friendly and secure which will further attract consumers to trust and use these technologies.

The research proposed a system for home security which uses a network of sensors to detect intruders, fire and gas leak and notifies user via email remotely, if the user is connected with the internet he/she will get the notification immediately as the sensor detect something and send the data to microcontroller.

Keywords: Home automation, Home security, motion sensor, gas sensor, temperature sensor, microcontroller, ATMEGA328P.

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Chapter 1

Introduction

Home automation refers to controlling of home appliances with the help of different protocols and technologies, remote monitoring and controlling of appliances through wifi and internet. Today's home automation systems consists sensors and different relays and switches to make the home more secure and safe.

1.1 History of Home Automation

Smart homes was just an idea first, people thought of homes way more interacting and functioning and as science fiction explored for decades a prolific writer Ray Bradbury imagined a future with self-functioning smart homes. Although smart homes existed short while the idea or the concept has been around for quite some time.

1901-1920: In 1901 first vacuum cleaner was invented although we would not consider it as "smart" but it was quite a start as it was electrically powered appliance and back then it was a leap into future of electrically powered appliances after that more electrically powered devices were invented like cloth dryers, toasters, iron and washing machines.

1966-1967: It was the time when first smart device ECHO IV was invented, it was the first smart kitchen computer that has multiple functionalities like it stores food recipes, kitchen lists and even has functionality to turn the appliances on/off connected to it although it never was commercially sold.

1991: In this time gerontology and technology was combined to form GeronTechnology to make the life of senior citizens easier there was a lot of research done in this area.

1998- early 2000s: It is the time when home automation or smart homes gain popularity, different technologies began to emerge. Home automation seems to be as more affordable option to people and more people were opting for smart homes and became a viable technology for consumers.

Today's Smart Home: today smart homes are more towards security and greenery and by greenery we means the power saving capabilities of the technology. Smart homes today are sustainable enough to save unnecessary energy and help in intruder break-in cases and making the home more secure in the presence as well as absence of the owner.

1.2 Evolution of IoT

IoT is the inter connection of the devices or any other embedded system that comprises of sensors, software's, electronics which enables these devices to exchange each other's data. IoT has made a fundamental change in working of all the industries from healthcare to agriculture. In a time span of few years all these industries will be connected to each other. With such inter connections among the industries it will become more difficult to store data over the internet because of the large amount of data for which new ways of storing and transmitting data has to be encountered. Inter connection among these devices will result in guiding to automation in every field expanding to the concept of smart cities. These devices with the help of existing technologies are capable of collecting the useful data and then exchanging the data with other devices "Home Automation" is an example of such technology existing in the market. According to the survey conducted by Gartner, there will be nearly 20.8 billion devices on the IoT by 2020. Various applications of IoT are as follow: Environmental Monitoring, it generally uses sensors to help in environmental protection like monitoring of water quality, air quality, soil conditions, monitoring the endangered species by following their movements and their habitats. In case of natural disasters like earthquakes and tsunami, early warning systems can be used to reduce or minimize the impact and provide a better aid. Another application of IoT can be infrastructure management, in this rural and urban infrastructure such as railway tracks, bridges can be monitored. This IoT infrastructure can be used to monitor the events that cause the change in the structure that makes it more risky, it can also help in organising the repair activities at regular intervals. Many other applications of IoT are agriculture, weather predictions can help the farmers to improve and innovate new farming methods and techniques. Energy Management, Medical and healthcare are other few application of IoT.

1.3 Cloud IoT Paradigm

Cloud computing and IoT are the two technologies gained popularity and seen rapid growth in the last few years. Cloud Computing and IoT together when combined are known as Cloud loT paradigm. Cloud loT involves completely new applications, challenges etc. IoT compensates for the technological constraints of the Cloud from its virtual unlimited capabilities whereas on the other hand Cloud can benefits from IoT by enhancing the scope of dealing with the real world problems in a more dynamic way. Cloud provides with an intermediate layer between application and the things, hiding the complexity.

1.4 Home Automation Features

Home automation refers to managing the home electronic system and running the household smoothly, in most of the systems they can be customized according to the requirements of the user. But there are still some features that are necessary and definitely makes the job of designing a system a bit easier.

Interoperability: A good home automation system is considered the one which ties different electronic devices together and makes them perform as one unified system, the designing of such system can be simple or can be complex depending on the openness of the system, the more devices it is open to connect with the more easier it is for the devices to communicate with each other.

Remote Access: Home automation is all about controlling electronic appliances, and it should also be the same when you are not home, user should have proper remote access to their house when they are not at home and can monitor their household and being able to communicate with their house. Remote access of the system is most revered feature of home automation.

Expandability: The system should have expandability capabilities, ways of living will be completely different after 5 years from now technology continues to evolve it is also possible that you live in completely different place from now so the system should have the capabilities to expand in such situations.

Upgradeability: The hardware of the system sure plays the important part in the system but software is what put life to the system, without the software it cannot function at all and the more the software is sophisticated more is the system perform well. The system software should be upgradable when technology changes.

Variety of Interfaces: depending on the budget for the system it can be designed like if you want to control it with a handheld device like phone or remote or you want a wall mounted keypad or touchscreen control or sliding your finger across iTouch.

Commitment to Energy Savings: Home automation can help saving a lot of energy by turning the devices on/off when not in use, varies with system to system their energy saving capabilities.

Protection: The system should always have the backup options in case of emergencies like power cut off, intruder break-in or if some bug attacks the system.

1.5 Need for Home Automation

Home automation is a method to control or monitor devices of your home from remote places by means of a smartphone or computer. Home security through automation is monitoring your house using sensor networks which notifies you every time sensor reads.

Home automation not only helps you control the appliances of your home but also helps saving energy too like it helps detecting appliances on standby and turn them off when not in use and thus saves energy. Securing your home has never been much simpler as it is today with automation user can remotely look after their home and the home itself notifies them in case of emergency.

Gartner projected that 4.9 billion connected devices will be in use by 2016, which is approximately 30% higher than previous year. These smart devices are useful on their own, their combined power can make a real difference in the lives of people and the world as whole. Consumers worry because of the present state of security of their data. They want proper safety and security of their data from hackers and malicious users on internet and proper safety of their home family through usage of smart devices IoT gives people the power to remain connected with their home anytime and

from anywhere using any service and any network. Security is another application of IoT, it is using pir sensors, temperature sensors, thermal sensors, cameras or gas and smoke sensors for safety and security of your house.

IoT is the future of household and is conquering market at good pace. One can always argue about the benefits and harms of it as hackers can always attack as your data is out there open in cloud and on the other hand you are moving towards a digital world.

1.6 Home Security

Home security refers to protecting your home from theft, fire, gas leak or any other tragedies. FBI reported that 58.6 percent of burglaries involves forcible entries to prevent that model is proposed in this paper. Basic home security model constitutes:

Device: a monitor can be a mobile phone or a computer.

Transmission mode: SMS, Bluetooth, Wi-Fi or through Internet.

Sensors: Pir sensors for movement detection at your absence, gas leak, smoke sensor and temperature sensor for fire and gas leak detection.

Controller: a central hardware component that communicates with the sensors and the Device.

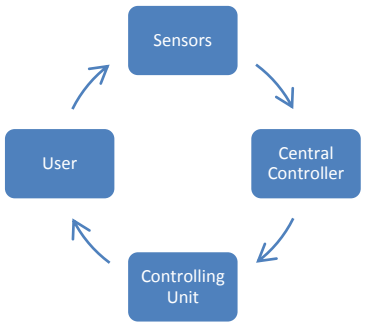

Fig.1.1 Home Security Block Architecture

1.7 Transmission Medium

1.7.1 Bluetooth

It is a standard for communicating over short ranges and exchanging data over short distances. It was invented in 1994 by telecom vendor Erricson. It implements key

generation and verification over phones for security i.e. for establishing connection it generates a pin and both devices have to verify that key in order to establish the connection.

Bluetooth device can communicate with a maximum of seven devices in a piconet (an ad-hoc computer network using Bluetooth technology), though not all devices reach this maximum. The devices can switch roles, by agreement, and the slave can become the master. It is used for exchanging data over short distances.

1.7.2 Wi-Fi

It is a technology for wireless local area networking with devices based on the IEEE 802.11 standards. 802.11 is the "radio frequency" needed to transmit Wi-Fi. WEP(Wired Equivalent Privacy) was first designed to protect the network from snooping but, it is no longer considered safe as anyone can crack it using tools available online. WPA2 is the latest advanced encryption standard which is used and supported by almost all networks today as it is more secure and safe.

Wi-Fi compatible devices can connect to the Internet via a WLAN network and a wireless access point. Such an access point has a range of about 20 meters (66 feet) indoors and a greater range outdoors. Hotspot coverage can be as small as a single room with walls that block radio waves, or as large as many square kilometres achieved by using multiple overlapping access points.

1.7.3 Zig-Bee

It is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other wireless personal area networks. Its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics. ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. It is typically used in low data rate applications that require long battery life and secure networking (its networks are secured by 128 bit symmetric encryption keys.) It has a

defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device.

1.7.4 GSM

Global system for mobile is the widely used telephony system it uses the variation of time division multiple access[13]. It basically compresses data and then send it to the downward channel with two more streams of user data. It operates in 900 and 1800Mhz frequency band in more than 213 countries and represents 82.4% of all global mobile connections.

It uses several cryptography algorithms to ensure over the air voice privacy. The A5 stream ciphers are used for better security.[14]

Technology	**Speed**	**Distance**	**Security**
Bluetooth	2.4ghz	<10m	E0 cipher suite, undiscoverability and pairing.
WiFi	2.4 and 5ghz	20m	WiFi protected access.
ZigBee	2.4ghz	10-100m	128 bit symmetric encryption
GSM	900-1800mhz 2g and 2100mhz 3g	Remotely	End to end security

Table1.1: Comparison Wireless Technologies

1.8 Sensors

An electrical module used to detect change in events and record the changes in its environment. They work in certain range to record various physical changes, they are used almost everywhere like touch sensing elevator buttons.

1.8.1 Motion Sensor

Pir sensor also known as the motion sensor detects changes in the amount of radiation of infrared grafting on it, it depends upon the temperature and surface characteristics in front of the sensor. The sensor detects the temperature and other characteristics and changes it into the output voltage and hence triggers the sensor accordingly.

The sensor contains the plastic window through which the infrared rays enter and reaches the sensor the plastic window helps the other particles present in the environment to stop obscuring the field of the sensor present. The sensor used is HC-SR501 which has three ports one for input i.e. the vcc, ground and the output of the sensor.

1.8.2 Temperature Sensor

The lm35 temperature sensor in integrated circuit device which have the output voltage linearly proportional to the centigrade temperature. It has the advantage over other devices that it is linearly proportional to centigrade temperature other than other devices which gives the output in kelvin and hence reduces calculations to convert to centigrade.

Single power supplies are used to power the device, it has sealed sensor circuitry which protects the sensor from oxidation, etc. The sensor does not require any extra calibration and trimming.

1.8.3 Gas Sensor

The gas sensor MQ-2 consist a steel cover under which the sensing element stays which is used to detect the flammable gas and triggers the sensor accordingly. Different gas sensors are available in the market depending upon the type of gases for which it is used to detect.

They are also used with alarms which is triggered when the sensor detects any flammable gas present in the room, applications include switching the system on/off depending upon the data from the sensor like switching the gas supply off if there is gas leak in the room.

1.9 Microcontroller

1.9.1 Arduino

It is an open source hardware board freely available with designs and codes on the official website of arduino. Most of the boards consists of the Atmel 8-bit AVR microcontroller i.e. Atmega8, Atmega328 , Atmega168, Atmega 1280 and Atmega2560 with varying features, pins and memory. It was first built in 2003 as a program aiming to provide students low cost microcontrollers for do it yourself projects with sensors and actuators.

Arduino Uno board comes with Atmega328 chipset on board with 14 digital i/o out of which 6 are pwm pins and 6 analog pins with flash memory of 32kb and 2kb ram.

Arduino Mega comes with Atmega2560 chipset on bard with 54 digital i/o pins out of which 15 provide pwm output and 16 analog input pins. It has 256kb of flash memory and 8kb ram.

1.9.2 Raspberry Pi

It is a credit card sized single board computer developed in united kingdom. Its first model was released in 2012 i.e. raspberry pi model B and since then four models A, B, B+ and zero has been released of different generations.

First model B came with an ARMv6Z 32 bit architecture with 700Mhz single core CPU and now the latest raspberry pi model B and zero comes with ARMv8A 64/32 bit and ARMv6Z 32 bit architecture with improved CPU performance 1.2Ghz quad core and 1Ghz single core CPU chip set embedded on it.

Model B comes with 1 GB ram shared with the GPU with 4 usb port and wifi and Bluetooth networks on board and an Ethernet port. Model A and zero both have 512 mb ram shared with the GPU with 2 usb port on model A and 1 micro usb on zero and for network support model A has none on board whereas zero has 802.11n wireless and Bluetooth 4.1 on board support.

1.9.3 LPC1768

It is ARM Cortex m-3 based microcontroller used for embedded applications. The microcontroller runs at a frequency of up to 100Mhz maximum with 512kb flash memory and 32kb ram included and is both capable of in chip and in application programming with the help of on chip boot loader software.it has 70 general purpose i/o pins with usb 2.0 serial interface and has standard JTAG debug interface.

Processor	Arduino (Uno)	Raspberry Pi 2	Lpc1768	Arduino (Mega)
Speed	16mhz	1.2Ghz	100mhz	16mhz
Power Consumption	5V	5V	5V	5V
Memory	32kb	1gb	512kb	128kb
S/W support	Arduino IDE	Raspbian OS	Code Composer Studio	Arduino IDE
Cost	Rs.350	Rs. 3000	Rs. 4000	Rs. 900
Pins	14	40	100	54

Table 1.2: Comparison of Microcontrollers

1.10 Research Motivation

IoT has become an emerging technology in IT industry. Home automation applications are emerging day by day more people are opting for home automation today. The home automation system varies according to price the more you pay more features you get like touchscreen control panel and number of devices you want to control and interface of the system from keypads to remote and smartphone controls.

Home automation faces several challenges and one of it is that the system in fact today is not economical most of the people still can’t afford the system and that is the main motive behind this research to give quality under minimum expense. A basic model for home automation and security is designed in much economical rates so that

even tier 2 and tier 3 can also afford and take part in modern and digital world in a leap towards future.

1.11 Thesis Structure

Rest of the Thesis is organised as follows:

Chapter 2: This chapter gives a detailed literature review of different home automation and security architectures.

Chapter 3: This Chapter defines the problem statement of home automation techniques and technologies and their main service requirements.

Chapter 4: This chapter provides the home automation and security architecture of the system proposed.

Chapter 5: This chapter discusses the results obtained by implementing the proposed system with some existing approaches.

Chapter 6: This chapter describes the conclusion of the work done and future work of research possible.

Chapter 2

Literature Review

2.1 Home Automation Using Bluetooth

Home automation system that uses Bluetooth[1] uses a centralized system to control the appliances and is designed in such a way that it can turn the lights on/off according to the time periods like on automatically after sunset and off after sunrise in can also alarm the user in case any smoke is detected in the house. It uses arduino mega board as a centralized controller for the devices and is also easily connected with android device. As Bluetooth works only in a certain and comparatively small range the system is only accessible if both the controller and phone are reachable to each other. However Bluetooth only works in a certain range and hence the user always needs to be in the range of the microcontroller in order to send commands and they also used arduino mega microcontroller which is not necessary here this piece of work can also be done using arduino uno board which is less expensive than mega.

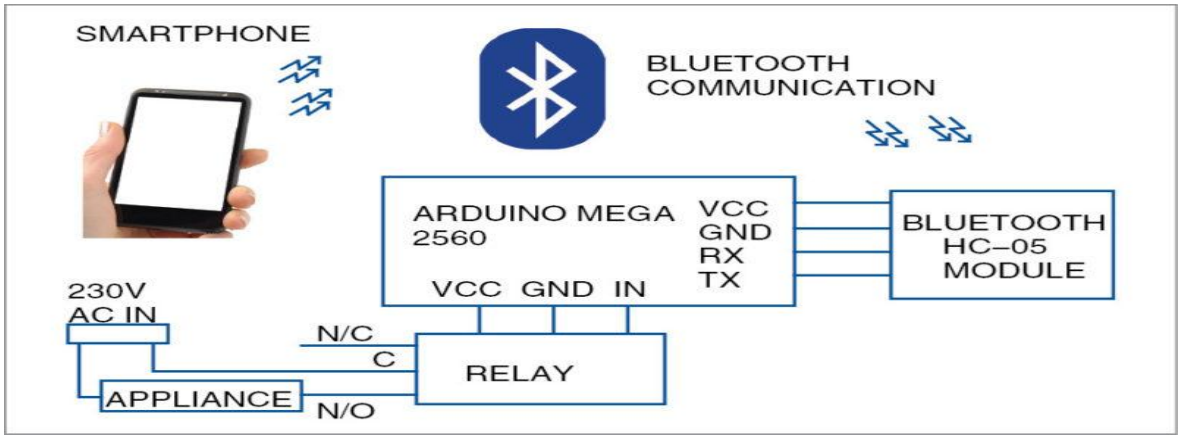

Fig. 2.1 Voice controlled Bluetooth based Home Automation[1]

A Bluetooth based home automation system consists a main controller and multiple Bluetooth sub controllers. Devices are connected to the sub controllers each sub controller for each device and all are connected to the primary controller. The devices are wired to the sub controllers and all the sub controllers are wirelessly connected to the primary controller. But, for the realization of this concept is quite expensive as all

the devices need a dedicated Bluetooth module and to reduce that a single Bluetooth module is shared among various devices which comes with a disadvantage of access delay. It reduces the need of physical wiring and hence complexity of the installation through the use of wireless technology[39].

2.2 Smart Home Using GSM

Smart home security system that uses GSM to send SMS[2] to the user and notifies the user in case of any intruder break-in or in case of fire is designed by configuring a sensors network considering most of the aspects like gas, smoke and temperature sensors for fire detection and IR sensors for the case of intruder break-in it is controlled by an atmega644 microcontroller mounted with a SIM548C based quad band GSM module which sends an SMS to the user anytime a sensors read anything and notifies the user where ever the user is and also alarm the people in the house using buzzers and turn on the lights using relays connected to the microcontroller ,but the gsm module used in the architecture is quite expensive hence make the model less economical from the user point of view.

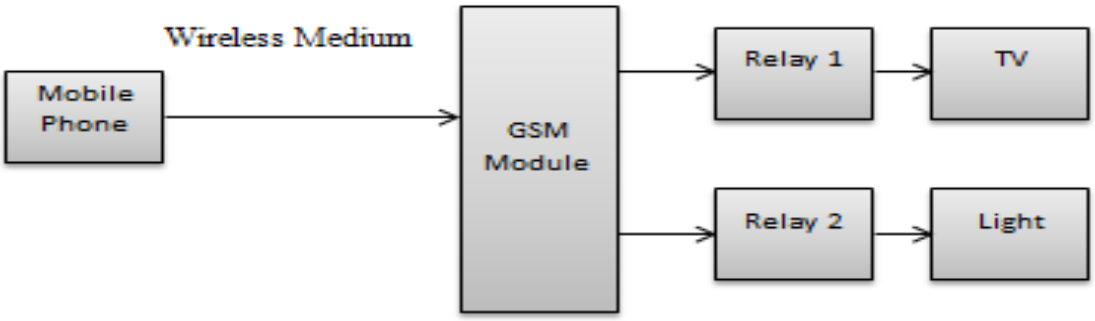

Fig. 2.2 GSM based Home Automation system[2]

According to Reddy's GSM command home automation architecture responses to the messages received by the user to the microcontroller. It uses an AVR AT mega processor as a centralised microcontroller and a GSM module which receives messages and the microprocessor recognizes the command in the message and

performs the task accordingly like switching the lights on/off. The GUI is designed on android, user selects the command the phone then sends the command to the microprocessor. User can control the appliances remotely.[8]

2.3 Home Security using Wi-Fi camera and 3G

The home security system which uses wireless technologies[3] to alarm people inside the house using buzzers and relays are quite obsolete a new system is designed for home security uses the wifi camera and 3g transmission to not only alert the users but also sends the images of the intruder or any person trying enter the house when the owner is not at home. It uses lpcl768 hardware platform as a centralized controller and pir sensor for detecting any motion in their absence and a prescribed camera application in the phone to see the video images from anywhere. It uses the wifi camera which is not at all economical from user point of view and it concerns the visible intruders but not the most common threats of households like gas leaks which can be identified using a wifi camera and hence don't covers overall security of home.

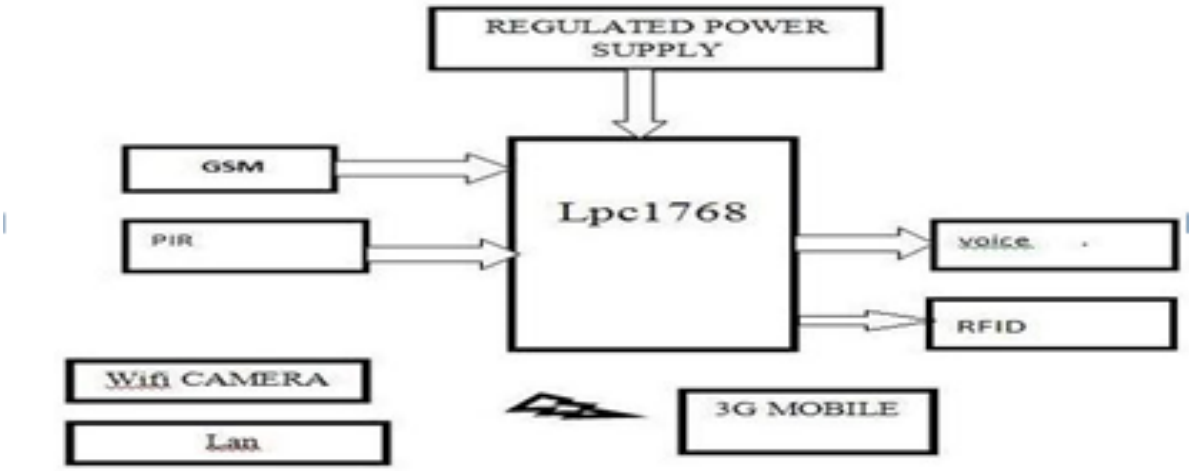

Fig. 2.3 Wi-Fi based Home Security Block Diagram[3]

2.4 Home Automation and Security system Using Android application

Home automation architecture design with three main components uses arduino mega as centralized controller, an Ethernet shield to create a web server, a sensors network and an android smartphone to communicate and give commands remotely via internet to the microcontroller to control the appliances. It also notifies user by sending an email to the registered email id of the user in case the sensors read anything user can control lights fans and air conditioner too and check the appliances if it is already on and can switch then off or on from anywhere. It gives user the comfort and power to monitor their home in their absence.[4]

In Kumar's proposed[7] system an Android application is designed for the sole purpose of providing user the convenience to controlling and monitoring. Any device with android operating system can be used. The application also has voice command functionality and timers can also be set to turn the appliances on and off.

2.5 Ambient Control Home Automation System

Ambient control home automation architecture[5] is also proposed which controls the ambient of the room according to the temperature of the room it uses lm35 temperature sensor along with and amplifier and relays and stepper motors to control the speed of the fans and runs according to the temperature of the room. The sensor reads the data and sends it to the controller the data is analysed and further instruction is sent to turn the relays close or open accordingly. It is a smart way of home automation provides convenient to the user however lights also plays an important role in the ambient of the room future work can be an improved architecture to control the intensity of the lights too.

2.6 Hand Gesture Controlled Home Automation

Hand gesture controlled electronic devices are gaining more popularity these days it is fine piece of technology, a hand gesture based infrared device controlled system is proposed which mainly uses three main components an accelerometer, and ir emitter and a microcontroller the gesture is detected using the accelerometer and Ir emitter sends the command to the receiver in the appliance like television or air conditioner

and task is performed accordingly Bluetooth technology is used for the devices which do not use infrared gesture is detected and command is send to device through microcontroller via Bluetooth.[6]

Proposed system of control networks using hand gestures. The user uses a glove to make hand gestures to control the system, although it seem a bit futuristic system but it too have a disadvantages of inaccurate gesture making like if the device does not recognize the accurate gesture and detect something else and perform wrong actions[40].

2.7 Password protected Home Security System

Home security system proposed by Hassan includes and atmega16 microcontroller and Bluetooth which unlocks the door of using a password which can be entered using phone via Bluetooth or can be manually entered using a 4*4 keypad and an lcd display. Once the user is authorised the servo motors are connected to the doors which opens the door in case the user is not authorised or someone tries to enter the premises the pressure sensors on the door and windows will send signals to the microcontroller and will ring alarm and switch on the led's.

Phone based home and office controller system was proposed which uses fixed telephone line for communication not the internet. The system can be accesses using a phone that supports DTMF(Dual tone multiple frequency). It has its disadvantages too as user need to remember the access code they also have to recognize the buttons used to control the connected devices.[40]

-2.8 Software Platforms for Home Automation

2.8.1 IControl

This platform enables the growth of market place for smart home devices. Many leading home security companies and service providers have deployed their applications on this platform. In 2015 icontrol software platform managed more than 26 million sensors and devices, 100 billion events, alerts and commands.

Fig. 2.4 IControl Interface

2.8.2 Calaos

This is a full stack home automation platform with a touchscreen interface a web application, a server application and smartphone support too with their native android and ios applications. It runs on a preconfigured Linux operating system.

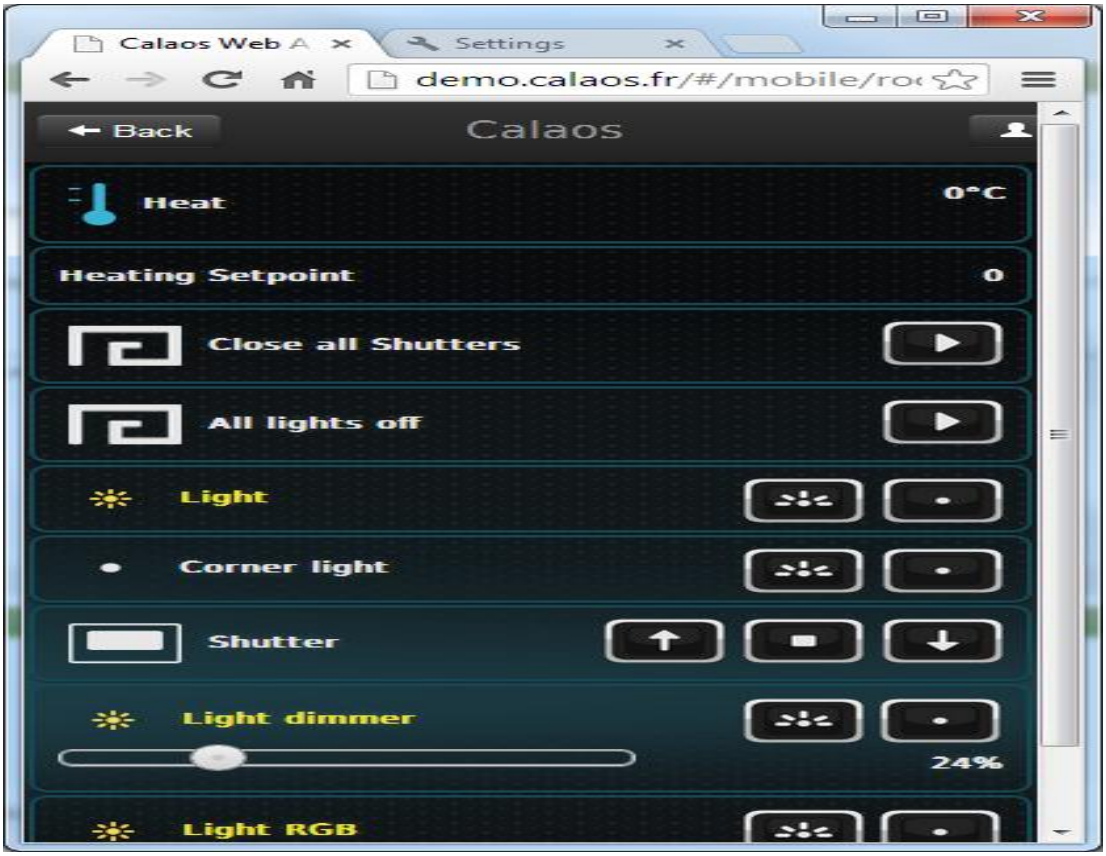

Fig. 2.5 Calaos Interface

2.8.3 Home Assistant

It is an open source platform which can be deployed on any machine that run python. Integrated with a number of open source as well as commercial offerings for example ifttt, weather information and amazon echo.

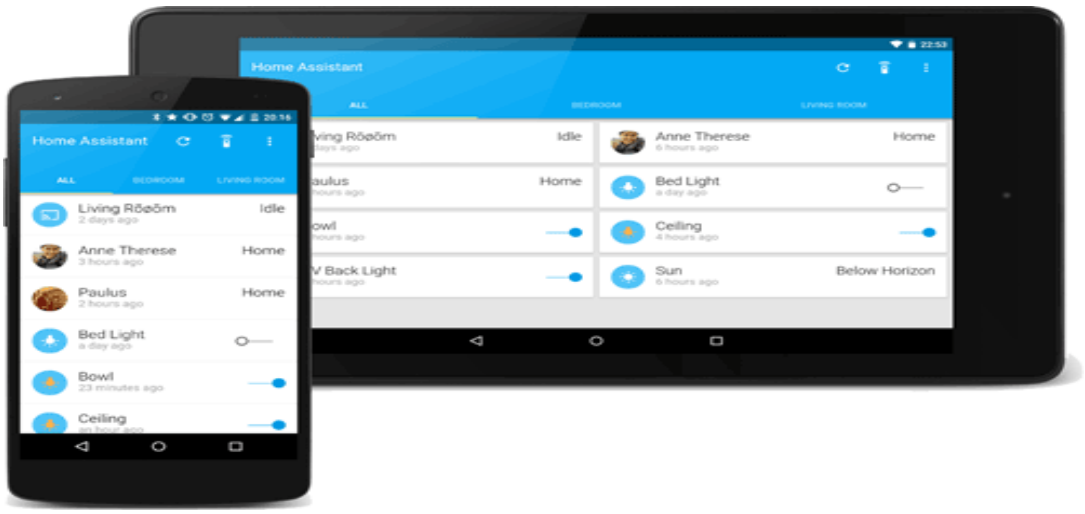

Fig.2.6 Home Assistant Interface

2.8.4 Open Hab

It is one of the best known open source home automation tools in the market integrated with a large number of devices and is supported by many. It also has its native android and ios applications for smartphones as well as design tools so user can create its own UI for their home.

Fig. 2.7 OpenHab Interface

2.8.5 Open Motics

It is a home automation system with both hardware and software under open source license. It is designed for providing a comprehensive system for controlling all devices rather than just stitching devices from different providers together.

Platform	Features	Supported hardware
Calaos	Touchscreen interface, android ios apps, html5 web page, preconfigured Linux OS	IPX800, Web API, X10Zibase I/O, GPIO (Linux based GPIO, for direct use of RaspberryPI GPIO header), CCTV IP (Axis, Mjpeg…).
Home Assistant	No data is stored in the cloud, offers REST API, send notification using telegram etc, lights on/off at sunrise and sunset.	Any hardware that can run python 3.
Open HAB	Multi-platforms, web based UI as well as android and ios, APIs for integrate in other systems.	RaspberryPI, BeagleBone Black, UDOO and Cubietruck.
OpenMotics	Detail power management, multi-zone heating, sensor inputs, automated actions and moods.	Multiple Hardware support.

Table 2.1: Comparison Software Platforms

Chapter 3

Home Automation Challenges

3.1 Smart Home Service Requirements

Smart home devices should be designed to address the requirements of mass market. Consumers are concerned for reliability, usability and affordability. People living in their homes face many problems like power wastage, resources wastage, home security and time. A system should be designed in such a way that it solves maximum of their problems in order to do that we must take into consideration certain things.

Usability: smart home system must be designed in such a way that it is less complicated to understand and more user friendly that a consumer with less or no technical should also be able to understand on how to use the system and how the system is beneficial to the user.

Reliability: the system should be reliable enough that the user can trust the message coming from the system and the system guarantees that the message coming from the system is genuine and not a false alarm.

Affordability: the system should be more economical so that mass market of consumers can afford the system and get benefitted.

Security: the consumers are always concern about their personal data which they are feeding to the system is secure or not form the attackers and hackers, the system must be secure.

Device Communication: devices connected should be able to talk with each other all the time in order to give better output and accurate implementation of the system.

Connectivity: various wireless protocols are available for the connectivity and totally depend on the requirements of the user which protocol will suit them better.

Back-end Support: A robust back-end support is one of the prime requirements to gather and process data from sensors and connected devices. Continuous bug free, high performance and ease to use API's are expected from back-end support.

3.2 Obstacles

Smart home is the demand of present and future from previous times though technological barriers have been overcome to meet the growing needs of smart devices. However, still there are many obstacles.

Cost: cost has been the most significant barrier to the adoption of smart homes.

Privacy/Data Concerns: most of the consumers are worried about the possibility of data breach. 71% consumer's shares the concern of personal information may get hacked or misused.

Bugs: 61% of the consumers hesitate to use smart devices due to the fear of bugs.

Devices may not talk: over 60% consumer's shows the concern that individual devices may work properly but these devices may not talk well with each other. This causes difficult management and increased stress on the consumer.

3.3 Feasibility of Home Automation

Different technologies are used for home automation in today's world varying on different levels and those comes with different prices and different complexities for example if the user is more concerned for power saving then different sensors can be installed in the household which will control the lights of the house and if the user is concerned for security of the house surveillance cameras can also be installed along with the sensors which will lookout in the home for intruders and stores the data like images and videos of the intruders and send it to the user. But, different levels of automation come with different complexities and hence change the economical point of view of the consumer as it goes with the old saying "the more you pay, the more you get" the price also differs with the quality and type of components used to make the system. The system should be designed in such a way that it should be economical as well as reliable the components used should not be very expensive and should also be not of cheap quality as the reliability of the hardware contributes the most in the success of the system if the hardware will not be of good quality then the system will most likely fail.

Chapter 4

Proposed System

4.1 Proposed Approach

Home automation as the term indicates is the automation of home using the network of sensors and other input and output devices like buzzers and relays for getting control on the appliances and lights in the house.

Security has been evolved a lot in time and will grow and evolve in coming time. Home security is an extension of home automation. New concepts of home security in automation provides the comfort and convenience to the occupants and on the same hand gives them a safe environment i.e. safety from the intruders in their absence.

This thesis focuses on the concept of providing the home security when the user is away from home. The proposed system uses internet and network of sensors to detect intruder break in, fire and gas leaks to alert user when from home.

The system proposed here uses an ATMEGA328P based microcontroller and an Ethernet shield to connect the board to the internet and uses HC-SR501 Pir sensor for motion detection, MQ-2 gas sensor, TMP36 temperature sensor and a buzzer.

Sensors connected to the microcontroller get readings from the house and accordingly send sensor data to the microcontroller the controller then responds according to the situation and notifies user on the phone via email and buzzer will alarm the neighbours. The whole purpose of the system is to notify the user in case of intruder break in, fire or gas leaks in the house if the owner of the house is not present.

4.1.1 System Design

The proposed model of smart home security system is prepared using low cost hardware so as to make it affordable for tier 2 as well as tier 3 people too. It consists of various sensors like pir motion sensor, temperature sensor and gas sensor it also includes a buzzer to notify people nearby in case of emergency.

The proposed system is controlled by ATMEGA328P microcontroller. The purpose of using this microcontroller is to make the system economical. The microcontroller collects data from the sensors and makes decision accordingly and if it detects any interruption in the sensors or any suspicious data it sends immediate notification to the home owner. If the temperature is risen above a certain level or the gas sensor goes high it notifies the owner and alarm the buzzer.

4.1.2 Hardware Design

Hardware system contains sensors ATMEGA328P microcontroller, Ethernet shield and buzzer. The system design is shown in figure.

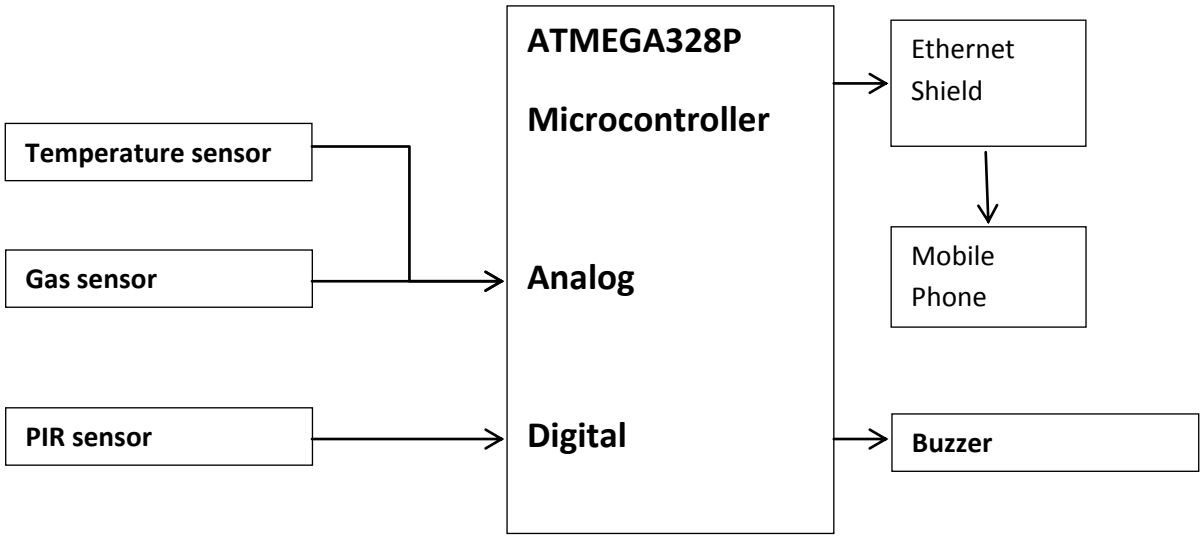

Fig 4.1 Proposed System Hardware Design

The outputs of the temperature and gas sensor are connected to the analog input as these sensors will give some numeric values according to which the decision will be taken by the microcontroller, and the output of the pir sensor is connected to the digital input. The pir sensor will be installed on the windows and gas and temperature sensors near the kitchen. Sensors will monitor continuously the temperature if the reading exceeds the defined limit it will notify user same is for gas sensor if the value goes high user will be notified.

4.1.2.1 Hardware Specifications

4.1.2.1.1 Microcontroller Unit

ATMEGA328P microcontroller is used in the system which is mounted on an Arduino uno board, it has 14 digital input/output pins out of which 6 can be used as PWM outputs and has 6 analog inputs at which the temperature and gas sensors are connected, it also has a 16Mhz crystal, a power jack an ICSP header and a reset button. It has 32kb of flash memory and 2kb of ram with 1kb of eeprom.[29]

4.1.2.1.2 Ethernet Shield

The Ethernet shield allows arduino board to connect to the internet, it is based on the wiznet w5500 Ethernet chip, it provide a network stack cable of both TCP and UDP. It support up to 8 simultaneous socket connections, it also has an on board SD card slot which can be used to store files for serving over the internet it is IEEE802.3af compliant[32].

4.1.2.1.3 Sensors

HC-SR501 Pir motion sensor is used on the windows to detect intruders which has a sensing range of about 7 meters and sensing angle approximately 120 degrees it has operating voltage of 5-20V. LM35 temperature sensor[30] is used for detecting the temperature in case of fire its output voltage is linearly proportional to the Celsius temperature. MQ2 gas sensor is used for gas leak detection in the household it has operating voltage of 5V.

4.1.3 Software Flow Design

Algorithms:

Motion Detection

1. Install Motion Sensor
2. Initialize Motion sensor(MS)
3. SetPinMode(Input) //Motion Sensor
4. SetPinMode(Output) //Buzzer
5. Set(MS pin == HIGH)
6. While(MS PIN)

7. {
8. For(int i=1 to N times)
9. {
10. SendMail(“Login Credentials”, “Message”)
11. Buzzer ON
12. Wait 30 sec
13. }
14. }
15. Set Buzzer OFF
16. Repeat

Output= no integer value just make the pin HIGH and Sends the email

Gas leak detection

1. Install Gas Sensor
2. Initialize Gas sensor(GS)
3. SetPinMode(Input) //Gas Sensor
4. SetPinMode(Output) //Buzzer
5. Set(GS pin == HIGH)
6. GetValue(GS)
7. While(GS Pin Value == 0)
8. {
9. For(int i=1 to N times)
10. {
11. SendMail(“Login Credentials”, “Message”)
12. Buzzer ON
13. Wait 30 sec
14. }
15. }
16. Set Buzzer OFF
17. Repeat

Output: 1 for flammable gas 0 for normal

Fire Detection

1. Install Temperature Sensor
2. Initialize Temperature sensor(TS)
3. SetPinMode(Input) //Temperature Sensor
4. SetPinMode(Output) //Buzzer
5. Set(TS pin == HIGH)
6. GetValue(TS Pin)
7. While(TS Pin value >350)
8. {
9. For(int i=1 to N times)

10. {
11. SendMail(“Login Credentials”, “Message”)
12. Buzzer ON
13. Wait 30 sec
14. }
15. }
16. Set Buzzer OFF
17. Repeat

Output = temp value in Celsius example 34.3

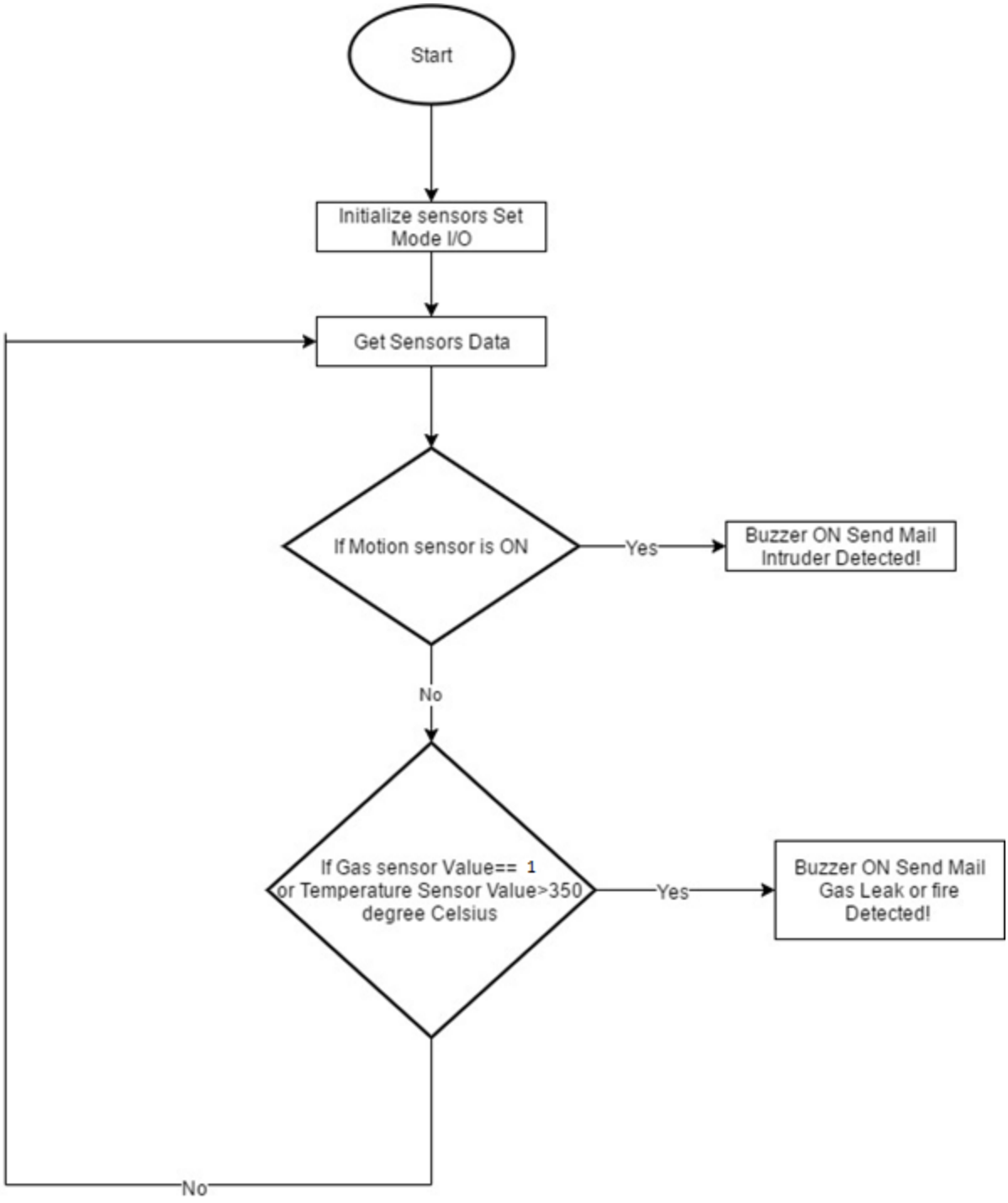

Fig. 4.2 Flow Chart of the System

Experiments and Results

In order for the system to work properly the kit must always be connected to the internet, Results are taken both with internet connected to the kit and without the internet cable connected to the kit screenshot of both the results is shown below.

```
0
34.67

Waiting...

0
34.67

Waiting...

0
34.67

Waiting...

0
34.67

Waiting...

0
34.18

Waiting...

0
34.67

Waiting...
```

Fig. 5.1 Values When Not Connected to Internet

Figure above shows the values recorded by the sensors, the first 0 shows the gas value if there is flammable gas present in the premises value will change to 1 and hence activating the buzzer and the kit to send mail to the user notifying them to take certain action for the emergency. The second value i.e. 34.67 shows the temperature of the premises in Celsius if this value crosses 350 the kit will again sends mail to the user

notifying for the same as the temperature rises above this only in case of fire. The waiting part shows that since the internet is not connected to the kit it is not sending any mail even if the motion sensor detects motion in the premises in the absence of the owner.

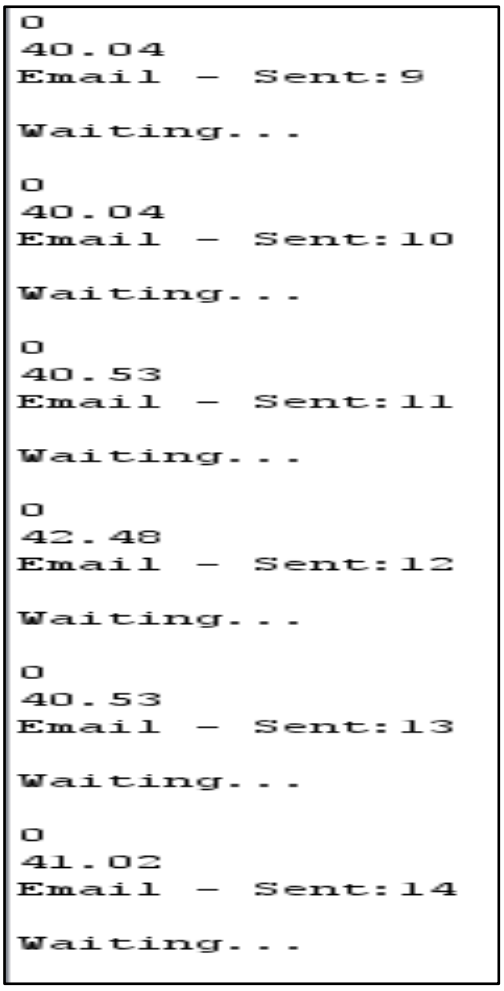

Fig. 5.2 Values When Connected to Internet

Figure above shows the values when internet is connected to the kit the gas and the temperature values are shown and email is sent to the owner when motion is detected by the sensor. The kit will send emails in the intervals of 50 seconds till the kit is sensing motion or drastic changes in gas or temperature.

Figure below shows the message it sends when it detects motion on the kit.

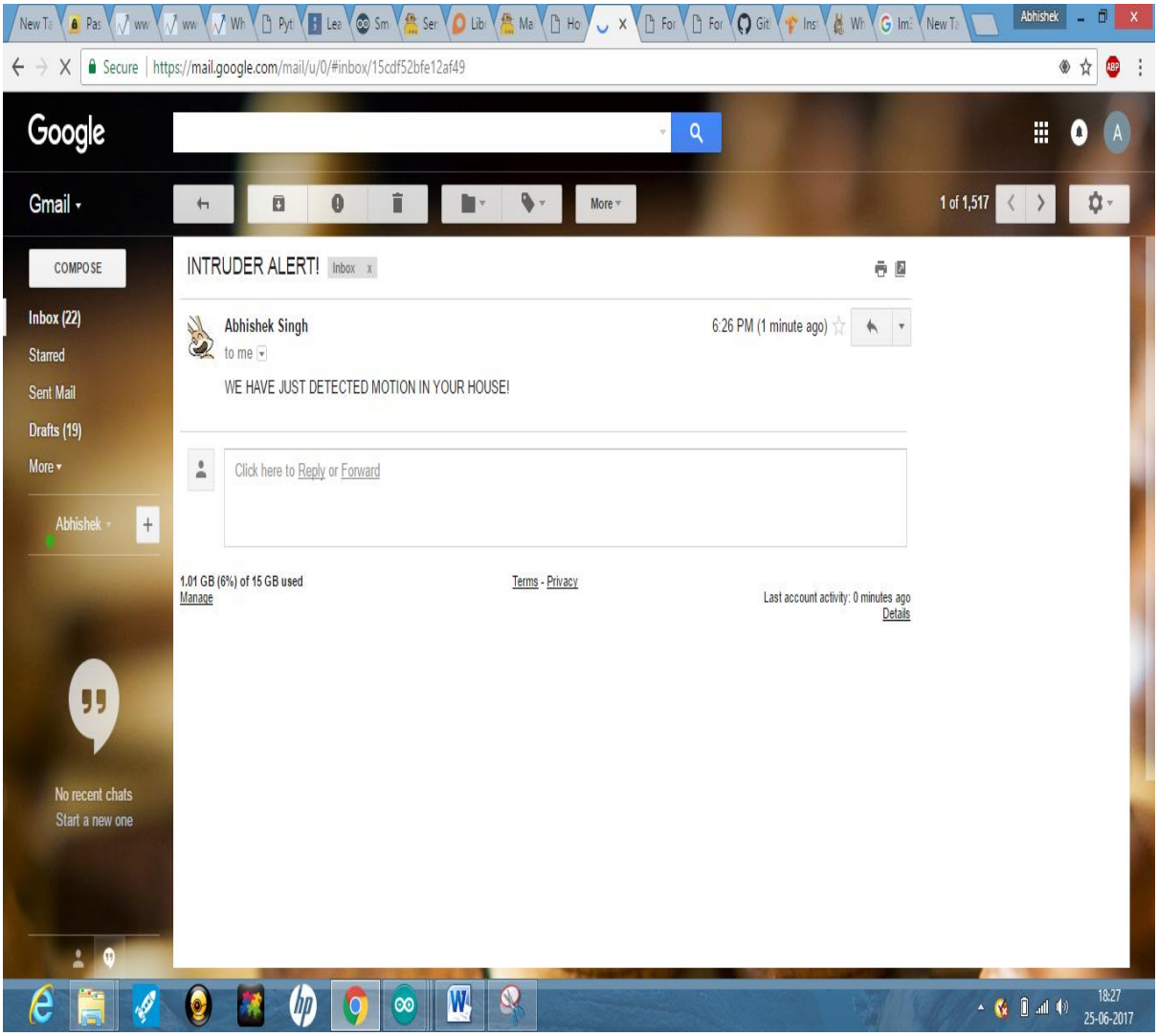

Fig. 5.3 Screenshot of Email sent by the Kit

Chapter 6

Conclusion and Future Scope

Conclusion

Our work is focused on the security aspects of different home automation architectures proposed by various researchers. Consumers are interested to spend money on smart devices for better sleep, higher comfort and improved safety and security.

Converting daily life products into connected products and linking them into smart home system is a complex process. However, home users experience must be easy and intuitive. By achieving the ease of use through entire process including purchase, installation configuration, operation and management of smart home solutions, smart home technology can be made more popular and accessible to everyone.

Advantages of the proposed system:

1. It is very cost effective even people with not very high income can afford it.
2. No extra cost is included as it sends notifications via internet and nowadays everyone is connected to it.

Disadvantages of the System:

1. It is possible that in some places there would not be enough network coverage to remain connected to internet.

The economical architecture of home security has been proposed in the thesis and been tested with the connected network to the device. The owner get alerts anywhere through the internet via mail making the location of the system independent. The system is very user friendly and easy to understand the whole system is useful when the owner of the house is not present in the house. The cost of the system is minimal so as to make it affordable for even lower middle class people and taking them further with automation and digitization of modern world.

Future Scope

The proposed work discovered few shortcomings in the existing systems. Present systems underutilize the resources and do not provide comprehensive solution for home automation resulting in increased cost and comer some usage. In near future authors will propose an economical and efficient system which will be easy to use and control various home devices through single window. Moreover, robust and improved architecture will satisfy the greater needs of home security and safety.

Home Automation and security architecture using latest wireless protocols like SimpleLink and LoRa are in heat as they have long ranges and very allows very less interference and hence work with very long ranges. And microcontrollers can be made by integrating different ics and hence the whole system can be made much more small and more feature rich.

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List of Publications:

[1] Abhishek Singh, Vindo Kumar Bhalla. “Survey- Home Automation Techniques and Technologies” *International Journal of Research in Computer Science (IJRCS)*Volume 04, no. issue 02 (2017): 81-85.