IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727
PP 57-64
www.iosrjournals.org

i-Homes: An Intelligent Home Automation And Security System Using Android and Cloud

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Abstract: *Now we are living in the 21st century where automation is playing an important role in human life. Home automation helps us to control household appliances like light, door, fan, AC etc. It also provides home security as well as emergency system to be activated. Home automation not only refers to reduce human the efforts but it is also energy efficient and time saving. This paper puts forwards the design of home automation and security system. The project proposes an efficient implementation for IoT (Internet of Things) used for monitoring and controlling the home appliances via World Wide Web. Home automation system uses the portable devices as a user interface. Here we are using cloud for storing the user threshold values so that the user can access the appliances remotely. The main purpose of this system is to provide security by giving alert alarm or notification to user via email, sms, etc.*

Keywords : *Cloud, Database, Embedded Systems, Home Automation, Internet of Things, Security, Sensors, Web Server.*

I. Introduction

Now we are living in 21st century where automation plays very important role. In automations, home automation is one of the known concept. Home automation helps us to automate various house appliances such as Fan, AC, and Light etc. It provides comfort and ease to humans. As human need more comfort the number of smart devices is also increasing accordingly. As large number of smart devices being used, so it is hard to keep a watch on every individual device. So our purpose is to make the devices smarter and active about their condition. And they can be handled using android app. We are implementing a home automation system which is Smarter and remotely accessible. The actual purpose is to make the devices smarter and prevent them from getting damaged. The devices should act smarter and provide security to the users. Whenever the devices would fail to work automatically then we have a cloud interface so user can access the devices manually from remote location via android app.

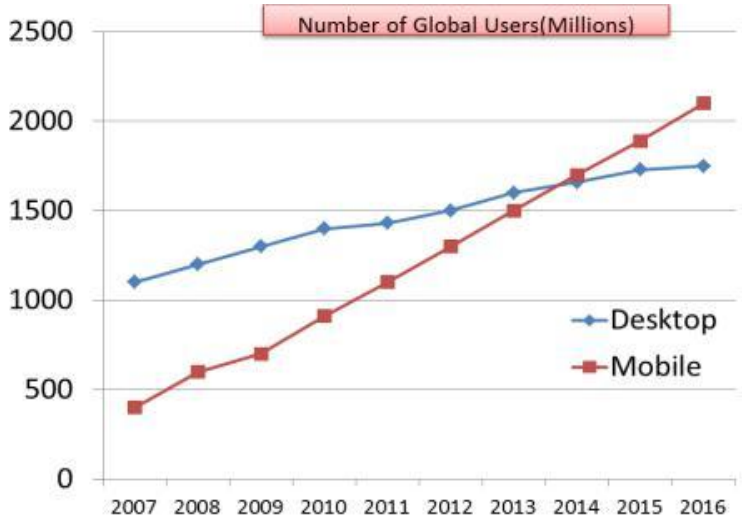

Fig. 1: Use of Smartphones

As we can see that in the above fig.1 the use of smartphones is increasing day by day very rapidly. Due to this rapid increase its difficult to handle the devices properly. So, the purpose of our project is to design fully automated home system to use every device properly and efficiently. Here we are developing an android app through which we can handle our devices manually.

II. Detailed Design

1. INTRODUCTION

As there is increase in use of smartphones and devices, so handling them becomes a difficult job. So in order to get ease in monitoring and controlling these devices we have proposed this system of home automation. In this we are developing an android app which is used to control the devices from remote place. Here we have software requirements such as PC app, a server, MYSQL Database, etc. We also have different hardware requirements such as microcontroller, sensors, and devices which we want to control.

2. SOFTWARE REQUIREMENTS

2.1 CLOUD SERVER

The main purpose of cloud server in our system is to provide remote access to the household appliances by Nicholas Dickey, Darrell Banks, and Somsak Sukittanon [1] via android app. We can use public as well as private cloud according to our need. The cloud server is used to store the user threshold values of particular device. Here, we are using Glass Fish as a Web server. It is open source server and a private cloud. The database uses MYSQL as a database library to store the user data. It is of 5.1 and above version. It has Java Web Services. The IDE is designed by Netbeans 7.1 and above versions. The PC application sets the threshold values and that is also stored in database. This database server is connected to the PC by HTTP link. The client server communication takes place via SOAP/XML protocols.

2.2 PC APPLICATION

This application is the Admin application. The GUI is simple and designed by using AWT/SWING. The IDE is designed by Netbeans 7.1 and above versions. PC application is used to set the threshold values for all the devices. It maintains all the values received from sensors and also maintain previous recorded values. The PC application is app which provides interface to the hardware of overall system. This is used to read the sensor's values received from microcontroller. It sets the threshold values for every device or appliances. The PC App is connected to the Database server by HTTP link or KSOAP2 lib protocols. This App is also connected to android App through Internet/Wi-Fi. Here we are also using a camera for motion detection technique. This uses image processing to detect the changes in motion. Used for 2D graphics.

2.3 ANDROID APPLICATION

Android app is designed to control the household appliances remotely from any location via cloud. It is user friendly and easy to access by the users.Android App is created by Eclipse/Jdk 1.6 above version. The GUI used is a XML layout. It uses SOAP i.e. Simple Object Access Protocol. This android app is used to control and monitor the devices. The threshold values set by the PC app can be changed by this android app. The security alert or notifications are received at the Android App. We can also access the home appliances locally using this app by Bluetooth for small distance interactions R.Piyare, M.Tazil [6].

3. HARDWARE REQUIREMENTS

3.1 SENSORS

Sensors are used to sense the surrounding values and send those values to the devices. Then depending upon the sensor’s values and the set threshold values the devices perform their action i.e. whether to get on or off. Over here we are using various types of sensors. They are IR Sensor, Humidity, Sensor, Level Sensor, Temperature Sensor, Vibration Sensor and Light Sensor. The IR is used in motion detection system. It detects and gives an alert or notification to user when motion is detected. The Humidity Sensor is used to detect the humidity level in the room. If the humidity is not same as that of regular, then it gives alert. Level Sensor is used to check the level. For e.g. Water tank overflow occurs then gives alert. Temperature Sensor is used to sense the temperature and maintain it to normal. Light Sensor is used to automatic turn on and off the lights when required.

3.2 MICROCONTROLLER

Here we are using AVR-ATMega-32 microcontroller which is of 40pin. This is low cost and easily accessible micro controller stated by Jiri Spale [2]. It performs one instruction per clock cycle. It has embedded C into it. This microcontroller is attached to a driver which has the various devices or appliances connected to it. The microcontroller also has a signal converter which converts the sensors values and sends it to the AVR board. This Microcontroller is connected to our PC by serial communication which uses MAX 232 RxTx Lib. The microcontroller plays an important role in home automations as stated by Laur, I. [3]

III. PROPOSED System And Architecture

The Architecture of the System consists of several parts such as Cloud server, Micro-controller, Database, Sensors, Smart phones, Camera and home appliances as per our requirement. Firstly the most important thing in this system is our Home appliances. These various home appliances are connected with Relay Board which has various drivers installed and it is our hardware component. The relay board is attached to the device driver which acts as interface between home appliances and hardware of system. With the help of these drivers Micro-Controller permits various functions to the devices attached on it. This Micro-controller is also attached with Signal Conditioner and this signal conditioner is connected to ADC which can grab or fetch sensors value and convert it. Then it passes those values to signal conditioner. The ADC is used for converting analog signal to digital signal and vice versa. The signal conditioner provides the necessary signals and does the signal conditioning.

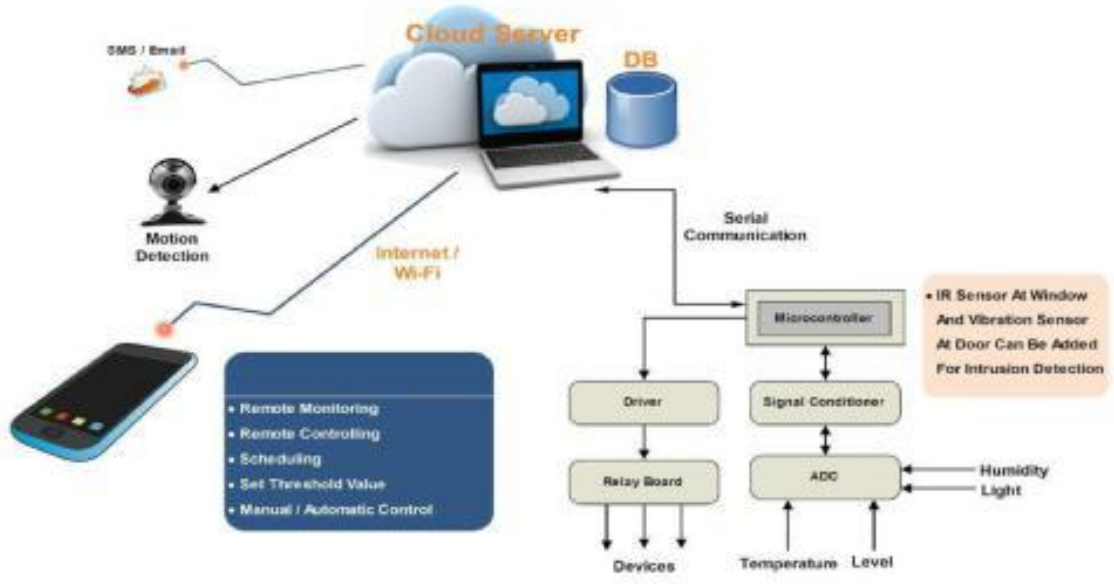

Fig. 2: Architecture of System

The sensors are the main part of hardware system. Sensors are used to sense the environment conditions and send the values to the microcontroller. Then depending upon the sensor value and allotted threshold value, actions are taken.

As per our requirement we can install various types of sensors like:

- IR SENSOR
- TEMPERATURE SENSOR
- HUMIDITY SENSOR
- LIGHT SENSOR
- LEVEL SENSOR
- VIBRATION SENSOR

Then the core part of hardware is nothing but the microcontroller named AVR- ATMega 32. It is a 40 pin IC containing 4 ports i.e. port A, port B, port C, port D. AVR is Advanced Virtual RISC which performs 1 instruction per clock cycle. It is more scalable and cost efficient. The instruction type is simple and hardware is complex. The main purpose of microcontroller is to control and monitor the whole hardware shown by Jiri Spale[2]. This Microcontroller (AVR) is connected to the local PC i.e. Admin with Serial Communication MAX 232. This MAX 232 serial communication converts signal from RS 232cable serial port to signal suitable for TTL digital Logic Circuit. MAX 232 consists of Dual RxTx lib. The RS 232 cable is signal converter. It stands for Serial Communication Transmission of Data. RS 232 is used for synchronous and asynchronous transmission. It also supports the signal connection between a DTE (Data Terminal Equipment) such as PC and DCE (Data Circuit Equipment) such as Modem/Hardware. Once the connection is established between the

hardware and PC then the data transmission gets started. In this local PC, there is application which is built by using NetBeans 7.1 and above version. Whereas JAVA jdk 1.6 and above version is also used. This local PC is connected to the Web Server i.e. Cloud which is type of Glass Fish. The Web Server is used for storing the data in MYSQL Database. Here we have used MySQL database (version 5.1 and above). The PC application is the Admin of overall system. It is java base application which communicates with the hardware via RS 232 Serial Communication Cable. This application is used for user authentication and user login methods. It contains and maintains all user related data. It also helps to set thresholds, update threshold, monitor devices, show device status, test hardware, view logs, live monitoring as well as motion detection. Whenever any error occurs then this app generates alert message and send to user via emails, sms, notifications etc. It also communicates with Web Server through SOAP. The interaction between hardware, PC application and Web Server together makes the entire system to work properly.

As for the smart and automated system there is use of Smartphones. So here, we have also made an Android Application which is developed by using Android Studio. It communicates with Server through KSOAP2 Lib. These smartphones is linked to the local PC via Wi-Fi/Internet. User can also change or set threshold values by android app. It also keeps the record of device status and monitors the devices. In this application user can monitor the appliances remotely, control remotely, and schedule the threshold values. For local access to the devices through android app we use Bluetooth protocol. If there is any problem in the appliances the system will notify to the smartphones via email, sms, notification, alert, etc. So the user will be able to take some action.

IV. Implementation Of SYSTEM

1. HARDWARE WORKING

The sensors keep scanning the environment all the time. And if any change occurs in the entire environment then the sensor values update accordingly. The sensor values are scanned continuously via serial communication using RS232 protocol. These values are compared with the threshold values based on which the necessary actions (Device ON/OFF) taken. There is android client interface by which the client can remotely view live parameters on it android phone. Client also has the provision to set the threshold value remotely. A provision for manual mode is provided using which the client can switch devices ON/OFF as per his requirement. In this mode the threshold values are considered for switching. After getting those values from drivers it passes them to the microcontroller and then performs its task.

1.1. ULN 2803

ULN provides continuous current to the hardware system for its proper functioning. Main feature is to provide continuous load current ratings upto 500 mA for each of the drivers. ULN28xx has high voltage, high-current.

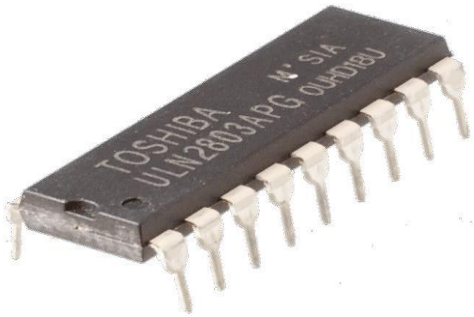

Fig. 3:ULN 2803 APG

Darlington arrays are ideally appropriate for interfacing between low-level logic circuitry and multiple peripheral power loads. Particularly loads contain relays, solenoids, stepping motors, magnetic print hammers, multiplexed LED and incandescent displays, and heaters. All devices feature open-collector outputs with integral clamp diodes.

1.2. MAX 232

The MAX232 IC is used to convert the TTL/CMOS logic levels to RS232 logic levels during serial communication of microcontrollers with PC. The controller operates at TTL logic level (0-5V) whereas the serial communication in PC works on RS232 standards (-25 V to + 25V). This makes it difficult to establish a direct link between them to communicate with each other.

Microcontroller	**MAX232**		**RS232**
Tx	T1/2 In	T1/2 Out	Rx
Rx	R1/2 Out	R1/2 In	Tx

The intermediate link is given by MAX232. The MAX232 is a dual driver/receiver which includes a capacitive voltage generator to supply RS232 voltage levels from a single 5V supply. Each receiver has ability to convert RS232 inputs to 5V TTL/CMOS levels. These receivers (R1 & R2) can accept ±30V inputs. The drivers (T1 & T2), also called as transmitters, convert the TTL/CMOS input level into RS232 level.
The PIN Layout is stated below:

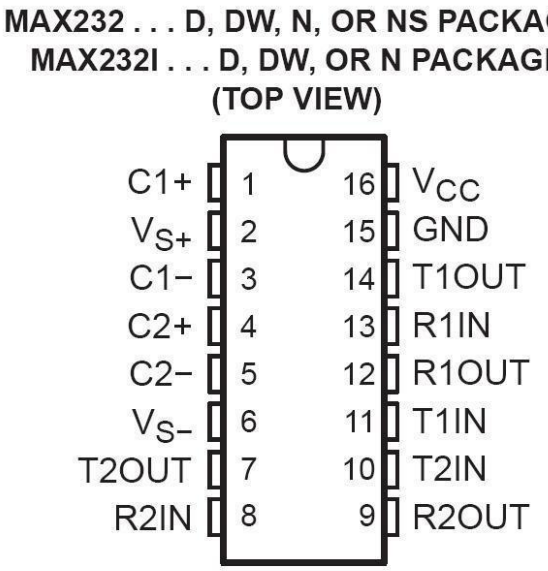

Fig. 4: PIN Diagram

The controller's serial transmission pin gives the input to transmitter and then it sends the output to RS232's receiver. Then the receiver takes the input from transmission pin of RS232 serial port and gives the serial output to microcontroller's receiver pin. The MAX232 needs four external capacitors with have values ranging from 1µF to 22µF. To maintain the voltage regulation between the hardware and the devices we have used a Voltage Regulator to regulate the voltage range for every distinguish component. The design of hardware is Feed Forward Design. Along with voltage regulator we are using a step down transformer which maintains the Secondary Voltage < Primary Voltage. To maintain the valid level of current even though certain devices are disconnected we have used number of Pull of Registers.The continuous monitoring of the hardware is done by the Admin application.

2. APPLICATION WORKING

2.1. ADMIN APPLICATION i.e PC APP

The design of admin application is done using JAVA jdk 1.6 and above version and built using Net-Beans 7.1 and above version. The main aim behind designing the admin app is to monitor and control the whole home automation system. If the hardware gets damaged or turns off then admin app helps to find out the problem and fix it out. The access to the Admin App is only to the authorized person. It plays an important role in providing security. The user whoever is going to use this system should register his/her details to form an account. Unless and until the user authentication is successful, the user is not allowed to login and store their data in Database. When the authentication is successful the user can login to admin application. User can also change their password through registered mail/phone No. OR the user can update details as and when required or register to new account. GUI of Admin Login is below:

2.2. REMOTE APPLICATION i.e ANDROID APP

In this system we have also developed a smartphone application to control and monitor the appliances which we are using in day-to-day life. Using **Android studio / Eclipse** we can build the android application. Android App is created by Eclipse/Jdk 1.6 above version. The GUI used is a XML layout. It uses SOAP i.e. Simple Object Access Protocol for communication. The android app is same as that of PC app. It also requires

user authorized admin login to control and monitor the system. The main distinct difference between these two apps is that the android app is remotely as well as locally helpful to control the system whereas the PC can do local control only. The GUI is simple and user friendly. The app is connected to the PC app via WiFi/Internet. It is as well connected to the web server and can send or receive data. It provides us certain features like Remote Monitoring, Remote Controlling, Scheduling, Set threshold and Manual or Automatic control.

3. MOTION DETECTION TECHNIQUE

Motion detection technique is based on Image Processing technique. The basic algorithm is used is of image processing concept. The purpose is to detect the unknown motion and generate alert by buzzer. Whenever unknown source comes under the camera observation, the buzzer rings and user gets aware of the unknown source. The process of detecting unknown sources is done by image processing. First of all the video camera interface is done. Depending upon the received input from camera, frame extraction is done on it. The image blurring is performed on the input feed. Already a base image is set. By considering the received input feed and base image the image subtraction is done. Image RGB value to Gray scale value conversion is done. The intensity threshold and motion threshold values are set. If threshold values exceed, then the buzzer rings.
The overall review of image processing is shown in the fig.5 below.

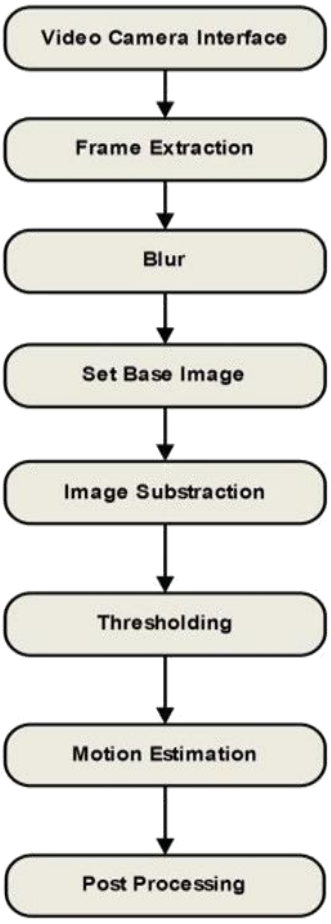

Fig. 5: Image Processing Flow Diagram

V. Experimental Result

We have used our system on various on various type of images, like novel, books, and records, historical literature. Some of the results are stated as follow: In this system we have implemented smart home application using various techniques such as Motion detection, Image Processing, Cloud computing, IOT, Android, Embedded System etc. for security of home and making it intelligent as well as automate it. We have used several sensors which help to sense the surrounding and response it. Every sensor has specific threshold value in upper and lower limits. Whenever the values exceeds the devices turns on/off.

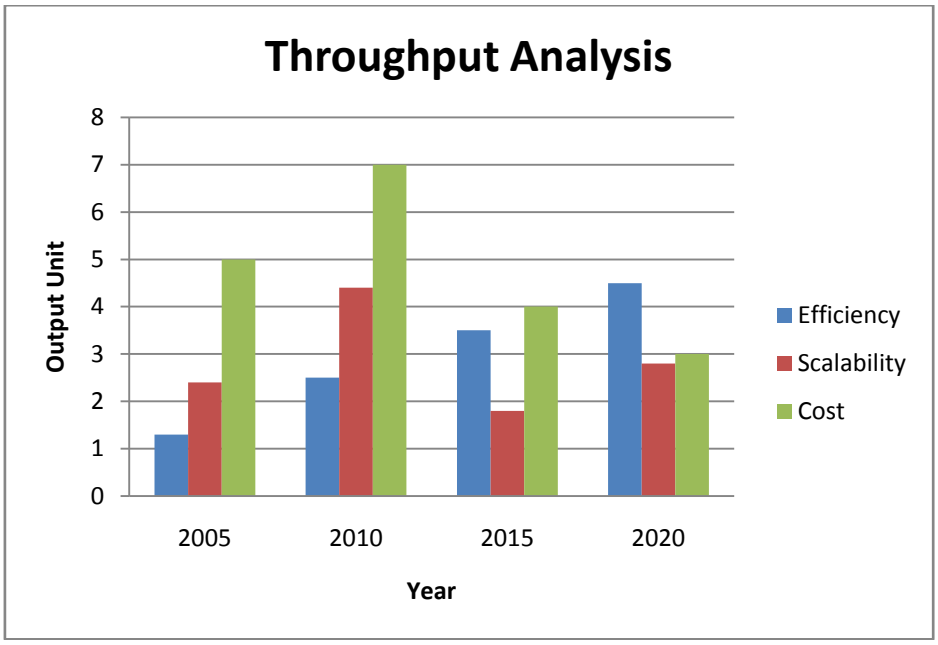

Fig. 6: System Analysis

The devices can be set to auto as well as manual mode as per the user choice. In auto set mode, the devices turns automatically on/off depending upon the threshold values. Whereas in the manual mode, devices can be switched on/off from remote location through android application by user. In motion detection, whenever unknown sources feed is detected through the camera the i.e. when the motion threshold and intensity threshold values exceed the set values then the motion detection error gets generated and notification is send via email, buzzer alert, sms. The camera is turned on and image scanning is done by comparing intensity threshold and motion threshold values when the input feed is received.

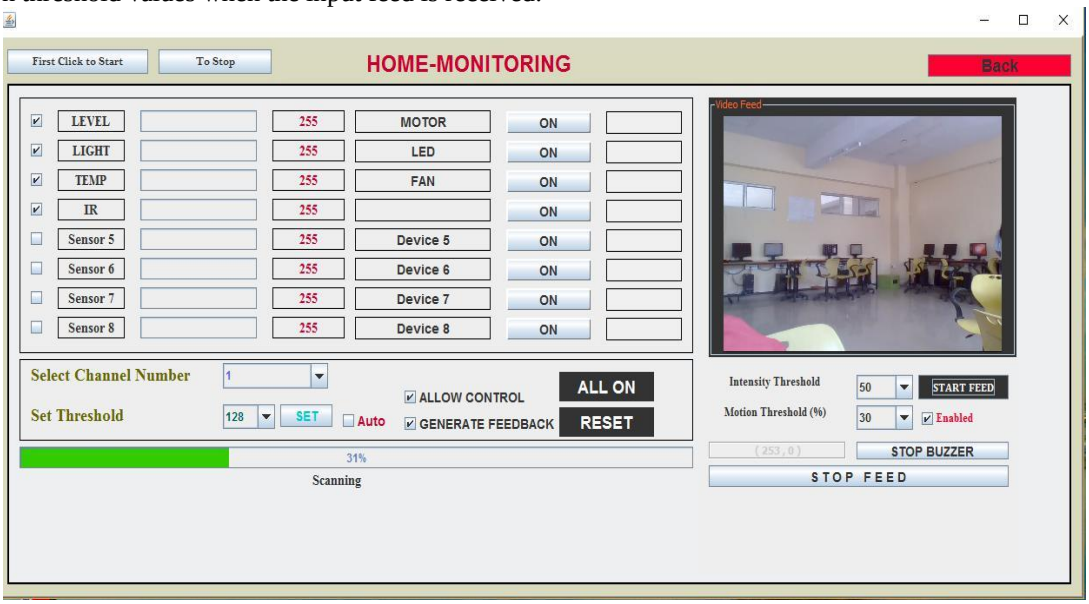

Fig. 7: Motion Detection Technique

VI. Conclusion

Thus in this proposed system of Intelligent Home we enables the full automation of home using Android application and provides security to it by authentication and cloud server. It reduces human efforts and is time scalable.By combining multi-touch mobile devices, cloud networking, wireless communication, and power-line communication, we are able to design and build a fully functional home automation system. It allows the user to control various appliances within their house from any location in the world using 1) mobile devices, 2) PCs or 3) in-home remote controller. Using this system as framework, the system can be expanded to include various other options which could include home security feature such as open-door and motion detection, energy monitoring, or weather stations.

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