

## Home Automation Prototype using IoT

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**Abstract—Home automation allows controlling of the electronic appliances automatically. It is a step forward to the popular and emerging technology called Internet of things (IoT). The aim of this paper is to design a prototype which gives access to control and monitor devices at home from anywhere in the world.**

**Keywords—Home automation; IoT; Bluetooth; GSM; GPRS; Android (key words)**

### I. INTRODUCTION

#### A. Overview

The home automation system improves the living standards and also helps the elderly and disabled people. It gives the user the ability to control the electronic and electrical home appliances not only from one location but throughout the country. Home automation system focuses on controlling home electronic devices whether you are inside or outside your home. It gives an individual the ability to remotely or automatically control things around the home.

The recent developments in technology which permit the use of radio frequency technology such as Bluetooth have enabled communication between different devices. Bluetooth technology aims at eliminating wired connections between devices. In this, every device has small transmitters/receivers. The radio frequency used (2.4 GHz) is so high that the range of transmission will be small. These are a few reasons that make Bluetooth technology ideal for home automation. With this in mind, a Bluetooth based

home automation system is proposed for remote control of home appliances.

Android application provides real time based remote control home automation system [1], [2]. Remote operation is achieved by any smartphone/Tablet etc., with Android operating system [1], [2], upon a Graphical User Interface (GUI) based touch screen operation. In order to achieve this, Android application act as transmitter, which sends ON/OFF commands to the receiver where loads are connected.

Many people are always on the move from place to place due to business demands. Some people can spend a couple of days away from their home leaving all their household appliances without any kind of monitoring and control. Some devices are left plugged into power sockets whereas others are supposed to be plugged into and out of power sockets at different intervals depending on the time of the day. All of this requires an individual to manually attend to each of the devices independently from time to time. All such monitoring and control can be done without necessarily being around or inside the home. Some devices if not controlled properly consume a lot of energy which leads to extra expenditure on electricity. Therefore a SMS/Internet based home automation system is proposed which will enable one to remotely manage the home appliances from anywhere, anytime.

Home automation system processing:

1. Within a limited or Bluetooth range, the user sends the commands using an android application to the microcontroller via Bluetooth module which is received from the user. The microcontroller receives and interprets the command and performs the action.
2. Beyond this range, the user sends the commands in the form of SMS to the microcontroller via GSM/GPRS module. In case of GPRS, the mobile device is first linked to the home server via Internet. The microcontroller receives and interprets the command and performs the action.

In this method, the user is able to communicate with devices, control and monitor the functionalities such as device ON/OFF without limiting the range in environment.

### B. Applications

Home automation does not only reduce human efforts but also saves time. A complete automation may sound complex and expensive, but these are surprisingly affordable and simple to install. Home automation has wider range of application such as:

1. Heating, ventilation and air conditioning (HVAC) Regulations: It is possible to have remote control of all home energy monitors over the internet incorporating a simple and friendly user interface. [3]
2. Appliance control and integration with the smart grid and a smart meter. [4], [5]
3. Security: A home automation system integrated with a security system can provide security services such as remote surveillance of security cameras over the Internet, or smart locks for doors and windows. [6]
4. Energy management and Savings: The smart devices can be synced with appliances with real-time energy information.
5. Leak and smoke detection: With sensors integrated in the system, gas leakage and smoke detection is possible.
6. Lighting Control: Lighting control system allows the user to control, schedule and monitor lights, lamps, outer lights, etc.

## II. RELATED RESEARCH

The home automation system is designed using various technologies such as Bluetooth, ZigBee, Internet, short message service (SMS) based. These latest technologies give user friendly home automation system with low cost.

### A. Bluetooth Based Home Automation

The system makes use of a cell phone and Bluetooth technology [7]. Bluetooth technology is secured and low cost. It makes use of an Arduino Bluetooth board. An interactive python program is used in the cell phone to provide the user interface. The I/O ports of the Bluetooth board and relays are used for interfacing with the devices which are to be controlled. The Bluetooth is password protected to ensure that the system is secure and not misused by any intruders. The Bluetooth has a range of 10 to 100 meters, 2.4 GHz bandwidth and 3Mbps speed. There is a diagnostic system that can detect problems in the circuitry. The main drawback with respect to Bluetooth is that it takes a long time to discover and access devices in its vicinity. It does not provide energy conservation tips. Real time access cannot be achieved. Anywhere access to the devices cannot be achieved. Access is limited to within the Bluetooth range. The Bluetooth module that is connected to it will allow it to receive various commands via Bluetooth. Bluetooth devices can scan and detect other devices easily. It might also be possible to check whether devices are working properly or not. The system also has an illumination sensor that can turn on lights when external light is dull and a temperature sensor. This system has the advantage of being able to fit onto an existing system. There is also low cost involved in this system.

Bluetooth is intended to enable the short-range peripherals of those computers. The capabilities of Bluetooth are good and current cell phones, laptop, tablets have built-in-adaptor that will indirectly reduce the cost of the system. However it limits the control to within the Bluetooth range of the environment [2], [8].

### B. ZigBee Based Home Automation

The ZigBee wireless communication technology can be applied for home automation. The system uses microcontroller for this purpose. The microcontroller transmits the commands through ZigBee to the receiver. The receiver unit has another microcontroller that can process the command. It uses relays to control the respective appliances. This system has the drawback that ZigBee is a low range communication medium. So remote access is hindered from far away locations. This system is integrated with several sensors. For example, a smoke detector system integrated with the HAS. When smoke is sensed, it sends a message to the user's built-in mobile number. ZigBee in home automation reduces the cost of wiring and provide reliable and secure communication [2], [8], [9]. The early sensor networks were used with Routing Algorithms and RF technologies. The recent systems have been using standard-

based algorithms and RF solutions. ZigBee is considered as a low data rate wireless network standard, with added features like low-cost, low power consumption and fast reaction and it is most suitable for small area network.

### C. GSM/GPRS Based Home Automation

The system provides two means of controlling the home appliances: the GSM network and the Internet. The real time monitoring of the home devices is an important feature that can be used in the home automation systems. This feature allows the user to be informed and updated in real time as soon as a change in the status of the devices occurs. In a GPRS based HAS the user commands are sent to a server via Internet. The server processes the user commands and sends them to the relevant units of HAS. This can help control the appliances. In places where there may not be proper internet connectivity, GSM acts as the communication medium in order to establish connection.

The system uses the GSM network along with an AVR microcontroller. This is an SMS based HAS. Any GSM enabled mobile phone is used to get the commands from the user. There is a GSM module that is attached to the microcontroller. The commands sent via SMS by the user will be received by the module. AT commands are used to communicate with the modem. The microcontroller in turn instructs a driver circuit to control the appliances as per user necessity. This system has remote access capabilities from all over the world.

The system is enabled with the added feature of GPRS. This is an Internet based HAS. A server is setup at the home end. The server has three engines running – the web server, database and main control program. Any GPRS enabled mobile phone is used to communicate with the server via Internet. The user authentication is performed. Then the commands from the user are sent to the GPRS module through a GPRS network. AT commands are used to communicate with the modem. The microcontroller in turn instructs a driver circuit to control the appliances as per user necessity. The remotely accessible home automation system is made by using database and web server. The PC is used as a server that reduces the cost and power consumption while others require web page hosting that adds up the extra cost.

### III. PROPOSED DESIGN

A Smart Home is one which can recognize the user's expectation and manage the things themselves to meet the

needs. It provides more technological advantages to the user of the leading technology Internet of Things. The things in a smart home, including appliances, security system can be controlled using the smart phone with wireless connectivity. This connectivity is achieved in this system with the help of Bluetooth and GSM technology. Basically, this system deals with an internet based home automation for an intelligent control over appliances.

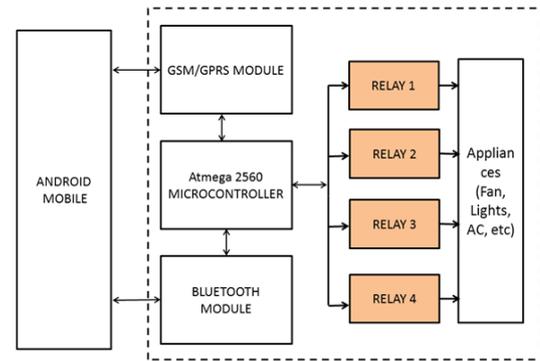


Figure 1: Overview of Home automation system

The overview of home automation system is shown. The system consists of an android developed application which controls the home appliances. It also consists of microcontroller in which electrical appliances are directly interfaced to it by using relays. The android phone communicates with the module and sends the control commands to the microcontroller. Therefore according to the requirement specified in the command, it switches the relays which control related appliances.

### IV. SYSTEM IMPLEMENTATION

The overall process of the proposed work can be viewed as a flowchart as shown in figure 2.

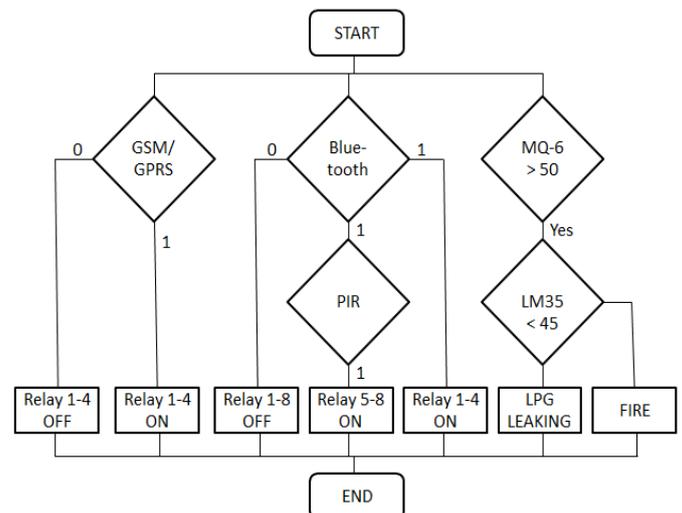


Figure 2: Flow of overall process

#### Microcontroller board Arduino 2560

The main component of the proposed system is this paper is an Arduino ATmega 2560 controller, which facilitates the user with four UART [Universal Asynchronous Receiver Transmitter] ports, which is the reason to use this board as the interfacing of Bluetooth and GSM requires two different UART [10]. We use the board for the control of the relays with the help of predefined code which on receiving the inputs through the GSM or the Bluetooth module. In case of GSM the AT commands [11] are used to receive the messages of control information from the user are used to send valuable information to the user as feedbacks and also notify the user if in case of emergency or discrepancy detected by the sensors.

The proposed work is implemented in 2 phase:

- A. Bluetooth interface
- B. GSM/GPRS interface

#### A. Bluetooth Interface

The Bluetooth module used in this system is HC-05. HC-05 is a serial port module which makes it very easy to use. The communication between Bluetooth module and microcontroller happens through UART which works in a standard baud rate of 9600. Bluetooth module is interfaced to smart phone using an android developed application 'Arduino Bluetooth control device'. Once the Bluetooth module is connected, scan for the new devices in the specified application. It should be connected to the device named HC-05. The default pairing code for this is '1234'. The application software sends commands to the microcontroller based on the buttons that are operated for desired states.

#### B. GSM/GPRS Module

The control module used in the proposed model is a SIM900A [12] by SIMCOM. This module has the capability to perform normal voice calls and SMS (Short Message Service) facility along with the addition of GPRS (General Packet Radio Service) capability which allows us to connect to the internet on inserting a valid SIM (Subscriber's Identifying Module) card with SMS [13] and GPRS facility. The two methods we are concerned with are the SMS and the GPRS connectivity.

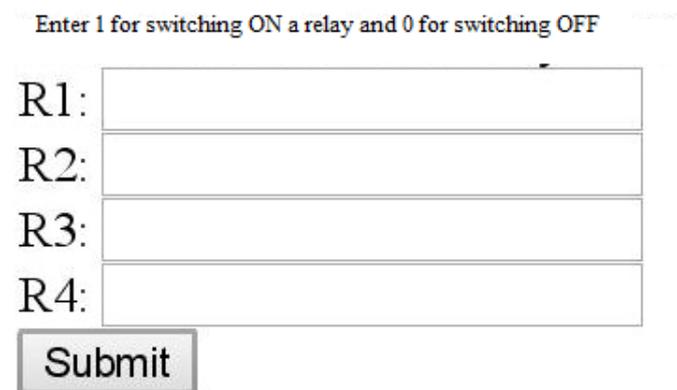
##### 1. SMS HAS Control

The SIM900A module used here provides SMS facility using which we can send characters which are defined in the

predefined code of the proposed model. In this model we are using the SMS facility to control home appliances [7] as required. The module uses AT commands as specified for the SIM900A module provided by SIMCOM for sending and receiving SMS. In this paper we are proposing for a feedback each time a control is specified by the user for controlling a specific appliance.

##### 2. GPRS HAS Control

The application of GPRS facility extends the further concept of IoT which is the innovation towards the future. In addition to the major provision of the SIM900A module, the GPRS facility is a notable one. This can be used to connect to the internet and access web pages. In the proposed system we are using a web server which has a simple user interface using PHP code and a free hosting service to keep the site active. The webserver has four inputs which correspond to the four appliances at the receiver end, which is updated in the database of the server. The inputs provided are decoded by the strings received by the Arduino predefined code for the control of home appliances. Figure 3 shows the webserver where the inputs are provided for the control of the respective relays which in turn is used to control the required appliances.



Enter 1 for switching ON a relay and 0 for switching OFF

R1:

R2:

R3:

R4:

Figure 3: Webserver input screen

The response of the webserver will be linked to the Arduino code for the model which will take the input codes as 0's and 1s to which the relay is switched ON/OFF which is indicated in figure 4.

1010Record updated successfully

### New Status

R1 : ON

R2 : OFF

R3 : ON

R4 : OFF

Figure 4: The response of the webserver

### V. CONCLUSION AND FUTURE WORKS

The proposed system is an economical and efficient system to extend the idea of IoT to better use for connecting devices together and also to help the physically disabled and elderly people with an aid to control the basic necessity appliances to provide them the ability and confidence to lead their life without relying on others. The main use of the proposed model is the alternate provision of the SMS along with the Bluetooth which extends the range as well as the ability for non-smart phone users with the ability to control the devices. The extensive use of the SIM900A module with the GPRS facility is an added feature with the help of a basic webserver for the appliances control which possess a great deal of further improvements. The main disadvantage of SIM900A module is the inability to form a TCP server which would have allowed us to use it as a local network and control the appliances, nevertheless webserver acts as a great alternative with the added features.

Future additions which could be suggested are as follows:

1. The addition of security features along with addition of more sensors to make a complete home system.
2. The use of better network components to provide wide range of applications.
3. The webserver used here is of a simple user interface to control the appliances, can be ported to an application to provide effective and real time control and notifications.

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