3

METHODOLOGY

CONTENT

CHAPTER 3

3. METHODOLOGY

3.1 System Framework

The present system is an integrated Home Automation System that can be used to operate, control and manage various electrical home appliances. The entire module of the system contains two sub modules as the server and the hardware interface. User can transfer their commands to the home automation server through different four communication mechanisms like GSM, Web, Speech, IoT and can get back the responses also. The requested commands are first checked for authentication, then processed and digitized and finally sent to the relevant sub-module i.e switching circuit to be processed.

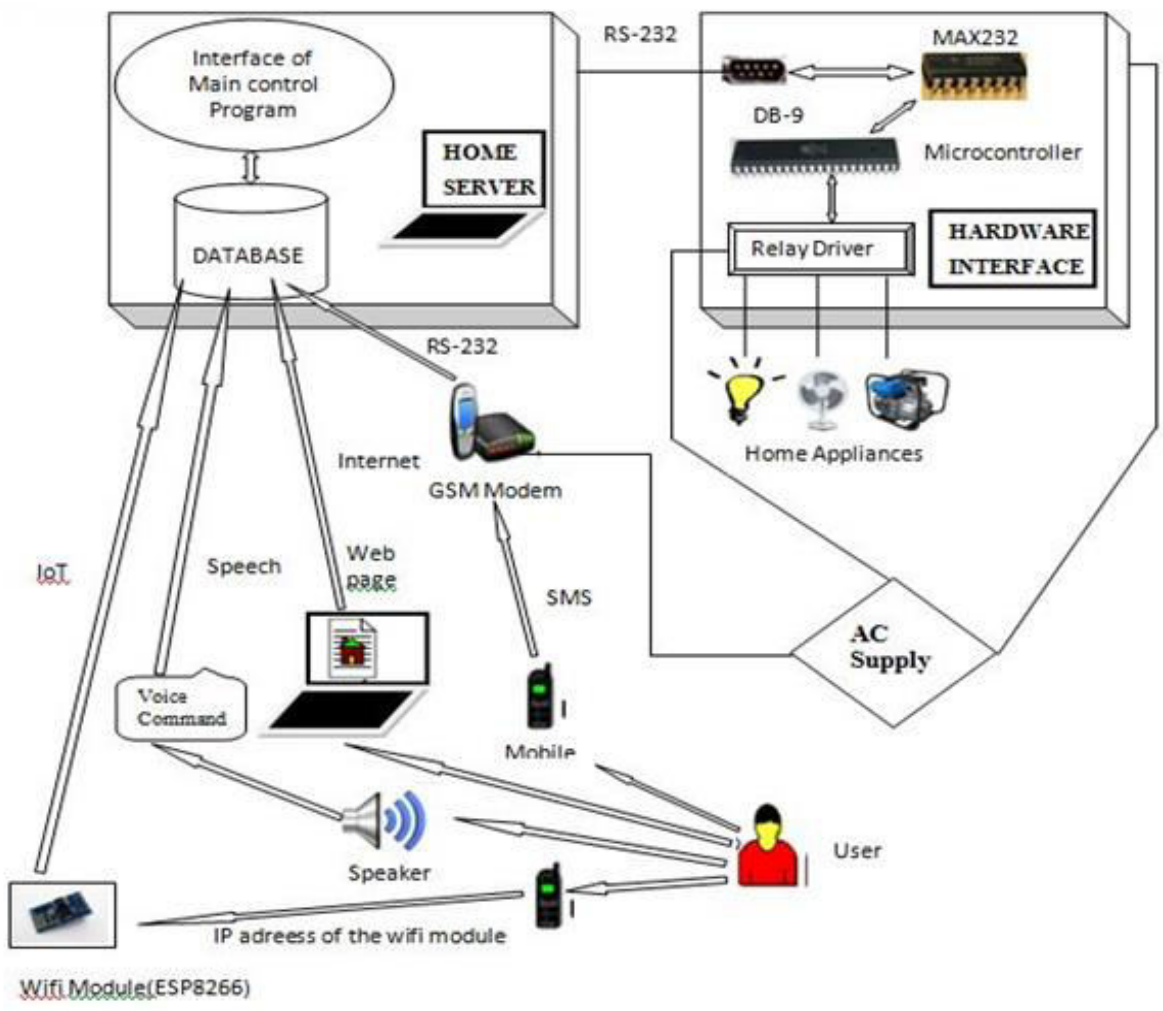

Figure 3.1: System Architecture of Entire System [44]

The software package burned into the microcontroller present in the electronic circuit has also the ability to response the status of the devices by sending back to the users of the system so that everything can be monitored in real time. After receiving the responses from the appliance nodes, the server explained them and performs the needful and necessary actions.

3.2 Communication Mechanism

In the entire Home Automation System, four communication mechanisms (GSM, Web, Speech, IoT) have been implemented to handle electrical appliances. All mechanisms are atomic and independent to each other, but connecting through only a common database. With the help of this kind of mechanisms, people can interact with the Devices as like as with the other people.

3.2.1 GSM Communication

Usually, GSM is used for the communication among peoples to each other from a remote place. But here, GSM modem or a mobile is used for the communication between human and electrical devices located in a remote place. There are two GSM modems where one is available in User's hand that is used to send the human commands or message and another is connected with the server that is used to receive that particular message through SMS service and store the commands in the database. Finally the system will forward the commands to the microcontroller by using the serial port communication and the devices will be operated accordingly over the actuators. The SMS will be sent by the user and received by the Server through AT command. Before that already the valid action commands are pre-stored in the database using server side programming. The connection of the GSM modem is easily made with the server by using a USB to serial communication cable. RS-232 is used for serial port communication between the GSM modem and Server PC [45].

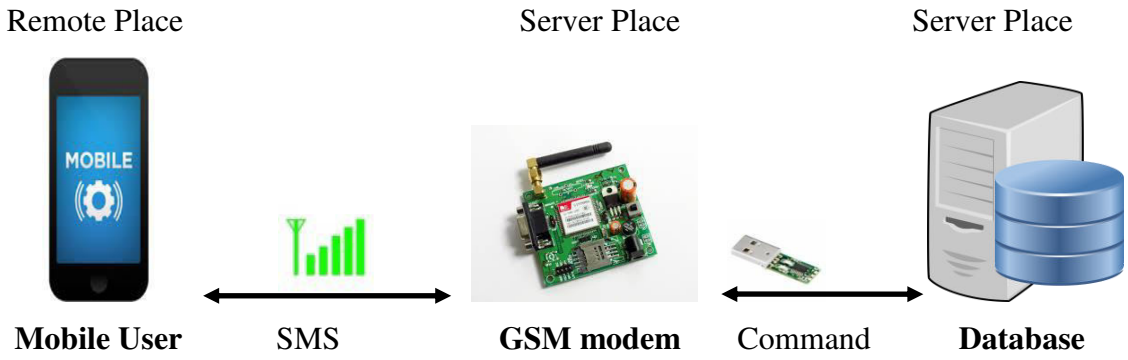

Figure 3.2 : Block diagram for GSM Communication

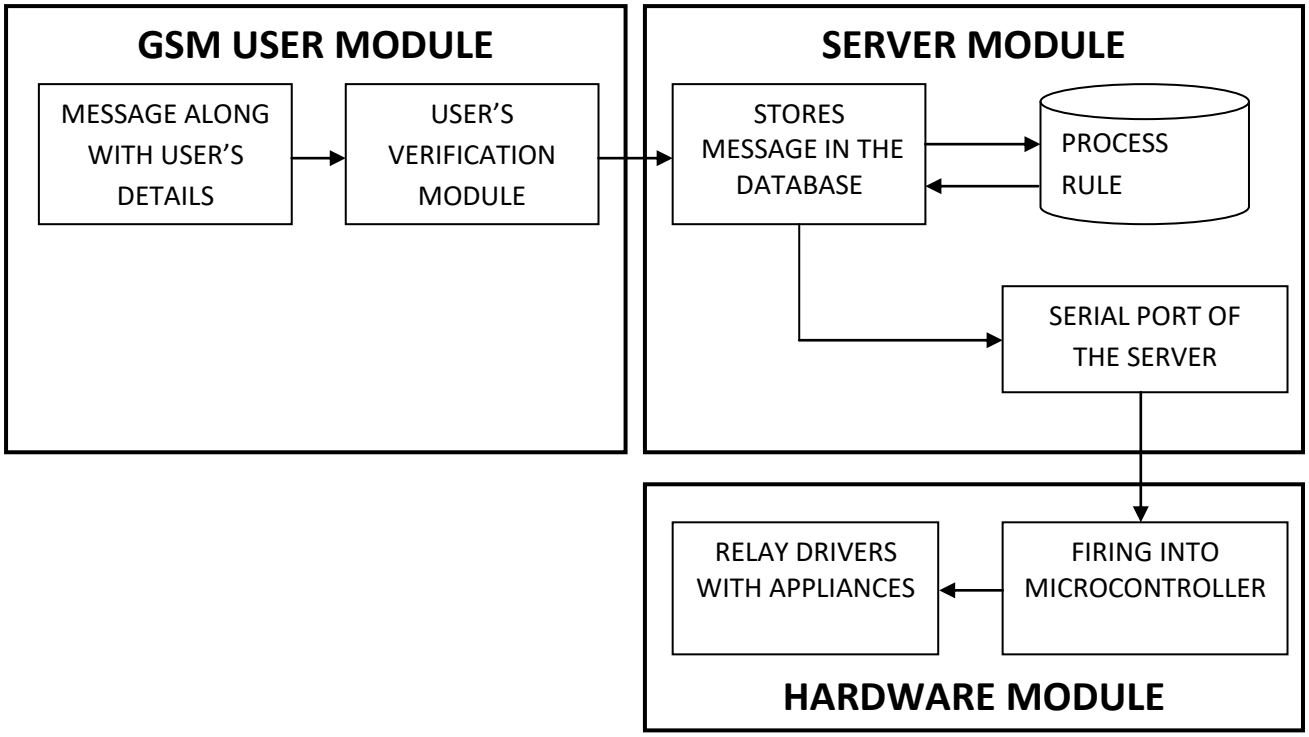

Figure 3.3: Frame work for GSM Communication

3.2.2 Web Communication

In our day to day life, we frequently use the web page and Internet to send some queries and access or get some information regarding those queries globally. But here, web page designed in PhP is used to send some commands that will be stored in the database connected with the Server and some electrical devices. As a result, Devices are controlled according to the commands. For this communication, the remote users have to open the

webpage where different buttons are available for different appliances. In the web page, the current statuses of devices are also available so the user can choose the correct action for operation. A web server is responsible for creating a platform for dynamic web application.

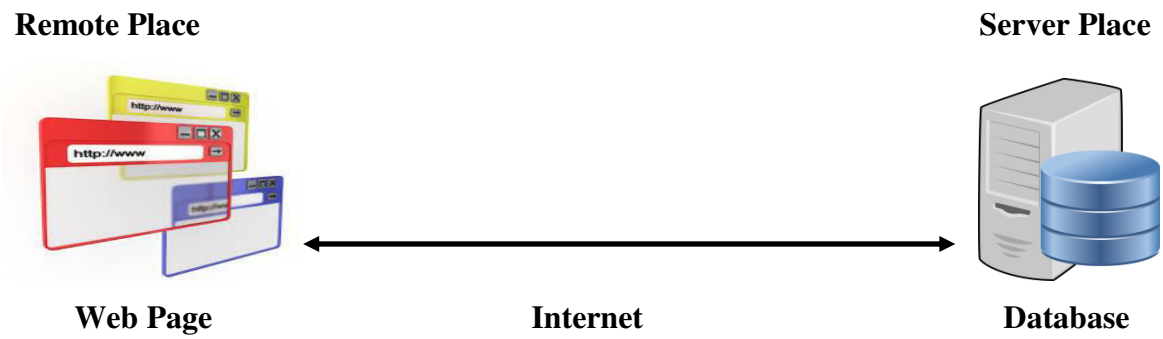

Figure 3.4: Block Diagram for Web Communication

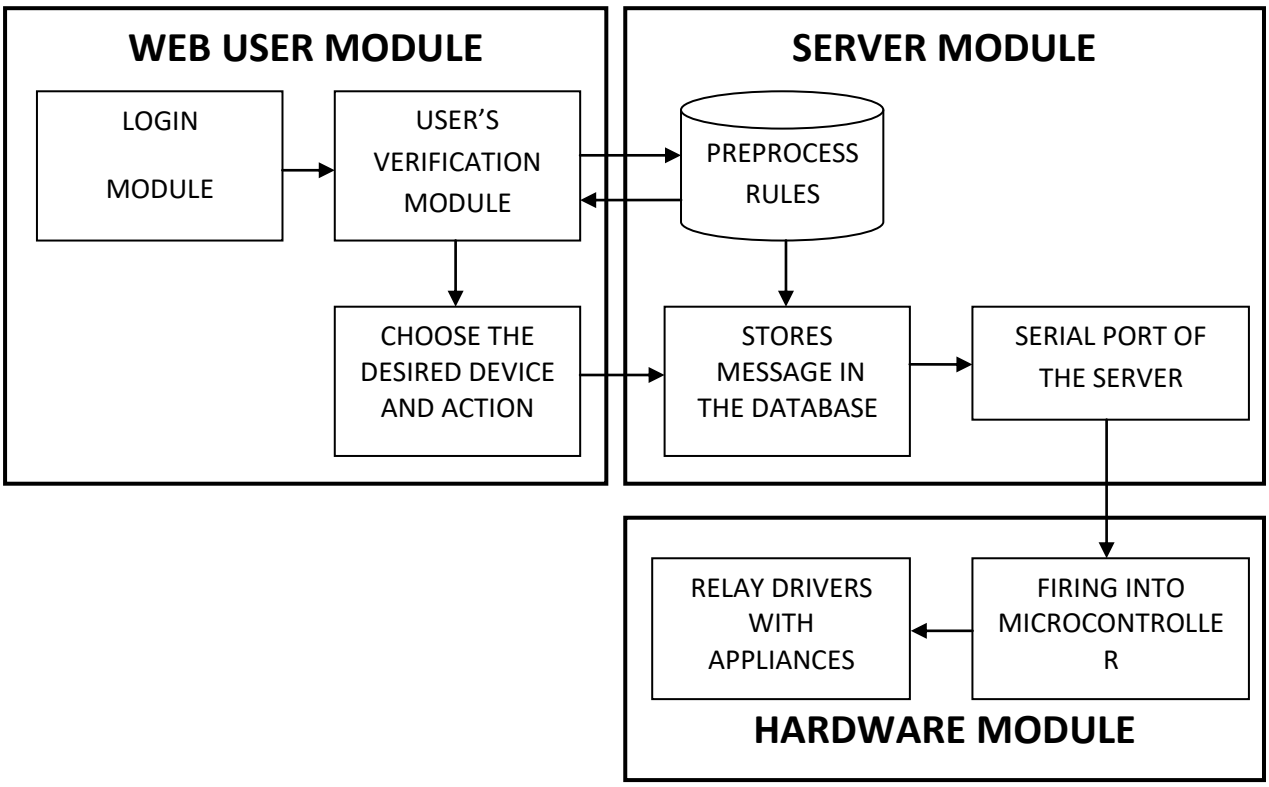

Figure 3.5: Frame work for WEB Communication

3.2.3 Speech Communication

This Communication is to design and development of an Asterisk based Interactive Voice Response (IVR) platform that allows the users to access and control the status of their home appliances remotely. In this IVR based platform, a mobile phone is connected to the system through Bluetooth or a PRI line. A computer system is considered as the Asterisk PBX server. Hence, users are able to make a call to the Bluetooth enabled mobile phone and then the users will be redirected to the server to offer the IVR based platform, through which the users will be able to give their choices of actions to be performed over the electrical devices [46]. A database is also maintained in the server to store the user's registered phone number and training set of voice samples or speech commands so that only authorized users can access the system. Once an authorized user inputs the action commands over the IVR platform, the voice commands will be tested with the trained voice samples stored in the database and the system will forward the commands to the microcontroller by using the serial port communication and the devices will be operated accordingly over the actuators.

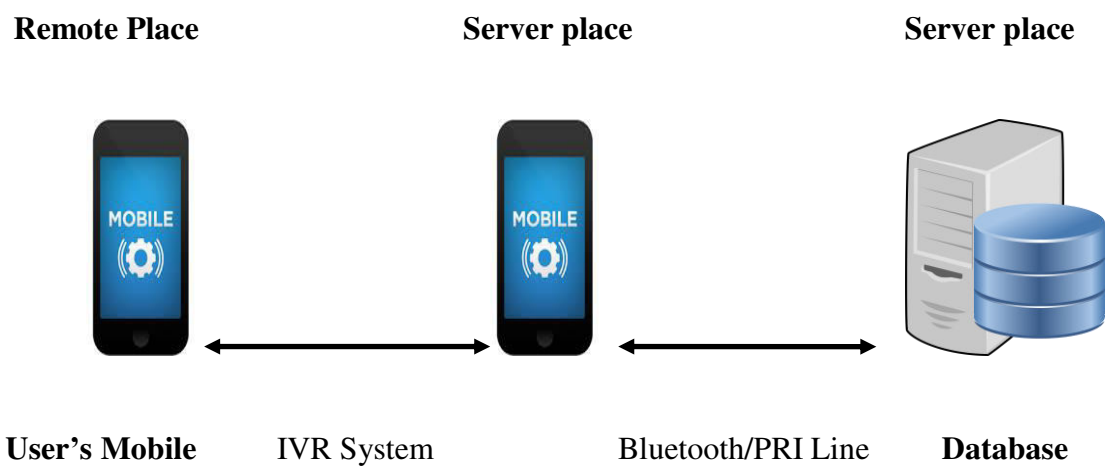

Figure 3.6: Block Diagram for Speech Communication

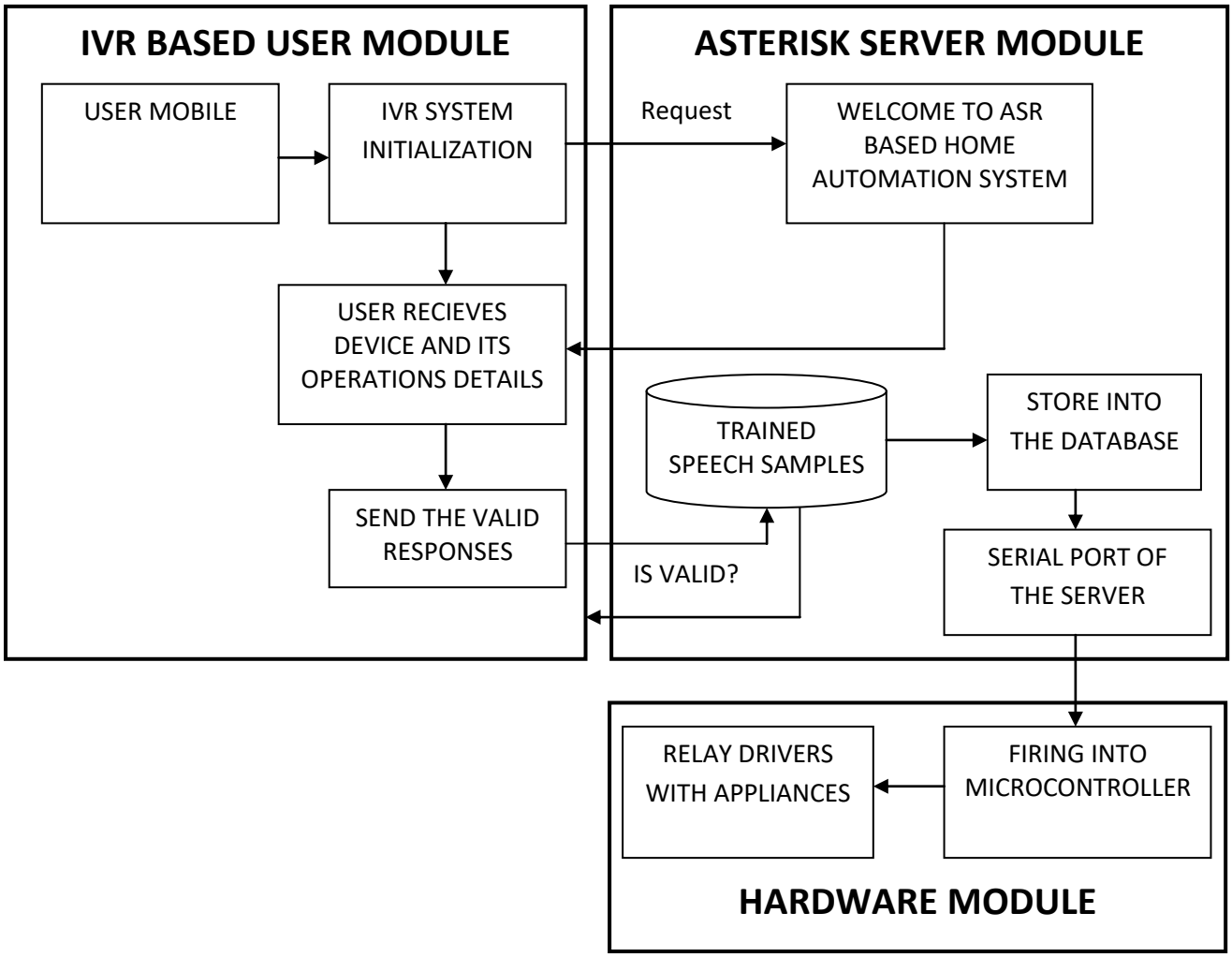

Figure 3.7: Frame work for SPEECH Communication

2.2.4 IoT Communication

There are lots of Wi-Fi modules for the connectivity between two terminals (Client & Server). But here, ESP8266 Wi-Fi module is connected with the user's Mobile using the particular IP address of ESP8266. The ESP module is an integrated chip which offers an inbuilt strong and high range Wi-Fi connectivity. For operating the devices on cloud or over the internet the data is transferred wirelessly to database. Therefore this module provides the most efficient service in its quality. It is a low cost Wi-Fi chip. The programming for ESP8266 is designed by using an extensible and light weight programming language, "Lua" [47]. The Wi-Fi module is connected with the server with the integrated Database. At the very beginning, the user's mobile should be connected with the system through ESP8266

module. Then users have to put the IP address in the URL of the user's mobile. Users can see a page designed by 'Lua' programming Language in his/her mobile where the different action commands are available to be operated.

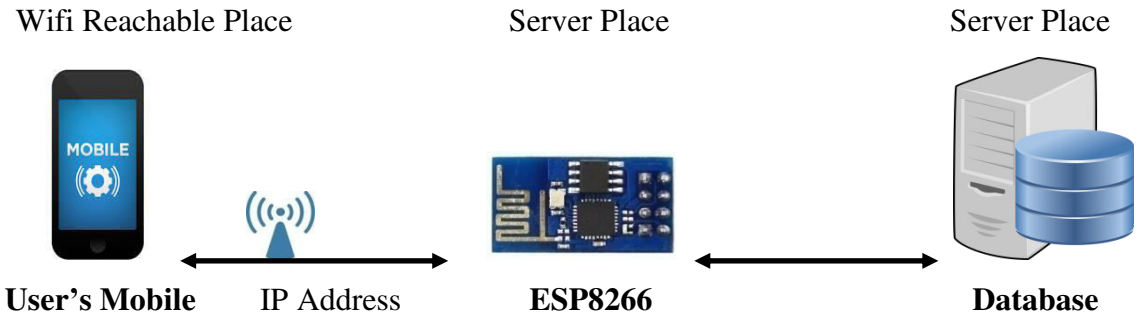

Figure 3.8: Block Diagram for Wi-Fi Communication

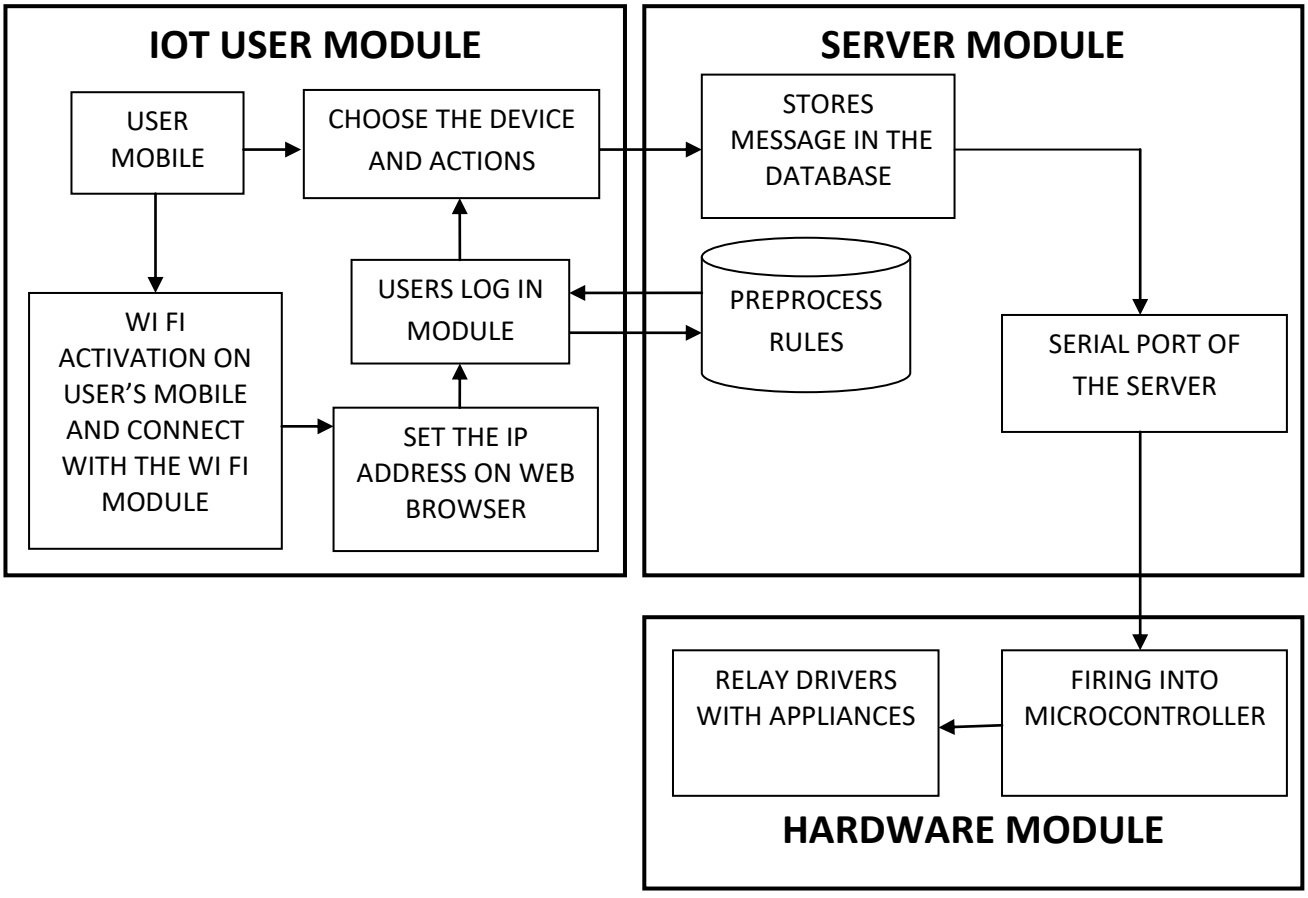

Figure 3.9: Frame work for Wi-Fi Communication

In the below figure, an idea about the operation of home automation system can be gained. The four different appliances such as fan, light, freeze and TV are operated remotely using Wi-Fi and through an application installed on mobile. These appliances are connected through the microcontroller with its digital input/output pins. These devices are connected with local Wi-Fi using a communicating module called esp8266. This hardware implementation contains 4 different parts. (i)A 16X2 LCD display for displaying status of the system and IP address of the local Wi-Fi network (ii) Relay for switching the load automatically, (iii) AT89S52 Microcontroller for decision maker and (iv) esp8266 version 12 for connecting to local Wi-Fi.

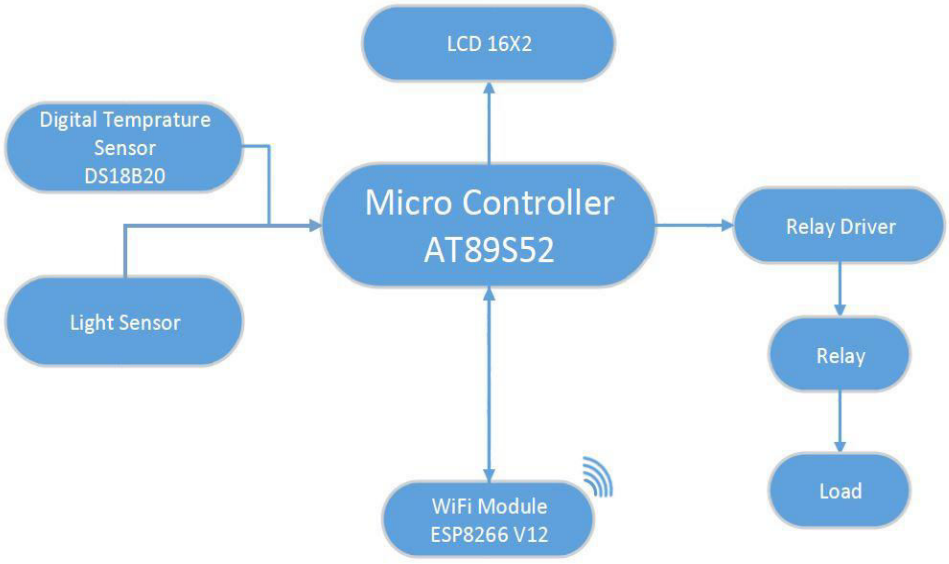

Figure 3.10: Components for IoT Communication[46]

3.2 FUNCTIONAL DETAILS OF DIFFERENT MODULES

3.2.1 SERVER MODULE

The server module contains a common database and the software package, the two sub-modules of the systems. The database is the core part of the home server because it is only responsible for storing all the information details regarding the electrical devices and its controlling for the users as well as the administrator. The integrated database is always ready for the incoming information (command/action) to the server that can be delivered through

four communication mechanisms like SMS, Web Page, Speech and Wi-Fi. Basically, server has the accessibility for accessing web page which is present in the user's PC through internet and also can access messages from the mobile phone through GSM network. In Speech Communication, the voice commands given by the user are stored into the same database through an IVR system. In IOT mechanism, user can send their action command through and interface present in their mobile through an IP address of a Wi-Fi Modem. In this system, we have used Lua, lightweight multi-paradigm programming language designed primarily for embedded systems and clients to write script for ESP8266 module to support remote control of device.

Similarly, on the other hand, users can know the status of the electrical devices. At a particular time, Users can visualize the status at a moment when he/she wants either in the web page or in their cell phone from a remote place. The remote communication between the server and the internet connected user's computer can be established by a static IP address (Internet IP). The GSM modem is simply connected to server by a USB to serial communication cable [44].

The server module also can be easily configured to handle one hardware interface module. Server machine is nothing but a normal PC containing software package. The server software is developed using Python, so server should support python application for open source Linux based operating System. The software package can access the database containing by the home server. The hardware module can be controlled by the server locally as well as remotely. RS232 communication protocol is selected to be the network infrastructure that connects server and hardware interface modules. The main functions of the server is to manage, control, and monitor distrusted system components, that enables hardware interface modules to execute their assigned tasks and to report server with triggered events.

3.2.2 Hardware Interface Module

The hardware interface module contains two sub modules as microcontroller and the connecting the electrical devices. The AT89S52 microcontroller is the core part of the hardware interface and electronic circuit board is the intermediate between microcontroller and the household appliances. Besides, a software package is developed in embedded C

programming using the compiler named as Keil for controlling the 8051 microcontroller. The source code for the ARM microcontroller was written in programming language C. The IDE used was KeilμVision.TheμVision IDE from Keil combines project management, make facilities, source code editing, program debugging, and complete simulation in one powerful environment. The μVision development platform is easy-to-use and helps us quickly create embedded programs that work. The μVision editor and debugger are integrated in a single application that provides a seamless embedded project development environment. The serial port present in the hardware module is responsible for receiving the instruction given by the server machine. The server's instructions are transmitted into microcontroller via a TTL to serial convertor MAX 232. On the other hand, for implementing IoT based communication, ESP8266 Flasher is used for flashing the firmware into the ESP8266 Wi-Fi module. Then ESPlorer is used which is an IDE for ESP developers. SciTE is used because is an IDE for Lua development [47]. The microcontroller is connected with the electronic circuit board by simply a wired connection and board is also directly connected to the electrical appliances using direct wired connections. Hardware interface module provides the controlling of electronic devices like lights, water pump, freeze and fans etc. Actually, the hardware interface is none other than an electronic circuit with a relay driver board. An adapter will supply 12 V to the whole electronic circuit and relay driver board.

Administrator or User can see the status and all the information regarding the device control in a LCD display locally. The LCD display is also controlled by the software package present in the microcontroller. In other hand, the hardware interface has the ability to send the status of the device or reply of the user's command.