2

LITERATURE SURVEY

CONTENT

CHAPTER 2

LITERATURE SERVEY

2.1 Overview

Automation system has been a feature of science fiction writing for many years, but has only become practical since the early 20th Century following the widespread introduction of electricity into the home, and the rapid advancement of information technology. In 1889, Nikola Tesla patented an idea for the remote control of vessels and vehicles. In between 1915 and 1920, the emergence of electrical home appliances began. This leads to the decline of domestic servants and their gradual replacements by cheap and mechanical household devices. Ideas similar to modern home automation systems originated during the World's Fairs of the 1930s. Fairs in Chicago (1934) and New York (1939) depicted electrified and automated homes. In 1966, Jim Sutherland, an engineer developed a home automation system called "ECHO IV"; this was a private project and never commercialized. The first "wired homes" were built by American hobbyists during the 1960s, but were limited by the technology of the times. In 1984, the term "smart house" was first coined by the American Association of House builders [5].

2.2 Basics of PC Based Device Controlling

While the fundamental purposes and functions of instrumentation systems have remained the same from its inception there is a paradigm shift over the years in methodology of measurement and interpretation and control due to continuous technological innovations. The introduction of fast and digital technology and components such as analog to digital convertors, microprocessors associated with revolutionary advancement in communication technology has replaced natural scale-up versions of manual monitoring and control to highly advanced automated process monitoring and control systems[6].

The industrial revolution has contributed largely in the development of machine based control where machines in process industries were took over the work done by the human physical power. The early production processes were natural scale-up versions of the traditional manual practices. These are designed as batch process which later was expanded to continuous processes resulting in economical and technological benefits. Industrial PCs (IPCs) become more and more important in the field of automation technology. Due to their scaling options and various combinations of visualisation and control on one device, Industrial PCs provide clear advantages for many applications.

PCs are available with the following software equipment-

- PC as component, on request with operating system, without further software
- Industrial PC as visualisation system
- Industrial PC as control and visualisation system

2.2.1 Wired Based Communication from Source to PC

The concept of home automation technology emerged in 1975, when a company in Scotland developed X10. X10 allows various devices and appliances in the house to communicate with each other over the already existing electrical wires. All the appliances and devices (such as lights, fans, air-conditioners, TV etc) are equipped with receivers, and the means of controlling the system, such as remote controls or keypads, are equipped with transmitters. These receivers detect a certain signal initiated by the transmitter so that the user can operate them via a remote command. To turn off a lamp in another room, the transmitter will issue a message signal in numerical code which will be transmitted through power-line cable to the specific lamp and commands the lamp to turn off.

X10 is the father of power line home automation protocols. It facilitates control of household devices over the existing home wiring system. X10-compatible devices are still popular in home automation products because of their low cost and ease of installation. But communication over electrical lines using X10 is not always reliable because the lines may get "noisy" from powering other devices. An X10 device could interpret a false electronic interference as a command and react, or it might not receive the command at all. So, noise filters and phase couplers will be required to implement X10 which makes it very expensive.

Lon work is an important type of bus-line home automation protocols. It uses Home and commercial control network. A Lon Works control network is any group of devices working together to sense, monitor, communicate, and control. A Lon Work smart homes use a separate 12-volt cable (twisted pair) to transmit data to devices, which runs in parallel to the traditional mains cable. The use of this cable means that devices are independent of conventional mains borne power supplies [7].

Ce-Bus is another type of bus-line home automation protocols. The Consumer Electronic Bus (Ce-Bus) Standard is a protocol specification developed by the Electronic Industries Association for electronic devices to transmit commands and data.

The RS-232 is a cable communication protocol that connects the computer with the device directly. It is a standard protocol used in asynchronous serial communication. It is the primary protocol used over modem lines. It is the protocol used by the MicroStamp11 when it communicates with a host PC. The communication is achieved via a computer serial port and the serial port of the device. In order to connect to a PC or laptop that doesn’t have a serial port, it is possible to convert the serial port to a USB using a USB-to-Serial converter. On the other hand, the RS- 485 is a cable which allows many devices to be connected to a computer. Through a single RS-485 cable multiple devices can communicate with a computer. The communication is achieved via a computer serial port and the serial port of the devices.

2.2.2 Wireless Based Communication from Source To PC

In 1895, Guglielmo Marconi opened the way for modern wireless communications by transmitting the three-dot Morse code for the letter ‘S’ over a distance of three kilometers using electromagnetic waves. From this beginning, wireless communications has developed into a key element of modern society. From satellite transmission, radio and television broadcasting to the now ubiquitous mobile telephone, wireless communications has revolutionized the way societies function. In the early 1900s, voice and then music was transmitted and modern radio was born. Early radio systems transmitted analog signals. Today most radio systems transmit digital signals composed of binary bits, where the bits are obtained directly from a data signal or by digitizing an analog signal. A digital radio can transmit a continuous bit stream or it can 8group the bits into packets. The introduction of wired Ethernet technology in the 1970’s steered people from radio-based networking. In 1985, the federal Communications Commission (FCC) enabled the commercial development of wireless LAN [8].

In Wireless Communication, one can transmit/receive voice and data using electromagnetic waves in open space. The information from sender to receiver is carrier over a well-defined frequency band (channel).Each channel has a fixed frequency bandwidth and Capacity (bit-rate). Different channels can be used to transmit information in parallel and independently.

2.2.2.1 Infrared Based Mechanism

An infrared based home automation system will employ a remote control that sends infrared signals to the receivers attached with each home appliance. These infrared signals carry a command that specifies the activation of the device. Infrared technology is very cheap and is easily affordable but infrared requires line of sight to transmit signals from transmitter to receiver. Infrared remote controls use invisible light pulses below the visible wavelength spectrum (approx. 950nm). In terms of its radiation behaviour it is like any other visible source of light: There must be a line of sight between the transmitter (light source) and the receiver (light detector). Any obstacles between transmitter and receiver will prevent from correct reception. Under good conditions scattered light or light reflected from walls may keep the system working. Having walls between the remote controller and the receiving device will definitely disable the remote control. This obvious disadvantage of IR remote controls simplifies the protocol at the same time [9].

2.2.2.2 Bluetooth Based Mechanism

Bluetooth is a promising technology for short-range, low-power wireless communications. Operating in the 2.4GHz license-free ISM (Industrial, Scientific-Medical) band, Bluetooth adopts a 79-channel Frequency Hopping Spread Spectrum (FHSS)1 technology with a hopping rate of 1600 hops per second. In Bluetooth, before any two devices can communicate with each other, they must go through a device discovery procedure which consists of two steps, inquiry and paging. The former is for devices to find each other, while the latter is to establish actual connections. According to the specification, the inquiring procedure may take 10.24 seconds or longer, and the paging, 7.68 seconds or longer. This long connection setup time is fine for static applications, but is intolerable for mobile applications demanding quick and short connections, such as multi-media name card exchange and pedestrian surroundings information retrieval. Consequently, many approaches have been proposed to speed up the Bluetooth device discovery procedure.

One major component in the discovery delay is the long frequency-matching time. Bluetooth adopts master-slave architecture. To establish a connection between two devices, a potential master should be in the inquiry state to periodically send consecutive ID packets on some predefined 32 channels (or frequencies2), and a potential slave should be in the inquiry scan state trying to catch an ID packet from the right channel at the right time. Only when a frequency-matching occurs, i.e., the slave correctly receives an ID packet, can the inquiry-paging procedure be started [10].

2.2.2.3 Zigbee Based Mechanism

Nowadays the most prominent network used in home automation is ZigBee. ZigBee is a high level communication protocol that uses small, low-power radio waves based on an IEEE 802 standard for personal area networks. ZigBee technology employs mesh networks, meaning there's more than one way for the message to get to its destination. A ZigBee mesh provides multiple pathways from device to device (like the Internet) and uses Routing Algorithm to determine the fastest route for messages to reach the device receivers. ZigBee eliminates a single point of failure because if nodes go down or are removed, ZigBee devices can "zig" and "zag" through the network to their destination like a bumblebee. ZigBee is similar in concept to other WPAN such as the well known “Bluetooth”. However, it is designed to provide connectivity between small packet devices (battery powered active nodes), while Bluetooth concerns connectivity between large packet user devices such as mobile phones and laptop computers. Thus, ZigBee devices are much less complex as well as less expensive than comparable Bluetooth devices. ZigBee provides long range signal transmission among nodes in a mesh network where each node of the network requires power source (batteries). Although ZigBee is suitable in case of large buildings and wide campus, in case of a Home or office rooms it leads to huge power consumption and expensive installation. Besides, home automation networks don't need all the complexity of a ZigBee mesh network or WPAN because activation commands are short messages and can be communicated within short range [11].

2.2.2.4 Web Based Mechanism

Internet is a reliable and feasible option for achieving the interaction with the home automation network from the remote place. To accomplish this achievement, a web server should be needed to receive requests and responses from remote clients. The clients can send requests to the home appliances. The home appliances can send their statuses to be displayed for the remote client through the server. A web page is constructed as an interactive interface where commands can be submitted by the client to change and also monitor the status of the devices. Using a web page through the internet we can access the database directly. The status changes that are reflected to the database are transferred to the device through first the master and then to the slave nodes, which will be described in the next section. In addition a login/password based access is setup to prevent unauthorized accesses. With the internet page, authorized users can login to their home environment, monitor and change the status of the devices of their choice.

A user interface is built to bridge the database with the hardware attached. Along being a user interface this program with certain intervals synchronizes the status of the devices to match their status with the database value. If there is any change in status of a device in the database, this change is synchronized with the device. Similarly the statuses of the devices are updated on the database as the conditions on devices change [12].

2.2.2.5 GSM Based Mechanism

The GSM is an excellent choice in establishing a communication from remote locations where Internet may not be available. The communication between the user and the home is established by the SMS (Short Message Service) protocol. A GSM modem is connected to the home automation server. The communication between the home automation server and the GSM modem is carried out by the AT (Attention) commands. Sending and receiving SMS messages are all performed in the PDU (Protocol Description Unit) mode since the text mode may not be available on all GSM modules. The Global System for Mobile Communications (GSM) is a digital standard wireless technology GSM is the most widely used wireless technology in the world with one billion customers globally, which represents 72% of all wireless customers. GSM has a high presence among users (almost everybody has a mobile) raising the probability of the remote controlled HAS to be accessible, furthermore by programming the GSM modem using AT/AT+ commands it provides another security layer (modem will respond only to specific mobiles) and certain robustness. At this backup level, the interaction with the user is very simple; the bilateral communication is reduced to the minimum, only representing emergency processes. Eventually, the remote-controlled HAS will send alerts to the user´s mobile informing about unusual state changes in the sensors within the building, afterwards user is able to activate/deactivate some automated devices required to solve the issue either by dials or messaging or, in the usual case, using a web interface, in any case the user will have always two possible accesses in case that one fails. Normally the probability of accessing the GSM network will be higher than accessing the Internet [13].

2.2.2.6 Speech Based Mechanism

An automated home is also called as a smart home. As we know, the speech is a special kind of communicator among all human beings for their communication; Human voice commands are used for speech based home automation system to operate the electrical home appliances. This idea is most beneficial for human society, especially for old age and physically handicapped people. Basically, speech based home automation system has two schemes for controlling and automating devices. When users are at home, Bluetooth technology is used as one of the schemes for controlling of electrical appliances. It uses a kind of Bluetooth module and a Bluetooth controller mobile application to switch on or switch off the devices. When users are at outside home, the GSM/GPRS technology is used as another scheme for controlling the electrical devices. The total system also alarms the users about any disturbance or interruption into the house when users are stayed outside. This system is designed and developed on microcontroller board. A programming language integrated development environment (IDE) is used for developing the necessary software. Relays and bulbs are used as load to demonstrate the working of the prototype system. Speech based Home automation system provides accessibility, comfort and energy efficiency along with security surveillance [14].

2.2.2.7 IOT Based Mechanism

Home automation is the process of controlling or operating various equipment, electrical devices automatically with the help of lots of control and communication techniques or mechanisms. The electrical devices present at home like fan, lights, water pump, fire alarm, refrigerator etc. can be managed using different controlling mechanisms mentioned already above. The recent emerging technique to control electrical devices is Internet of Things(IoT) over the cloud. There are lots of home automation systems like Wi-Fi based through a static or dynamic IP address from an android mobile phone, Arduino based home automation, remote android application based home automation system, RFID based home automation system and some other home automation based touch screen. [15]. The most effective and innovative application of IOT is nothing but the Wireless home automation through Internet of Things that can be developed to control electrical devices from a remote place over the cloud. The desired components and tools for home automation system using IoT are mentioned like a Wi-Fi module, TRIAC, Resistors, Capacitors, Opto-coupler, diode, regulators, loads etc.

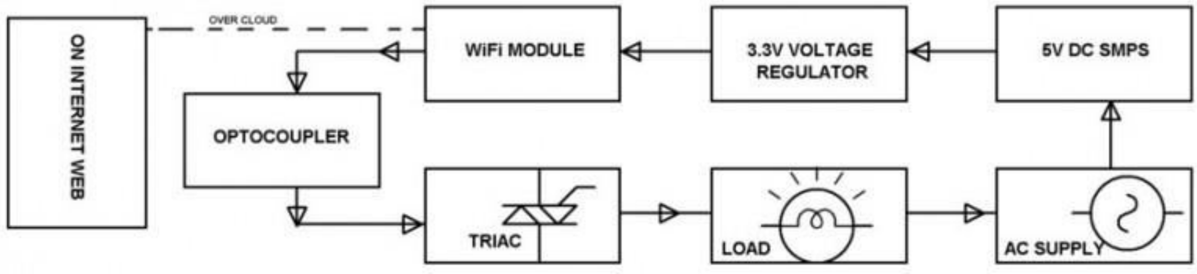


Figure 2.1: Required Blocks for IOT based Home Automation

The entire system framework of home automation using IOT can be divided into various blocks like power supply, Opto-coupler, Wi-Fi module, Switch Mode Power Supply (SMPS), TRIAC, voltage regulator, and loads.

Wi-Fi Module

Wireless Fidelity is one kind of wireless networking technology to interchange the information among more than one device without using any cable or a single wire. Wi-Fi technologies have various standards such as Wi-Fi 802.11a, 802.11b, 802.11g and 802.11n. Wi-Fi module is used to receive the requests and responses in terms of commands from the internet and activate the relay drivers connected to the loads using TRIAC & Opto-coupler by running a program within the Wi-Fi module [16].

Voltage Regulator

Voltage regulator is electronic equipment. Usually, in the power system, it is used for regulating voltage. There are different models of voltage regulators. First one is variable voltage & another one is fixed voltage regulators. Fixed voltage regulators are again subdivided into various types such as electro-mechanical, automatic voltage, linear, hybrid regulators, etc.. In fact, for a Wi-Fi module, 3.3V voltage regulator is required to provide sufficient power supply from 5V SMPS power supply.

Figure 2.2: voltage Regulator

Opto-coupler

Opto-coupler is the package of light emitting device and light sensitive device where electrical connections are not existed. Opto-coupler is called as also Opto-isolator. The connection between the light emitting & light sensitive devices is established by using a beam of light. The light emitting device is simply a LED and light sensitive device is a TRIAC. Therefore, system used to drive loads depending on the signal that can be received from a Wi-Fi module. [17].

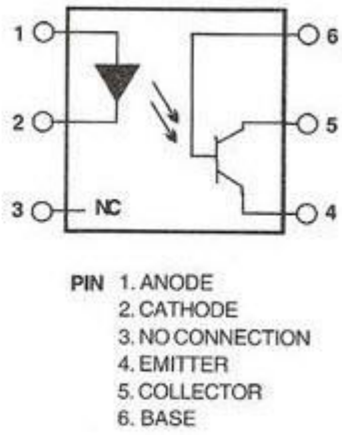


Figure 2.3: Opto - Coupler

User can control and monitor the loads using a web page with self designed interface. The user can send action request through the static IP and these actions are fed to Wi-Fi module. Any reachable wireless modem is used to configure the Wi-Fi module to access internet. The action requests received by a Wi-Fi module are executed by a software package programmed in a Wi-Fi module. The Wi-Fi module is configured to TRIAC & Opto-coupler using the loads are turned ON & OFF and status based on action requests. The web page is used to display the load status (ON or OFF or STATUS).

2.3 Global System for Mobile Communication

Global System for Mobile communications (GSM) is an open sourced digital cellular technology based communication technique that is used to transmit human voice and data services through a mobile. GSM differs from first generation wireless systems in that it uses digital technology and Time Division Multiple Access (TDMA) transmission methods. GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz time-slots.

2.3.1 GSM Module

GSM module is used to establish communication between a computer and a **GSM system**. **Global System for Mobile communication (GSM)** is an architecture used for mobile communication in most of the countries. **GSM module consists of a GSM modem assembled together with power supply circuit,** AT command set and RS232 communication interface on CMOS level. [18]

Figure 2.4: GSM/GPRS Modem

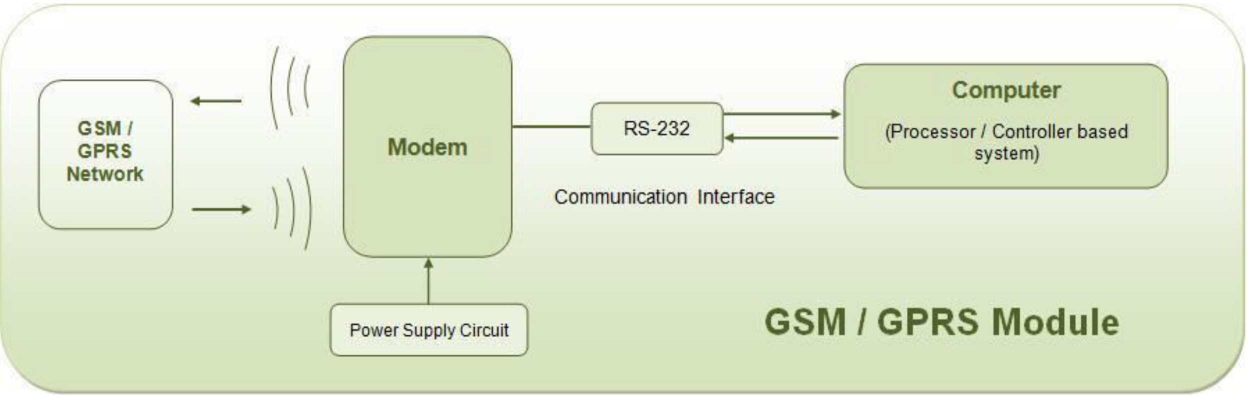


Figure 2.5: Communication module GSM/GPRS Modem

GSM MODEM is a wireless device that generates, transmit or decode data from a cellular network, for establishing communication between the cellular network and the computer. These are manufactured for specific cellular network (GSM/UMTS/CDMA) or specific cellular data standard (GSM/UMTS/GPRS/EDGE/HSDPA) or technology (GPS/SIM). Wireless MODEMs like other MODEM devices **use serial communication** to interface with and need **Hayes compatible** AT commands for communication with the computer (any microprocessor or microcontroller system).

A GSM modem requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Also they have IMEI (International Mobile Equipment Identity) number similar to mobile phones for their identification. A GSM MODEM can perform the following operations:

1. Receive, send or delete SMS messages in a SIM.
2. Read, add, search phonebook entries of the SIM.
3. Make, Receive, or reject a voice call.

The MODEM needs AT commands, for interacting with processor or controller, which are communicated through serial communication. These commands are sent by the controller/processor. The MODEM sends back a result after it receives a command. Different AT commands supported by the MODEM can be sent by the processor/controller/computer to interact with the GSM cellular network.

2.3.2 SMS Technology

SMS Technology i.e. short message service technology is a mechanism of delivery of short messages over the mobile networks. It is a store and forward way of transmitting messages to and from mobiles. The message (text only) from the sending mobile is stored in a central short message center (SMS) which then forwards it to the destination mobile. This means that in the case that the recipient is not available; the short message is stored and can be sent later. Each short message can be no longer than 160 characters. These characters can be text (alphanumeric) or binary Non-Text Short messages. An interesting feature of SMS is return receipts. This means that the sender, if wishes, can get a small message notifying if the short message was delivered to the intended recipient. One user can send short messages to any other GSM mobile user around the world. So SMS is more or less a universal mobile data service [17].

Two services given by SMS Technology –

1. Short message Mobile Terminated (SMS-MT): the ability of a network to transmit a Short Message to a mobile phone. The message can be sent by phone or by a software application.
2. Short message Mobile Originated (SMS-MO): the ability of a network to transmit a Short Message sent by a mobile phone. The message can be sent to a phone or to a software application.

How does SMS work –

The figure below shows a typical organization of network elements in a GSM network supporting SMS.

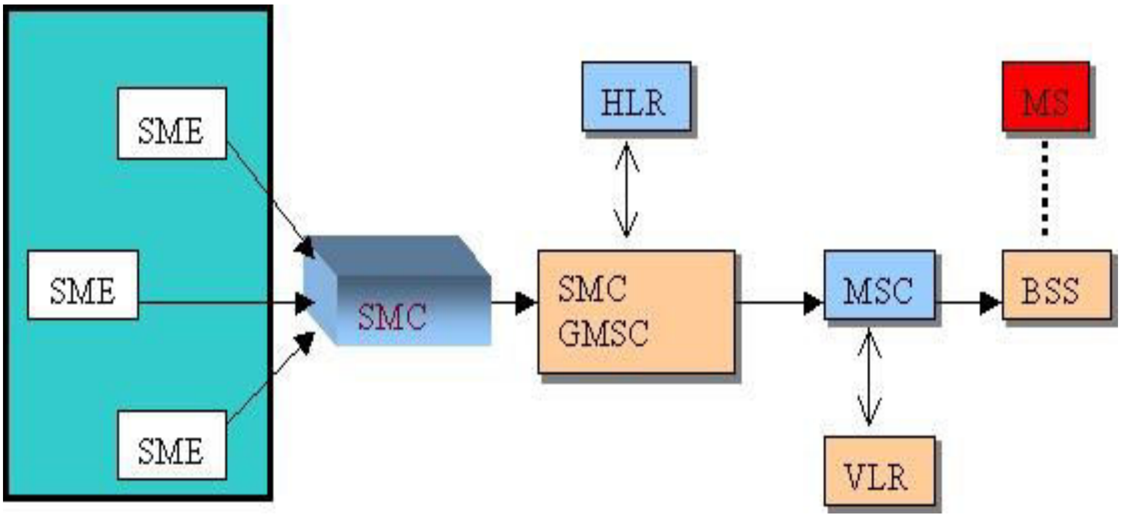


Figure 2.6: Organization of SMS module

The SMC (Short Message Centre) is the entity which does the job of store and forward of messages to and from the mobile station.

The SME (Short Message Entity) which can be located in the fixed network or a mobile station, receives and sends short messages. [18]

The SMS GMSC (SMS gateway MSC) is a gateway MSC that can also receive short messages. The gateway MSC is a mobile network's point of contact with other networks. On receiving the short message from the short message centre, GMSC uses the SS7 network to interrogate the current position of the mobile station form the HLR, the home location register.

HLR is the main database in a mobile network. It holds information of the subscription profile of the mobile and also about the routing information for the subscriber, i.e. the area (covered by a MSC) where the mobile is currently situated. The GMSC is thus able to pass on the message to the correct MSC.

MSC (Mobile Switching Centre) is the entity in a GSM network which does the job of switching connections between mobile stations or between mobile stations and the fixed network.

A VLR (Visitor Location Register) corresponds to each MSC and contains temporary information about the mobile, information like mobile identification and the cell (or a group of cells) where the mobile is currently situated. Using information from the VLR the MSC is able to switch the information (short message) to the corresponding BSS (Base Station System) which transmits the short message to the mobile. The BSS consists of transceivers, which send and receive information over the air interface, to and from the mobile station. This information is passed over the signalling channels so the mobile can receive messages even if a voice or data call is going on. In our proposed system, SMS sending and receiving Technology is implemented with the reference to AT command.

2.3.3 AT Commands

AT commands are sets of commands used for communication with the cellular modem. **AT** commands are comprised of assemblies of ASCII characters which start with the **"AT"** prefix and finish with a suffix<CR> character. The **AT** prefix is derived from the word **AT**tention, which asks the modem to pay attention to the current request (command) [19].

There are four types of AT commands classified as-

a) Test commands - used to check whether a command is supported or not.

b) Read command - used to get mobile phone or modem settings for an operation.

c) Set commands - used to modify mobile phone or modem settings for an operation.

d) Execution commands - used to carry out an operation.

AT commands are used to request services from the cellular modem.

Such as:

- **Call services**: dial, answer and hang up.
- **Cellular utilities:** send/receive SMS.
- **Modem profiles:** Auto Answer.
- **Cellular Network queries:** GSM signal quality

2.3.3.1 General Syntax Definition Used In AT Command

Table 2.1: General Syntax Definition of AT Command [19]

Syntax	Definition
<CR>	Carriage return character
<LF>	Line-feed character
<...>	Name enclosed in angle brackets is a syntax element. The brac themselves do not appear in the command line.
[...]	Optional sub-parameter of a command or an optional par terminal information response, enclosed in square brackets. brackets themselves do not appear in the command line.
//	Denotes a comment, and should not be included in the comman

2.3.3.2 AT Commands Protocol

The **AT** commands interface is basically a Modem Services upon Request. Communication always begins from the terminal side. This means that any service should be requested from the terminal. Thus a request is called a "command". Each command must be answered by a "results code" from the cellular modem. The results code reports command status to the terminal. Some commands may include several "Response" requests to the terminal.

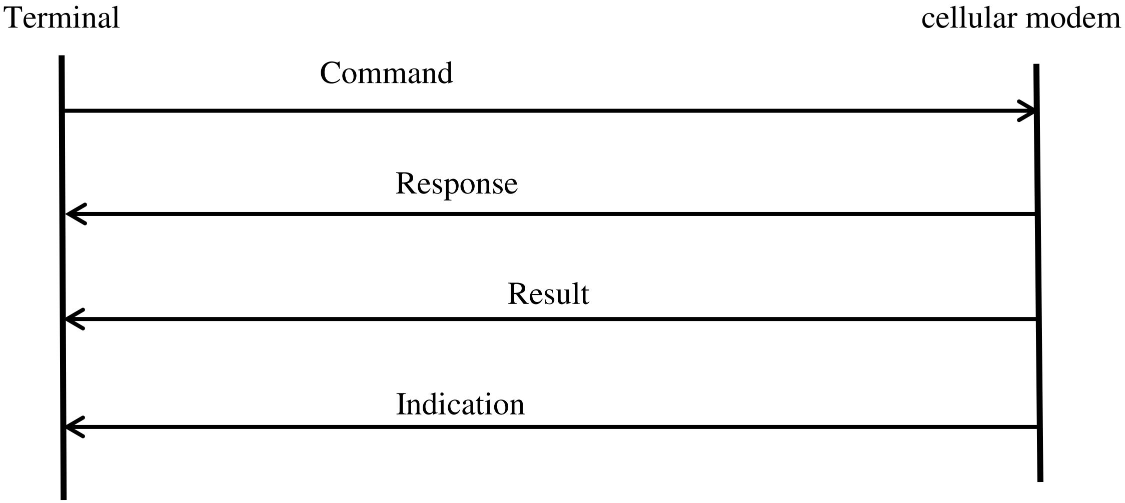


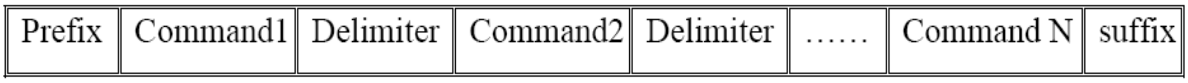
Figure 2.7: AT Commands Protocol

The figure 2.7 shows a general messaging sequence of AT commands protocol between the terminal and the cellular modem.

2.3.3.3 AT Commands Structure

An AT command line may contain one or more commands. Delimiters are used to separate the commands from each other, according to the following structure:

Table 2.2: General Syntax Definition Used In AT Command



Prefix	Command1	Delimiter	Command2	Delimiter	……	Command N	suffix

- Each AT command has the "AT" prefix string.
- Each AT command has the suffix <CR>.

- The delimiter is either a semicolon ";" or none, meaning space.

The Different basic structure of an AT command line:

Table 2.3: Syntax Definition of ATD

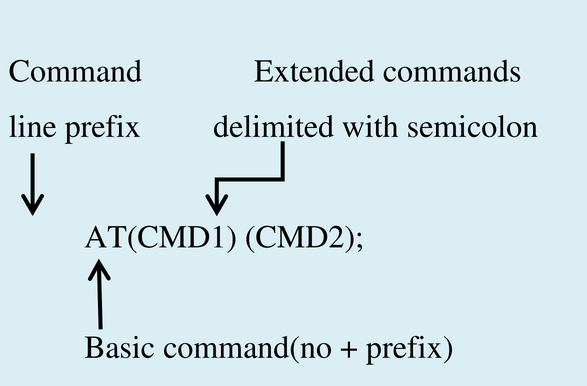
 Command line prefix Extended commands delimited with semicolon AT(CMD1) (CMD2); Basic command(no + prefix)	As Example, ATD 9706733484 ; This is used to dial this certain Number.

Table 2.4: Syntax Definition of CMGF

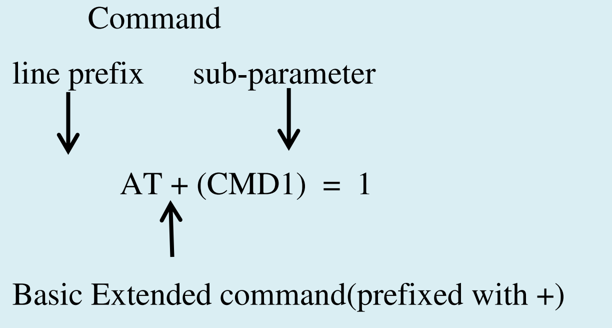
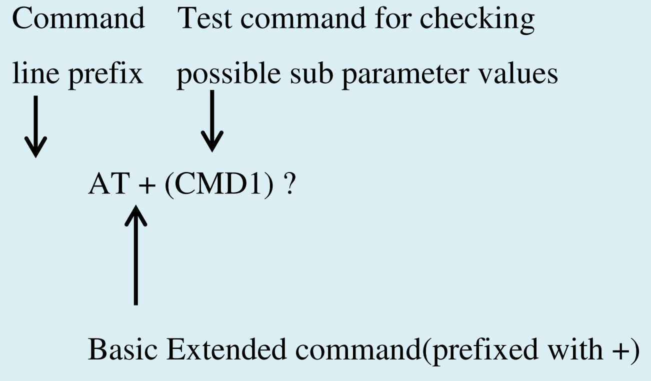
 Command line prefix sub-parameter AT + (CMD1) = 1 Basic Extended command(prefixed with +)	As Example, AT + CMGF =1 This is used to make the message format as text

Table 2.5: Syntax Definition of CPIN

 Command line prefix Test command for checking possible sub parameter values AT + (CMD1) ? Basic Extended command(prefixed with +)	As Example, AT + CPIN? This is used to know The SIM PIN state is ready or not.

2.3.3.4 Results Code Structure

When a command is issued, the cellular modem responds with a message, called a "Result Code", which tells the terminal the result of the command that was requested.

The result code has the following structure:

Prefix	Code	Suffix

2.3.3.5 Response and Indications Structure

The following is the information response and indications structure:

Token	Separator	Arguments

Where,

The separator is ":".

In this proposed system, basically three of AT command are used. They are given below-

2.3.3.6 Call Control AT Commands

- Dial command D

Description: The ATD command sets a voice, data or fax call. As per GSM 02.30, the dial command also controls supplementary services. For a voice call, the application sends the following ASCII string to the product.

Syntax: **ATD< nb >;** Where, <nb> is the destination phone numbe

Here,

Semicolon (;) : When given after <number string>, a voice call is originated to the given address, otherwise a data call is originated.

- Hang-Up command H

Description: The ATH (or ATH0) command disconnects the remote user. In the case of multiple calls, all calls are released (active, on-hold and waiting calls). The specific Wave com ATH1 command has been appended to disconnect the current outgoing call, only in dialling or alerting state (i.e. ATH1can be used only after the ATD command, and before its terminal response (OK, NO CARRIER,...). It can be useful in the case of multiple calls.

Syntax: ATH;

2.3.3.7 Short Messages Commands

- New Message Indications to Terminal +CNMI

Description: This command handles enabling of unsolicited notifications to the terminal when an SMS is received by the GSM modem. After sending an unsolicited response to the TE, the G24 will expect a +CNMA (new message acknowledgement) from the TE within a predefined timeout of 60 seconds. The GSM modem will not send another unsolicited response to the TE before the previous one is acknowledged. If acknowledged within the timeout, the new SM is not saved in the message storage. If not, the new SM is saved in the message storage and +CNMI parameters are set to 0.

Syntax: AT+CNMI= [<mode> [,<mt>[,<bm> [,<ds>[,<bfr>]]]]]

Defined values:

<mode>: controls the processing of unsolicited result code
<mt>: sets the result code indication routing for SMS-DELIVERs. Default is 0.
<bm>: set the rules for storing received CBMs (Cell Broadcast Message) types depend on its coding scheme, the setting of Select CBM Types (+CSCB command) and Default is 0
<ds> : for SMS-STATUS-REPORTs. Default is 0.
<bfr>: Default is 0

- Preferred Message Format + CMGF

Description: The message formats supported are *text mode* and *PDU mode*. In PDU mode, a complete SMS Message including all header information is given as a binary string (in hexadecimal format).Therefore, only the following set of characters is allowed:

{‘0’,’1’,’2’,’3’,’4’,’5’,’6’,’7’,’8’,’9’, ‘A’,‘B’,’C’,’D’,’E’,’F’}. Each pair or characters are converted to a byte (e.g.: ‘41’ is converted to the ASCII character ‘A’, whose ASCII code is 0x41 or 65). In Text mode, all commands and responses are in ASCII characters. The format selected is stored in EEPROM by the +CSAS command.

Syntax: AT+CMGF=<index>

As example, AT + CMGF=1 for text mode

AT + CMGF=0 for PDU mode

➢ Read message +CMGR

Description: This command allows the application to read stored messages. The messages are read from the memory selected by +CPMS command.

Syntax: AT+CMGR=<index>

➢ Send message +CMGS

Description: The <address> field is the address of the terminal to which the message is sent. To send the message, simply type, <ctrl-Z> character (ASCII 26). The text can contain all existing characters except <ctrl-Z> and <ESC> (ASCII 27). This command can be aborted using the<ESC> character when entering text. In PDU mode, only hexadecimal characters are used (‘0’…’9’,’A’…’F’).

Syntax: Command syntax in text mode*:*
AT+CMGS= <da>[,<toda>] <CR>
text is entered <ctrl-Z / ESC >

Command syntax in PDU mode*:*
AT+CMGS= <length><CR>
PDU is entered <ctrl-Z / ESC >

Parameters used in the syntex are given below-

<da>: Destination address in quoted string. This field contains a single MIN number.

<toda>: Type of DA. Value between 128-255 (according to GSM 03.40.9.1.2.5). If this field is not given and first character of <da> is '+', <toda> will be 145, otherwise 129.

<length>: Size of message in PDU mode format, in octets, excluding SMSC data.
<mr>: Sent message reference number.

2.4 World Wide Web Communication

The World Wide Web communication is a system of interlinked hypertext documents accessed via the Internet. With a web browser, one can view web pages that may contain text, images, videos, and other multimedia, and navigate between them via hyperlinks.

2.4.1 WAMP Server

WAMP Server is a web development platform on Windows environment allowing anyone to create dynamic web applications with Apache2, Php and MySQL. WAMP is an acronym formed from the initials of the operating system Microsoft Windows and the principal components of the package: Apache, MySQL and one of Php, Perl or Python. Apache is a web server. MySQL is an open-source database. Php, Perl and Python are scripting languages that can manipulate information held in a database and generate web pages dynamically each time content is requested by a browser. Other programs may also be included in a package, such as phpMyAdmin which provides a graphical user interface for the MySQL database manager. [20]

2.4.1.1 Apache web server

Apache is basically a most widely used Web server based on HTTP in the world. Originally, apache is introduced for open source environments like UNIX. But later on, the Apache Web server has been designed and developed for Windows and other environment also. It is playing a key role in the initial growth of the World Wide Web. Apache was originally based on NCSA HTTP code. The NCSA code has since been removed from Apache, due to a rewrite. [21]

Apache supports some common language interfaces like Perl, Python, Tcl, and Php. Apache features configurable error messages, DBMS-based authentication databases, and content negotiation. It is also supported by several graphical user interfaces (GUIs). It supports password authentication and digital certificate authentication. Apache has a built in search engine and an HTML authorizing tool and supports FTP. Because the source code is freely available, anyone can adapt the server for specific needs, and there is a large public library of Apache add-ons.

Apache has a few salient features like Stability, Efficiency, Portability and Open-source.

2.4.1.2 Php

Php (Php: Hypertext Preprocessor) was created by Rasmus Lerdorf in 1994. It was initially developed for HTTP usage logging and server-side form generation in UNIX. Php is a server scripting language, and is a powerful tool for making dynamic and interactive Web pages. Php code is interpreted by a web server with a Php processor module which generates the resulting web page: Php commands can be embedded directly into an HTML source document rather than calling an external file to process data. It has also evolved to include a command-line interface capability and can be used in standalone graphical applications. [22]

The main functional activities of Php regarding this present work are -

- ✓ generate dynamic page content
- ✓ create, open, read, write, and close files on the server
- ✓ collect form, data from the server
- ✓ send and receive cookies
- ✓ add, delete, modify data in the common database.
- ✓ restrict users to access some pages on the website
- ✓ encrypt data

Php is used in this present work because -

- ✓ Easy to use: Code is embedded into HTML.
- ✓ Cross Platform : Runs on almost any Web server on open source OS also.
- ✓ Cost Benefits : php is free.
- ✓ Huge databases : support for a wide range of databases.

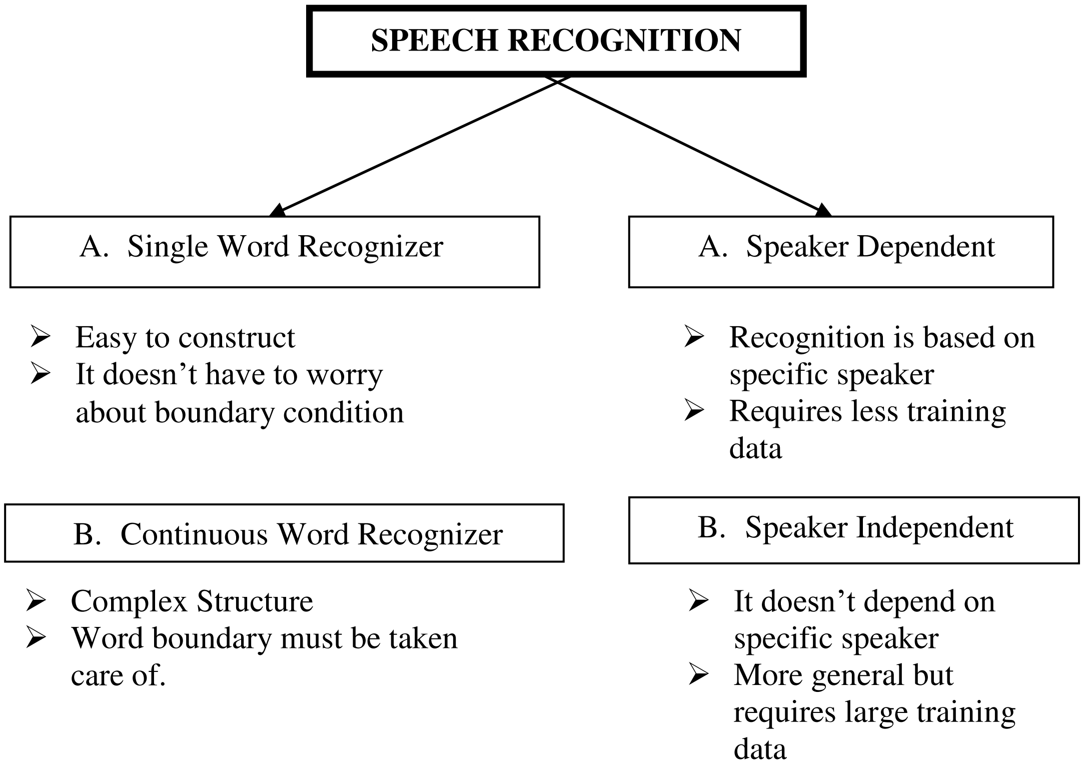
2.4.1.3 MySQL

MySQL is a database system used on the web and runs on a server. MySQL is developed, distributed, and supported by Oracle Corporation. It is a Multi-user and multi-threaded RDBMS server. MySQL is ideal system for both small and large databases. It uses SQL to interact with and manipulate data. It supports various programming languages. MySQL is very fast, reliable, and easy to use. MySQL can Access tables from different databases. MySQL is a relational database management system (RDBMS), and ships with no GUI tools to administer MySQL databases or manage data contained within the databases [23].

2.5 Speech Recognition Tools for Communication

The Speech is one of the most essential & primary mode of Communication among peoples. Human beings are always motivated to create computer system that can understand and talk like humans. So, Speech Recognition becomes one of the important research areas. In this context, automatic speech recognition (ASR) becomes most essential which can be built using HTK and Sphinx toolkit based on Hidden Markov Model. In the matter of our system, both toolkits were tried to use for speech recognition. But, Finally HTK was preferred for our system.

Speech recognition is a process of converting speech signal to a sequence of word. Various approaches have been used for speech recognition which includes Dynamic programming and Neural Network.



SPEECH RECOGNITION

A. Single Word Recognizer

- Easy to construct
- It doesn't have to worry about boundary condition

B. Continuous Word Recognizer

- Complex Structure
- Word boundary must be taken care of.

A. Speaker Dependent

- Recognition is based on specific speaker
- Requires less training data

B. Speaker Independent

- It doesn't depend on specific speaker
- More general but requires large training data

Figure 2.8: Speech Recognition Process Module

2.5.1 Speech Recognition and HMM

Speech recognition consists of two main modules, feature extraction and feature matching. The purpose of feature extraction module is to convert speech waveform to some type of representation for further analysis and processing, this extracted information is known as feature vector. The process of converting voice signal to feature vector is done by signal-processing front end module. As shown in below block diagram input to front-end is noise free voice sample and output of it is feature vector. In feature matching, the extracted feature vector from unknown voice sample is scored against acoustic model, the model with max score wins, and its output is considered as recognized word. There are a few methods for implementing front-end (for extracting feature factor) [24].

- MFCC (Mel-Frequency Cepstrum Coefficient)
- LPC (Linear Predictive Coding)

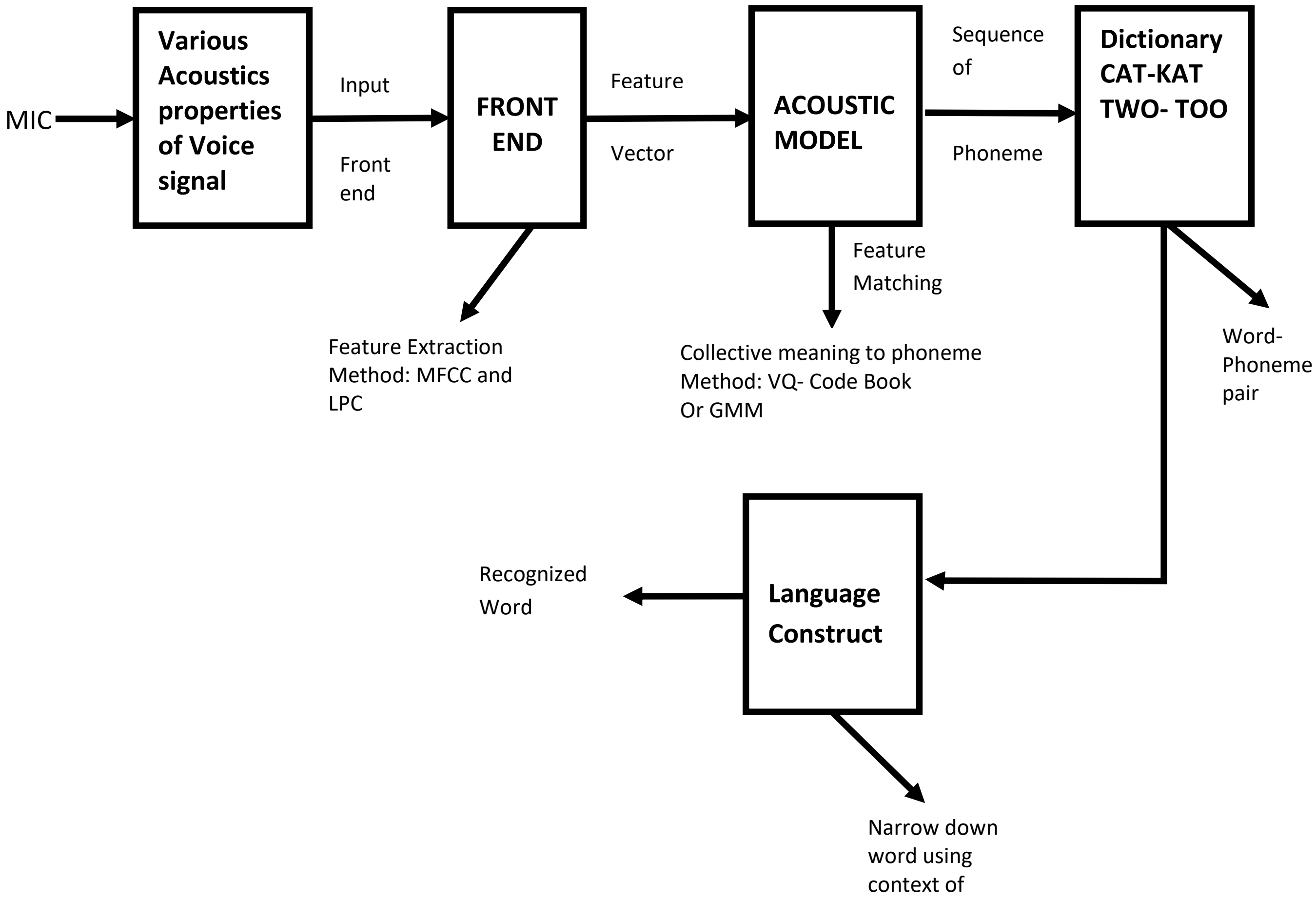

MIC
Various Acoustics properties of Voice signal
Input
Front end
FRONT END
Feature Extraction Method: MFCC and LPC
Feature
Vector
ACOUSTIC MODEL
Feature Matching
Collective meaning to phoneme Method: VQ- Code Book Or GMM
Sequence of
Phoneme
Dictionary CAT-KAT TWO- TOO
Word-Phoneme pair
Language Construct
Recognized Word
Narrow down word using context of

Figure 2.9: Speech Recognition model using HMM

2.5.2 Recognizing Toolkit – HTK

The HTK tools are best introduced by going through the processing steps involved in building a sub-word based continuous speech recognizer.

There are 4 main phases:

- Data preparation
- Training
- Testing
- Analysis.

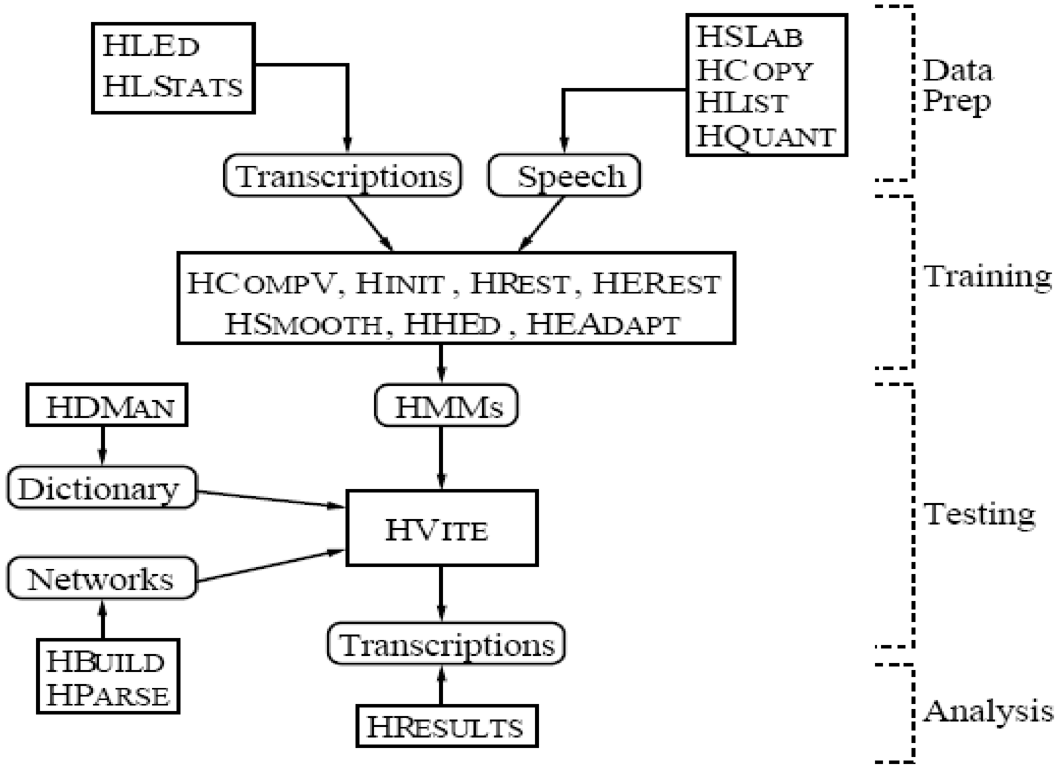


Figure 2.10: HTK Processing Stages

2.5.2.1 Data Preparation Tools

For building a set of HMMs, a set of speech data files and their associated transcriptions are required. Very often speech data will be obtained from database archives. Before it can be used in training, it must be converted into the appropriate parametric form and any associated transcriptions must be converted to have the correct format and use the required phone or word labels.

Although all HTK tools can parameterise waveforms *on-the-fly*, in practice it is usually better to parameterise the data just once. The tool HCopy is used for this. HCopy is used to copy one or more source files to an output file. Normally, HCopy copies the whole file, but a variety of mechanisms are provided for extracting segments of files and concatenating files. By setting the appropriate configuration variables, all input files can be converted to parametric form as they are read-in. Thus, simply copying each file in this manner performs the required encoding [25].

Transcriptions will also need preparing. Typically the labels used in the original source transcriptions will not be exactly as required, for example, because of differences in the phone sets used. Also, HMM training might require the labels to be context-dependent. The tool HLEd is a script-driven label editor which is designed to make the required transformations to label files. HLEd can also output files to a single *Master Label File* MLF which is usually more convenient for subsequent processing. Finally on data preparation, HLStats can gather and display statistics on label files in preparation for building discrete probability HMM system.

2.5.2.2 Training Tools

The second step of system building is to define the topology required for each HMM by writing a prototype definition. HTK allows HMMs to be built with any desired topology. HMM definitions can be stored externally as simple text files and hence it is possible to edit them with any convenient text editor. Alternatively, the standard HTK distribution includes a number of example HMM prototypes and a script to generate the most common topologies automatically. With the exception of the transition probabilities, all of the HMM parameters given in the prototype definition are ignored. The purpose of the prototype definition is only to specify the overall characteristics and topology of the HMM. The actual parameters will be computed later by the training tools. Sensible values for the transition probabilities must be given but the training process is very insensitive to these. An acceptable and simple strategy for choosing these probabilities is to make all of the transitions out of any state equally likely [26]

Firstly, an initial set of models must be created. If there is some speech data available for which the location of the sub-word (i.e. phone) boundaries has been marked, then this can be used as *bootstrap data*. In this case, the tools HInit and HRest provide *isolated word* style training using the fully labeled bootstrap data. Each of the required HMMs is generated individually. HInit reads in all of the bootstrap training data and *cuts out* all of the examples of the required phone. It then iteratively computes an initial set of parameter values using a *segmental k-means* procedure.

On the first cycle, the training data is uniformly segmented, each model state is matched with the corresponding data segments and then means and variances are estimated.

If mixture Gaussian models are being trained, then a modified form of k-means clustering is used. On the second and successive cycles, the uniform segmentation is replaced by Viterbi alignment. The initial parameter values computed by HInit are then further re-estimated by HRest. Again, the fully labelled bootstrap data is used but this time the segmental k-means procedure is replaced by the Baum-Welch re-estimation procedure. When no bootstrap data is available, a so-called *flat start* can be used. In this case all of the phone models are initialized to be identical and have state means and variances equal to the global speech mean and variance. The tool HCompV can be used for this.

Once an initial set of models has been created, the tool HERest is used to perform *embedded training* using the entire training set. HERest performs a single Baum-Welch re-estimation of the whole set of HMM phone models simultaneously. For each training utterance, the corresponding phone models are concatenated and then the forward-backward algorithm is used to accumulate the statistics of state occupation, means, variances, etc., for each HMM in the sequence. When all of the training data has been processed, the accumulated statistics are used to compute re-estimates of the HMM parameters. HERest is the core HTK training tool. It is designed to process large databases, it has facilities for pruning to reduce computation and it can be run in parallel across a network of machines [26]

The philosophy of system construction in HTK is that HMMs should be refined incrementally. Thus, a typical progression is to start with a simple set of single Gaussian context-independent phone models and then iteratively refine them by expanding them to include context-dependency and use multiple mixture component Gaussian distributions. The tool HHEd is a HMM definition editor which will clone models into context-dependent sets, apply a variety of parameter typing and increment the number of mixture components in specified distributions. The usual process is to modify a set of HMMs in stages using HHEd and then re-estimate the parameters of the modified set using HERest after each stage. To improve performance for specific speakers the tools HERest and HVite can be used to adapt HMMs to better model the characteristics of particular speakers using a small amount of training or adaptation data. The end result of which is a speaker adapted system.
The single biggest problem in building context-dependent HMM a system is always data insufficiency.

The more complex the model set, the more data is needed to make robust estimates of its parameters, and since data is usually limited, a balance must be struck between complexity and the available data. For continuous density systems, this balance is achieved by tying parameters together as mentioned above. Parameter tying allows data to be pooled so that the shared parameters can be robustly estimated. In addition to continuous density systems, HTK also supports fully tied mixture systems and discrete probability systems. In these cases, the data insufficiency problem is usually addressed by smoothing the distributions and the tool HSmooth is used for this.

2.5.2.3 Recognition Tools

HTK provides a recognition tool called HVite that allows recognition using language models and lattices. HLRecsore is a tool that allows lattices generated using HVite (or HDecode) to be manipulated for example to apply a more complex language model. An additional recogniser is also available as an extension to HTK HDecode. Note: HDecode is distributed under a more restrictive licence agreement.

HVite

HTK provides a recognition tool called HVite which uses the token passing algorithm described in the previous chapter to perform Viterbi-based speech recognition. HVite takes as input a network describing the allowable word sequences, a dictionary defining how each word is pronounced and a set of HMMs. It operates by converting the word network to a phone network and then attaching the appropriate HMM definition to each phone instance. Recognition can then be performed on either a list of stored speech files or on direct audio input. As noted at the end of the last chapter, HVite can support cross-word triphones and it can run with multiple tokens to generate lattices containing multiple hypotheses. It can also be configured to rescore lattices and perform forced alignments [26].

The word networks needed to drive HVite are usually either simple word loops in which any word can follow any other word or they are directed graphs representing a finite-state task grammar. In the former case, bigram probabilities are normally attached to the word transitions. Word networks are stored using the HTK standard lattice format. This is a text-based format and hence word networks can be created directly using a text-editor.

However, this is rather tedious and henceHTK provides two tools to assist in creating word networks. Firstly, HBuild allows sub-networks to be created and used within higher level networks. Hence, although the same low level notation is used, much duplication is avoided. Also, HBuild can be used to generate word loops and it can also read in a backed-off bigram language model and modify the word loop transitions to incorporate the bigram probabilities. It should be noticed that the label statistics tool HLStats mentioned earlier can be used to generate a backed-off bigram language model. As an alternative to specifying a word network directly, a higher level grammar notation can be used. This notation is based on the Extended Backus Naur Form (EBNF) used in compiler specification and it is compatible with the grammar specification language used in earlier versions of HTK. The tool HParse is supplied to convert this notation into the equivalent word network. Whichever method is chosen to generate a word network, it is useful to be able to see examples of the *language* that it defines. The tool HSGen is provided to do this. It takes as input a network and then randomly traverses the network outputting word strings. These strings can then be inspected to ensure that they correspond to what is required. HSGen can also compute the empirical perplexity of the task. Finally, the construction of large dictionaries can involve merging several sources and performing a variety of transformations on each sources. The dictionary management tool HDMan is supplied to assist with this process.

2.5.2.4 Analysis Tool

Once the HMM-based recogniser has been built, it is necessary to evaluate its performance. This is usually done by using it to transcribe some pre-recorded test sentences and match the recognizer output with the correct reference transcriptions. This comparison is performed by a tool called HResults which uses dynamic programming to align the two transcriptions and then count substitution, deletion and insertion errors. Options are provided to ensure that the algorithms and output formats used by HResults are compatible with those used by the US National Institute of Standards and Technology (NIST). As well as global performance measures, HResults can also provide speaker-by-speaker breakdowns, confusion matrices and time-aligned transcriptions. For word spotting applications, it can also compute *Figure of Merit* (FOM) scores and *Receiver Operating Curve* (ROC) information.

2.5.3 Recognizing Toolkit – Sphinx

Sphinx is an open source toolkit for automatic speech recognition. Sphinx is a large vocabulary speech recognizer with high accuracy and speed performance. It is also a collection of tools and resources that enables developers or researchers to build successful speech recognizers [27]

There are three stages for Sphinx recognizer

a) Data Training
b) Data Testing
c) Performance Evaluation

Stages of training

- ✓ Training context Independent phone HMMs
- ✓ Training context Dependent phone HMMs
- ✓ Decision tree building
- ✓ Training context Dependent tied phone HMMs
- ✓ Recursive Gaussian splitting

2.5.4. Asterisk

Asterisk is a software platform, runs on the numbers of operating systems like NetBSD, OpenBSD, FreeBSD, Mac OS X and Solaris; although initially designed for Linux using a GNU General Public licence (GPL) as a free software licence. It was first introduced in the year 1999 by Mark Spencer to have an implementation of telephone PBX. PBX stands for Private Branch Exchange that allows connected phones to make calls to each other, as well as capable of connecting VoIP and PSTN services. Asterisk starts with loading the dynamic module loader and initializing the drivers associated with channels, and linking them with appropriate internal APIs. The PBX of Asterisk accepts calls from the interfaces and handles them accordingly based on the dial plan. Asterisk dial plan is the kernel of all Asterisk based system, which talks about handling of inbound and outbound calls, based on a configuration file named extensions.conf. The dial plan works based on four important components- namely contexts, extensions, priorities and applications [28].

- **Contexts** - This is the subsection of the dial plan, which is defined by giving the name (name can be made up of numbers, letters, hyphen and underscore) of the context in the square bracket.
- **Extensions** - For accepting a call by the Asterisk, series of steps are to be performed and those steps are uniquely defined through the extensions.
- **Priorities** - As extensions are having numbers of steps, those steps are known as priorities and each step executes one application.
- **Applications** - It is for performing a specific action on the current channel. Some of the inbuilt applications are Answer ( ), Hangup ( ) are already available.

2.6 IOT BASED WI-FI COMMUNICATION

IoT (Internet of Things) is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system. They enhance data collection, automation, operations, and much more through smart devices and powerful enabling technology.

IoT systems allow users to achieve deeper automation, analysis, and integration within a system. They improve the reach of these areas and their accuracy [29].

2.6.1 IoT − Key Features

The most important features of IoT include artificial intelligence, connectivity, sensors, active engagement, and small device use. A brief review of these features is given below:

AI – IoT makes virtually anything ‘smart’ essentially i.e. it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks. This can mean something as simple as enhancing your freeze and cabinets to detect when milk and your favourite cereal run low, and to then place an order with your preferred grocer.

Connectivity – It enables technologies for networking, and specifically IoT networking, mean networks are no longer exclusively tied to major providers. Networks can exist on a much smaller and cheaper scale while still being practical. IoT creates these small networks between its system devices.

Sensors – IoT loses its distinction without sensors. They act as defining instruments which transform IoT from a standard passive network of devices into an active system capable of real-world integration.

Active Engagement – Much of today's interaction with connected technology happens through passive engagement. IoT introduces a new paradigm for active content, product, or service engagement.

Small Devices – Devices, as predicted, have become smaller, cheaper, and more powerful over time. IoT exploits purpose-built small devices to deliver its precision, scalability, and versatility.

2.6.2 Programming Language –Lua

Lua is a lightweight multi-paradigm programming language designed primarily for embedded systems and clients. Lua is cross-platform, since it is written in ANSI C, and has a relatively simple C API. In the context of this system, Lua has been used to write script for ESP8266 module to support remote control of device. The features of Lua are described in brief below-

- simple
- efficient
- portable
- extensible
- adaptable to a broad range of applications
- Lua is an extension programming language
- Suitable for use as an embedded language within a host application
- Cross Platform Support
- Implemented in ANSI C
- Lightweight core occupies just 60k and executable footprint of just 140k

2.6.3 Embedded Web Server

Embedded systems have traditionally been isolated, self-contained systems; at most, they might have communicated with other systems within a limited range on a local network. This is no longer the case as embedded systems, especially small, very deeply-embedded devices, increasingly use the Internet as a way to communicate with each other and with the people managing them. The use of embedded devices to communicate to other devices using internet is called embedded web technology.

An embedded system that includes integrated web connectivity so that it can respond to browser requests and respond accordingly is known as an embedded web server. Such Internet functionality can be acquired in a variety of forms from a variety of sources, both open-source and commercial. These generally fall into one of two categories: small, simple web servers and application servers having greater functionality.

A web server has one role: to implement the HTTP protocol. This protocol allows a browser to issue a request to which a server will respond. Today's web is highly sophisticated, featuring elaborate graphics and streaming media, yet surprisingly, HTTP is a very simple protocol. All it does is transport requests and responses. Because HTTP is a stateless protocol, there is no intelligence in the operation, there is no decision-making or context, and there are no scripts or code to execute. There is also no concept of dynamic page creation; if a page is going to be created dynamically, some other program has to do that work and put the result where the web server expects it to be.

HTTP understands only nine operations (typically called "methods" or "verbs"), of which the most important are GET and POST. GET is used to download a "resource" (typically a file) located at a specified location (the "uniform resource locator", or URL). The response to a GET request contains the resource, accompanied by HTTP header information. When someone clicks a link in a web browser to go to a new page, they are sending a GET request to the server asking for the HTML page located at the URL they clicked.

POST is used to submit data from the web browser back to the server. This is the request that is generated when someone hits the "Submit" button on a filled-out form. A basic web server cannot process a POST request, since it will have no idea what to do with the data in the request. It must rely on some other program or utility to process the data. On older standard websites, that utility might be a Common Gateway Interface (CGI) plug-in as the web server would simply hand any POST requests over to be handled by CGI. While CGI isn't appropriate for most embedded applications due to its size, performance, and inability to exist in a monolithic architecture, the fact remains that the web server needs something else to handle data returned by a web browser.

Unlike desktop-based web applications which typically provide information or entertainment, embedded web applications can actually cause something to happen on the device. For example, we might change the direction of an antenna; we might control the power supply of devices or we might open or close a valve. The hard buttons that would normally be built into the system are effectively replaced by, or duplicated by, virtual buttons in a browser-based form. Using the Internet to control an embedded system has a direct impact on the cost of building and maintaining the system. Physical controls like buttons mean additional components and cost as well as a design that must accommodate access to the controls. Even more importantly, embedded systems are increasingly being deployed in remote locations. In those applications, the cost isn't dominated by components, but rather by the people that must go out to maintain and operate the system. This makes remote access critical to the cost-effectiveness of the system. The Internet is the most straightforward way of getting to the target system because worldwide infrastructure already exists [30].

2.6.4 ESP8266 Wi-Fi Module

The ESP8266 Wi-Fi Module is an essential module for Wi-Fi communication which has basic useful features as mentioned below-

- 32-bit RISC CPU
- 64 KB of instruction RAM, 96 KB of data RAM
- External QSPI flash: 512 KB to 4 MB* (up to 16 MB is supported)
- IEEE 802.11 b/g/n Wi-Fi
- WEP or WPA/WPA2 authentication, or open networks
- 16 GPIO pins
- SPI
- I^{2}C

- I^2S interfaces with DMA (sharing pins with GPIO)
- UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2
- 10-bit ADC

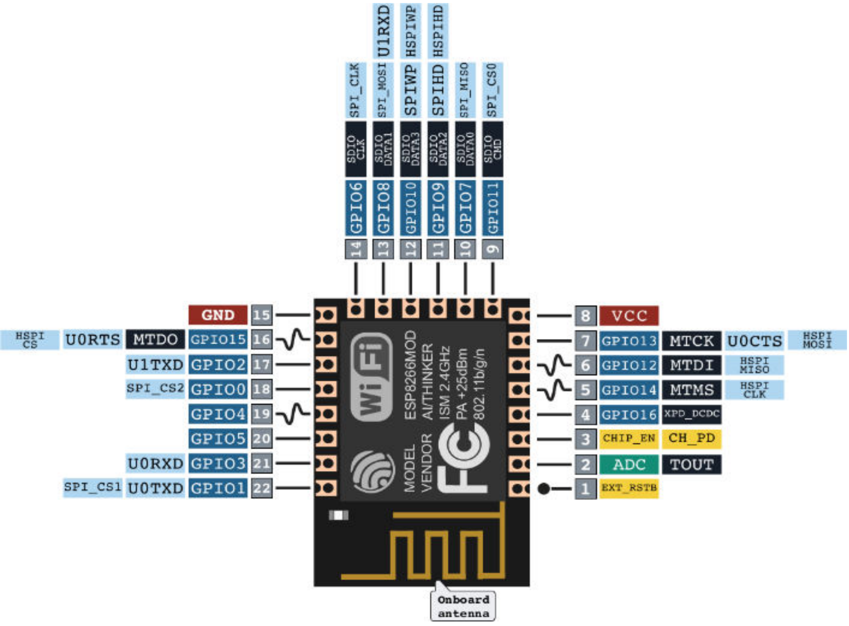


Figure 2.11: Pinout of ESP8266

2.7 OVERVIEW OF AT89S52 Microcontroller

AT89S52 is a popular 8051 chip designed and developed by ATMEL. It is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density non-volatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM con-tents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset [31].

2.7.1 Architecture of AT89S52

Detailed Pin diagram and block diagram of AT89S52 Microcontroller is shown in the fig. 2.4 and fig 2.5 respectively

VCC*:* Supply voltage.

GND: Ground.

a) Port 0

Port 0 is an 8-bit open drain bi-directional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high impedance inputs. Port 0 can also be configured to be the multiplexed low-order, address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups. Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pull-ups are required during program verification.

b) Port 1

Port 1 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. In addition, P1.0 and P1.1 can be configured to be the timer/counter 2 external count input (P1.0/T2) and the timer/counter 2 trigger input (P1.1/T2EX), respectively, as shown in the below figure.

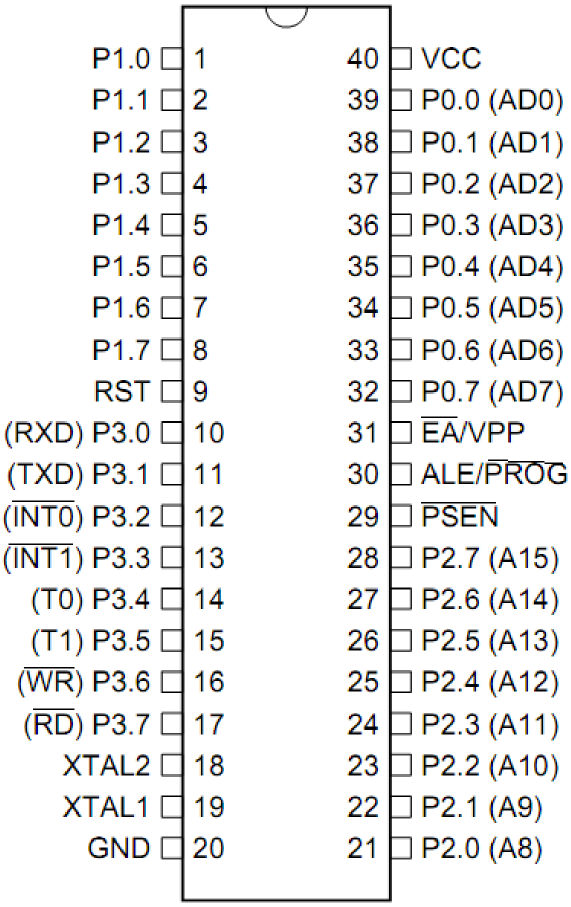


Figure 2.12: Pin out diagram of AT89S52

c) Port 2

Port 2 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MOVX @ DPTR). In this application, Port 2 uses strong internal pull-ups when emitting 1s. During accesses to external data memory that use 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register. Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

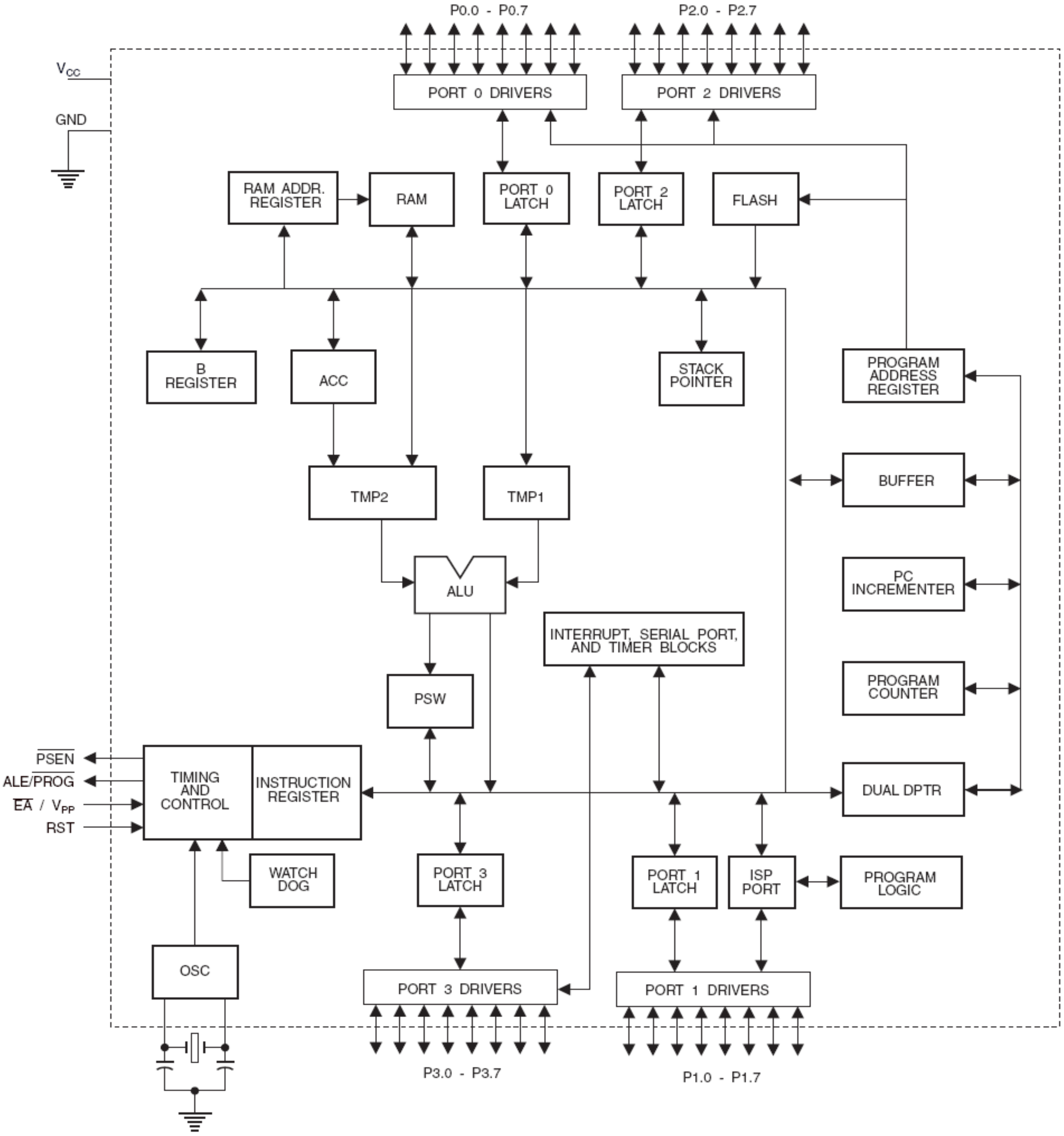


Figure 2.12: Block Diagram of microcontroller

d) Port 3

Port 3 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups and can be used an inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups. Port 3 also serves the functions of various special features of the AT89S52.

e) RST

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

f) ALE/PROG

Address Latch Enable is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming. In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external data memory. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode**.**

g) PSEN

Program Store Enable is the read strobe to external program memory. When the AT89C52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

h) EA/VPP

External Access Enabled. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions.

This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming when 12- volt programming is selected.

i) XTAL1

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

j) XTAL2

Output from the inverting oscillator amplifier.

2.7.2 Instruction Set Architecture Of AT89C51

There are lots of Function registers present in the AT89S52 microcontroller.

a) SBUF Register: For a byte of data to be transferred via the TxD line, it must be placed in the SBUF. SBUF holds the byte of data when it is received by the 8051's RxD line.

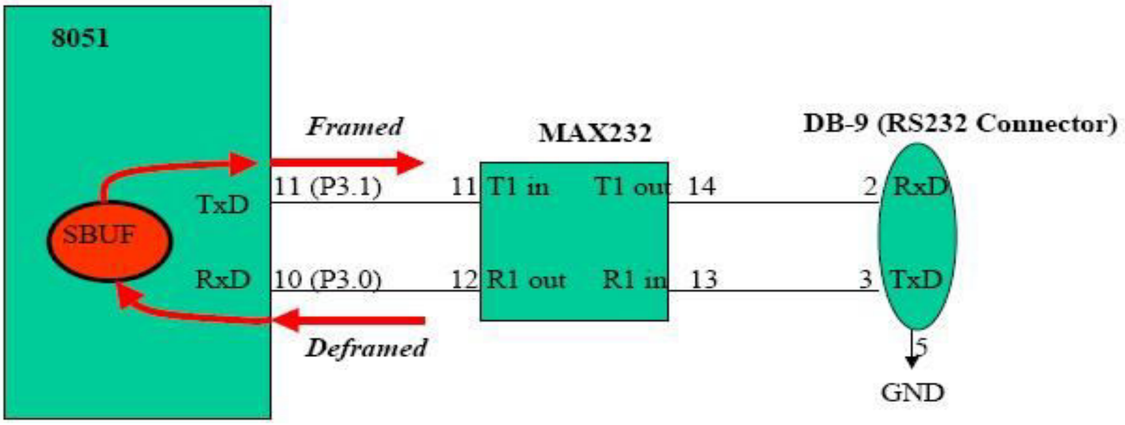


Figure 2.14: Block Diagram of SBUF register with MAX232

Here,

MAX232 : TTL to Serial Connector, DB9 : 9-pin D-type connector

b) SCON Register: This is the serial port control register. It should be set to hexadecimal 0x50 for 8-bit data mode.

SM0	SM1	SM2	REN	TB8	RB8	TI	RI

i) SM2 enables the multiprocessing capability of the 8051.

ii) REN (Receive Enable): It allows the 8051 to receive data on the RxD pin. If user wants 8051 to both transfer and receive data, REN must be set to '1'.

iii) TB8 (Transfer bit 8): It is used for serial modes 2 and 3, so here we make TB8=0.

iv) RB8 (Receive bit 8) :It is used for serial modes 2 and 3, so here we make RB8=0.

v) TI (Transmit Interrupt) :This is a flag bit. When 8051 finish the transfer of the 8-bit character, it raises the TI flag to indicate that it is ready to transfer another byte.

vi) RI (Receive Interrupt) : When 8051 receive data via RxD, it get rid of the start and stop bits (deframed procedure) and places the byte in the SBUF. Then it raises the RI flag to indicate that a byte has been received and should be picked up before it is lost.

c) TMOD: This register controls the timers for baud rate generation and it should be set to hexadecimal 0x20 to enable timer 1 to operate in 8-bit auto-reload mode.

d) TH1: This register should be loaded with a constant so that the required baud rate can be generated. Table 6.3 shows the values to be loaded into TH1 and the corresponding baud rates for two different clock rates.

e) TR1: This register starts/stops the timer and it should be set to 1 to start timer 1.

f) TI: This register should be set to1 to indicate ready to transmit.

2.7.3. MAX 232: TTL to Serial Convertor

RS232 is bi-polar and a voltage of 3 to 12 V indicates an ON state while a voltage of 3 to 12 V indicates an OFF state. Standard TTL logic devices, including the AT89S52 microcontroller, operate with TTL logic levels between the voltages of 0 and 5 V. Voltage level converter ICs are used to convert between the TTL and RS232 voltage levels. One such popular IC is the MAX232, manufactured by MAXIM, and operators with 5 V supply. The MAX232 is a 16-pin DIL chip incorporating two receivers and two transmitters and the device requires four external capacitors for proper operation. The microcontroller can be connected to external RS232 compatible equipment via a MAX232 type voltage converter IC [32].

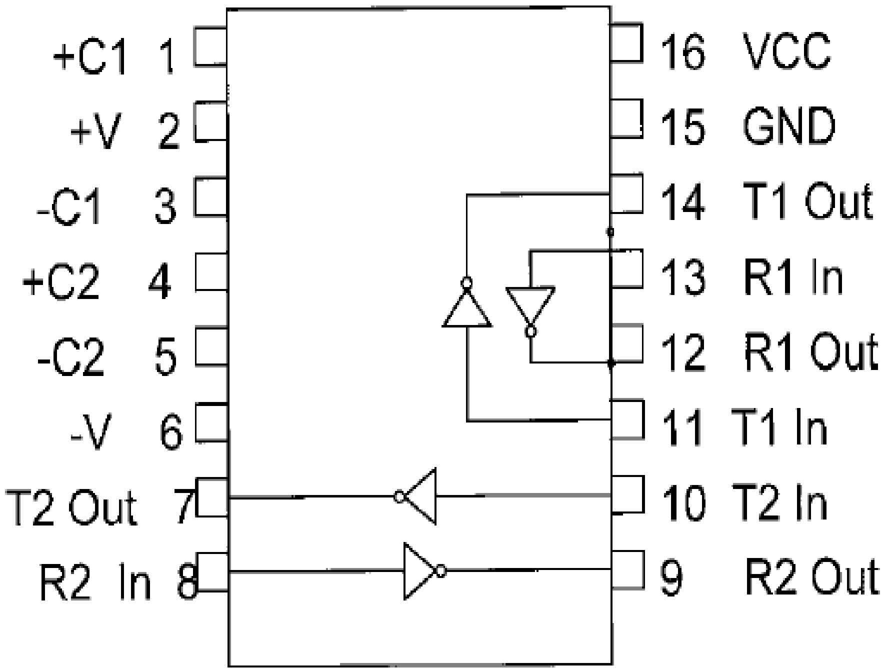


Figure 2.15: Pin Diagram of MAX232

Since RS232 standard is not TTL compatible, so a MAX232 line driver is needed.

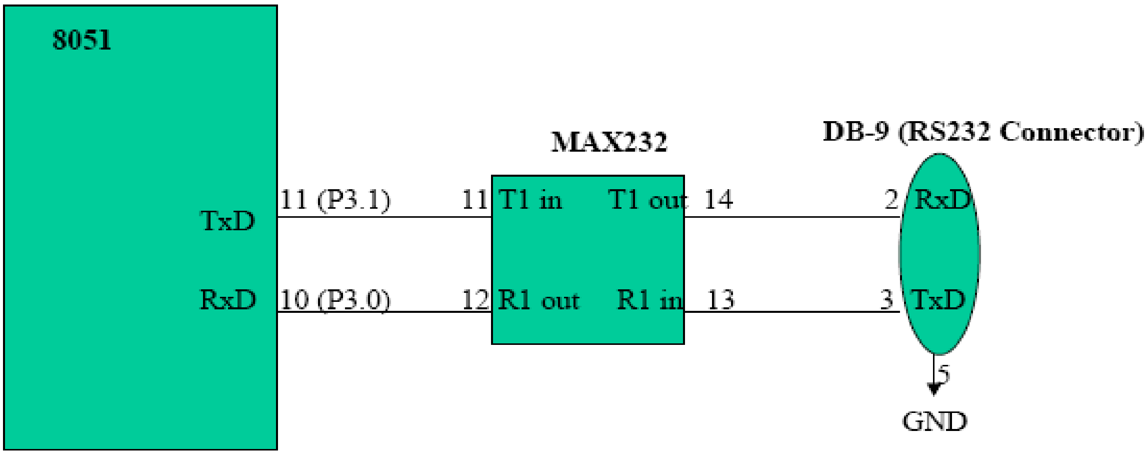


Figure 2.16: Communication of RS232 with MAX232

2.7.4 Keil

The Keil 8051 Development Tools are designed and developed by ARM to solve the complex problems facing embedded software developers. Keil development tools for the 8051 Microcontroller Architecture support every level of software developer from the professional applications engineer to the student just learning about embedded software development.

The industry-standard Keil C Compilers, Macro Assemblers, Debuggers, Real-time Kernels, Single-board Computers, and Emulators support all 8051 derivatives. The Keil µVision3 is a Windows-based software development platform that combines Project Management, Source Code Editing, Program Debugging, and Flash Programming in a single, powerful environment [33].

2.7.5 Universal Burner

A universal microcontroller programmer or microcontroller burner is a hardware device accompanied with software which is used to transfer the machine language code to the microcontroller/EEPROM from the PC. The compiler converts the code written in languages like assembly, C, java etc to machine language code (which is understandable by the machines/microcontrollers) and stores it in a hex file. A universal burner acts as an interface between the PC and the target controller. The API/software of the programmer reads data from the hex file stored on the PC and feeds it into the controller's memory. The target controller on which the program needs to be burned is placed on the programmer using a ZIP socket. The software transfers the data from the PC to the hardware using serial, parallel or USB port.

Depending on the way it interacts with PC, there are three types of microcontroller programmers:

a) Parallel Programmer uses the parallel port of the PC. They are low cost programmer but not widely used.

b) Serial Programmers uses the serial port to interact with PC via RS232 protocols. They are more popular among hobbyist working on PC. However both the serial and parallel programmers will become obsolete in near future. The major reason is being unavailability of parallel and serial ports in the PCs & Laptops in the coming years.

c) USB Programmer uses the USB interface to transfer the data from PC. The main advantage of the USB burner is that they are powered from the PC itself and there is no need of any additional supply. The USB programmers have already become popular and will soon replace the serial and parallel programmer [34].

2.6 RELATED WORKS

Since 20th century, lots of work has been done by the researcher in all over the world to develop a better, efficient and cost effective home automation system. Some of them are pointed out.

Armando Roy Delgado, Rich Picking and Vic Grout [1] describe an investigation into the different aspects and potentiality for remote controlled operation of home automation systems. The concept of "intelligent home" is also illustrated in terms of automated systems in this paper. The research persons said that the future home network will have ubiquitous embedded computation with an increasing number of appliances having wireless communication. In fact, there are many recent tendencies to integrate various kinds of embedded devices and consumer appliances into software systems. The journal explains possible actual benefits for Home Automation Systems discuss several issues that may affect a remote-controlled Home Automation System and Proposes a standardized remote-controlled Home Automation System architecture. So, it is concluded that one access to many devices within a building at any time, from anywhere saving a significant amount of time.

Prof. Mamata Bhamare, Tejashree Malshikare, Renuka Salunke, Priyanka Waghmare [2] describes a system to control, manage and monitor the network from our wireless handheld device i.e. mobile phone from any remote place irrespective of distance. In this journal, it is considered that the basic setup of LAN with the server PC connected to GSM service provider through a GSM modem. The interaction between the clients and the wireless media happens through this server. A small text file from any of the client or server machine can be opened in user mobile phone. In the block diagram of the proposed system explained in the paper, it is seen that from mobile, message is sent to server through GSM modem. In the message, there is mobile number of the user, client name and operations to be performed on system. That message is sent to server then server recognizes the authorized client among all clients. Then, client sends the response to the server after completion of that requested operation on the client. After that, server sends feedback to the administrator through GSM modem. Again message parsing is used to send SMS to the administrator that specifies that operations on the client are performed. So, it is concluded that SMS remains the most efficient communication system for pushing the content on to the mobile devices. The software is developed on a server based software application that provides ability to send and receive messages through GSM network and communicates through standard TCP/IP protocol.

Avigyan Datta Gupta, Sayan Samanta, Avishek Acharjee [3] have presented a circuit that one can operate home appliances like light, freeze, fan and water pump from office or any other remote place. So if one forgets to switch off light or other electrical appliances while going out, it helps to turn off them from a remote place with your mobile phone. The mobile phone works as the remote control from any area covered by GSM network for home appliances. One can control the desired appliance by pressing the corresponding key. In this paper work, a device controller is introduced that can represent a safe & secured wireless communication with proper authentication and less data loss. The circuit of the proposed project explained in the journal has two parts. One is the hardware part and other is software part. The hardware part contains of microcontroller AT89C51 and the software part consists of a program for the microcontroller is written using microcontroller programming software. In this paper, AT89C51 Specification is described very clearly using the pin out diagram of AT89C51. Here, Detailed Pin Description of Microcontroller AT89C51 that is used in this paper work is explained which gives a vast knowledge in the time of literature review about the particular microcontroller. So, it is concluded that project has shown a system using a simple extra mobile phone; user can control their electrical home appliances.

Soumya Sunny P, Roopa .M [5] explain an embedded web server that enables a situation where it is possible to monitor and control electrical devices using any one of standard web browser. According to this paper, a web server in the system facilitates the accessibility to the user interface functions for the electrical appliances using a web page. A web server can be attached into any electrical devices and communicated to the Internet so that the devices can be monitored and controlled remotely using the web browser in a computer. This paper mentions a solution for embedded system which has the accessibility to the Internet using which one can get the access, monitor and maintain conveniently. In the literature review of this journal, it gives a extensive knowledge about embedded web server and its benefits with web browser. Now-a-days, in different places, designed embedded web server can be used with the equipments and instruments of industrial and medical science field. An admin can observe and operate the tools simply. Administrator can design more powerful user interface without extra hardware requirements. So, it is summarized that users located at a remote place can only require a simple internet web browser to run the experiments on real hardware configuration.

M.Can Filibeli,Oznur Ozkasap,M.Reha Civanlar [4] describes that Powerful microcontrollers are used as parts of most home and office appliances of today. Integrating web servers to these intelligent devices will aid in controlling them over the Internet and also in creating effective user interfaces in the form of web pages. This paper presents a novel approach to control devices with embedded web servers over the Internet and to form device networks such that their components can make use of one another's services and functions while improving the user interfaces. The main benefits of this approach include its lightweight design, automatic configuration, and, utilization of widely available and tested network protocols of TCP/IP. The system explained in this paper provides for easy control of house appliances through the Internet. The journal describes also that based on the use of well-known and stable protocols such as TCP/IP, HTTP, and PPP; the system is robust and easy to develop. It offers user-friendly, low-cost interfaces to the household devices instead of expensive and complex ones. So, it is concluded that the Internet has been mostly used to connect personal computers so far, but shortly all kinds of home appliances with embedded computers will exchange information over the Internet.

Inderpreet Kaur [35] described that an automatic systems are being preferred over manual system. The journal describes that the automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. This paper explains the concept and need of home automation very extensively. An automated home can be a very simple grouping of controls, or it can be heavily automated where any appliance that is plugged into electrical power is remotely controlled. Costs mainly include equipment, components, furniture, and custom installation. Control system security may be difficult and costly to maintain, especially if the control system extends beyond the home, for instance by wireless or by connection to the internet or other networks. So, from this paper it is concluded that Each and every product will be smart devices that are used daily and that will be controlled through a smart chip called microcontrollers. Each and Every home appliances will be controlled either by PC or hand held devices like PDA or mobile handsets. Some examples of it are when anybody want he/she can switch on/off Fan of your home by mobile handset or PC.

Ali Ziya Alkar [36] presents the design and implementation of a low cost but yet flexible and safe and secure internet based home automation system. According to the author aim of home automation is to control home devices from a central control point. The communication between the devices is wireless. The protocol between the units in the design is enhanced to be suitable for most of the appliances. The system is designed to be low cost and flexible with the increasing variety of devices to be controlled. An embedded version of this system with a network capable PC processor embedded in a single package with the master node is also in progress.

Mr. Abhishek Vichare, Ms. Shilpa Verma [37] explains the connection of a micro-controller with Local Area Network and how it can be used as a web server. This paper offers a new method for users with an option from a local server, using the Internet to control household devices from a remote location. This system is developed by personal computers, interface cards, microcontroller, along with window-type software and microcontroller control software. The present system is configured to control household appliances (on/off/yes/no) to regulate their output power. In this project work, researchers use Philips P89C51RD2BN microcontroller.

L. R. Rabiner, B.H. Juang, C.H. Lee [38] analysed some of the key point in several areas of automatic speech recognition. Authors also briefly discuss the requirements in designing successful real-time applications and address technical challenges that need to be faced in order to reach the ultimate goal of providing an easy, natural and flexible voice interface between people and system. They also described that Speech recognition systems have been developed for a wide variety of applications, ranging from small vocabulary keyword recognition over dial-up telephone lines, to medium size vocabulary voice interactive command and control systems on personal computers, to large vocabulary speech dictionary, automatic speech understanding, and limited-domain speech translation.

Faisal Baig, Saira Beg, Muhammad Fahad Khan [39] discussed that the advancement in technology has made their scope much larger then before by taking these technologies from industry to home and daily usage appliances. This paper presents the system frameworks of universal remote based on mobile phone. The proposed system provides facility to users in order to control their home appliances using voice command. System has ability to recognize speaker and speech by using the recognition engine which limits the access to only authorized persons that can interact and control the home appliances. The main purpose of this method is to merge both mechanisms bring them on a single platform to facilitate severely disabled, low vision and old person. The focus of this research is to provide a universal remote which can easily control remote control appliances using voice command in secured manner.

D. Pavithra, Ranjith Balakrishnan [40] proposes an efficient implementation for IoT (Internet of Things) used for monitoring and controlling the home appliances through Internet. Home automation system uses the computer as a user interface. They can communicate with home automation network through an Internet gateway, i.e. low power communication protocols like Zigbee, Wi-Fi etc. This project aims at controlling home appliances via mobile phone using Wi-Fi as communication protocol and raspberry-pi as server system. The user here will move directly with the system through a web-based interface over the Internet, whereas home appliances like lights, fan are remotely controlled through a easy designed web page. An extra feature that enhances here is to protect from fireplace accidents is its capability of removing smoke in order that within the event of any fireplace, associates an alarming message and an image is sent to Smartphone. The server will be interfaced with relay hardware circuits that control the appliances running at home. The communication with server allows the user to select the appropriate device. The communication with server permits the user to pick out the acceptable device. The server communicates with the corresponding relays. If the web affiliation is down or the server isn't up, the embedded system board still will manage and operate the appliances locally. By this the system provides a climbable and price effective Home Automation system.

Wang, D., Lo, D., Bhimani, J., & Sugiura, K. [41] describes technologies for Internet of Things (IoT) such as sensor, network and data processing which are flying rapidly. According to the evolution, many potential applications have been developed in the fields of home automation system. In this paper, a platform was designed to connect sensor data with user daily life. As an application of it, a home appliances monitoring and controlling system was implemented that can be operated and controlled by any authorized user. Although home appliances are becoming more intelligent day by day, not only the manufacturers are promoting new smart appliances, there are also many web enabled mobile oriented remote controller products. Anyways, current products always have platform compatibility problems, additionally, user interaction in such systems is becoming more and more complex. This work proposes an approach to enhance traditional appliances and the controlling experience using an IoT based electrical Appliances Controlling System. With sensors the appliances can be controlled environment condition like temperature, light etc. The sensor data are processed by single-board computer and delivered to mobile applications through wireless communication. The results of implementation and experimentation have shown in the proposed system and platform can provide more IoT application possibilities in day to day life.

Ravi Kishore Kodali, Vishal Jain, Suvadeep Bose and Lakshmi Boppane [42] explained that Internet of Things (IoT) represents the idea of remotely connecting and monitoring real world objects (things) through the Internet. When it comes to our house, this concept can be applied incorporated to make it smarter, secured and automated. This IoT project focuses on building a smart wireless home security system which sends alarms to the owner by using Internet in case of any trespass and raises an alarm optionally. Besides, the same can also be utilized for home automation by making use of the same set of different sensors. The exertion obtained by preferring this system over the similar kinds of already existing systems is that the alarms and the status sent by the Wi-Fi connected microcontroller managed system can be received by the user on his phone from any distance irrespective of whether his mobile phone is connected to the internet.

Md. Saidur Rahman, Saqif Masud, Shahida Sultana [43], proposed an efficient and cost-effective IoT-based smart home automation system where electrical appliances can be controlled and monitored. The proposed system is an integration of the traditional electrical appliance controls and web and Internet of Things based control system. With the proposed system, user gets both the option to control or monitor the electrical appliances remotely over internet using a static IP addresses and also through switch circuit and electrical board available at home. The system is developed fulfilling three specific objectives like user-comfort, cost-effectiveness and real-life implementation. The system is designed for mass usage with the possible commercial service operation. A miniature prototype has been developed with the proposed system to prove the possibilities and show its feasibility.