A MINI PROJECT REPORT

On

ADVANCED NAVIGATION CANE FOR VISUALLY IMPAIRED

Submitted to

GURU NANAK INSTITUTIONS TECHNICAL CAMPUS
HYDERABAD

In partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

Bhanavath Rakesh	21WJ1A0438
Banoth Varun	21WJ1A0433
Bhukya Rohith Kumar	21WJ1A0439

Under the guidance of

Dr. Mohassin Ahmad
Asst. Professor
Department of ECE

Department of Electronics and Communication Engineering

GURU NANAK INSTITUTIONS TECHNICAL CAMPUS
(UGC Autonomous Institution, NAAC A+ & NBA Accredited for ECE,CSE & MECH, Approved By AICTE, New Delhi & Affiliated to JNTUH Hyderabad)
Khanapur Village, Ibrahimpatnam, Manchal Mandal, Ranga Reddy Dist, Telangana -501506.

GURU NANAK INSTITUTIONS TECHNICAL CAMPUS

www.gniindia.org

Approved by AICTE - New Delhi | Affiliated to JNTU - Hyderabad | Accredited by National Assessment and Accreditation Council | Accredited by National Board of Accreditation

AUTONOMOUS under Section 2 (f) & 12 (b) of University Grants Commission Act

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that the project report entitled "**ADVANCED NAVIGATION CANE FOR VISUALLY IMPAIRED**" being submitted by

Bhanavath Rakesh	21WJ1A0438
Banoth Varun	21WJ1A0433
Bhukya Rohith Kumar	21WJ1A0439

in partial fulfillment for the award of the Degree of **Bachelor of Technology in Electronics and Communication Engineering** to **Guru Nanak Institutions Technical Campus (Autonomous)** affiliated to Jawaharlal Nehru Technological University, Hyderabad during the academic Year 2024-2025.

PROJECT GUIDE

Dr. Mohassin Ahmad
Assistant Professor

PROJECT COORDINATOR

Mr. K. Krishna Kumar,
Assistant Professors &
Mr.O.Ravinder,
Associate Professor

HEAD OF THE DEPARTMENT

Dr. S. Maheswara Reddy
Professor and HOD ECE

EXTERNAL EXAMINER

RAM Innovative Infotech
M : +91 9581 012 012
E : raminnovativeinfotech@gmail.com
Flat No.#309, Amrutha Ville,
Opp: Yashoda Hospital, Somajiguda,
Hyderabad-82, Telangana, India
Www.raminnovativeinfotech.webs.com

PROJECT COMPLETION CERTIFICATE

This is to certify that the following students of final year B. Tech, Department of **Electronics and Communication Engineering** – Guru Nanak Institutions Technical Campus (GNITC) have completed their training and project at GNITC successfully.

	STUDENT NAME:	ROLL NO:
1.	**B. VARUN**	**21WJ1A0433**
2.	**B. RAKESH**	**21WJ1A0438**
3.	**B. ROHITH**	**21WJ1A0439**

The training was conducted on **Embedded Systems** (**ES**) Technology for the Completion of the project titled "**ADVANCED NAVIGATION CANE FOR VISUALLY IMPAIRED"** in **2024 - 2025.** The project has been completed in all aspects.

Signature

Mini & Major IEEE Live project for
M. E/M. TECH, BE/BTECH, MCA, MS.

Acknowledgement

We want to express our sincere gratitude to our guide **Dr. Mohassin Ahmad , Assistant Professor**, Department of Electronics and Communication Engineering, for her excellent guidance and invaluable support, which helped us to accomplish our Bachelor's degree and prepared us to achieve more life goals in the future. Her total support of our dissertation and countless technical and professional development contributions made for a delightful and fruitful experience.

We are thankful to our beloved mentors, **Mr. D. Naresh, Assistant Professor & Mr. K. Sathish, Assistant Professor**, ECE, GNITC, Hyderabad.

We are very much grateful to our **Project Coordinators, Mr. K.Krishna Kumar, Assistant Professor & Mr. O.Ravinder, Associate Professor** of ECE, GNITC, Hyderabad, who are not only shown utmost patience but were fertile in suggestions, vigilant in directions of error, and have been infinitely helpful.

We are also thankful to our Academic Coordinator, IV Year, **Dr. D. Surendra Rao, Associate Professor** of ECE, GNITC, Hyderabad, for his support.

We were also thankful to **Dr. Maheswara Reddy Sura, Professor & HOD** of ECE & Academic Coordinator, GNITC, Hyderabad, for being so helpful with valuable insights and guidance during our project.

We are thankful to **Dr. P. Parthasaradhy, Joint Director,**GNITC for his good support and given valuable inputs in our project work.

We express our deepest gratitude to **Dr. S. Sreenatha Reddy, Director**, GNITC, for his constant support and encouragement and for providing us with all the facilities in the college during our project work.

Our sincere thanks to all our faculties, administrative staff, and management of GNITC without whose support, our work would always remain incomplete.

On a more personal note, we thank our beloved parents and friends for their moral support during our project.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The Smart Walking Stick aims to significantly improve the safety and independence of visually impaired individuals. Traditional walking canes only provide tactile feedback and have limited effectiveness in detecting obstacles. In contrast, this smart walking stick integrates several advanced technologies to provide a more comprehensive solution. The ultrasonic sensor constantly monitors the user's environment, detecting obstacles and alerting the user with a buzzer, ensuring safer navigation. The system is powered by an 8051 microcontroller that processes the sensor data and triggers the necessary responses.

Additionally, the device features a GPS module for outdoor navigation, helping users stay on track, even in unfamiliar environments. The GPS offers real-time location tracking, ensuring that the user can navigate effectively, even in areas where traditional cane methods fall short. This feature becomes especially valuable when venturing into large or open spaces, offering increased autonomy. To enhance safety further, the system includes an emergency alert feature, which can notify predefined contacts in case of an accident or when the user needs immediate assistance.

The integration of these technologies allows for a more reliable and versatile tool for the visually impaired, promoting not just mobility but overall independence. This system is also designed to be cost-effective, making it accessible to a wider range of people in need. Through the use of affordable yet powerful components, the smart walking stick addresses several challenges faced by the visually impaired, ultimately improving their quality of life by providing a reliable, multifaceted solution for navigation and safety.

CHAPTER-1

INTRODUCTION

General Overview

According to the 2017 World Health Organization (WHO) survey, approximately 285 million people globally suffer from visual impairment. Of these, 39 million are blind, and 246 million have low vision. In India alone, over 12 million people are visually impaired, constituting about one-third of the global population of the visually impaired. Many of these individuals struggle with mobility due to financial constraints and lack of affordable assistive technology. This makes navigating crowded or unfamiliar spaces especially difficult. Though several assistive technologies exist, they often have limitations in terms of usability, affordability, or performance in real-world environments.

Traditional tools like the white cane offer tactile feedback, but they do not provide an accurate picture of the surroundings. These canes can detect obstacles only when they are physically touched, limiting the ability to avoid hazards proactively. Wearable systems, such as CasBlip, have been introduced to provide object detection, but the short-range detection of these systems poses safety risks for the users. Other solutions, such as GPS-based navigation aids, are hindered by inaccuracy in dense urban environments, making them less reliable for outdoor use.

This project aims to create an advanced navigation cane for visually impaired individuals, integrating ultrasonic sensors for obstacle detection, GPS for location tracking, and a GSM-based communication system for emergency alerts. This comprehensive system will offer an affordable, effective solution for increasing mobility, safety, and independence for the visually impaired.

1.1 Existing Systems

Existing technologies to assist the visually impaired generally include tactile devices like the white cane or advanced GPS-based solutions. However, traditional white canes offer limited feedback, relying on physical contact with obstacles. While they serve their purpose in basic environments, they fail in providing full navigation capabilities or feedback about objects beyond direct reach.

More advanced systems have been developed to offer object detection using ultrasonic sensors and GPS modules for outdoor navigation. These systems, such as wearable aids, help the visually impaired navigate by detecting obstacles and providing feedback through audio signals. However, the range of detection often remains short, and performance degrades in certain environments like dense urban areas where GPS signals can be inaccurate.

A notable limitation of these systems is that many require the user to wear bulky or uncomfortable devices that may not be practical for daily use. Additionally, the detection systems are often unable to assess the type of obstacles or their precise location, which can lead to dangerous situations for the user.

1.2 Proposed System

This project proposes an innovative solution that integrates an 8051 microcontroller with ultrasonic sensors for real-time obstacle detection, a GPS module for outdoor navigation, and an emergency communication system based on GSM technology. The system is designed to be both cost-effective and lightweight, ensuring that it is accessible and comfortable for users.

- **Obstacle Detection**: Ultrasonic sensors will detect obstacles in the path of the user, sending signals to the microcontroller to activate a buzzer or provide auditory feedback.
- **GPS Navigation**: The system will use a GPS module to track the user's location and provide audible navigation instructions. This feature is especially useful in outdoor environments and unfamiliar areas.
- **Emergency Communication**: In case of emergencies, the user can press a button on the cane to send an alert message via GSM to predefined contacts for assistance.
- **Integration with Microcontroller**: The system's core functionality is powered by the 8051 microcontroller, which processes data from the sensors, manages the navigation instructions, and triggers the communication systems.

This advanced cane is designed to enhance the safety and mobility of visually impaired individuals, enabling them to navigate more independently and avoid accidents.

1.3 Significance of the Project

This system offers several key advantages over existing solutions:

1. **Increased Safety**: The obstacle detection mechanism ensures that users are warned in time to avoid collisions, while the emergency button allows them to call for help in urgent situations.
2. **Cost-Effectiveness**: Unlike high-end navigation systems, which may be prohibitively expensive, this project aims to provide a low-cost solution that is accessible to a wider range of users.

3. **Portability and Comfort**: The system is designed to be lightweight and easy to wear, ensuring that it does not burden the user or reduce their comfort during daily activities.
4. **Versatility**: The combination of obstacle detection, GPS navigation, and emergency communication makes this cane suitable for both indoor and outdoor use, providing a more comprehensive solution than traditional white canes or current wearable devices.

CHAPTER 2

PROJECT DESCRIPTION

2.1 Overview of Embedded System

An embedded system can be defined as a computing device that does a specific focused job. Appliances such as the air-conditioner, VCD player, DVD player, printer, fax machine, mobile phone etc. are examples of embedded systems. Each of these appliances will have a processor and special hardware to meet the specific requirement of the application along with the embedded software that is executed by the processor for meeting that specific requirement. The embedded software is also called “firmware”. The desktop/laptop computer is a general purpose computer. You can use it for a variety of applications such as playing games, word processing, accounting, software development and so on. In contrast, the software in the embedded systems is always fixed listed below:

- Embedded systems do a very specific task, they cannot be programmed to do different things.
- Embedded systems have very limited resources, particularly the memory. Generally, they do not have secondary storage devices such as the CDROM or the floppy disk. Embedded systems have to work against some deadlines. A specific job has to be completed within a specific time. In some embedded systems, called real-time systems, the deadlines are stringent. Missing a deadline may cause a catastrophe-loss of life or damage to property. Embedded systems are constrained for power. As many embedded systems operate through a battery, the power consumption has to be very low.
- Some embedded systems have to operate in extreme environmental conditions such as very high temperatures and humidity.

Application Areas

Nearly 99 per cent of the processors manufactured end up in embedded systems. The embedded system market is one of the highest growth areas as these systems are used in every market segment- consumer electronics, office automation, industrial automation, biomedical engineering, wireless communication, data communication, telecommunications, transportation, military and so on.

Consumer appliances:

At home we use a number of embedded systems which include digital camera, digital diary, DVD player, electronic toys, microwave oven, remote controls for TV and air-conditioner, VCO player, video game consoles, video recorders etc. Today's high-tech car has about 20 embedded systems for transmission control, engine spark control, air-conditioning, navigation etc. Even wristwatches are now becoming embedded systems. The palmtops are powerful embedded systems using which we can carry out many general-purpose tasks such as playing games and word processing.

Office Automation:

The office automation products using embedded systems are copying machines, fax machines, key telephone, modem, printer, scanner etc.

Industrial Automation:

Today a lot of industries use embedded systems for process control. These include pharmaceutical, cement, sugar, oil exploration, nuclear energy, electricity generation and transmission. The embedded systems for industrial use are designed to carry out specific tasks such as monitoring the temperature, pressure, humidity, voltage, current etc., and then take appropriate action based on the monitored levels to control other devices or to send information to a centralized monitoring station. In hazardous industrial environments, where human presence has to be avoided, robots are used, which are programmed to do specific jobs. The robots are now becoming very powerful and carry out many interesting and complicated tasks such as hardware assembly.

Medical Electronics:

Almost every medical equipment in the hospital is an embedded system. These equipment include diagnostic aids such as ECG, EEG, blood pressure measuring devices, X-ray scanners; equipment used in blood analysis, radiation, colonoscopy, endoscopy etc. Developments in medical electronics have paved the way for more accurate diagnosis of diseases.

Computer Networking:

Computer networking products such as bridges, routers, Integrated Services Digital Networks (ISDN), Asynchronous Transfer Mode (ATM), X.25 and frame relay switches are embedded systems which implement the necessary data communication protocols. For example, a router interconnects two networks. The two networks may be running different protocol stacks. The router's function is to obtain the data packets from incoming pores, analyze the packets and send them towards the destination after doing necessary protocol conversion. Most networking equipment, other than the end systems (desktop computers) we use to access the networks, are embedded systems.

Telecommunications:

In the field of telecommunications, the embedded systems can be categorized as subscriber terminals and network equipment. The subscriber terminals such as key telephones, ISDN phones, terminal adapters, web cameras are embedded systems. The network equipment includes multiplexers, multiple access systems, Packet Assemblers Dissemblers (PADs), sate11ite modems etc. IP phone, IP gateway, IP gatekeeper etc. are the latest embedded systems that provide very low-cost voice communication over the Internet.

Wireless Technologies:

Advances in mobile communications are paving the way for many interesting applications using embedded systems. The mobile phone is one of the marvels of the last decade of the 20'h century. It is a very powerful embedded system that provides voice communication while we are on the move. The Personal Digital Assistants and the palmtops can now be used to access multimedia service over the Internet. Mobile communication infrastructure such as base station controllers, mobile switching centers are also powerful embedded systems.

Insemination:

Testing and measurement are the fundamental requirements in all scientific and engineering activities. The measuring equipment we use in laboratories to measure parameters such as weight, temperature, pressure, humidity, voltage, current etc. are all embedded systems. Test equipment such as oscilloscope, spectrum analyzer, logic analyzer, protocol analyzer, radio communication test set etc. are embedded systems built around powerful processors. Thanks to miniaturization, the test and measuring equipment are now becoming portable, facilitating easy testing and measurement in the field by field-personnel.

Security:

Security of persons and information has always been a major issue. We need to protect our homes and offices; and also the information we transmit and store. Developing embedded systems for security applications is one of the most lucrative businesses nowadays. Security devices at homes, offices, airports etc. for authentication and verification are embedded systems. Encryption devices are nearly 99 per cent of the processors that are manufactured end up in embedded systems. Embedded systems find applications in every industrial segment- consumer electronics, transportation, avionics, biomedical engineering, manufacturing, process control and industrial automation, data communication, telecommunication, defense, security etc. Used to encrypt the data/voice being transmitted on communication links such as telephone lines. Biometric systems using fingerprint and face recognition are now being extensively used for user authentication in banking applications as well as for access control in high security buildings.

Finance:

Financial dealing through cash and cheques are now slowly paving the way for transactions using smart cards and ATM (Automatic Teller Machine, also expanded as Any Time Money) machines. Smart card, the size of a credit card, has a small micro-controller and memory; and it interacts with the smart card reader! ATM machine and acts as an electronic wallet. Smart card technology has the capability of ushering in a cashless society. Well, the list goes on. It is no exaggeration to say that eyes wherever you go, you can see, or at least feel, the work of an embedded system.

Overview of Embedded System Architecture

Every embedded system consists of custom-built hardware built around a Central Processing Unit (CPU). This hardware also contains memory chips onto which the software is loaded. The software residing on the memory chip is also called the ‘firmware’. The embedded system architecture can be represented as a layered architecture as shown in Fig. The operating system runs above the hardware, and the application software runs above the operating system. The same architecture is applicable to any computer including a desktop computer. However, there are significant differences. It is not compulsory to have an operating system in every embedded system. For small appliances such as remote control units, air conditioners, toys etc., there is no need *for* an operating system and you can write only the software specific to that application. For applications involving complex processing, it is advisable to have an operating system. In such a case, you need to integrate the application software with the operating system and then transfer the entire software onto the memory chip. Once the software is transferred to the memory chip, the software will continue to run *for* a long time. You don’t need to reload new software.

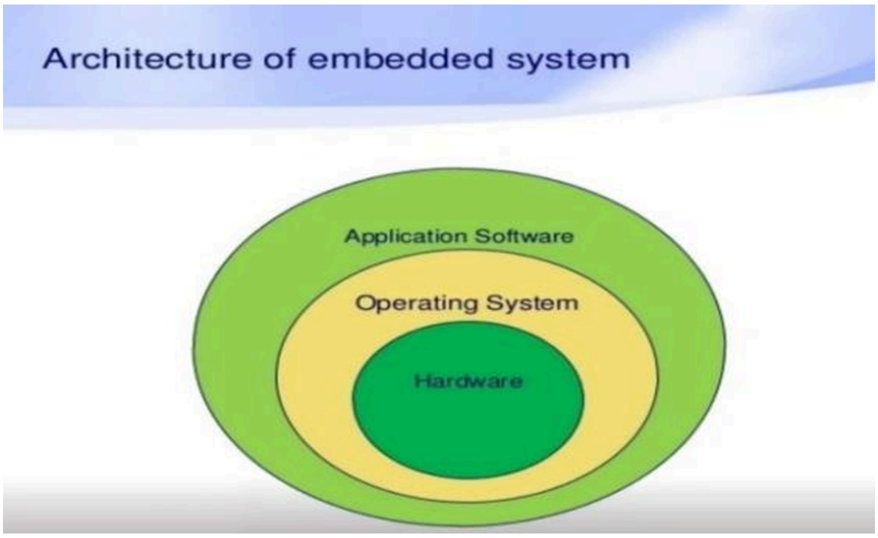

Fig 2.1.1: Layered Architecture of an Embedded System

Now, let us see the details of the various building blocks of the hardware of an embedded system. As shown in Fig. the building blocks are;

- Central Processing Unit (CPU)
- Memory (Read-only Memory and Random Access Memory)
- Input Devices
- Output devices
- Communication interfaces
- Application-specific circuitry

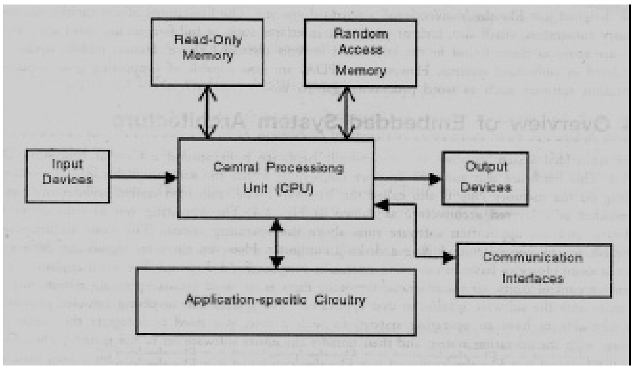

Fig 2.1.2: Building Blocks

Central Processing Unit (CPU):

The Central Processing Unit (processor, in short) can be any of the following: microcontroller, microprocessor or Digital Signal Processor (DSP). A micro-controller is a low-cost processor. Its main attraction is that on the chip itself, there will be many other components such as memory, serial communication interface, analog-to-digital converter etc. So, for small applications, a microcontroller is the best choice as the number of external components required will be very less. On the other hand, microprocessors are more powerful, but you need to use many external components with them. D5P is used mainly for applications in which signal processing is involved such as audio and video processing.

Memory:

The memory is categorized as Random Access Memory (RAM) and Read Only Memory (ROM). The contents of the RAM will be erased if power is switched off to the chip, whereas ROM retains the contents even if the power is switched off. So, the firmware is stored in the ROM. When power is switched on, the processor reads the ROM; the program is executed.

Input Devices:

Unlike the desktops, the input devices to an embedded system have very limited capability. There will be no keyboard or a mouse, and hence interacting with the embedded system is no easy task. Many embedded systems will have a small keypad-you press one key to give a specific command. A keypad may be used to input only the digits. Many embedded systems used in process control do not have any input device for user interaction; they take inputs from sensors or transducers 1'fnd produce electrical signals that are in turn fed to other systems.

Output Devices:

The output devices of the embedded systems also have very limited capability. Some embedded systems will have a few Light Emitting Diodes (LEDs) to indicate the health status of the system modules, or for visual indication of alarms. A small Liquid Crystal Display (LCD) may also be used to display some important parameters.

Communication Interfaces:

The embedded systems may need to interact with other embedded systems as they may have to transmit data to a desktop. To facilitate this, the embedded systems are provided with one or a *few* communication interfaces such as RS232, RS422, RS485, Universal Serial Bus (USB), IEEE 1394, Ethernet etc.

Application-Specific Circuitry:

Sensors, transducers, special processing and control circuitry may be required fat an embedded system, depending on its application. This circuitry interacts with the processor to carry out the necessary work. The entire hardware has to be given power supply either through the 230 volts main supply or through a battery. The hardware has to be designed in such a way that the power consumption is minimized.

2.2 BLOCK DIAGRAM:

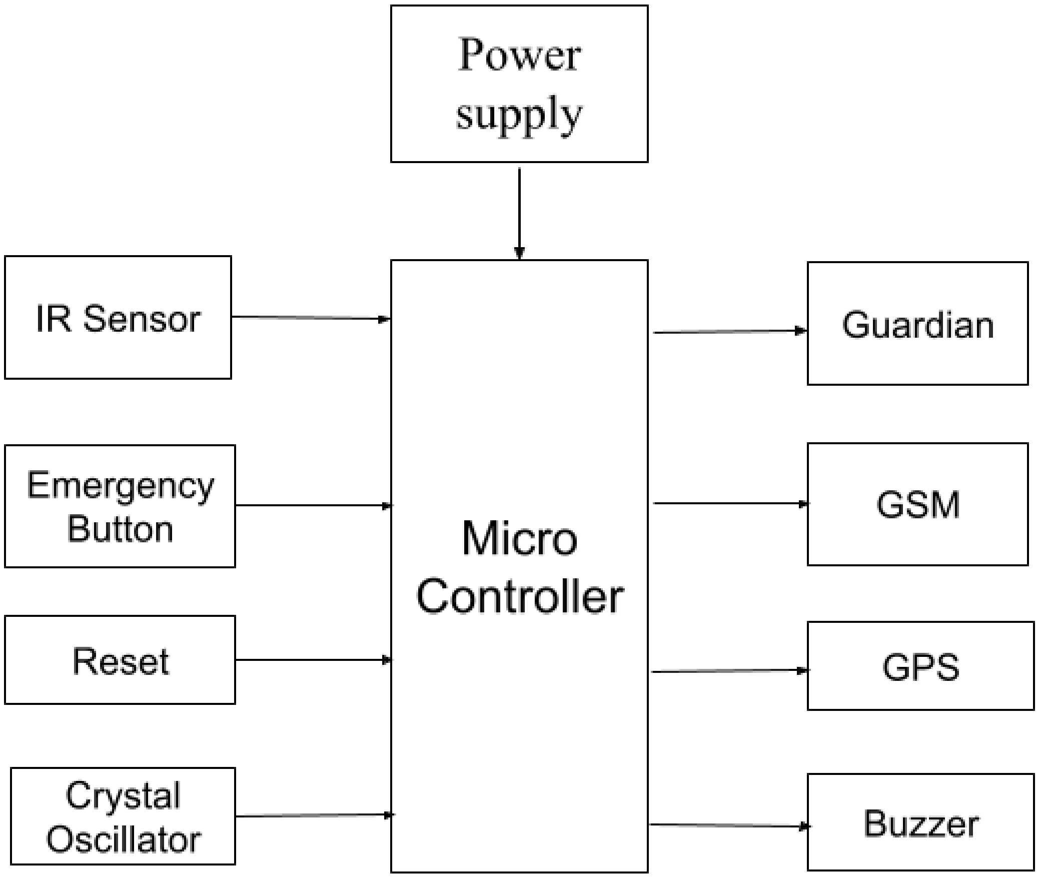

Fig 2.2.1: Block Diagram of the Project

2.3 MODULES:

2.3.1 POWER SUPPLY:

The power supply section is the section which provides +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.

The ac voltage, typically 220V, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

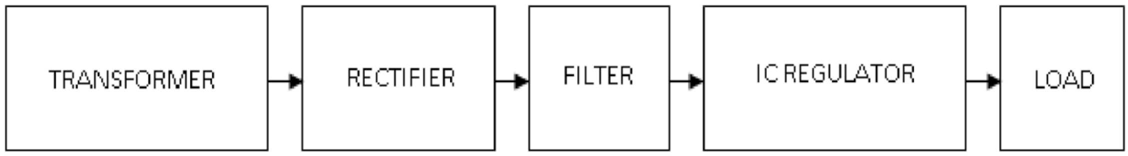

Fig: Block Diagram of Power Supply

2.3.2 Transformer

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.

Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in India) to a safer low voltage.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The transformer will step down the power supply voltage (0-230V) to (0- 6V) level. Then the secondary of the potential transformer will be connected to the bridge rectifier, which is constructed with the help of PN junction diodes. The advantages of using a bridge rectifier are it will give peak voltage output as DC.

2.3.3 Rectifier

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC

2.3.4 Bridge Rectifier

When four diodes are connected as shown in figure, the circuit is called a bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

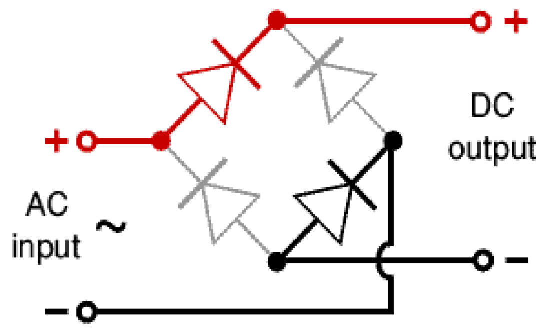

Fig 2.3.1: Bridge Rectifier

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

i. The main advantage of this bridge circuit is that it does not require a special centre tapped transformer, thereby reducing its size and cost.

ii. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown below.

iii. The result is still a pulsating direct current but with double the frequency.

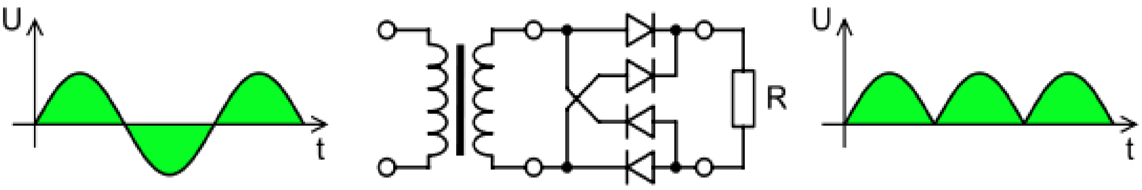

Fig 2.3.2: Output Waveform Of DC

Smoothing

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.

2.3.5 Voltage Regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustable set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts. Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

Many of the fixed voltage regulator ICs have 3 leads and look like power transistors, such as the 7805 +5V 1Amp regulator. They include a hole for attaching a heat sink if necessary.

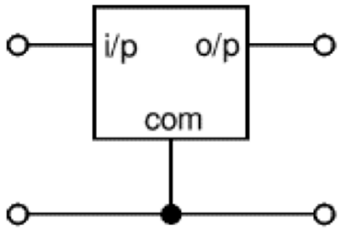

Fig 2.3.3: Regulator

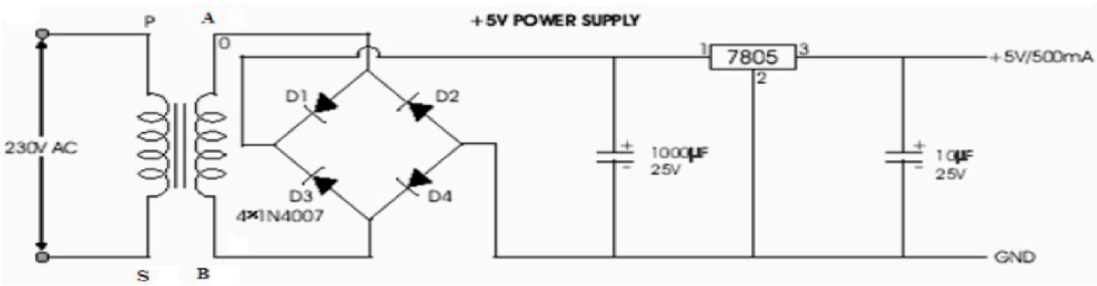

Fig 2.3.4: Circuit Diagram Of Power Supply

2.4 MICROCONTROLLER:

A Microcontroller (or MCU) is a computer-on-a-chip used to control electronic devices. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor (the kind used in a PC). A typical microcontroller contains all the memory and interfaces needed for a simple application, whereas a general purpose microprocessor requires additional chips to provide these functions.

A microcontroller is a single integrated circuit with the following key features:

- central processing unit - ranging from small and simple 8-bit processors to sophisticated 32- or 64-bit processors
- input/output interfaces such as serial ports
- RAM for data storage
- ROM, EEPROM or Flash memory for program storage
- clock generator - often an oscillator for a quartz timing crystal, resonator or RC circuit

Microcontrollers are inside many kinds of electronic equipment (see embedded system). They are the vast majority of all processor chips sold. Over 50% are "simple" controllers, and another 20% are more specialized digital signal processors (DSPs) (ref?). A typical home in a developed country is likely to have only one or two general-purpose microprocessors but somewhere between one and two dozen microcontrollers. A typical mid-range vehicle has as many as 50 or more microcontrollers. They can also be found in almost any electrical device: washing machines, microwave ovens, telephones etc.

2.4.1 FEATURES:

- Compatible with MCU®-51 Products
- 8K Bytes of In-System Programmable (ISP) Flash Memory
  - Endurance: 10,000 Write/Erase Cycles
- 4.0V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 33 MHz
- 256 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/Counters
- Eight Interrupt Sources
- Full Duplex UART Serial Channel
- Low-power Idle and Power-down Modes
- Interrupt Recovery from Power-down Mode
- Fast Programming Time
- Flexible ISP Programming (Byte and Page Mode)

Description

The AT89S52 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 nonvolatile 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 nonvolatile 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, 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.

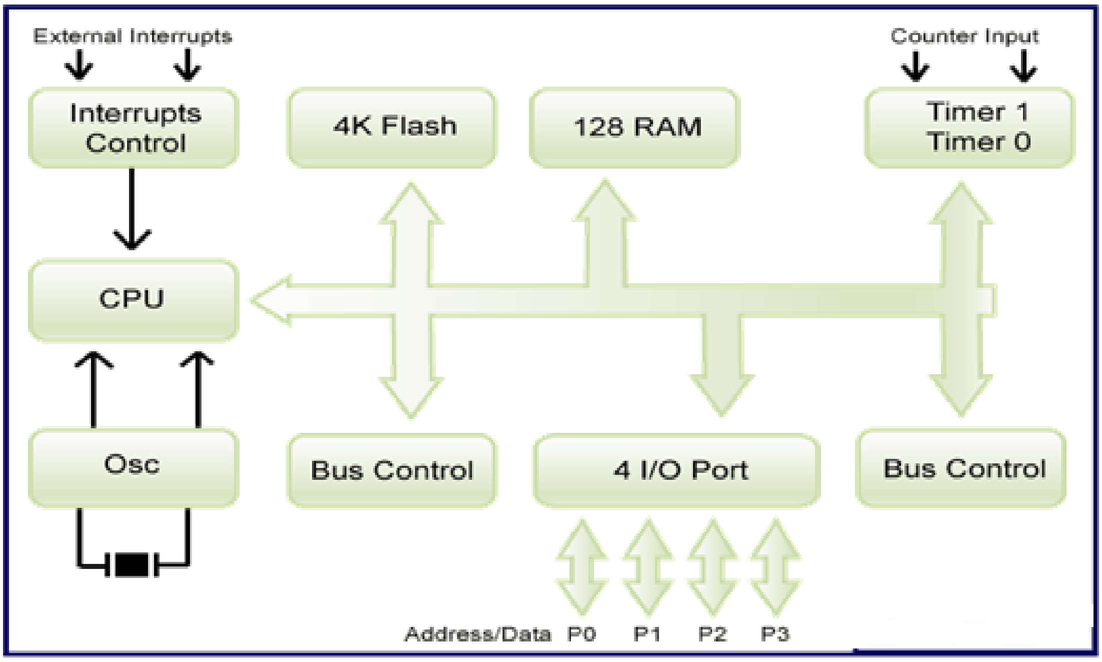

Fig 2.4.1: Block Diagram of 8052

2.4.2 PIN DIAGRAM:

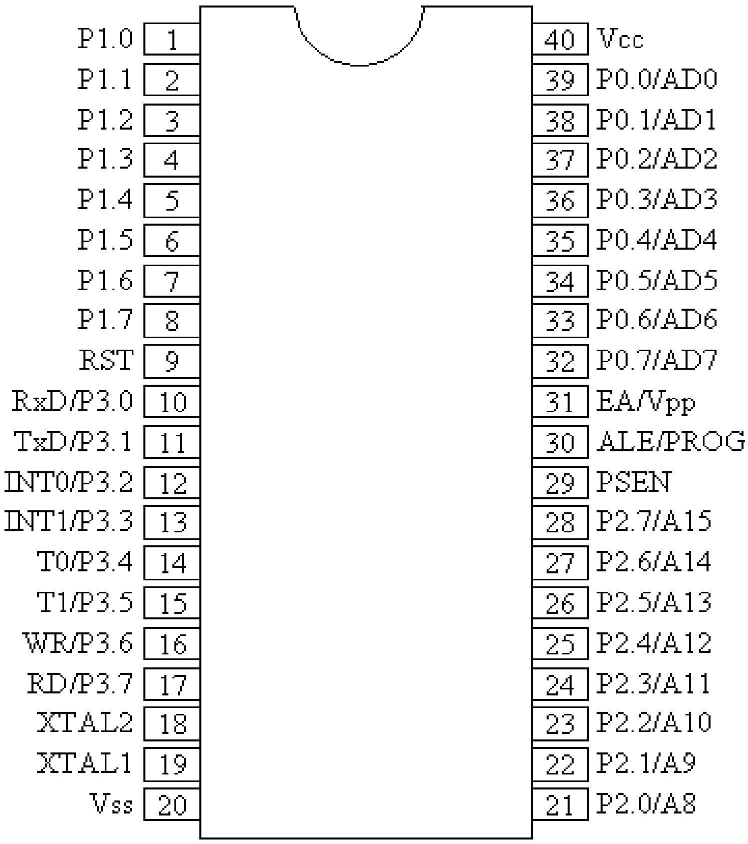

Fig 2.4.2: Pin Diagram of 8052

PIN DESCRIPTION

40 pin VCC Supply voltage.

20 pin GND Ground.

Port 0

Port 0 is an 8-bit open drain bidirectional 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 programs and data memory. 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.

Port 1

Port 1 is an 8-bit bidirectional 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.

Port 2

Port 2 is an 8-bit bidirectional 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 because of the internal pull-ups. In this application, Port 2 uses strong internal pull-ups when emitting 1s. During access to external data memory that uses 8-bit addresses, 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.

Port 3

Port 3 is an 8-bit bidirectional 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 as inputs. As inputs, Port 3 pins that are externally being pulled low will source current because of the pull-ups. Port 3 also serves the functions of various special features of the AT89S52, as shown in the following table.

Table 2.4.1: Pin Description of 8052 (Port 3)

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{\text{INT0}}$ (external interrupt 0)
P3.3	$\overline{\text{INT1}}$ (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	$\overline{\text{WR}}$ (external data memory write strobe)
P3.7	$\overline{\text{RD}}$ (external data memory read strobe)

RST

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

WR

It is an active low write O/P control signal. During External RAM (Data memory). Write to external RAM.

RD

It is an active low read O/P control signal. During External RAM (Data memory). Read from External RAM.

XTAL1 Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2 Output from the inverting oscillator amplifier.

ALE/PROG

Address Latch Enable (ALE) 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. 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.

PSEN

Program Store Enable (PSEN) is the read strobe to external program memory. When the AT89S52 is executing code from external program memory, PSEN is activated twice each machine cycle.

EA

External Access Enable. 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.

2.4.3 ARCHITECTURE OF 8052:

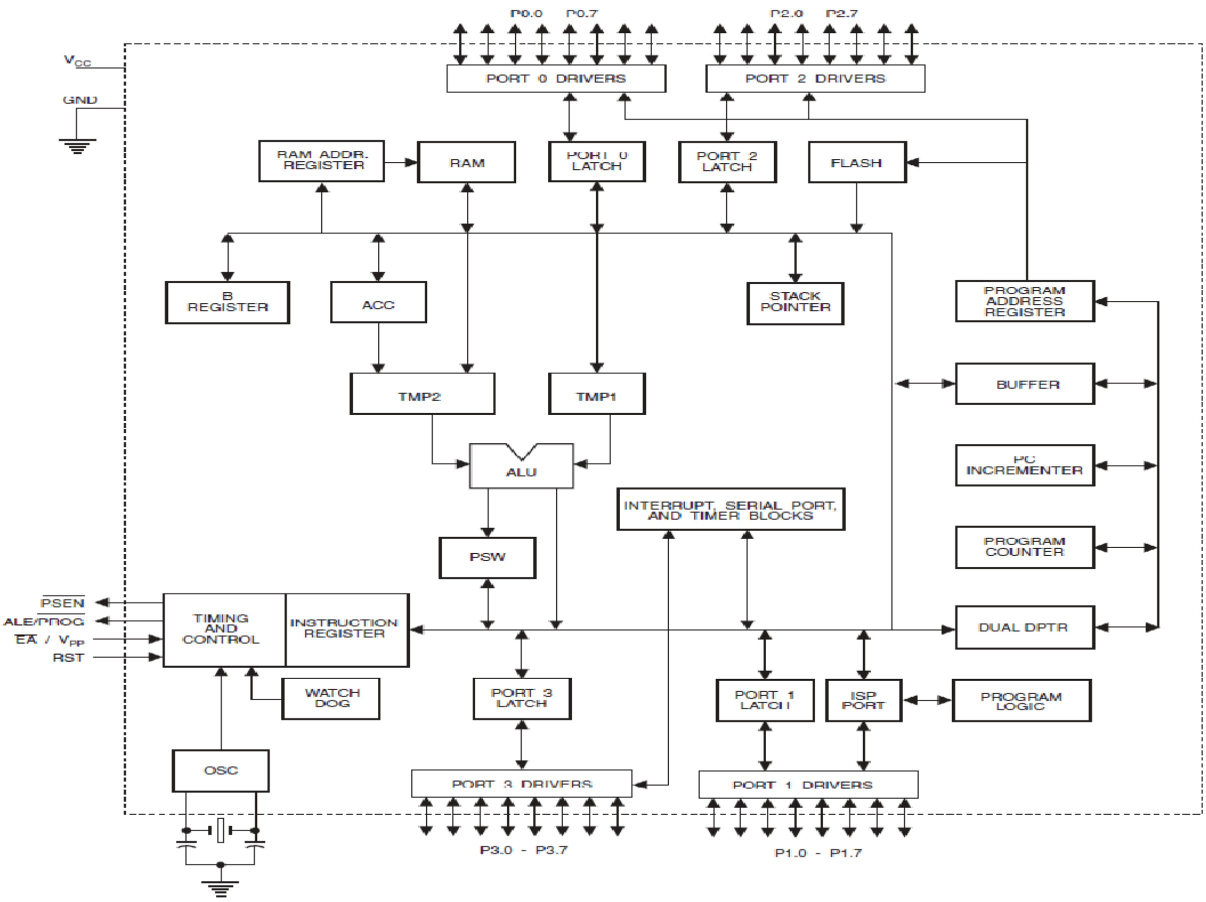

Fig 2.4.3: INTERNAL ARCHITECTURE OF 8052

2.4.4 REGISTERS:

Registers and accumulators serve as temporary memory locations during CPU operations. The exchange of information among them takes place through one or more internal buses. The length of each register is equal to the width of the internal data bus. Registers are categorized as general-purpose registers and special-purpose registers.

A general-purpose register may be used as an accumulator or as a data register for (arithmetic) and logic operations. An accumulator is a register for storing the results of an arithmetic operation. A general-purpose register may also be used as an address register.

A special-purpose register is dedicated to a specific function. Some of these registers are the program counter (PC), the instruction register (IR), the address register (AR), the status register, and the stack pointer (SP).

The program counter holds the address of the next instruction to be executed. When the CPU executes a branch instruction telling it to branch to another part of the program, the new address is loaded into the program counter and the sequential order resumes.

The instruction register extracts the operation code (op code) from an instruction. An instruction consists of opcode and operand(s). The contents of the instruction register are decoded by the control unit. The status register or condition code register consists of status or flag bits and control bits.

The flag bits are: carry/borrow (C), overflow (V), negative (N), zero (Z), and half-carry (H). The logic states of the flag bits are used by the CPU's branch instructions to make decisions. The program counter sends its contents (address) to the address register. The address register then sends this address to the address bus.

A stack is a specially reserved area in memory where information is stored or removed in a last-in-first-out (LIFO) fashion. The stack pointer points to the next free location on the stack. That is, it holds the address of the top of the stack. Each time data is stored in the stack, the stack pointer is automatically decremented and each time data is retrieved from the stack, the stack pointer is automatically incremented.

2.4.5 Memory Organization:

MCU-51 devices have a separate address space for Program and Data Memory. Up to 64K bytes each of external Program and Data Memory can be addressed.

The instructions to be executed by the microcontroller CPU and the data to be operated on by these instructions are stored in memory. When the CPU accesses the information stored in memory, it is performing a read operation. When the CPU sends information to be stored in the memory, it is performing a write operation. Memory is classified as internal and external memory. Internal memory is on-chip memory and is a semiconductor type with low capacity and high speeds. External memory is outside the chip and includes the semiconductor type and serial memory such as magnetic disks, magnetic tapes, and bubble memory. Semiconductor memory may be volatile or nonvolatile. Volatile memory loses its contents after the power is removed from the memory chip. Nonvolatile memory does not lose its contents when power is removed. The nonvolatile memory can store information permanently or at least semi-permanently (ten years or more). Volatile memory includes RAM while nonvolatile memory includes ROM, EPROM, EEPROM, and battery-backed RAM.

RAM (random access memory) comprises DRAM (Dynamic RAM) and SRAM (Static RAM). Each storage cell of DRAM consists of a capacitor and a MOSFET (Metal Oxide Semiconductor Field Effect Transistor). If the capacitor is charged, a logic 1 is stored in the cell. If the capacitor has no charge, a logic 0 is stored in the cell. The charge stored in the capacitors dissipates fast because of leakage. Therefore, a DRAM has to be periodically refreshed otherwise its contents will fade away after some time even in the presence of the power to the memory chip.

The storage cell of a ROM (Read-only memory) consists of a BJT (Bipolar Junction Transistor). A ROM may be programmed at the manufacturing stage using a mask process. Such a ROM is called a mask-programmed ROM. The contents of a mask-programmed ROM cannot be changed once it is programmed.

2.4.6 Data Memory:

The AT89S52 implements 256 bytes of on-chip RAM. The upper 128 bytes occupy a parallel address space to the Special Function Registers. This means that the upper 128 bytes have the same addresses as the SFR space but are physically separate from SFR space.

When an instruction accesses an internal location above address 7FH, the address mode used in the instruction specifies whether the CPU accesses the upper 128 bytes of RAM or the SFR space. Instructions which use direct addressing access the SFR space.

UART (Universal Asynchronous Receiver and Transmitter)

One of the microcontroller features making it so powerful is an integrated UART, better known as a serial port. It is a full-duplex port, thus being able to transmit and receive data simultaneously and at different baud rates. Without it, serial data send and receive would be an enormously complicated part of the program in which the pin state is constantly changed and checked at regular intervals. When using UART, all the programmer has to do is to simply select serial port mode and baud rate. When it's done, serial data transmit is nothing but writing to the SBUF register, while data received represents reading the same register. The microcontroller takes care of not making any error during data transmission.

2.4.7 TIMERS:

Timer is used to generate time delay, a timer always counts up. It doesn't matter whether the timer is being used as a timer, a counter, or a baud rate generator: A timer is always incremented by the microcontroller. There are 3 timers i.e., Timer 0, Timer 1 and Timer 2.

Timer 0 and 1

Timer 0 and Timer 1 in the AT89S52 operate the same way as Timer 0 and Timer 1 in the 8051.

Timer T0 is a 16 bit timer. The 16-bit Timer 0 is accessed as low byte and high byte. the low byte is called TL0(Timer 0 low byte)and the high byte is referred to as TH0(Timer 0 high byte).

Timer 1 is also a 16-bit timer split into two bytes, referred to as TL1 (Timer 1 low byte) and TH1(Timer 1 high byte). These timers are accessible in the same way as the Timer 0.

Timer 2

Timer 2 is a 16-bit Timer/Counter that can operate as either a timer or an event counter. The type of operation is selected by bit C/T2 in the SFR T2CON (shown in Table 5-2). Timer 2 has three operating modes: capture, auto-reload (up or down counting), and baud rate generator. Timer 2 consists of two 8-bit registers, TH2 and TL2. In the Timer function, the TL2 register is incremented every machine cycle. Since a machine cycle consists of 12 oscillator periods, the count rate is 1/12 of the oscillator frequency.

In the Counter function, the register is incremented in response to a 1-to-0 transition at its corresponding external input pin, T2. In this function, the external input is sampled during S5P2 of every machine cycle. When the samples show a high in one cycle and a low in the next cycle, the count is incremented. The new count value appears in the register during S3P1 of the cycle following the one in which the transition was detected. Since two machine cycles (24 oscillator periods) are required to recognize a 1-to-0 transition, the maximum count rate is 1/24 of the oscillator frequency. To ensure that a given level is sampled at least once before it changes, the level should be held for at least one full machine cycle.

2.4.8 INTERRUPTS:

The AT89S52 has a total of six interrupt vectors: two external interrupts (INT0 and INT1), three timer interrupts (Timers 0, 1, and 2), and the serial port interrupt.

Each of these interrupt sources can be individually enabled or disabled by setting or clearing a bit in Special Function Register IE. IE also contains a global disable bit, EA, which disables all interrupts at once.

Timer 2 interrupt is generated by the logical OR of bits TF2 and EXF2 in register T2CON. Neither of these flags is cleared by hardware when the service routine is vectored to. In fact, the service routine may have to determine whether it was TF2 or EXF2 that generated the interrupt, and that bit will have to be cleared in software.

The Timer 0 and Timer 1 flags, TF0 and TF1, use the cycle in which the timers overflow. The values are then polled by the circuitry in the next cycle. However, the Timer 2 flag, TF2, is set at S2P2 and is polled in the same cycle in which the timer overflows.

2.5 LIQUID CRYSTAL DISPLAY (LCD):

LCD (Liquid Crystal Display) screen is an electronic display module and finds a wide range of applications. A 16x2 LCD display is a very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

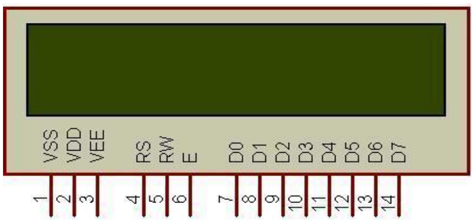

Fig 2.5.1: 16x2 LCD

2.5.1 Introduction

The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580.

2.5.2 Pin Description

Most LCDs with 1 controller have 14 Pins and LCDs with 2 controllers have 16 Pins (two pins are extra in both for back-light LED connections). Pin description is shown in the table below.

Pin Configuration table for a 16X2 LCD character display:-

Pin Number	Symbol	Function
1	Vss	Ground Terminal
2	Vcc	Positive Supply
3	Vdd	Contrast adjustment
4	RS	Register Select; 0→Instruction Register, 1→Data Register
5	R/W	Read/write Signal; 1→Read, 0→ Write
6	E	Enable; Falling edge
7	DB0	Bi-directional data bus, data transfer is performed once, thru DB0 to DB7, in the case of interface data length is 8-bits; and twice, through DB4 to DB7 in the case of interface data length is 4-bits. Upper four bits first then lower four bits.
8	DB1	
9	DB2	
10	DB3	
11	DB4	
12	DB5	
13	DB6	
14	DB7	
15	LED-(K)	Back light LED cathode terminal
16	LED+(A)	Back Light LED anode terminal

Table 2.5.1: Pin Description of LCD

Data/Signals/Execution of LCD

Coming to data, signals and execution.

LCD accepts two types of signals, one is data, and another is control. These signals are recognized by the LCD module from the status of the RS pin. Now data can be read also from the LCD display, by pulling the R/W pin high. As soon as the E pin is pulsed, the LCD display reads data at the falling edge of the pulse and executes it, same for the case of transmission.

LCD displays take a time of 39-43µS to place a character or execute a command. Except for clearing display and to seek cursor to home position it takes 1.53ms to 1.64ms. Any attempt to send any data before this interval may lead to failure to read data or execution of the current data in some devices. Some devices compensate for the speed by storing the incoming data to some temporary registers.

Instruction Register (IR) and Data Register (DR)

There are two 8-bit registers in the HD44780 controller Instruction and Data register. Instruction register corresponds to the register where you send commands to LCD e.g LCD shift command, LCD clear, LCD address etc. and Data register is used for storing data which is to be displayed on LCD. When the enable signal of the LCD is asserted, the data on the pins is latched into the data register and data is then moved automatically to the DDRAM and hence is displayed on the LCD. Data Register is not only used for sending data to DDRAM but also for CGRAM, the address where you want to send the data, is decided by the instruction you send to LCD. We will discuss more on LCD instruction sets further in this tutorial.

Commands and Instruction set

Only the instruction register (IR) and the data register (DR) of the LCD can be controlled by the MCU. Before starting the internal operation of the LCD, control information is temporarily stored into these registers to allow interfacing with various MCUs, which operate at different speeds, or various peripheral control devices. The internal operation of the LCD is determined by signals sent from the MCU. These signals, which include register selection signal (RS), read/write signal (R/W), and the data bus (DB0 to DB7), make up the LCD instructions (Table 3). There are four categories of instructions that:

- Designate LCD functions, such as display format, data length, etc.
- Set internal RAM addresses
- Perform data transfer with internal RAM
- Perform miscellaneous functions

Table 2.5.2: Showing various LCD Command Description

Command	Code										Description	Execution Time
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Clears the display and returns the cursor to the home position (address 0).	82μs~1.64ms
Return Home	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position (address 0). Also returns a shifted display to the home position. DD RAM contents remain unchanged.	40μs~1.64ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and enables/disables the display.	40μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Turns the display ON/OFF (D), or the cursor ON/OFF (C), and blink of the character at the cursor position (B).	40μs
Cursor & Display Shift	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing the DD RAM contents.	40μs
Function Set	0	0	0	0	1	DL	N$	F	*	#	Sets the data width (DL), the number of lines in the display (L), and the character font (F).	40μs
Set CG RAM Address	0	0	0	1	A_{CG}						Sets the CG RAM address. CG RAM data can be read or altered after making this setting.	40μs
Set DD RAM Address	0	0	1	A_{DD}							Sets the DD RAM address. Data may be written or read after making this setting.	40μs
Read Busy Flag & Address	0	1	BF	AC							Reads the BUSY flag (BF) indicating that an internal operation is being performed and reads the address counter contents.	1μs
Write Data to CG or DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	46μs
Read Data from CG or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	46μs
	I/D = 1: Increment I/D = 0: Decrement S = 1: Accompanies display shift. S/C= 1: Display shift S/C = 0: cursor move R/L= 1: Shift to the right. R/L= 0: Shift to the left. DL = 1: 8 bits DL = 0: 4 bits N = 1: 2 lines N = 0: 1 line F = 1: 5x10 dots F = 0: 5 x 7 dots BF = 1: Busy BF = 0: Can accept data *# Set to 1 on 24x4 modules* *$ With KS0072 is Address Mode.*										DD RAM: Display data RAM CG RAM: Character generator RAM A_{CG}: CG RAM Address A_{DD}: DD RAM Address Corresponds to cursor address. AC: Address counter Used for both DD and CG RAM address.	Execution times are typical. If transfers are timed by software and the busy flag is not used, add 10% to the above times.

Although looking at the table you can make your own commands and test them. Below is a brief list of useful commands which are used frequently while working on the LCD.

2.5.3 List of Command

No.	Instruction	Hex	Decimal
1	Function Set: 8-bit, 1 Line, 5x7 Dots	0x30	48
2	Function Set: 8-bit, 2 Line, 5x7 Dots	0x38	56
3	Function Set: 4-bit, 1 Line, 5x7 Dots	0x20	32
4	Function Set: 4-bit, 2 Line, 5x7 Dots	0x28	40
5	Entry Mode	0x06	6
6	Display off Cursor off (clearing display without clearing DDRAM content)	0x08	8
7	Display on Cursor on	0x0E	14
8	Display on Cursor off	0x0C	12
9	Display on Cursor blinking	0x0F	15
10	Shift entire display left	0x18	24
12	Shift entire display right	0x1C	30
13	Move cursor left by one character	0x10	16
14	Move cursor right by one character	0x14	20
15	Clear Display (also clear DDRAM content)	0x01	1
16	Set DDRAM address or cursor position on display	0x80+add*	128+add*
17	Set CGRAM address or set pointer to CGRAM location	0x40+add**	64+add**

Table 2.5.3: Frequently Used Commands and Instructions for LCD

* DDRAM address given in LCD basics section see Figure 2,3,4

** CGRAM addresses from 0x00 to 0x3F, 0x00 to 0x07 for char1 and so on.

Liquid crystal displays interfacing with Controller

The LCD standard requires 3 control lines and 8 I/O lines for the data bus.

• **8 data pins D7:D0**

Bi-directional data/command pins.

Alphanumeric characters are sent in ASCII format.

• **RS: Register Select**

RS = 0 -> Command Register is selected

RS = 1 -> Data Register is selected

• **R/W: Read or Write**

0 -> Write, 1 -> Read

• **E: Enable (Latch data)**

Used to latch the data present on the data pins.

A high-to-low edge is needed to latch the data.

2.6 INFRARED (IR) SENSOR

Infrared (IR) sensors are electronic devices that use infrared radiation to detect objects or measure parameters such as distance, motion, or temperature. These sensors operate in the infrared region of the electromagnetic spectrum, typically between 0.7 to 1000 micrometers. IR sensors are widely used in various fields, including industrial automation, healthcare, robotics, and consumer electronics.

Features of IR Sensors

- **Non-contact Detection**: Detects objects or parameters without physical contact.
- **Compact Design**: Small size and lightweight, making them suitable for various applications.
- **Wide Operating Range**: Functions effectively in both bright and dark environments.
- **High Sensitivity**: Capable of detecting slight changes in radiation.
- **Low Power Consumption**: Ideal for battery-powered devices.
- **Digital or Analog Outputs**: Flexible integration with microcontrollers or electronic systems.

Description

Infrared sensors work by emitting infrared radiation through an IR LED and detecting the reflected or emitted radiation from objects using an IR receiver. These sensors are categorized into two types:

1. **Active IR Sensors**: Emit infrared radiation and detect the reflected rays to measure the presence or distance of an object. Active sensors are widely used in proximity detection and line-following robots. They have applications in automated systems where precise detection of an object's position is necessary.
2. **Passive IR Sensors (PIR)**: Detect infrared radiation emitted by objects, commonly used for motion detection. PIR sensors are extensively used in home security systems, automatic lighting controls, and smart home automation systems due to their sensitivity to thermal radiation emitted by humans and animals.

Infrared sensors rely on the principle that objects emit infrared radiation based on their temperature. The sensor’s emitter sends out a beam of infrared light, which interacts with the object. Depending on the material and distance of the object, some of this light is reflected back and detected by the receiver. The amount of reflected light helps determine the proximity and presence of the object.

Advanced IR sensors also integrate ambient light filters to minimize interference from natural or artificial light sources. This makes them reliable in varying environmental conditions, such as low-light areas or spaces with bright illumination.

Applications of IR sensors include proximity detection, object counting, temperature measurement, and security systems. These sensors are also instrumental in industrial robotics, where they help guide robotic arms during precision assembly processes. The versatility of IR sensors makes them essential in robotics, automation, consumer electronics, and healthcare systems.

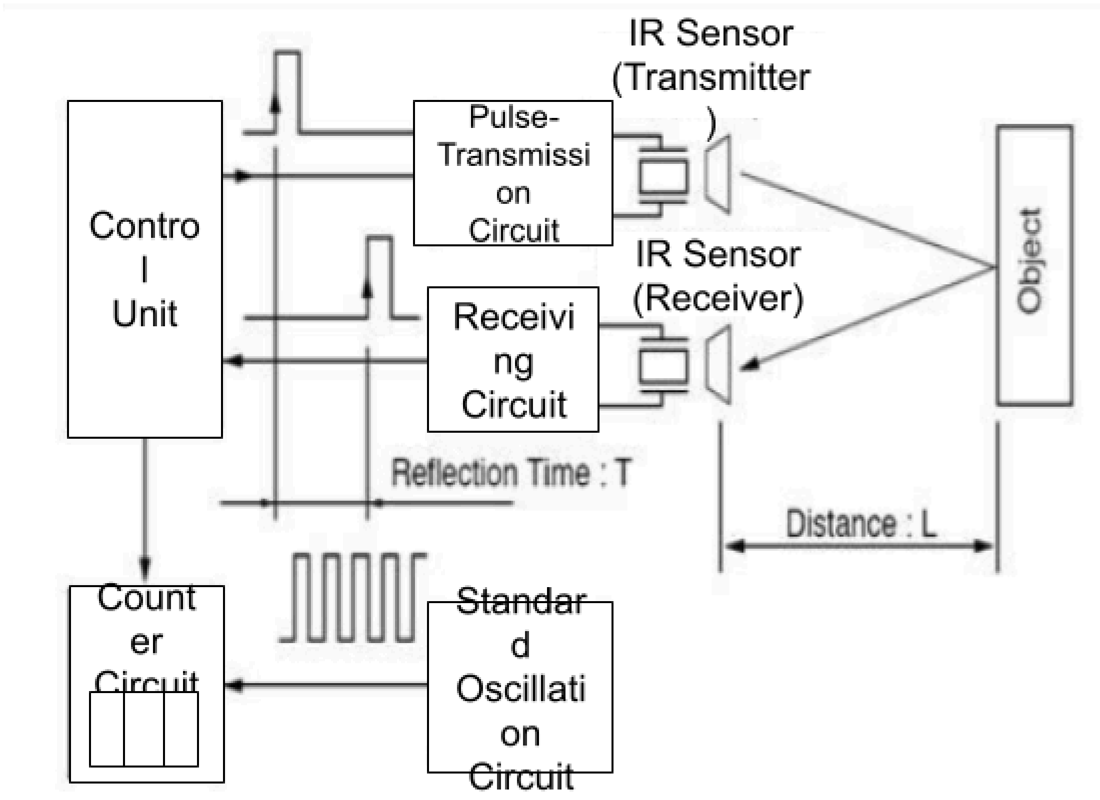

Fig 2.6.1: Block Diagram of IR Sensor

An IR sensor typically consists of:

- **IR Emitter (LED)**: Emits infrared radiation.
- **IR Detector (Photodiode/Phototransistor)**: Detects the reflected or emitted IR radiation.
- **Amplifier**: Boosts the weak signal for processing.
- **Signal Processor**: Converts the signal into a readable output.
- **Output Interface**: Provides analog or digital signals for external systems.

Transducers

IR transducers convert electrical energy into infrared radiation and back into electrical signals for processing. These transducers form the core of IR sensor systems, ensuring accurate detection and response. The performance of an IR transducer depends on several factors, including:

- **Emitted Wavelength**: The infrared wavelength emitted by the IR LED, typically in the range of 700 nm to 1 mm, determines the type of objects and surfaces it can interact with.

- **Detector Sensitivity**: The efficiency with which the photodiode or thermopile detects infrared radiation. Higher sensitivity improves the accuracy and range of the sensor.
- **Environmental Conditions**: Factors such as ambient light, dust, and temperature fluctuations can influence transducer performance. Modern transducers are equipped with filters to minimize interference.

For example:

- **Emitter**: An IR LED that generates a focused beam of infrared radiation. High-power LEDs enhance the range and strength of the signal.
- **Detector**: A photodiode or thermopile that converts the received IR radiation into an electrical signal for further processing. Some advanced systems use multi-element detectors to improve spatial resolution.

The range and accuracy of IR transducers are determined by:

- **Optical System**: The use of lenses or reflectors to focus the IR beam improves detection over long distances.
- **Operating Medium**: Transducers function optimally in clean air but may require compensation mechanisms when used in dusty or smoky environments.
- **Temperature Compensation**: Ensures consistent performance by accounting for variations in ambient temperature.

Advanced transducers also integrate signal amplification and noise reduction circuits to improve reliability in challenging conditions. They are widely used in applications such as gesture recognition, gas sensing, and high-precision distance measurement.

Range

The operating range of IR sensors varies with the application. Proximity sensors typically have a range of 2 cm to 80 cm, while advanced modules may extend to several meters. The resolution depends on the detection mechanism, often achieving sub-centimeter precision. Some high-end sensors can operate in ranges exceeding 2 meters for industrial applications.

Working

IR sensors work by emitting infrared light through the emitter. When the light strikes an object, it is reflected back and captured by the receiver. The intensity and time delay of the reflected signal are processed to determine the object's presence, distance, and sometimes even its shape or texture.

Mechanism:

1. **Emission**: The IR emitter (an LED) generates infrared light in a specific wavelength. Advanced emitters may include filters or lenses to focus the beam for improved accuracy and range.
2. **Reflection**: When the emitted light hits an object, part of it is reflected back towards the sensor. The amount of reflection depends on the object's material, color, and distance.
3. **Detection**: The reflected IR radiation is detected by a photodiode or phototransistor, which generates an electrical signal proportional to the intensity of the received light.
4. **Processing**: The detected signal is amplified and processed using operational amplifiers and microcontrollers to produce a usable output.

IR sensors can also utilize triangulation or phase-shift techniques for more precise distance measurements. In triangulation, the angle of reflected light is used to calculate the object's position. Phase-shift techniques analyze the time difference between emitted and reflected signals to estimate distance with higher precision.

Example:

A standard IR sensor module has the following pins:

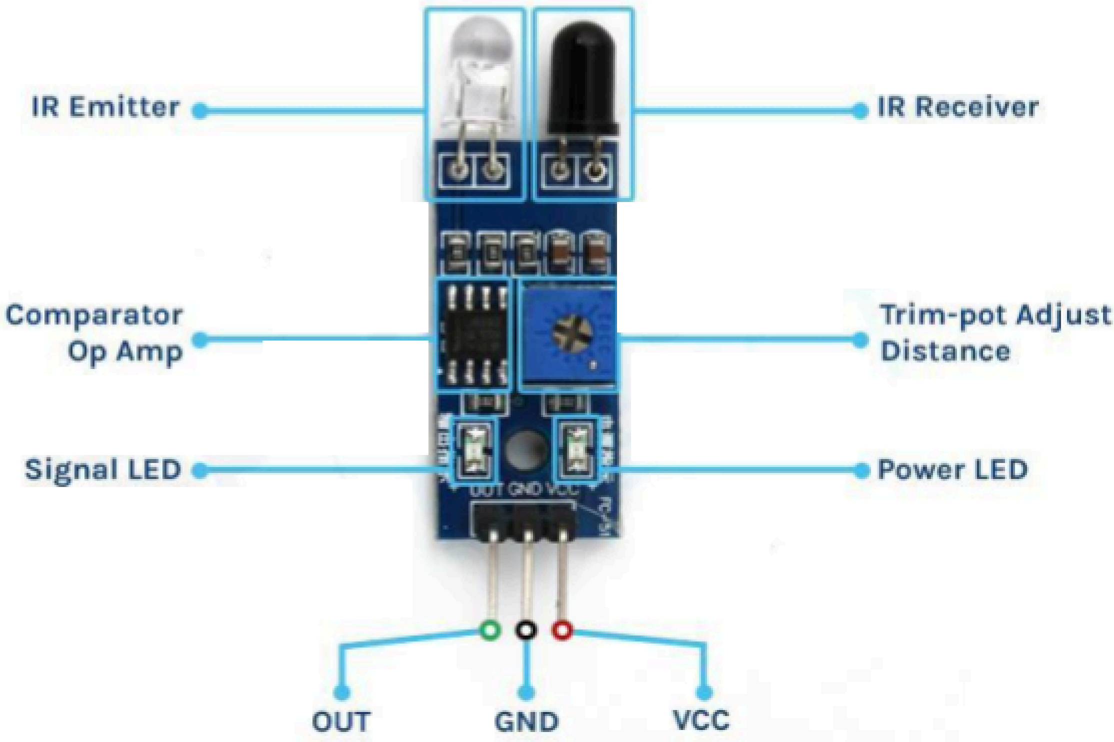

Fig 2.6.2: IR Sensor

1. **VCC**: Connects to a 5V DC power supply.
2. **OUT**: Provides the output signal (digital or analog).
3. **GND**: Ground connection.
4. **EN (Optional)**: Enables or disables the sensor.

Advanced Circuitry:

The circuit typically includes:

- **Operational Amplifiers**: To amplify weak signals detected by the receiver.
- **Comparators**: For converting analog signals into digital outputs.
- **Microcontroller Integration**: Some modules include onboard processors to interpret signals directly, reducing the need for external computation.
- **Ambient Light Filtering**: To improve reliability in environments with bright lighting or variable light conditions.

This setup is widely used in applications such as:

- **Robotics**: For object detection, obstacle avoidance, and navigation.
- **Home Automation**: In touchless appliances like faucets, hand sanitizer dispensers, and lighting systems.
- **Industrial Systems**: For product counting, alignment verification, and conveyor belt automation.

Applications with Feedback Systems:

More advanced systems integrate feedback mechanisms where the sensor continuously adjusts its sensitivity based on environmental conditions. For example, in autonomous vehicles, IR sensors can dynamically adapt to changing light levels or detect objects with varying surface properties.

Such enhancements make IR sensors an integral part of modern automation and sensing systems.

Detectors

IR detectors, such as photodiodes or thermopiles, are integral to infrared sensors. These components respond to infrared radiation by generating a proportional electrical signal. Advanced systems may combine emitters and detectors in a single housing, simplifying design and improving efficiency.

Alternative methods for detection include:

- **Capacitive Detection**: Uses variations in capacitance caused by infrared radiation.
- **Thermal Detection**: Measures temperature changes due to absorbed radiation.

Applications

Use in Medicine

IR sensors are used in non-contact thermometers, thermal imaging devices, and wearable health monitors. These devices provide accurate readings without direct physical contact, making them essential for patient care.

Use in Industry

IR sensors are employed in manufacturing processes for quality control, object detection, and automation. They are also used in conveyor systems to detect products and monitor movement.

Application in Industries

- Measurement of changing distances or dimensions.
- Monitoring of liquid levels and flow rates.
- Object counting in automated systems.
- Motion detection for security and safety applications.

Advantages

1. **Non-contact Operation**: Ideal for delicate or hazardous environments.
2. **Wide Temperature Range**: Suitable for extreme conditions.
3. **Cost-Effective**: Low-cost solutions for automation and detection.
4. **Fast Response Time**: Quickly detects objects or changes in the environment.

Limitations

1. **Environmental Sensitivity**: Affected by dust, smoke, or reflective surfaces.
2. **Limited Range**: Shorter detection range compared to ultrasonic or laser sensors.
3. **Angle Dependence**: May not detect objects accurately at sharp angles.

2.7 GLOBAL SYSTEM FOR MOBILE

Global System for Mobile Communications (GSM) modems are specialized types of modems that operate over subscription based wireless networks, similar to a mobile phone. A GSM modem accepts a Subscriber Identity Module (SIM) card, and basically acts like a mobile phone for a computer. Such a modem can even be a dedicated mobile phone that the computer uses for GSM network capabilities.

Traditional modems are attached to computers to allow dial-up connections to other computer systems. A GSM modem operates in a similar fashion, except that it sends and receives data through radio waves rather than a telephone line. This type of modem may be an external device connected via a Universal Serial Bus (USB) cable or a serial cable. More commonly, however, it is a small device that plugs directly into the USB port or card slot on a computer or laptop.

It is a widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.

Features

- Improved spectrum efficiency
- International roaming
- Compatibility with integrated services digital network (ISDN)
- Support for new services.
- SIM phonebook management
- Fixed dialing number (FDN)
- Real time clock with alarm management
- High-quality speech
- Uses encryption to make phone calls more secure
- Short message service (SMS)

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate.

As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem.

In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, you can do things like:

- Reading, writing and deleting SMS messages.
- Sending SMS messages.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.

The number of SMS messages that can be processed by a GSM modem per minute is very low -- only about six to ten SMS messages per minute.

GSM Modem Application

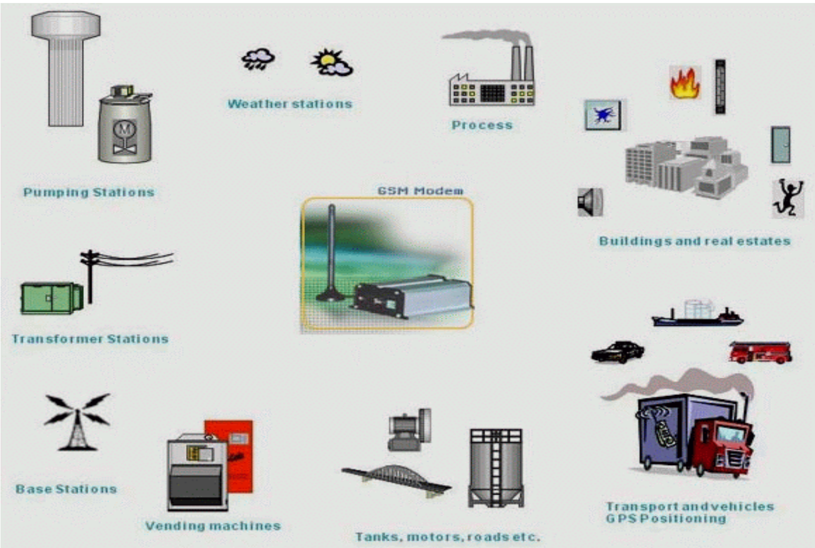

Fig 2.7.1 :GSM Modem Application

THE GSM NETWORK

GSM provides recommendations, not requirements. The GSM specifications define the functions and interface requirements in detail but do not address the hardware. The reason for this is to limit the designers as little as possible but still to make it possible for the operators to buy equipment from different suppliers. The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS).

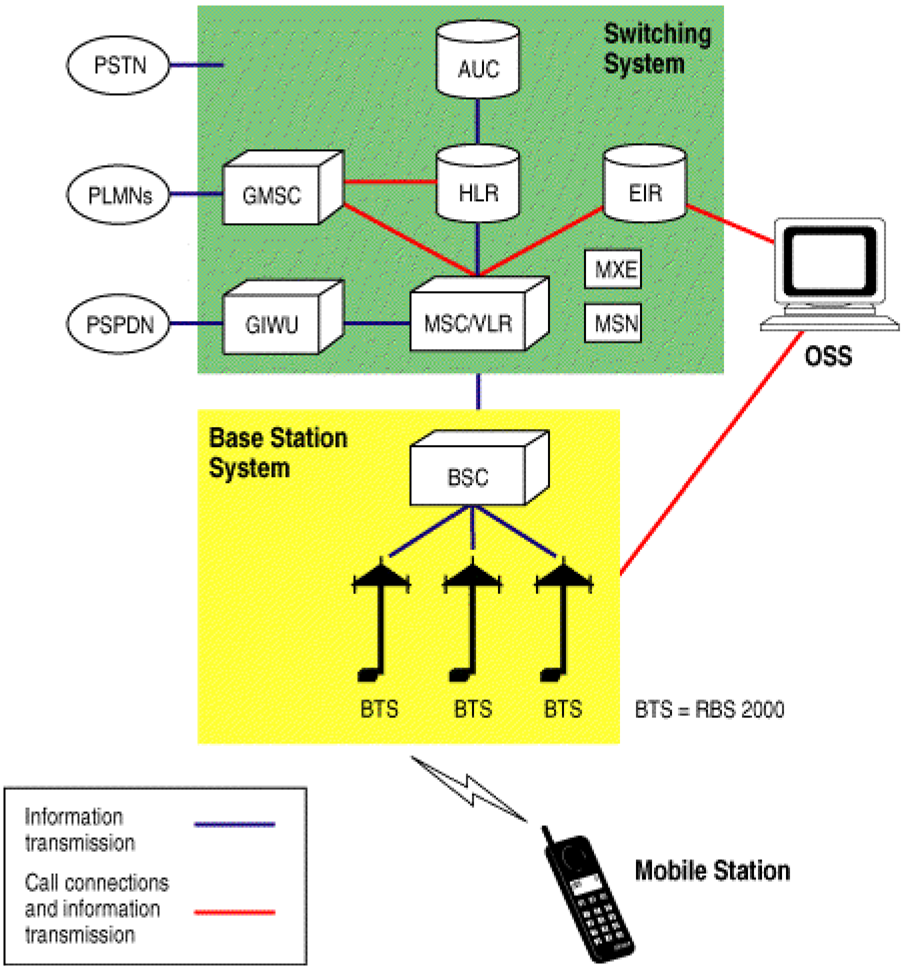

Fig 2.7.2: GSM Network Elements

The Switching System

The switching system (SS) is responsible for performing call processing and subscriber-related functions. The switching system includes the following functional units.

- **Home location register (HLR)**—The HLR is a database used for storage and management of subscriptions. The HLR is considered the most important database, as it stores permanent data about subscribers, including a subscriber's service profile, location information, and activity status. When an individual buys a subscription from one of the PCS operators, he or she is registered in the HLR of that operator.
- **mobile services switching center (MSC)**—The MSC performs the telephony switching functions of the system. It controls calls to and from other telephone and data systems. It also performs such functions as toll ticketing, network interfacing, common channel signaling, and others.
- **visitor location register (VLR)**—The VLR is a database that contains temporary information about subscribers that is needed by the MSC in order to service visiting subscribers. The VLR is always integrated with the MSC. When a mobile station roams into a new MSC area, the VLR connected to that MSC will request data about the mobile station from the HLR. Later, if the mobile station makes a call, the VLR will have the information needed for call setup without having to interrogate the HLR each time.
- **authentication center (AUC)**—A unit called the AUC provides authentication and encryption parameters that verify the user's identity and ensure the confidentiality of each call. The AUC protects network operators from different types of fraud found in today's cellular world.
- **equipment identity register (EIR)**—The EIR is a database that contains information about the identity of mobile equipment that prevents calls from stolen, unauthorized, or defective mobile stations. The AUC and EIR are implemented as stand-alone nodes or as a combined AUC/EIR node.

The Base Station System (BSS)

All radio-related functions are performed in the BSS, which consists of base station controllers (BSCs) and the base transceiver stations (BTSs).

- **BSC**—The BSC provides all the control functions and physical links between the MSC and BTS. It is a high-capacity switch that provides functions such as handover, cell configuration data, and control of radio frequency (RF) power levels in base transceiver stations. A number of BSCs are served by an MSC.
- **BTS**—The BTS handles the radio interface to the mobile station. The BTS is the radio equipment (transceivers and antennas) needed to service each cell in the network. A group of BTSs are controlled by a BSC.

The Operation and Support System

The operations and maintenance center (OMC) is connected to all equipment in the switching system and to the BSC. The implementation of OMC is called the operation and support system (OSS). The OSS is the functional entity from which the network operator monitors and controls the system. The purpose of OSS is to offer the customer cost-effective support for centralized, regional, and local operational and maintenance activities that are required for a GSM network. An important function of OSS is to provide a network overview and support the maintenance activities of different operation and maintenance organizations.

GSM Network Area

The GSM network is made up of geographic areas. As shown in *4.2*, these areas include cells, location areas (LAs), MSC/VLR service areas, and public land mobile network (PLMN) areas.

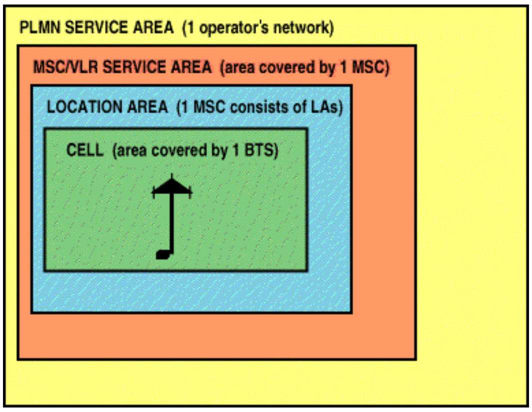

Fig 2.7.3: GSM Network Area

Network Areas

The cell is the area given radio coverage by one base transceiver station. The GSM network identifies each cell via the cell global identity (CGI) number assigned to each cell. The location area is a group of cells. It is the area in which the subscriber is paged. Each LA is served by one or more base station controllers, yet only by a single MSC (fig 4.3). Each LA is assigned a location area identity (LAI) number.

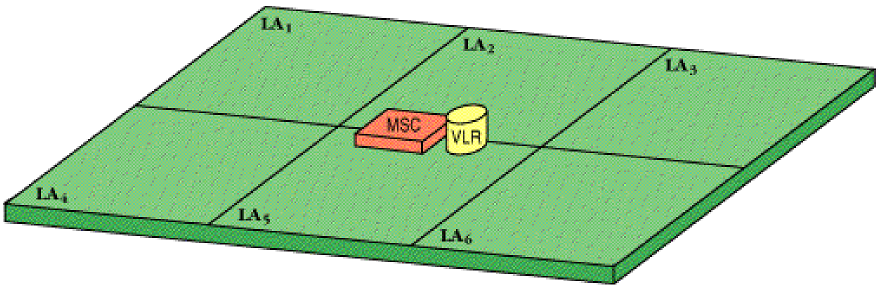

Fig 2.7.4: Network Areas

Location Areas

An MSC/VLR service area represents the part of the GSM network that is covered by one MSC and which is reachable, as it is registered in the VLR of the MSC (fig 4.4).

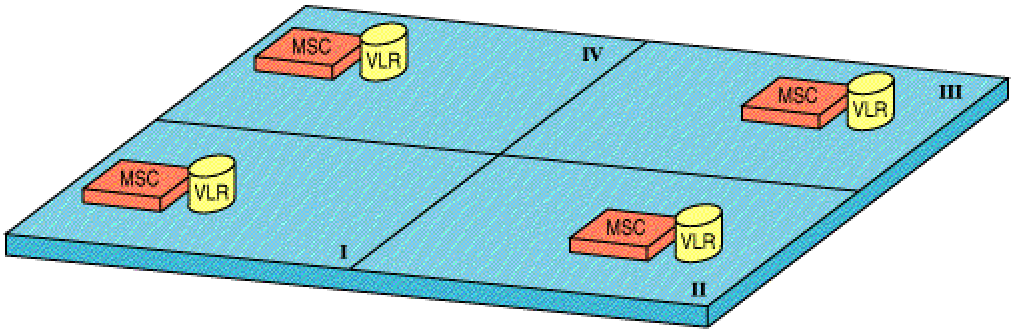

Fig 2.7.5: Location Areas

MSC /VLR Service Areas

The PLMN service area is an area served by one network operator.

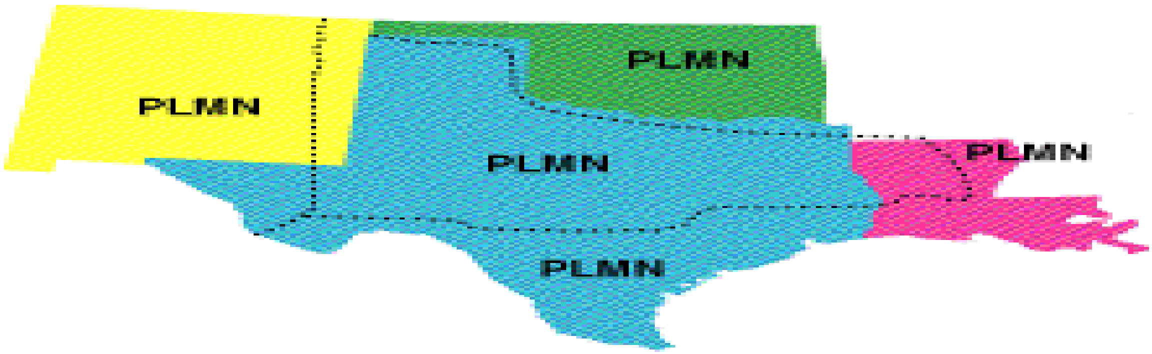

Fig 2.7.5(2): Location Areas

SPECIFICATIONS AND CHARACTERISTICS FOR GSM

- **frequency band**—The frequency range specified for GSM is 1,850 to 1,990 MHz (mobile station to base station).
- **duplex distance**—The duplex distance is 80 MHz. Duplex distance is the distance between the uplink and downlink frequencies. A channel has two frequencies, 80 MHz apart.
- **channel separation**—The separation between adjacent carrier frequencies. In GSM, this is 200 kHz.
- **modulation**—Modulation is the process of sending a signal by changing the characteristics of a carrier frequency. This is done in GSM via Gaussian minimum shift keying (GMSK).

- **transmission rate**—GSM is a digital system with an over-the-air bit rate of 270 kbps.
- **access method**—GSM utilizes the time division multiple access (TDMA) concept. TDMA is a technique in which several different calls may share the same carrier. Each call is assigned a particular time slot.
- **speech coder**—GSM uses linear predictive coding (LPC). The purpose of LPC is to reduce the bit rate. The LPC provides parameters for a filter that mimics the vocal tract. The signal passes through this filter, leaving behind a residual signal. Speech is encoded at 13 kbps.

GSM SUBSCRIBER SERVICES

There are two basic types of services offered through GSM: telephony (also referred to as teleservices) and data (also referred to as bearer services). Telephony services are mainly voice services that provide subscribers with the complete capability (including necessary terminal equipment) to communicate with other subscribers. Data services provide the capacity necessary to transmit appropriate data signals between two access points creating an interface to the network. In addition to normal telephony and emergency calling, the following subscriber services are supported by GSM:

- **dual-tone multifrequency (DTMF)**—DTMF is a tone signaling scheme often used for various control purposes via the telephone network, such as remote control of an answering machine. GSM supports full-originating DTMF.
- **facsimile group III**—GSM supports CCITT Group 3 facsimile. As standard fax machines are designed to be connected to a telephone using analog signals, a special fax converter connected to the exchange is used in the GSM system. This enables a GSM–connected fax to communicate with any analog fax in the network.
- **short message services**—A convenient facility of the GSM network is the short message service. A message consisting of a maximum of 160 alphanumeric characters can be sent to or from a mobile station. This service can be viewed as an advanced form of alphanumeric paging with a number of advantages. If the subscriber's mobile unit is powered off or has left the coverage area, the message is stored and offered back to the subscriber when the mobile is powered on or has reentered the coverage area of the network. This function ensures that the message will be received.

- **cell broadcast**—A variation of the short message service is the cell broadcast facility. A message of a maximum of 93 characters can be broadcast to all mobile subscribers in a certain geographic area. Typical applications include traffic congestion warnings and reports on accidents.
- **voice mail**—This service is actually an answering machine within the network, which is controlled by the subscriber. Calls can be forwarded to the subscriber's voice-mailbox and the subscriber checks for messages via a personal security code.
- **fax mail**—With this service, the subscriber can receive fax messages at any fax machine. The messages are stored in a service center from which they can be retrieved by the subscriber via a personal security code to the desired fax number.

2.8 GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a satellite based navigation system that can be used to locate positions anywhere on earth. Designed and operated by the U.S. Department of Defense, it consists of satellites, control and monitor stations, and receivers. GPS receivers take information transmitted from the satellites and use triangulation to calculate a user’s exact location. GPS is used on incidents in a variety of ways, such as:

Fig 2.8.1: GPS

GPS is made up of three parts: between 24 and 32 satellites orbiting the Earth, four control and monitoring stations on Earth, and the GPS receivers owned by users. GPS satellites broadcast signals from space that are used by GPS receivers to provide three-dimensional location (latitude, longitude, and altitude) plus the time.

- To determine position locations; for example, you need to radio a helicopter pilot the coordinates of your position location so the pilot can pick you up.

- To navigate from one location to another; for example, you need to travel from a lookout to the fire perimeter.
- To create digitized maps; for example, you are assigned to plot the fire perimeter and hot spots.
- To determine distance between two points or how far you are from another location.

Working

The basis of the GPS is a constellation of satellites that are continuously orbiting the earth. These satellites, which are equipped with atomic clocks, transmit radio signals that contain their exact location, time, and other information. The radio signals from the satellites, which are monitored and corrected by control stations, are picked up by the GPS receiver. A GPS receiver needs only three satellites to plot a rough, 2D position, which will not be very accurate. Ideally, four or more satellites are needed to plot a 3D position, which is much more accurate.

Three Segments of GPS

The three segments of GPS are the space, control, and user.

Space Segment — Satellites orbiting the earth

The space segment consists of 29 satellites circling the earth every 12 hours at 12,000 miles in altitude. This high altitude allows the signals to cover a greater area. The satellites are arranged in their orbits so a GPS receiver on earth can receive a signal from at least four satellites at any given time. Each satellite contains several atomic clocks. The satellites transmit low radio signals with a unique code on different frequencies, allowing the GPS receiver to identify the signals.

The main purpose of these coded signals is to allow the GPS receiver to calculate travel time of the radio signal from the satellite to the receiver. The travel time multiplied by the speed of light equals the distance from the satellite to the GPS receiver.

Control Segment — The control and monitoring stations

The control segment tracks the satellites and then provides them with corrected orbital and time information. The control segment consists of five unmanned monitor stations and one Master Control Station. The five unmanned stations monitor GPS satellite signals and then send that information to the Master Control Station where anomalies are corrected and sent back to the GPS satellites through ground antennas.

User Segment — The GPS receivers owned by civilians and military

The user segment consists of the users and their GPS receivers. The number of simultaneous users is limitless.

GPS RECEIVER SPECIFICATIONS

NAVIGATION FEATURES:

Waypoints/icons: 500 with name and graphic symbol, 10 nearest (automatic), 10 proximity

Routes: Automatic turn-by-turn routes; 20 manual point-to-point routes with up to 50 points each.

Tracks: Automatic track log; 10 saved tracks let you retrace your path in both directions

Trip computer: Resettable odometer, timers, average and maximum speeds

Alarms: Anchor drag, approach and arrival, off course and proximity waypoint

Tables: Built-in celestial tables for best times to fish and hunt, sun and moon rise/set based on date and location

Map datums: More than 100, plus user datum

Position format: Lat/Lon, UTM/UPS, Maidenhead, MGRS, Loran TDs and other grids, including user grid

Performance

Receiver: WAAS enabled, 12 parallel channel GPS receiver continuously tracks and uses up to 12 satellites to compute and update your position

Acquisition Times:

- Warm: Approximately 15 seconds
- Cold: Approximately 45 seconds

- AutoLocate®: Approximately 5 minutes

Update rate: 1/second, continuous

GPS Accuracy:

- Position: < 15 meters, 95% typical*
- Velocity: 0.05 meter/sec steady state

WAAS accuracy:

- Position: < 3 meters, 95% typical
- Velocity: 0.05 meter/sec steady state

Dynamics: 6g's

Interfaces: RS232 with NMEA 0183, RTCM 104 DGPS data format and proprietary Garmin

Antenna: Detachable with standard BNC connector

Differential: RTCM-104, WAAS

Physical

Size: 5.0"W x 2.3"H x 1.6"D (12.7 x 5.9 x 4.1 cm)

Weight: 9 ounces (255 g) w/batteries

Display: 2.2"W x 1.5"H (5.6 x 3.8 cm), 256 x 160 pixels, high-contrast FSTN with bright backlighting. Switchable orientation.

Case: Fully gasketed, high-impact plastic alloy, waterproof to IEC 529 IPX7 standards

Temperature range: 5° F to 158° F (–15° C to 70° C)

User data storage: Indefinite, no memory battery required

Power Source: 8-35v DC, 4 “AA” batteries (not included)

Applications:

There are so many devices made with the implementation of the Global Positioning System. Google Earth is the most famous application that uses the signals received by the GPS receivers. It enables the public also to access the maps which tell the users about the locations all around the world.3DEM is freely available software that will create 3D terrain scenes and flyby animations and export GIS terrain data files using any of the following freely available terrain data as a source. People use the Global Positioning System for several uses. A research published in a magazine states that the percentage of uses for each several requirements is as follows.

- Car navigation 37%
- Hand held 26%
- Tracking 10%
- GIS 8%
- Survey 7%
- Manufacturing 7%
- Vessel Voyage 2%
- Military Related 1%

2.9 BUZZER

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows.

It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Sonalert which makes a high-pitched tone. Usually these were hooked up to “driver” circuits which varied the pitch of the sound or pulsed the sound on and off.In game shows it is also known as a “lockout system,” because when one person signals ("buzzes in"), all others are locked out from signalling. Several game shows have large buzzer buttons which are identified as "plungers".

Fig 2.9.1: Buzzer

2.9.1 USES

- Annunciator panels
- Electronic metronomes
- Game shows
- Microwave ovens and other household appliances
- Sporting events such as basketball games
- Electrical alarms

CHAPTER 3

SOFTWARE SPECIFICATION

3. KEIL SOFTWARE:

Keil compiler is a software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code.

3.1 GENERAL INTRODUCTION:

Keil Software is the leading vendor for 8/16-bit development tools (ranked at first position in the 2004 Embedded Market Study of the Embedded Systems and EE Times magazine). Keil Software is represented world-wide in more than 40 countries. Since the market introduction in 1988, the Keil C51 Compiler is the de facto industry standard and supports more than 500 current 8051 device variants. Now, Keil Software offers development tools for ARM.

Keil Software makes C compilers, macro assemblers, real-time kernels, debuggers, simulators, integrated environments, and evaluation boards for the 8051, 251, ARM, and XC16x/C16x/ST10 microcontroller families.

Keil Software is pleased to announce simulation support for the Atmel AT91 ARM family of microcontrollers. The Keil µVision Debugger simulates the complete ARM instruction-set as well as the on-chip peripherals for each device in the AT91 ARM/Thumb microcontroller family. The integrated simulator provides complete peripheral simulation. Other new features in the µVision Debugger include:

- An integrated Software Logic Analyzer that measures I/O signals as well as program variables and helps developers create complex signal processing algorithms.
- An Execution Profiler that measures time spent in each function, source line, and assembler instruction. Now developers can find exactly where programs spend the most time.

"Using nothing more than the provided simulation support and debug scripts, developers can create a high-fidelity simulation of their actual target hardware and environment. No extra hardware or test equipment is required. The Logic Analyzer and Execution Profiler will help developers when it comes time to develop and tune signaling algorithms." said Jon Ward, President of Keil Software USA, Inc.

3.2 µVision3 Overview:

The µVision3 IDE is a Windows-based software development platform that combines a robust editor, project manager, and facilities. µVision3 integrates all tools including the C compiler, macro assembler, linker/locator, and HEX file generator. µVision3 helps expedite the development process of your embedded applications by providing the following:

- Full-featured source code editor,
- Device database for configuring the development tool setting,
- Project manager for creating and maintaining your projects,
- Integrated make facility for assembling, compiling, and linking your embedded applications,
- Dialogs for all development tool settings,
- True integrated source-level Debugger with high-speed CPU and peripheral simulator,
- Advanced GDI interface for software debugging in the target hardware and for connection to Keil ULINK,
- Flash programming utility for downloading the application program into Flash ROM,
- Links to development tools manuals, device datasheets & user's guides.

The µVision3 IDE offers numerous features and advantages that help you quickly and successfully develop embedded applications. They are easy to use and are guaranteed to help you achieve your design goals.

The µVision3 IDE and Debugger is the central part of the Keil development tool chain. µVision3 offers a Build Mode and a Debug Mode.

In the µVision3 Build Mode you maintain the project files and generate the application.

In the µVision3 Debug Mode you verify your program either with a powerful CPU and peripheral simulator or with the Keil ULINK USB-JTAG Adapter (or other AGDI drivers) that connect the debugger to the target system. The ULINK allows you also to download your application into the Flash ROM of your target system.

3.3 STEPS TO WRITE AN ASSEMBLY LANGUAGE PROGRAM IN KEIL AND HOW TO COMPILE IT:

1. Install the Keil Software on the PC in any of the drives.
2. After installation, an icon will be created with the name “Keil uVision3”. Just drag this icon onto the desktop so that it becomes easy whenever you try to write programs in keil.
3. Double click on this icon to start the keil compiler.
4. A page opens with different options in it showing the project workspace at the leftmost corner side, output window in the bottom and an ash coloured space for the program to be written.
5. Now to start using the keil, click on the option “project”.
6. A small window opens showing the options like new project, import project, open project etc. Click on “New project”.
7. A small window with the title bar “Create new project” opens. The window asks the user to give the project name with which it should be created and the destination location. The project can be created in any of the drives available. You can create a new folder and then a new file or can create a new file.
8. After the file is saved in the given destination location, a window opens where a list of vendors will be displayed and you have to select the device for the target you have created.
9. The most widely used vendor is Atmel. So click on Atmel and now the family of microcontrollers manufactured by Atmel opens. You can select any one of the microcontrollers according to the requirement.

10. When you click on any one of the microcontrollers, the features of that particular microcontroller will be displayed on the right side of the page. The most appropriate microcontroller with which most of the projects can be implemented is the AT89C51. Click on this microcontroller and have a look at its features. Now click on “OK” to select this microcontroller.
11. A small window opens asking whether to copy the startup code into the file you have created just now. Just click on “No” to proceed further.
12. Now you can see the TARGET and SOURCE GROUP created in the project workspace.
13. Now click on “File” and in that “New”. A new page opens and you can start writing a program in it.
14. After the program is completed, save it with any name but with the .asm extension. Save the program in the file you have created earlier.
15. You can notice that after you save the program, the predefined keywords will be highlighted in bold letters.
16. Now add this file to the target by giving a right click on the source group. A list of options open and in that select “Add files to the source group”. Check for this file where you have saved and add it.
17. Right click on the target and select the first option “Options for target”. A window opens with different options like device, target, output etc. First click on “target”.
18. Since the set frequency of the microcontroller is 11.0592 MHz to interface with the PC, just enter this frequency value in the Xtal (MHz) text area and put a tick on the Use on-chip ROM. This is because the program that we write here in the keil will later be dumped into the microcontroller and will be stored in the inbuilt ROM in the microcontroller.
19. Now click the option “Output” and give any name to the hex file to be created in the “Name of executable” text area and put a tick to the “Create HEX file” option present in the same window. The hex file can be created in any of the drives. You can change the folder by clicking on “Select folder for Objects”.
20. Now to check whether the program you have written is errorless or not, click on the icon exactly below the “Open file” icon which is nothing but Build Target icon. You can even use the shortcut key F7 to compile the program written.

21. To check for the output, there are several windows like serial window, memory window, project window etc. Depending on the program you have written, select the appropriate window to see the output by entering into debug mode.
22. The icon with the letter “d” indicates the debug mode.
23. Click on this icon and now click on the option “View” and select the appropriate window to check for the output.
24. After this is done, click the icon “debug” again to come out of the debug mode.
25. The hex file created as shown earlier will be dumped into the microcontroller with the help of another software called Proload/Topwin.

CHAPTER 4

IMPLEMENTATION

4.1 Code Implementation

```
#include<reg52.h>
#include<post.h>
#include<lcd4.h>
#include<serial.h>
#include<gsm.h>
#include<gps.h>

sbit ir = P1 ^ 0;
sbit eme = P1 ^ 1;
sbit BUZZ = P0 ^ 6;

void main()
{
 ir = 1;
 eme = 1;
 BUZZ = 0;
 serialinit();
 initlcd();
 gsminit();
 gps();
 stringlcd(0x80, "Navigation Cane");
 stringlcd(0xC0, "Visually Impaired");
 while (1)
 {
  if (ir == 0)
  {
   BUZZ = 1;
   stringlcd(0x80, "Obstacle Detected");
   gps();
   txs("AT+CMGS=\"9701142820\"\r\n");
   post(1000);
   txs("Obstacle Detected\r\n");
   tx(0x1A);
   post(400);
   gps();
   post(1400);
  }
```

```
  else if (eme == 0)
  {
   BUZZ = 1;
   stringlcd(0x80, "Emergency Alert");
   gps();
   txs("AT+CMGS=\"9xxxxxxxxxx\"\r\n");
   post(1000);
   txs("Emergency Alert\r\n");
   tx(0x1A);
   post(200);
   post(400);
   gps();
   post(1400);
  }
  else
  {
   BUZZ = 0;
   stringlcd(0x80, "Normal State");
   post(300);
  }
 }
}
```

4.2 Flow Chart

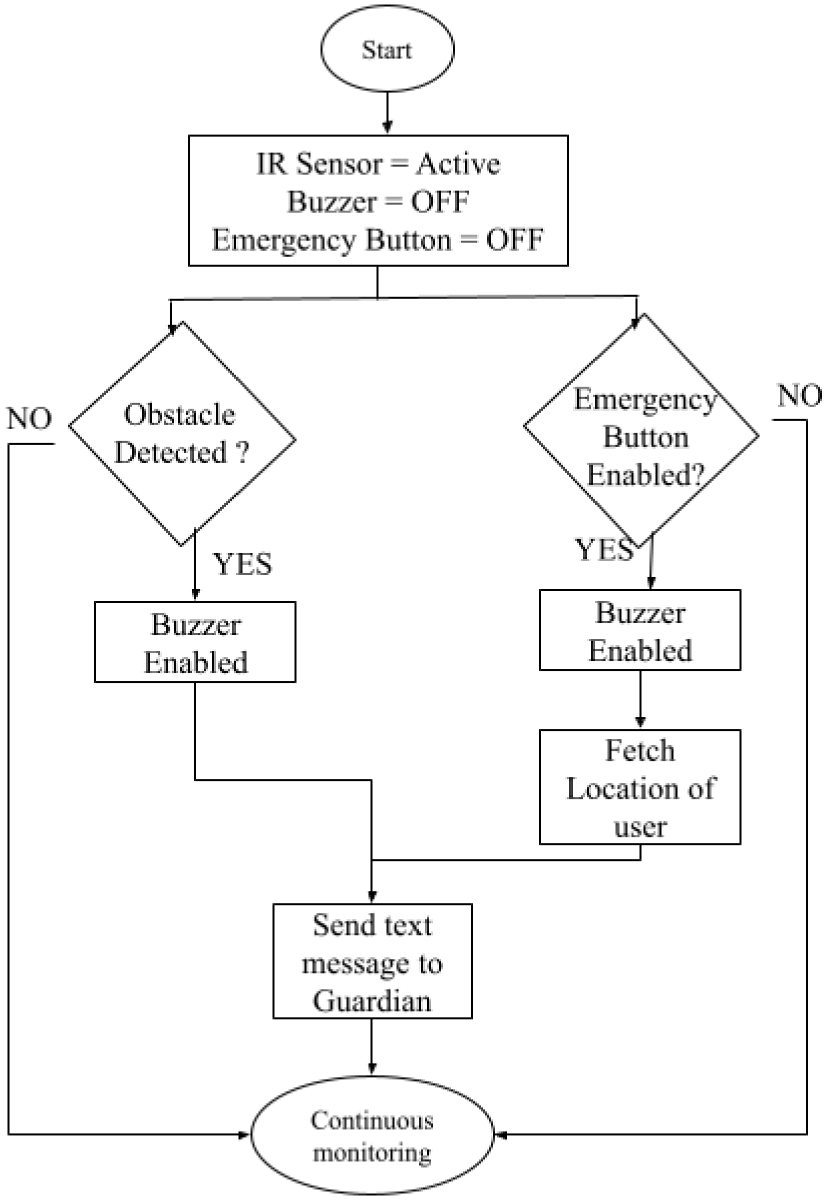

Fig 4.2: Flow Chart

CHAPTER 5

SIMULATION AND CIRCUIT DESIGN

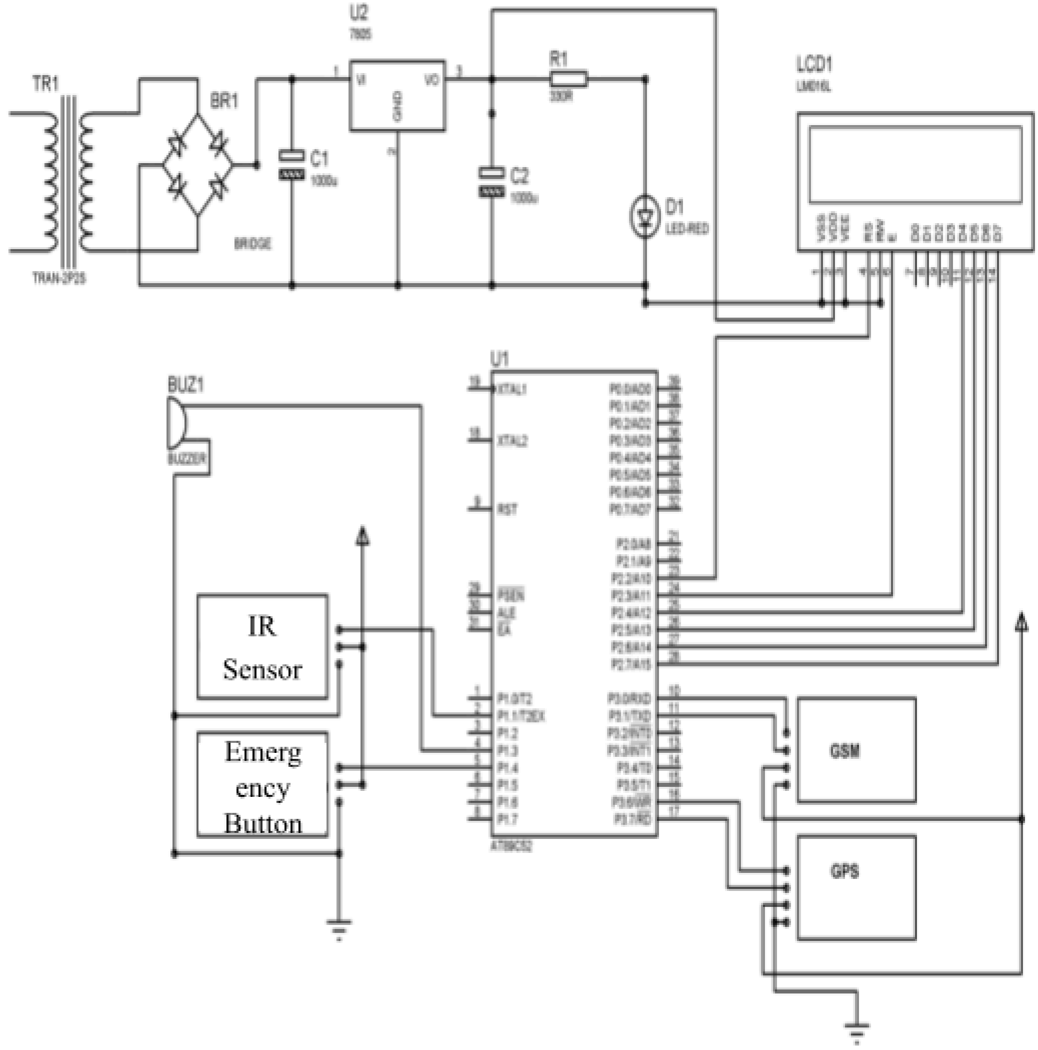

Fig 5.1: Schematic Diagram

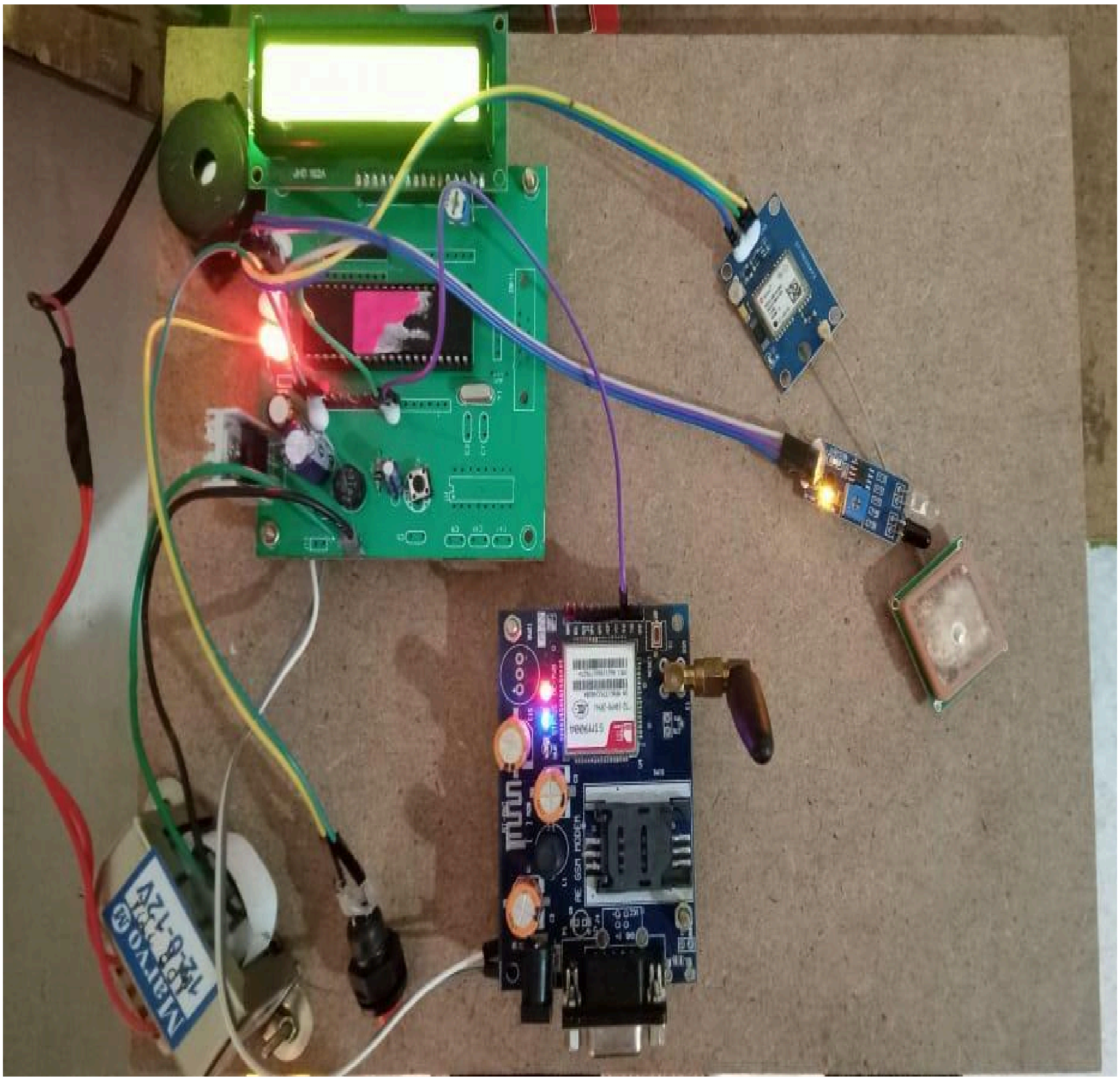

Fig 5.2: Output

CHAPTER 6

CONCLUSION

Conclusion

The smart walking stick developed in this project offers a highly effective solution to the challenges faced by visually impaired individuals, improving their safety and independence. By combining an IR sensor, GPS module, emergency alert system, and an 8051 microcontroller, the system can detect obstacles, provide real-time location data, and send emergency alerts. This integrated approach enhances user confidence while navigating through various environments, making the walking stick not only a tool for mobility but also a safety companion for the visually impaired.

Future Scope

The future development of this system offers several promising directions:

- **Advanced Obstacle Detection:** Expanding the detection range by integrating multiple IR sensors or using ultrasonic sensors can provide a more comprehensive detection of obstacles, allowing users to identify larger or more distant objects in their path.
- **Real-time Communication and Alerts:** Adding wireless communication technologies, such as Bluetooth or Wi-Fi, would enable the walking stick to send real-time alerts to a caregiver or family member. This would ensure that assistance is immediately available in case of an emergency.
- **Adaptive Navigation Systems:** Incorporating machine learning algorithms could help the walking stick adapt to the user's walking habits, providing personalized navigation assistance based on frequent routes or environmental changes.
- **Mobile App Integration:** A companion mobile application could be developed to provide additional functionality, such as route planning, real-time tracking, and monitoring the walking stick's battery life. The app could also allow users to set emergency contacts for alerts.

- **Battery Optimization:** Future work could focus on improving power efficiency, integrating renewable energy sources like solar panels, or implementing low-power modes to extend battery life, making the system more sustainable for long-term use.
- **Integration with Smart Home Systems:** The smart walking stick could be integrated with home automation systems to assist users in navigating their homes more effectively. This could include features like voice-controlled lighting or alerts for home appliances.

These improvements would help create a more intelligent, adaptive, and user-friendly solution that enhances the overall quality of life for visually impaired individuals, empowering them to navigate their environment with greater confidence and ease.

CHAPTER 7

REFERENCES

1. William A. Ainsworth A system for converting English text into speech IEEE Transactions on Audio and Electroacoustics, Vol. 21, Issue 3, Jun 1973

2. Michael McEnancy Finger Reader Is audio reading gadget for Index Finger IJECCE Vol. 5, Issue 4 July- 2014.

3. Velazquez, Pissaloux, E.E, Guinot, J.C. Maingreaud, F, "Walking Using Touch: Design and Preliminary Prototype of a Non-Invasive ETA for the Visually Impaired", 27th Annual International Conference of the Engineering in Medicine and Biology Society, IEEE-EMBS 2005. pp 6821-6824, 2005

4. Ran L, Helal S, Moore S, "Drishti: an integrated indoor/outdoor blind navigation system and service.", Proceedings of the Second IEEE Annual Conference on Pervasive Computing and Communications, pp 23-30, PerCom 2004.

5. Shraga Shovel, Iwan Ulrich, and Johann Borenstien, "NavBelt and the Guide Cane", IEEE Transactions on Robotics & Automation, Vol.10, No.1, pp. 9-20, March 2003.

6. Raja Venkatesan.T, M.Karthigaa, P.Ranjith, C.Arunkumar, M.Gowtham, "Intelligent Translate System for Visually Challenged People" International Journal for Scientific Research & Development (IJSRD), ISSN (online): 2321-0613, Vol. 3, Issue 12, 2016.

7. Anusha Bhargava, Karthik V. Nath, Pritish Sachdeva, Monil Samel (April 2015), "Reading Assistant for the Visually Impaired" International Journal of Current Engineering and Technology (IJCET), E-ISSN 2277 – 4106, P-ISSN 2347 – 5161, Vol.5, No.2.