CHAPTER 1

An Introduction to Computers

1.1 Introduction

Today computers have an important and widespread influence on our society. Every educated person should study the basic disciplines of computer operation and its application. A student must study the basics of fundamental. Wherever there are phenomena of interest to man, there can be a science to describe and explain those phenomena. Computer Science is therefore the study of computer and the phenomena requesting from their use. We can give a more specific definition of computer science after we describe a computer.

A Computer is a device capable of accepting information or data, processing the information, and providing the results as an output, more specifically, a computer can be described as follows:

Computer is a data processor machine that can perform substantial computation, including numerous arithmetic or logic operations, without intervention by a human operator during the processor. It may be defined as a device capable of solving problems by accepting data, performing described operations on the data, and supplying the results of these operations or

Computer is a programmable, multiuse machine that accept data – raw facts and figures and process, or manipulates, it into information we can use, such as summaries or totals.

A visual representation or schematic diagram (Fig. 1.1) shows how the computer processes the information.

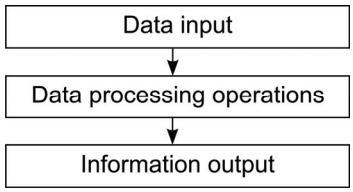


Fig. 1.1

1.2 Information Technology

Data communication, network and computer have brought a new technology, the information technology (IT). IT is the most powerful synthesis of computers and communications. Any information is useful only if it is accurate, relevant, precise and timely provide to the users. This would be possible, only when stored information is instantaneously retrievable at the time of need. Data receive from various sources and processing with the data, convert into information and forward it to other person or workstation. This is a networking environment.

Computer has become an indispensable tool, helping to shape the society it serves. The banking industry is an integrated part of the society, which has grown phenomenally since last three decades with manifold rise in its transactions and area of activities. Thus the role and utility of the computer and Information Technology cannot be over emphasized.

1.3 Comparison of Computer with Human Being

Computer and Human

- Have Memory
- Read Capability
- Perform arithmetic and logical calculation
- Manipulate symbols
- Make Comparisons

Human

- Make processing based on current situation
- Remember or read data from file
- Remember instructions for processing
- Write or speak out the output

Computer

- Hold program instruction in internal storage.
- Read data in machine readable form and store in the storage device.
- Make processing by choosing instruction based on comparison or an examination result at a point.
- Retrieve data from internal memory or secondary storage device.
- Output the results on an output device.

Comparison between Human and Computer

Character	Human	Computer
Speed of execution	Slow	Extremely fast
Continuous work	Poor	Excellent
Memory Retrieval	Inaccurate	Accurate
Accuracy	Make errors	No errors
Follow instructions	Perfect / Imperfect	Consistently
Ability to innovate	Good	Lacking

1.4 Characteristics of Computers

The vital characteristics of the computers are as follows:

Speed

Computer works on electrical pulses, which travel at incredible speeds and because the computer is an electronic device, its internal speed is instantaneous. An arithmetic calculation can be performed in a thousandth, millionth, billon thing even in a trillionth seconds. It is capable of executing over ten thousand instructions in a second.

Milli Sec. (ms) - 1/1000 of second
Micro Sec (ms) - 1/1000000 of second
Nano sec (ms) - 1/1000000000 of second
Pico sec (ps) - 1/1000,000,000,000

Storage

This is very important character of the computer, which separates it from other machine. The basic unit of storage is bit (acronyms of binary digit). The speed, at which computers perform, i.e. to input data and the instructions for processing, is humanly impossible. The storage space available in the central processing unit, being limited, large quantity of data and entire instructions of all the required programs cannot be stored in it. These are stored outside and read into the memory of CPU at the time of processing.

Bit - Smallest unit of storage
Nibble - 4 Bits
Byte - 8 Bits
KB - 1024 bytes
MB - 1024 KB
GB - 1024 MB

Accuracy

Accuracy of the computers is consistently high. Errors in computing are due to machine failure, imprecise programming logic, inaccurate data, poorly designed systems. Precision is the degree of accuracy to which the computer gives the result. The precision of computers is phenomenal.

Versatility

Computers seem capable of performing almost any task, provided the task can be reduced to series of logical steps. It performs numeric and non-numeric tasks equally well. An algorithm, a step-by-step procedure, which applied to the problem, leads to solution. Programming is to convert this computer language to solve the problem.

Automation

Once a program is in the computer's memory, CPU allows the instructions until it meets the last instruction. Once the process had begun it would continue without human intervention until completion.

Diligence

Being a machine, a computer does not suffer from the human tracts of tiredness and lack of concentration. If millions of calculation are to be performed, computer performs all these calculations with the same speed and accuracy.

1.5 Limitations of Computers

The computer also has certain limitations, the computer works at very high speed and extremely accurate, this very characteristic becomes its limitation when a mistake over, because when a wrong instruction is issued, it excuses it with the same speed and accuracy that it would have executed with a right instruction. As a result, these are hardly any scope or time to recover.

The computers understand only instructions and cannot distinguish between suspicious and genuine customers. It does not posses and degree of intelligence and cannot take up even a simple action unless instructed to do so. It does not possess any morals, and therefore can be easily misused in the hands of a wrong individual. However, the computers never make any mistake or error. Errors whenever found are the computer based processing, due to human errors.

1.6 Information Processing and the Electronic Digital Computer

The electronic computer allows man to increase his productivity and permits him to do tasks he would be enabling to complete without computer. As we discussed above, the computer is a machine capable of

- Accepting data
- Performing described operations on the data
- Providing the results of these operations.

Thus computer also permits man to improve his output permit of time, or productivity. We can say that the computer's two most important contributions as a tool are to increase.

I – Speed of the operation

II – Accuracy of the results.

Of course, when we consider these two factors, we realise that the computer enables us to accomplish tasks that we would probably never even attempt manually. For example, if the number of input data is greater than several million and the time necessary to accomplish a task is more than fifty years. We would probably never attempt it, yet it is just tasks that we can ask the computer to accomplish. The term electronic implies that the computer is powered by electrical and electronics devices rather than by mechanical ones or those affected by heat or air pressure. Here digital refers to discrete non-continues quantities, as contrasted with continuous quantities.

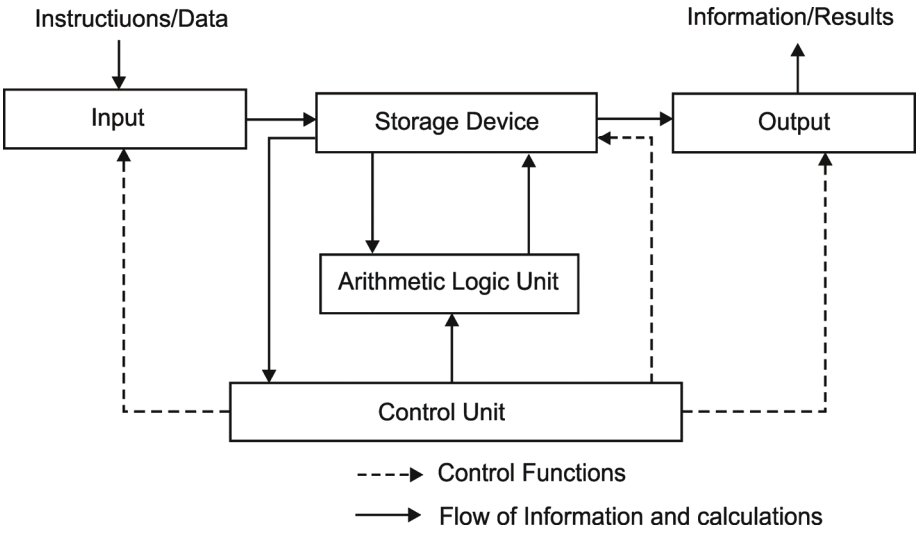


Fig. 1.2 Information Processing in Electronic Digital Computer

Electronic Digital computer is an information-processing device that accepts and processes data represented by discrete symbols. It is constructed primarily of electric or electronic devices.

We can use the computer to process the input data by sorting them, or by series of planned actions and operations open input taken may be illustrated by a common data processing operation which a person usually accomplishes manually, but which is increasingly accomplished automatically by data processing service companies. These processing works required:

- Data input
- Storage and retrieval of data
- Arithmetic Steps
- Output of result
- Control of all steps.

A Computer follows a similar process. It is composed of five basic units (Fig. 1.2).

Input unit: input data and instructions.

Storage or Memory unit: In which computer instructions and data as well as intermediate results are stored.

Arithmetic logic unit: In which mathematical operation can be performed and compare the numbers, results.

Output unit: provides the desired result in a suitable form.

Control unit: controls the data communication, operations and supervise overall operations of the computer.

The several devices are may accomplish the function of input, output and storages. The arithmetic and control functions are accomplished by the central processing unit located with storage in the pattern.

1.7 Components of the Computers

Computer is an electronic data processing machine. It is made up at various devices, which help you to enter date, process it and output the result. A computer system has three essential parts:

- Keyboard
- Central Processing Unit (CPU)
- Monitor

Block Diagram of a Computer

As shown in the block diagram (Fig. 1.3), the computer converts of three parts: Input device, CPU and output device. Keyboard, which is the input device, is connected to the central processing unit. Central processing unit consists of three sections memory, control unit and arithmetic logic unit

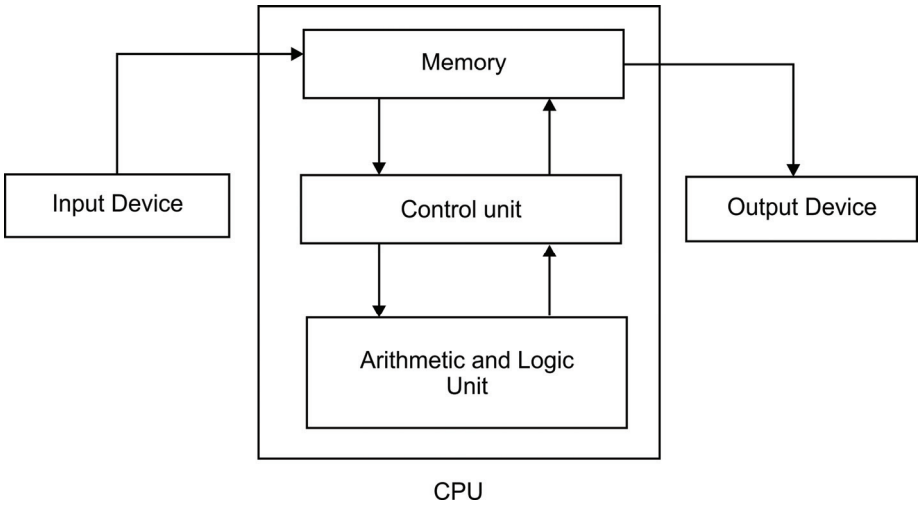


Fig. 1.3 Block diagram of computer

KEY BOARD: A common input device

Programs and data are entered into a computer through a keyboard, which is attached to a microcomputer or the terminal of a mini or large computer. A keyboard is similar to the keyboard of a type writer. It contains alphabets, digits, special characters and some control keys. When a key is pressed, an electronic signal is produced which is detected by an electronic circuit called keyboard encoder. A keyboard encoder may be special IC or a single chip microcomputer used as encoder. The function of an encoder is to detect which key has been pressed and send a binary code.

Central Processing Unit (CPU)

This is also called System unit, which is a technically known as Microprocessor (Fig. 1.4). CPU is the brain of computer.

It is made of three units:

1. Control unit 2. Arithmetic logic unit 3. Memory

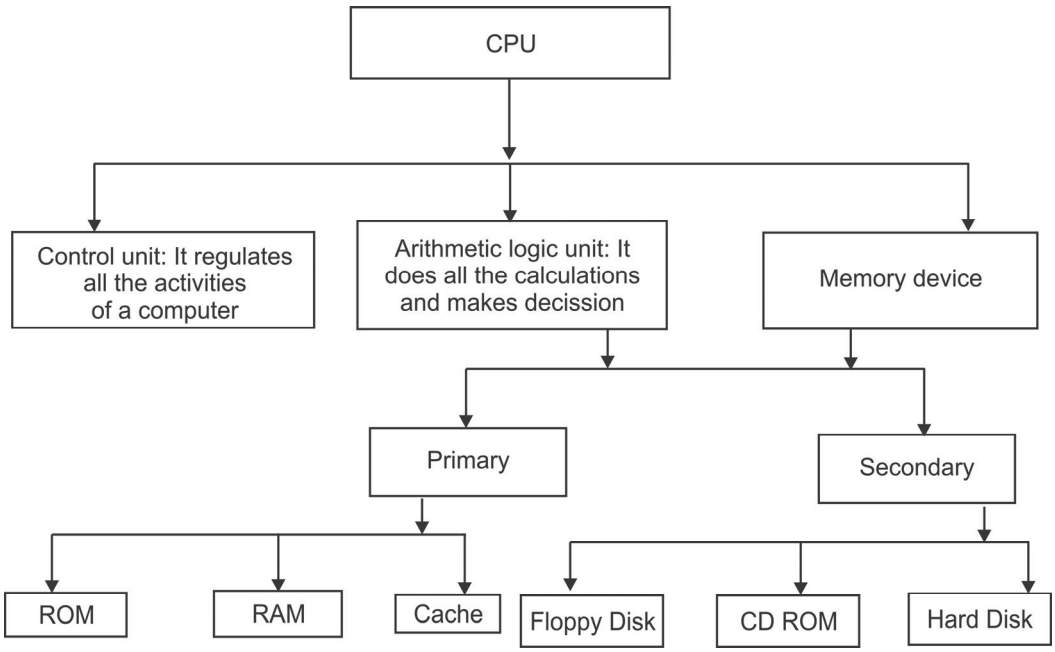


Fig. 1.4 Central Processing Unit with different Devices

- **Control unit:** The control section of the CPU maintains and directs the operations of the entire system. It acts like the central nervous system for all the components; though it does not process any data.
- **Arithmetic and logic unit (ALU):** The ALU processes the data entered all types of processing, mathematical calculation, comparison, decision making and processing of nonnumeric information takes place in ALU and data is once again moved to RAM
- **Memory:** Memory refers to the storage space in computer. Memory stores the data entered as well as the results given by the computer. Memory works on the application of binary system. The unit of memory is byte. Memory units can be divided into two sub-parts

  (a) Primary storage (b) Secondary storage

Monitor: A common output device

Monitor also called video display units or CRTs, are output devices, shown programming instructions and data as they are input and after it is processed. Sometime a monitor is also referred to a video display terminal (VDT).

1.8 Registers

The register is the smallest high-speed storage area in the CPU. All data must be represented in a register before it can be processed.

1.9 Bus Architecture

Bus is a communication system that transfers data between different internal components of the computer, or between computers. This expression covers all related hardware components (wire, optical fiber, etc.) and software, including communication protocol.

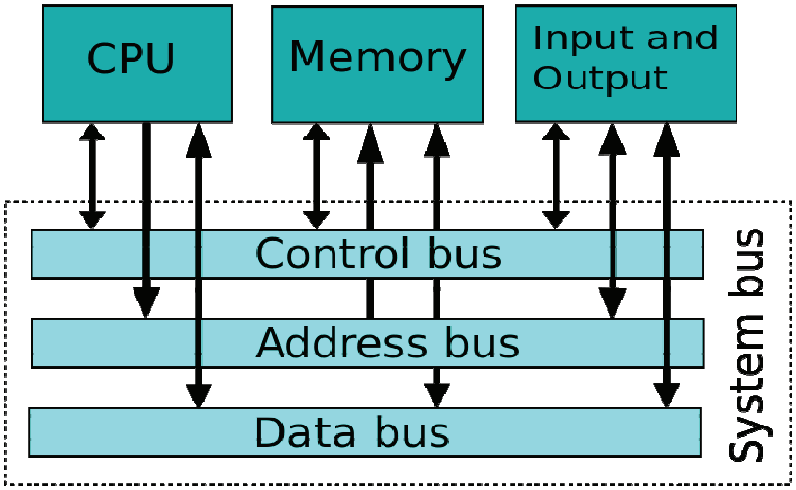
Early computer buses were parallel electrical wires with multiple connections, Modern computer buses can use both parallel and serial connections. In serial bus, only one bit data transferred at a time amongst the various components while in parallel bus, several bits data transferred at a time amongst the various components. Bus can be wired in either a electrical parallel or daisy chain topology, or connected by switched hubs. The speed of bus measured in terms of number of bits transferred per second between two hardware components.

Bus can be divided into three types:

1. Control bus
2. Address bus
3. Data bus

1. **Control bus:** A control bus is a computer bus that is used by the CPU to communicate with devices that are contained within the computer. This occurs through physical connections such as cables or printed circuits.

   The CPU transmits a variety of control signals to components and devices to transmit control signals to the CPU using the control bus. One of the main objectives of a bus is to minimize the lines that are needed for communication. An individual bus permits communication between devices using one data channel. The control bus is bidirectional and assists the CPU in synchronizing control signals to internal devices and external components. It is comprised of interrupt lines, byte enable lines, read/write signals and status lines
2. **Data bus:** Data bus is used for transfer data amongst the different internal components. In recent computers 32 bit data buses available means buses can transfer 32 bits data at a time.
3. **Address bus:** An address bus is used to specify a physical address. When a processor or DMA-enabled device needs to read or write to a memory location, it specifies that memory location on the address bus (the value to be read or written is sent on the data bus). The width of the address bus determines the amount of memory a system can address. For example, a system with a 32-bit address bus can address 2^{32} (4,294,967,296) memory locations. If each memory address holds one byte, the addressable memory space is 4 GB. It is also known as memory bus.



1.10 Instruction Set

Instruction set is a group of instruction that processor execute to perform various operation.

1.10.1 Classification of Instruction Set

A complex instruction set computer (CISC) has many specialised instructions, which may only be rarely used in practical programs. A reduced instruction set computer (RISC) simplifies the processor by only implementing instructions that are frequently used in programs; unusual operations are implemented as subroutines, where the extra processor execution time is offset by their rare use. Theoretically, important types are the minimal instruction set computer and the one instruction set computer, but these are not implemented in commercial processors. Another variation is the very long instruction word (VLIW) where the processor receives many instructions encoded and retrieved in one instruction word.

Complex instructions (CISC)

CISC processors include complex instructions in their instruction set. A single complex instruction does something that may take many instructions on other computers. Such instructions are typed by instructions that take multiple steps, control multiple functional units, or otherwise appear on a larger scale than the bulk of simple instructions implemented by the given processor. Some examples of complex instructions include:

- saving many registers on the stack at once
- moving large blocks of memory
- complex and/or floating-point arithmetic
- performing an automatic test-and-set instruction
- instructions that combine ALU with an operand from memory rather than a register

A complex instruction type that has become particularly popular recently is the SIMD or Single-Instruction Stream Multiple-Data Stream operation or vector instruction that is an operation that performs the same arithmetic operation on multiple pieces of data at the same time. SIMD have the ability of manipulating large vectors and matrices in minimal time. SIMD instructions allow easy parallelisation of algorithms commonly involved in sound, image, and video processing.

Reduced instruction set (RISC)

RISC is opposed to complex instructions can provide higher performance if this simplicity enables much faster execution of each instruction.

The general concept is that of a system uses a small, highly-optimized set of instructions, rather than a more specialsed set of instructions often found in other types of architectures. Another common trait is that RISC systems use the load/store architecture where memory is normally accessed only through specific instructions, rather than accessed as part of other instructions like.

The RSIC contains very few instructions from 0-100. It consists only frequently used instruction by the processor for the completion of program. The execution of these instructions is simple.

1.11 Computer Applications

The first digital computer was very costly and large sized and was used in military applications of calculating the speed of the ballistic missile. As computers have become less expensive, they are being used extensively in various areas of our lives. Computers have become ubiquitous in modern life. Computer can be used to get information about the location of a place in the map, reservation of tickets, books in a library, electronic mailing, banking, insurance, financial & weather forecasting, and entertainment, to name a few. Over the years, methods have been developed to allow computers to do things previously regarded as the exclusive domain of humans, for instance, read handwriting, play chess, or perform symbolic integration. The computer's characteristic as high speed of calculation, diligence, accuracy, reliability, and versatility has made it an integrated part in all business organizations. Some of the application areas of computers are discussed below.

- Computer Gaming
- Multimedia and Animation
- E-business
- Health Care
- Remote Sensing and Geographic Information System (GIS)
- Bio-Informatics
- Meteorology and Climatology

1.11.1 Computer Gaming

Computer gaming is one of the major important areas of Computer Applications. When computers were in its primitive stage, in the decade of 1950s, Tic-tac-toe and Tennis–for–two games were written by the programmers. It was envisioned very early that computers can be a great source of entertainment. Computer gaming today has shaped up as a multibillion dollar industry. In initial days games were designed and programmed by individual programmers. Slowly, with the advancement of hardware, computer gaming became popular and it became a

huge commercial activity. Today a computer game project involves a big team, huge money and months or even years to complete it.

Computer games are being widely used for education and learning. Domain specific games are there for learning. There are games which can improve our typing skills, language skills, mathematical skills, general awareness and management skills etc. But as a matter of fact major commerce has been drawn by games for entertainment and fun.

Besides entertaining, computer games have been observed to be helpful in other areas too. Some hospitals have tried to subject their patients to computer games while dressing their wounds. Such patients felt less pain. Multi user online games, family games and LAN games have increased social activity. It is also claimed that computer gaming can improve visual skills for tasks like driving. Nowadays advanced games can track body movements of the player. Such games allow players to play games by using physical movements and help them to keep fit. Of course games are natural trainers; hence they are excellent education aid.

Major hazards of excessive computer gaming are; time wasters, being addicted to computer games, obesity, damage of ligament or nerves in the thumbs or fingers, sag in spine due to bad postures, immune to violent scenes, hooking to cyber world etc.

In present era, computer games entertain every age group of both male and female gender. Computer game players are broadly classified as casual players, professional or hardcore player and social game players.

Computer technology and computer games

Growth of the computer hardware such as processor speed, memory, graphics cards, display devices and interactive devices have significantly contributed to

the advancement of computer games. Ultimately every computer game is software, essentially. Contemporary computer vendors had more or less similar hardware at any point of time but it is the developed game software and innovations that has given them edge over the others.

Computer gaming was started with devices with limited processing power, memory in Kilo Bytes, and ordinary graphics. Modern gaming is using 3D graphics, powerful multi-core processors, vast memories, multi button joysticks and movement measuring controlling devices. We are eyeing on utilizing cloud capabilities for easy resource sharing.

Initial computer games were solely developed by individual programmers. Modern computer gaming projects require teams comprising of programmers, story-writers, graphics and animation experts, sound specialists etc.

Personal Computer (PC) based Computer Games:

PC is a versatile machine with an easy upgradeability. PC has considerable advantage over consoles, such as:

- PCs are powerful machines with high processing speed and better graphics resolution.
- More memory and storage capacity
- Availability of mouse and keyboard
- Easy online connectivity.
- Being multi-utility device, PCs are widely available
- PC based games have taken lead on LAN gaming and online gaming. Its popular domain is MMORPG (Many Massive Multi-players Online Role Playing Games). Farmville is a popular game played together by millions on Face book, a social networking website.

Despite various advantages PCs pose serious challenges for game developers such as:

- Different PCs, may have different hardware configuration and operate on various platforms.
- It is a biggest challenge to hold on piracy of games.

Computer games are played on various devices. Game developer has to develop games for specific devices. Devices differ on various parameters. Be it played on any device with any name, ultimately it is software developed for that device. Video Games are also Computer Games. All devices on which computer games are played are also computers with some other forms. Other forms of computer games are presented below.

Arcade Machine Games

When computer games achieved initial commercial success, games were played on arcade machines. In market place there are specific machines on which computer games were played. As game parlour owners charge money on usage basis, games are required to be brief, easy to play and exciting. Player should always feel that next time, they can perform better. Such games are still very popular among kids and commonly available in Malls and Shopping arcades. The program developers have to consider all these factors for designing games for arcade machines.

Console Based Games: Console based games started their journey by gaming devices which are attached to the home TV, and cartridge containing various games were sold to be inserted into gaming device. Today, console based games have become very popular. These are dedicated gaming devices with state of the art configuration. These devices share maximum market share of computer gaming for following reasons.

- Game designers have to design games for specific machines with fixed hardware configuration, unlike Personal Computer games, where platform vary too much.
- It is easy to stop piracy of games, hence profitability is more.

Examples of recent console gaming devices are Play Station 3 by SONY, xBOX 360 by Microsoft and Nintendo's Wii etc.

Smart Phones, Tablets based computer gaming: Smart phones have brought revolution in games with their wide touch screens and online connectivity. Various independent developers offer downloadable game apps for smart phones like Apple's iPhone, android based and window based phones, that users can down load for free or on a nominal price. Computer games compatible to these devices even contribute to the sale of these devices. Modern tabs offer

bigger screen and more powerful processors over smart phones and many a times share common games

Hand held Device based games: These are dedicated hand held devices for computer gaming. These are convenient to carry but lack power and display area size. Game designers also have the challenge to create exciting games with these limitations. Play Station Portable (PSP) is an example of device in this category. Hand held devised games have less market share.

1.11.2 Multimedia and Animation

Multimedia applications are most fascinating applications of computers. A Multimedia application is an application which uses a collection of multimedia. Multimedia is the field concerned with the computerized integration of text, graphics, drawings, images, video, animation, audio, and any other media where every type of information can be represented, stored, transmitted and processed digitally.

The mutimedia data is usually large as it involves audio and video. Processing mutimedia applications pose high overheads of storage, transfer bandwidth and processing. Exponential growth of computer technolgy have been able to support ever inceasing demands of multimedia applications. Softwre techniques like Data compression techniques have also greatly increased portability of mutimedia. Multimedia applications have brought revolution in the fields of Entertainment, Education, Corporate communications and refernce contents. Following are some typical multimedia applications that need computer and IT resources.

- World Wide Web
- Video conferencing
- Video-on-demand
- Interactive TV
- Games
- Virtual reality
- Digital video editing and production systems

Animations word relates to animating, that is giving life to objects**.** Animation is possible because an object seen by the human eye remains chemically mapped on the eye's retina for a brief time after viewing. Utilizing this fact animation is created by a series of slightly changed images shown in sequence within small time frames. Everybody knows Mickey Mouse, 50 years ago Walt Disney gave it life through animation. Animation requires high imagination acumen and it involved extreme hard work to achive in the absense of computers.

Computers have given great support to animation. Nowadays, computer animation is an independent field of study and has got great commercial activity. Animated cartoons, films have given life to imaginary characters using state of the art computers and technology. Jurassic Park, Beauty and the Beast, Toy Story, Shrek and Avtaar are popular animation films that have used computers to the fullest.

A still image from Avtaar animation Movie

There are many softwares like Flash, Director, Animator, Studio Max, SuperCard and that provide multimedia authoring and animation capabilites. Animation is a component of Multimedia technology. Computres have given momentum to the art and science of animation.

1.11.3 E-Business

E-Business or Electronic Business is the mode of business using information and communication technology. This includes the buying and selling of goods and services, along with providing technical or customer support through the Internet. E-commerce (electronic commerce) and M-Commerce (Mobile commerce) are the components of e-business. With the proliferation of internet technologies and expanding internet support infrastructure, e-business has got significant momentum in the past few years.

E-Business is known for online trading of products and services via world wide web or internet. On-line shopping is the core application of e-business.

On-line shopping advantages

E-shopping or on-line shopping reduces the channel of intermediate vendors. On-line shops run on computers using web technologies and do not require maintaining inventories of products. The products are usually supplied from distributor outlets. On-line shopping drastically reduces manpower cost as most

of the tasks involved are taken care of by computer software. Some of the salient features of e-commerce through on-line shopping are presented below

- 24 x 7 shopping facility
- On-line updated catalogues
- No queues and crowds
- No requirement of carrying cash, on-line payment is facilitated
- Wide product range
- High availability of products
- Due to reduction of costs, on-line shops frequently offer discounts which shop owners are unable to match due to overheads

As the computer and internet is reaching to the masses, the e-shopping business is growing leaps and bounds. Some popular on-line shops are e-bay, flipkart, Amazon, homeshop18, naaptol and numerous others.

On-line Services Business

Computer users prefer to avail services as these saves their precious time. Banking, insurance, stock market updates, on-line bill payments are only a few amongst a plethora of services being offered on the internet.

E-advertising is a mode that is dominating prevalent modes of advertising. Google, everybody's essential tool, is the biggest service provider. Google has not charged a penny from its common end users and raised mammoth profits by e-advertisements.

With the popularity of cloud computing us of on-line services is expected to increase manifolds.

Other business support functions

In addition to providing on-line products and services there are many business activities where computers have significantly contributed. ERP solutions support the whole organization in functioning. ERP systems include modules to support all business functions. Even small business organizations need some back office support where computers have helped enormously. Some of them are listed below.

Marketing: Marketing is an essential component of a business comprising 4 Ps of Products, Promotions, Place and Price. Computer based marketing applications help managers to develop strategies that combine the four major elements of marketing.

Financial Accounting: Excellent benchmarked softwares are available to support timely finance and account management. Tally is a commonly used account software.

Forecasting: Computers have facilitated storing large amount of internal and external business data for the analysis and forecasting. Forecasting accuracy has increased with the use of specialized software. Sales forecasting is an important forecasting activity in business, among others.

Office Support: Modern offices are equipped with computer technologies to perform various tasks in an office system such as for document management system, message communication system, and office support systems.

1.11.4 Health Care

Computers and IT services have proved to be a boon for health care industry. The important applications of computers in health care are listed below.

Medical Records: In the past, organising, storing, and retrieval of medical records of patients were crucial tasks. Nowadays computers are efficiently used in health care to keep patient's records. These records can be patient files along with digital scans and X-rays. Computer databases provide an easy, low-space storage option for keeping a huge amount of information easily accessible to the medical staff members.

Computer Assisted Diagnosis: Sonography machines, CT Scanners and other technologically advanced scanners, function with the help of a computer. These automated machines assist doctors to diagnose obscure ailments with high degree of accuracy.

Minimally Invasive Surgery Tools: Nowadays minimally invasive surgeries with the help of computers are gaining advancement. These surgeries cut a small incision, and then place a small surgical tool with an attached camera inside the patient's body. This relieves the patient from a large surgical wound, and it helps in minimizing damage done to the body. Most of these minimally invasive tools use computers to drive the tools, and to relay images from inside the patient's body to provide a view to the doctors.

Internet Surgery: Internet Surgery makes use of fast Ethernet connections and robotic tools to perform the actual surgery. The surgeon does not have to be present in the room for this surgery to take place. The surgeon can be in any corner of the world and still feel exactly what he is doing, and looks at any tests he wants. With this technology, the surgeon can even practice the surgery before the actual surgery takes place.

Telemedicine: Telemedicine can be thought of as a specialised medical application which is concerned with providing medical care via remote communication links.

Medical Transcription: Medical transcription is a very rapidly growing IT enabled service industry. Medical transcription saves valuable time of busy doctors so that doctors can serve more patients. Medical transcriptionists help doctors from remote locations, by transcribing (typing) of doctor's reports from dictated audio files. The transcripts are maintained as patients visit details.

1.11.5 Use of computers in Remote Sensing & Geographic Information System

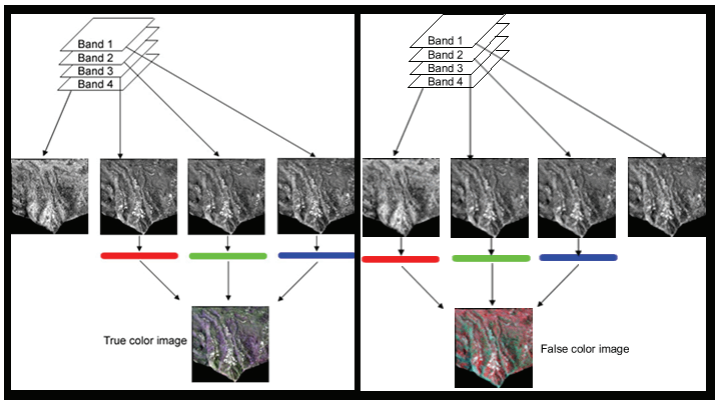
Remote sensing

Remote sensing is an extension of aerial photography which was prevailed for earth resources mapping and monitoring up to late seventies. The computers application facilitated the development of satellite borne systems and sensors for earth resources monitoring and promoted the technology of remote sensing for collection of information about the earth resources from space. Hence the remote sensing refers to technology and art of gathering the information (sensing) of earth resources from the large distance (Remote distance) and generally known as remote sensing technology.

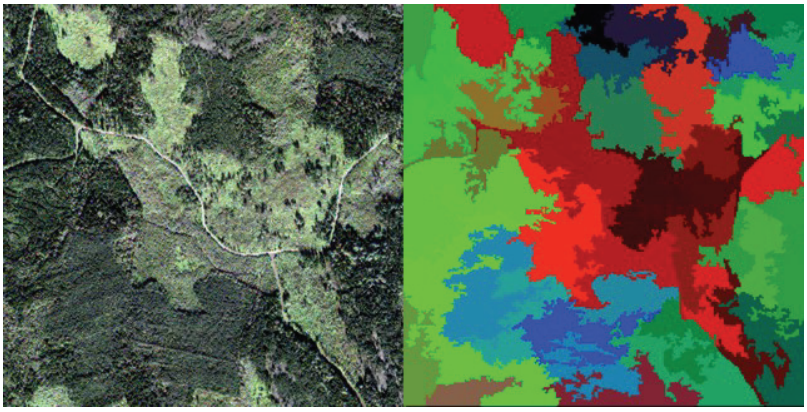
Nowadays, remote sensing is widely utilized for mapping and monitoring of various earth resources like water (ocean, rivers and reservoirs etc), groundwater exploration and management, soil mapping, agriculture acreage assessment and crop health monitoring, Forest mapping and monitoring, Minerals exploration and mines mapping, Geological mapping, topographic and Geomorphologic mapping & applications, climatic and atmospheric monitoring and predictions, sea surface temperature mapping and tsunami prediction and early warning, Urban planning and sprawl mapping etc.

Computer technology and applications are essential at every stage of remote sensing technology:

1. **Satellite and sensor design, command and control:** The sensor design involves the computer application for optimization of sensors to discriminate various earth features and objects. The computers are extremely useful for sending commands to control the in-orbit satellite in space.
2. **Satellite borne data recording and storage:** Onboard Computers plays important roles in data recording in digital format and storage of data onboard.
3. **Satellite data transfer to earth stations:** Computer assisted communication enables the recorded data to send back to earth stations for further processing and use.



4. **Data processing for corrections and generations of final data in the form of imagery for end users:** The recoded raw data need some correction for compensations to atmospheric affects, and geometric irregularities in order to match the imagery data with real earth surface.
5. Computer based data/Image visualization and development and printing of photographic products. The satellite data available in digital format contains huge pixel data and with the help of Image processing software these can be seen on computer screen. The photographic image are also generated for further visual interpretation.
6. Computer aided data enhancement using various mathematical models in order to enhance the level of interpretation by maximizing differentiation among various earth objects/features.
7. Computer assisted identification of earth features and classification of various earth features like water, soil, vegetation, land use, human settlements, civil infrastructures planning, and mining, and navigation etc.
8. Generation of thematic mapping, a theme based map portraying informational database and useful for decision makers and monitoring and administrative agencies.



Geographic Information System (GIS)

Geographic Information System **(**GIS**)** is a computer system for performing geographical analysis. GIS has four interactive components: an input subsystem for converting into digital form (digitizing) maps and other spatial data; a storage and retrieval subsystem; an analysis subsystem; and an output subsystem for producing maps, tables, and answers to geographic queries. GIS is frequently used by environmental and urban planners, marketing researchers, retail site analysts, water resource specialists, and other professionals whose work relies on maps.

GIS has evolved, in part, from the work of cartographers, who produce two types of maps: general-purpose maps, which contain many different themes, and thematic maps, that focus on a single theme such as soil, vegetation, zoning, population density, or roads. These thematic maps are the backbone of the GIS because they provide a method of storing large quantities of fairly specific thematic content that can later be compared. This relatively simple yet versatile technique allowed cartographers to create and simultaneously view several thematic maps of a single geographical area. This system of overlays is a crucial element of GIS, which uses digital map layers rather than the transparent plastic sheets.

The arrival of the computer in the 1950s brought another essential component of GIS. By 1959 the American geographer Waldo Tobler had developed a simple model to harness the computer for cartography. His MIMO ("map in–map out") system made it possible to convert maps into a computer-usable form, manipulate the files, and produce a new map as the output. This innovation and its earliest descendants are generally classified as computerized cartography, but they set the stage for GIS.

In 1963 the English-born Canadian geographer Roger Tomlinson began developing what would eventually become the first true GIS in order to assist the Canadian government with monitoring and managing country's natural resources (Because of the importance of his contribution, Tomlinson became known as the "Father of GIS."). Tomlinson and others produced the first cartographic digital input device (digitizer) and the computer code necessary to perform data retrieval and analysis. They also developed the concept of explicitly linking geographic data (entities) and descriptions (attributes).

The two most common computer graphic formats are vector and raster, both of which are used to store graphic map elements. Vector-based GIS represents the locations of point entities as coordinate pairs in geographic space, lines as multiple points, and areas as multiple lines. Topographic surfaces are frequently represented in vector format as a series of non overlapping triangles, each representing a uniform slope. This representation is known as Triangulated Irregular Network (TIN). Map descriptions are stored as tabular data with pointers back to the entities. This allows the GIS to store more than one set of descriptions for each graphic map object.

1.11.6 Bioinformatics

Each living organism is formed from cells which is the basic structural and functional unit of life. Every cell has a complete set of instructions about making cells and their components. This set of instructions is known as genome. Thus, a genome can be thought of as the entire set of hereditary instructions required for building, running, and maintaining an organism, and passing life on to the

next generation. The genome is made of a chemical called deoxyribonucleic acid or DNA. DNA's code is written using only four letters, A, C, G and T. As a sequence of alphabets makes a word, similarly, the meaning of DNA's code lies in the way the letters A, C, G, and T are arranged.

Cells read the DNA sequence to make chemicals that a body needs. The genomic code breaks down into thousands of individual genes. Information from genes is given to cells to make the functional molecules called *proteins*, which have a unique chemical property. Proteins interact with each other to carry out thousands of functions, from digesting your dinner to synthesizing the small molecules that form a barrier between the inside of your cells and the outside world.

Computer Applications in Bioinformatics

Biologists want to collect all information about every gene in every genome, and from that information construct models of how genes work together to build up and maintain a living body. Availability of huge amount of biological data for experiments has become possible because of data has been made available on computers through Web. Analyzing this data to develop new models of how biological systems function, and for finding patterns to analyze new data sets is the work of bioinformatics. Bioinformaticians use many areas of computer science and engineering to process biological data. Complex machines are used to read in biological data at a much faster rate than before. Databases and information systems are used to store and organize biological data. Analyzing biological data may involve algorithms in artificial intelligence, soft computing, data mining, image processing, and simulation.

Major areas of applications of computer science and engineering in bioinformatics are as follows.

- **Signal Collection and Processing:** Signals collected from devices such as, DNA sequencers, CCD devices, spectrophotometers etc. are fed to computers (via an analog to digital converter) for further processing.
- **Analysis of DNA Sequence:** In bioinformatics, sequence analysis refers to the process of analysis of a DNA sequence to understand its features, function, structure, or evolution. Computers help in extracting patterns and rules from large data collections to characterize and predict features in new data. Nowadays, many computerized techniques and tools such as BLAST are available that provide sequence comparison (sequence alignment) with some known functions and analyze the alignment product to understand its biology.

- **Genome Annotation:** Within a genome, all of the nucleotides are not a part of genes. Large parts of the DNA do not serve any obvious purpose and hence is called junk-DNA. Annotation is another aspect of bioinformatics in sequence analysis and is the process of marking the genes and other biological features in a DNA sequence. Automatic computational methods such as GeneMark program assign functional meaning to uncharacterized data.
- **Evolutionary Biology:** Biological evolution is defined as any genetic change in a population that is inherited over several generations. It helps researchers to trace the evolution of organisms by measuring changes in their DNA and study of events such as gene duplication and horizontal gene transfer. Some computational softwares available to solve the above mentioned purpose are BEAST, CERVUS and MCALIGN.
- **Analysis of Mutations:** Genomes change between generations or over a lifetime. These changes are called mutations. Mutations come in many different shapes and sizes: a single letter may be changed, a whole segment of DNA sequence may be flipped over and reverse itself, or huge sections of the genome could be duplicated or deleted. A few of these changes can be seen under a high-powered microscope but must require techniques that can compare the sequence or activity of specific DNA segments. Software such as *Pyromaker* can detect genetic mutations and can aid in the diagnosis and selection of treatment for cancer mutation.
- **Modeling and Simulation:** For better understanding of biological processes, it is necessary to prepare a model and simulate it. It helps bioinformaticians in visualization of the complex biological networking. VANESA is powerful and easy to use modeling software through which scientists can automatically reconstruct important biomedical systems using the information available from databases.

1.11.7 Meteorology and Climatology

Meteorology is associated with routine weather prediction. The three basic aspects of meteorology are observation, understanding and prediction of weather. Modern computers and supercomputers facilitate weather prediction and forecasts. Numerical weather prediction uses complex computer programs known as forecasts models that run on super computers to provide predictions on atmospheric variables such as temperature, pressure, wind and rain fall.

Modern meteorologists have improved prediction accuracy by **numerical forecasting**, which uses mathematical equations to predict the weather. Such forecasting requires powerful computers and lots of observational data collected from land, sea and air. Collectively, all of these observations are huge. A normal computer would not be able to process this vast data. Meteorologists, nowadays,

process this enormous data on supercomputers, millions of calculations per second. Thus computers have significant applications on meteorology.

Indian super computer PARAM YUVAII

Climatology is study of climate; this study is based on average values of weather records collected for a sufficiently longer duration. Climatologists use climate simulation models for simulation of past, present and future climates. This simulation again requires powerful computers.

Metrology and climatology differ in the sense that former predicts weather on daily or short term basis whereas latter predicts general trend of weather of a region over longer period of times.