CHAPTER : I
INTRODUCTION

C H A P T E R - I :: INTRODUCTION ::

1.1 COMPUTER GRAPHICS

According to the Oxford English Dictionary, Graphics is defined as 'of drawing, painting, engraving, etching, etc., vividly descriptive, lifelike; of diagrams and symbolic curves'. This definition indicates the scope of graphics and what computer can already do, or will be able to achieve, in the future. Computer Graphics is one of the most rewarding areas of new technology. This is not very much surprising considering that the predominant human sense is sight. So the attractive pictures drawn on the screen of the computer under the control of program, provides the most effective means of communication between computer and human user. Computer Graphics is one of those areas which sits astride the sciences and the arts and necessarily involves a synthesis of analytical and creative thinking. So creativity is one of the requirements of computer graphics. It has long been assumed that you can only get out of a computer what you put in. But this is not always the case. Now it has been demonstrated that something new can come out of computer, and that new something is knowledge. This knowledge, can be original ideas, strategies and solutions to real problems So creativity, can surely be introduced in computers. But it is a basic question what is creativity ?

1.2 CREATIVITY

The meaning of creation is 'to bring into being or form out of nothing'. Creativity is always explained interms of divine inspiration, romantic intuition or insight. It is a kind of puzzle, a paradox or a mystery. Artists and scientists rarely know how their original ideas come about.

People of a scientific cast generally try to define creativity interms of 'novel combinations of old ideas'. The surprise caused by a 'creative' idea is due to improbability of the combination, take an example of Shakespeare's poem.

How sweet the moonlight sleeps upon this bank'!. Here will we sit, and lets the sounds of music Creep in our ears : Soft stillness and the night Become the touches of sweet harmony.

These all connections seem to be nonsense. Moonlight does not sleep; no relation between sound and creeping exists, stillness and night cannot become touches. But the creativeness in Shakespeare relates to these things and there is birth of poem that moves us in a way that a less original assertion ever can. In other words, there is a 'novel combination of old ideas' in Shakespere's poem. So it is a classic example of creative idea. According to Margaret A. Boden[2], a research worker in the field of cognitive science, to call an idea creative is to say that it is not only new, but interesting (valuable). Combination theorists, usually omit value from their definition of creativity,

because they take it for granted that unusual combinations are always interesting. This also is not true. The fields that are often called creative are theories, poems, paintings, music etc .

According to Ms. Boden, there are two senses of creativity. One is Psychological (called as p-creativity), the other is historical (called as H-creativity). P-creativity is restricted to a person's domain. If an idea arises in a person's mind for the first time then it is p-creative, it doesn't matter if other persons have had this idea in their mind. There is no systematic explanation of H-creativity. An idea is H-creative if it is p-creative and no-one else has ever had it before. H-creative includes fashion, rivalries, illness, trade patterns, economics, war, flood and fire. In H-creativity, an idea may survive belost for a while and resurface later.

From last three decades, computers, the electronic brains, have been largely confined to mindless and predictable work. It is commonly believed that they lie right at the opposite end of the philosophical spectrum. But creativity will be a vital attribute of the computer of the future.

1.3 CREATIVE COMPUTER

The design of present day digital computer has its roots in the 'Analytical Engine'[2] developed by Charles Babbage. The analytical engine in principle, 'composes elaborate and scientific pieces of music of any degree of complexity or extent'. It seems that the Analytical Engine and so the present day digital

computers (which is based on the same principle) are creative. But the friend and collaborator of Mr. Babbage, Lady Lovelace, insisted that the creativity of the analytical engine is due to the engineer and not due to engine. This means that creativity of computer is due to the programmer and not due to the machine itself. So with Lady Lovelace's remark, the link between computer and creativity seems to become extinct. To validate the view, Boden has proposed four different questions which she called as Lovelace's questions, because many people respond to these questions with a dismissive No !.

The questions are as follows :

1. Whether the computer will help in understanding the possibility of human creativity ?
2. Whether the computer will be creative now or in future ?
3. Whether the computer could ever appear to recognize creativity ? i.e. whether we could ever use a computer to decide that the particular music, poem, drama is creative ?
4. Whether the computers themselves could ever really be creative i.e. without the aid of human programmer.

The first three questions are psychologically important and the answers provided by Boden to these questions are : Yes, definitely, Yes, upto a point and Yes necessarily. Fourth question is psychologically less important, and the answer of this question is 'No'. Boden has given two arguments [2] to defend the 'No', one is the brain-stuff argument and other is non-human

argument[1].

1.4 THE NEED FOR CREATIVITY

Computer control is successful if and only if the number of possible events are small. We can program the computer to take the appropriate action in case of each event. But in real-life-situations, the range of possibilities is so enormous that the programming solution for all of them, before-handed is an impossible thing. Here what required is a self learning computer that extends its model of world as it gains new experiences. John McCarthy[8] was one of the greatest pioneers of the scientific quest for intelligent computer. He stated that an useful computer should have 'common sense' which is an essential human attribute. Even with a more than a quarter century with computers, this is still a technical challange.

But if the idea of 'creative computer' comes into reality then it is possible to apply the computer to the harsher problems that confront society, and solutions will be possible. With the 'creative computer' we can foresee the day when poverty, hunger, disease and political strife have been solved through the use of new knowledge given out by computer.

1.5 THREATS TO HUMAN

The creative computer has artistic, religious, political and emotional associations of all kinds. It is a common fear that the explanation of creativity and its introduction in

computer would not merely bewilder creativity, but destroy it as well. Most people assume that a scientific psychology would at best devalue creativity, and at worst deny it.

From the invention of the computer, we have taken it for granted that the computers are just machines and they are superior in performing many purely mechanical, physical activities, such as numerical computation, information storage and repetitive operations. But still people have maintained their collective self image because there are certain things which computers can't acquire such as knowledge, belief, reality, truth, perception causality and creativity. People get worried when they see the efforts of A.I. workers to simulate intelligence and creativity in computers. There is a threat to damage the collective self image of people. M.A.Boden wrote in her book, 'The Creative Mind : Myths and Mechanisms'[2] as

"In many humanists' opinion, the literature of A.I. inevitably encourages the alienating mystification; that there is no essential difference between people and machines, and thus subtly supports those social systems that effectively treat people as though they were machines".

There are certain efforts to re-establish the self-esteem of man but only gives rise to muddled thinking Kurt Gödel[3], an American Mathematician, quoted that "In any sufficiently powerful mathematical systems (such as Arithmatic) there will

always be propositions that cannot be proved within the system- they simply have to be assumed". This theorem of 'Incompleteness' stated by Gödel, is a proof of man's superiority over machine. To restore the self image of man we have to gain a deep understanding of what machines can and cannot do.

1.6 COMPUTER AIDED DRAWING

Drawing and paintaing are supposed to be most basic creative activities. It is a natural tendency of an artist to exploit the latest technology which offers him tangible benefits : new colours, new alloys, new methods of print-making etc. There are two totally distinct approaches, to use computer in drawing and painting. In one, the computer is being used simply as a tool. Brushes of different sizes and options for different colours will be presented on the screen. By the movement of cursor, a user can draw any shape; and can freely paint that drawing. "Paint brush" systems have been developed for the artists. In the second approach, the artist feeds the program to computer and generates the desired image on the screen. This is the approach implemented here.

The first reference of the work in the field of 'computer aided drawing' is in 1951. Jay Forrester[1], the Director of MIT simulate a bouncing ball on whirlwind computer. The first interactive drawing package was developed by Ivan Sutherland[4] in 1963. The name of that package was 'Sketchpad'. Since 1971

the scene has changed dramatically , largely due to the development of micro-computers. Another factor that boosted the development in this field, is the decreasing cost of semiconductor memories. With the low cost memories, it is economical to go for raster scan technology. The concept of frame buffer has led to major developments in colour rendering and animation. In the same decade there was the development of plotters, with which, the attractive patterns produced on the screen can be copied on the paper.

Yet despite such promising start and the diverse and accelerating hardware innovation, over the many years have retarded the progress of the 'computer art'. According to Michael Batty[1], this is perhaps due to the longstanding myth, which continues to perpetuate in our society, that the computer will eventually 'usurp' most traditional human activities. The second reason of slow rate of progress is lack of parallel software development. But the scene has changed totally. "Machine-Independent" software has been developed in abundance. An international standard "GKS" has been developed, with which one can develop a fully portable graphics software.

1.7 SIGNIFICANCE OF COMPUTER ART

There are harsh criticisms in the development of computer art. This is because the computer scientists with a more or less artistic view has produced this art. Secondly the traditional artists are only interested in the quality of the end product and there has been no appreciation of art involved

in programming. So the criticism is partial and incomplete. Thirdly, the technology, computer art, is in its early stage of development. It will require many years of accelerating progress to compare itself with the traditional artists.

Computer art is a kind of liberation. Prior to its existance, art was possible to only those who have the mannual skill. But now anyone, with explicit thinking and logical problem solving, can write a program to produce the desired art.It is said that[1] "computer art is more closer to human mind and heart than other forms of art. Truly it is an art created by mind rather than body".

1.8 OUTLINE OF THE DISSERTATION

The name of the dissertation is "COMPUTER AIDED DRAWING" . Actually the names like computer graphics or computer art are also appropriate for this dissertation. But computer graphics implies a more definite scientific purpose, while computer art has no such scientific purpose. Computer art is more personal, expressive and inspired to recreate. The work implemented here covers both the sides. Mathematical graphics implemented in chapter II, computer aided learning approach implemented in chapter IV, for projectile trajectory and proportional control simulation are purely computer graphics applications. Fractal graphics implemented in chapter III

is purely computer art. While the program implemented in chapter V illustrates the basic interaction techniques and their final outcome is electronic circuit drawing. So a general name to all these varieties of computer art is "COMPUTER AIDED DRAWING".

Computer art can be viewed in many varieties. First is passive art and second is active or interactive art. In passive art the artist (here he is programmer also) concentrates on the computer program that produces the art. In active art, the artist concentrates on how picture and program structure interact. Here the program demands from user, certain parameters and produces the output according to those parameters. So one can understand the interaction between picture and program structure. Here the approach used is active art.

Many attractive and fascinating shapes can be produced on the screen of the computer under the control of a mathematical formula. These designs are based on constructing pictures using regular geometry and is a kind of regular art. Some such designs are implemented in chapter II. These functions are mainly circular functions. Linear spirals are produced by radius modulation of circle and rotation. By modifying the program for linear spirals, concentric lobe patterns are produced. The other programs in the chapter are

for producing contrarotating spirals, simulation of amplitude modulation of sine wave and the pretty Lissajous patterns.

A principle which is central to computer art involves replication. Replication makes life easier for artist. Here the artist has to design, only one basic primitive shape and a successful program can locate the copies of this primitive shape over whole the screen. Recursive programming is the main principle behind generation of such self similar patterns. This forms the main application in 'graphic handicrafts'[4]. Recursive squares and Koch recursion are implemented in the first part of the chapter III. Second part of this chapter deals with Mandelbrot or fractal graphics. To create illusion of natural patterns, fractals are necessary. Sierpinski curve is implemented in this part.

Computer graphics is a major tool in computer aided learning. Impossible, expensive, risky experiments can be simulated on computer. Two packages are developed in this chapter. First package effectively simulates a projectile. Second package gives a sound understanding of proportional control.

A computer aided design program accepts a picture as an input and deduces certain information from it. In chapter V a package is developed for electronic circuit drawing with limited components. It also illustrates basic interaction techniques such as picking and dragging technique, rubber band drawing.

Choice of language for the graphics applications is also an important issue. Graphics software still remains largely non-standard due to the fact that, graphics commands, known as graphics primitives, are usually adapted as an after thought to standard programming languages such as BASIC, FORTRAN, PASCAL etc. But 'C' is the most structural language having the standard graphics library. So it is a natural choice for the programs implemented in this dissertation.

1.9 OVERVIEW OF HARDWARE FOR GRAPHICS

Selecting the hardware is becoming more and more difficult. There are wide variety of technologies and models in the market. The hardware related to computer graphics is described in this point.

1.9.1 GRAPHIC ADAPTERS :

Application like CAD/CAM, presentation graphics, desktop publishing require high resolution. Graphics adapter[10] is an add-on board used to increase the resolution and colour capabilities of personal computer. Generally, graphics adapters employ one or more of the following standards for compatability with IBM PC monitors.

a) CGA (COLOUR GRAPHICS ADAPTER)

This adapter provides a resolution of 640 X 200 pixels in one colour from a palette of 64 colours and 320 X 200 pixels in four colours from a palette of 16 colours. Recent standards

offer higher resolutions and a more extensive choice of colours available onscreen simultaneously. Add-on board manufacturers frequently emulate the CGA standard to provide compatibility with older CGA software.

b) MDA (MONOCHROME DISPLAY ADAPTER)

It offers one-colour contrast such as black-and-white or green-and-white. The MDA standard works in text only and not graphics. It provides a text resolution of 80 characters X 25 lines, and each character is 9 X 14 dots.

c) EGA (ENHANCED GRAPHIC ADAPTER)

It is currently the most popular standards, designed for compatibility with the IBM Enhanced colour Display Monitor. It provides many more colours on-screen simultaneously, offers much higher resolutions and also defines a monochrome graphics mode for high definition text. Its highest resolution mode is 640 X 350 pixels in 16 simultaneous colours from a palette of 64 colours. The monochrome mode produces 640 X 350 graphics with four attributes viz. blinking, reverse video, on and off.

d) HGC (HERCULES GRAPHICS CONTROLLER)

This adapter is the product of Hercules Computer Technology of Berkeley and is the extension of MDA. It supports a mode of graphics with a resolution of 720 X 350 pixels as well as high definition text.

e) PGA (PROFESSIONAL GRAPHICS ADAPTER)

PGA is designed by IBM for high-end applications such as CAD. It is an intelligent board which supports 3-D images and provides a high resolution of 640 X 480 pixels in 16 colours from a palette of 64. PGA is considerably expensive than all other adapters, while HGC is much more economical and often used with low cost monitors.

1.9.2 PRINTING COMPUTER GRAPHICS

For printing computer graphics, the printer must have provisions for bit-image graphics[3]. While printing text, the wire firing pattern for each character is set by character generator chip (a ROM chip). A printer having bit image graphics facility, recognizes a certain code sent by the computer as an instruction to turn off the character generator and bypass the print logic that controls the firing order of the wires. Then the printer interprets the data stream following the turn-off code as direct orders to fire certain wires. This control permits the printing of a pattern of dots on the paper to form a graphic image. IF multicolored ribbon is used then the result is color printing. To give much higher resolution, the printer must have the capacity to print in more than one density.

Here I have developed a routine to take the printout of the graphics image. The name given for the header file is "gprnt.h". A function ghardpict is prototype in that file. The

Parameters of the function are the coordinates which cover the screen section to be printed.(listing on page number 164)

Hewlett-packard[6] company believes that within next five years colour will become a common attribute to desktop printers, just as multiple fonts and type styles are today. Though the colour monitor uses red, green and blue model, recent technologies mix three colours cyan, yellow and magenta to create millions of colour combinations. Users have a wide variety of colour printing technologies as dot matrix, thermal inkjet, solid inkjet, thermal wax transfer, dye sublimation laser printing etc. But HP believes that the affordability and excellent print quality of inkjet technology will lead to its acceptance as the most common colour printing technology for mainstream office, home office and personal colour applications. Colour laser printers are at the high end of the colour-print market, providing high print quality at correspondingly higher prices.

The printer build images from thousands of closely spaced dots, while a plotter draws continuous lines with a fiber, ballpoint or drafting pen. For publication quality plotting, a specially quoted paper is used. Three special kinds of plotter exist in market[9] : flat-bed, drum and roller-bed. While choosing a plotter, we have to consider its many specifications such as resolution, repeatability, pen velocity etc. Noise level of the plotter (which is proportional to pen velocity) is also important consideration if the plotter is to

be used in a crowded office, or in a home or apartment.

1.10 SILICON GRAPHICS : THE MAGIC OF HUES

Silicon Graphics International. Inc.[7] is a computer corporation founded by James H.Clark, who is also the inventor of "geometric engine". The graphics products of the company are excellent and it is said that it forces employees to go on leave. The names given to the products are also exotic such as Indigo, Crimson, Onyx ; rather than the more familiar but horrifically boring sounding Model 1200, 1500 and so on. The computer graphic systems given by the company are used in producing special-effects for blackbuster Hollywood movies such as Steven Spielberg's 'Jurrasic Park', 'Terminator 2', 'Beauty and The Beast', 'The Abyss' and also in high-profile music videos as Michael Jackson's 'Black or white'.

1.10.1 SILICON GRAPHICS PRODUCT PORTFOLIO

IRIS Indy : A personal workstation that offers a full motion colour video camera and multimedia application capabilities such as text, video and audio (cost : 4.5 lakhs).

IRIS Indigo : A high performance, colour RISC personal computer; also delivers 3-D graphics, DAT-quality audio and video (cost : eight lakhs).

Indigo Extreme : The Highest performance and most powerful graphics on the desktop.

IRIS Crimson : The first computer from any vendor based on the MIPS R4000 processor.

Onyx : A family of advanced graphics supercomputers that delivers combined compute and graphics performance.

Challenge : A broadest network resource server line spanning from entry level uniprocessor to enterprise-wide symmetric multiprocessing systems.

Power Challenge : Line of supercomputing server that puts the power of upto 18 cray Y-mp class supercomputers in a single RISC based system.

1.10.2 SILICON GRAPHICS APPLICATIONS PORTFOLIO

Computer-aided Design : Ranging from car and aircraft design to phones and sports design.

Scientific visualisation : including analysis of satellite data for global warming trends, weather patterns, etc.

Molecular Modelling and Computational Chemistry : As used in AIDS research and drug design.**Visual Simulation and Virtual reality.**[6] Used for the 1992 U.S. bobsled team training, and commercial and military training.

Special Effects and Animation : Used in movies such as Terminator 2, Beauty and The Beast, The Abyss and music videos such as Michael Jackson's Black or White from his latest album, Dangerous.

The U.S. based company has made its entry in Indian Market. The Indian counterpart is Silicon Graphics System (India) Pvt. Ltd., headed by Mr.Desai.

According to Murli Menon,[7] this is just the kind of company that the Indian Information technology needs at this stage. He says that the technology, the application possibilities and the expertise in the exciting areas of graphics, simulation and animation apart, it might just infuse that dash of colour and a completely new management style, orientation and culture in the Indian Industry.

1.11 OVERVIEW OF TURBO C GRAPHICS

The real difficulty in graphics programming is the variety of graphics adapters associated with various computers. Turbo C[11] provides a complete set of graphics functions for controlling the more popular PC's graphics adapters. The graphics tools are provided with the Borland Graphic Interface (BGI), and they are supported by both Turbo C and Turbo Pascal.

The BGI provides support to various adapters including CGA, EGA,VGA, Multicolour Graphics Array (MCGA) , the Hercules Graphics adapter, the 3270 PC Graphics Adapter and the IBM 8514 Graphics Adapter.

There are seven classes of the functions provided with the BGI viz. :

a) Graphics system control.

b) Drawing and filling routines.

c) Screen and viewport access.

d) Text display.

e) Color control.

f) Graphics error handling.

g) Graphics query routines.

Graphics system control functions initializes and shuts down the graphics system, loads device drivers, detects graphics hardware, allocates memory for the graphics system. Graphics system can be initialized with two modes, one is automatic mode which detects the type of graphics hardware automatically and other is user specified mode.

Class 'b' operations include draawing lines, arcs, rectangles, circles, setting the line styles and setting the current position for drawing objects. Filling routines are used to fill objects with different colors and predefined or user defined patterns.

Class 'c' operations are concerning about screen access and viewport definitions. With a viewport we can divide the screen into a region and limit all graphic output to the area defined by the coordinates of the viewport.

Text display services allow to label a figure in different font styles and sizes.Foreground, background colors as well as color paletter can be controlled by class (e) services. Graphics error handling category gives error codes and error messages for the wrong use of graphics operators. Graphics query routines gives the attributes of the current state of the graphics system. Some more standard query operations supported by this category of services are

* Obtaining the active graphics mode.
* Obtaining x and y cordinates of the current drawing position.
* Obtaining the current line style and its thickness.
* Obtaining the color of a pixel. Query functions also give the ranges for the current and graphics driver installed in a computer.

1.11.1 COMPUTER GRAPHICS- PIXEL ADDRESSING

The sole principle of computer graphics is to work with the individual pixels. Pixels are refered with row and column address. Resolution of the screen is nothing but available number of pixel rows and columns. The upper left corner of the screen is origin i.e. (0,0)and lower right corner is (last-pixel-column, last-pixel-row).

1.11.2 MODES

Each graphics adapter supported by the BGI provides a set of selectable modes. Resolution of the screen and the number of colors available are determined by the mode of the screen. The complete set of adapters and modes supported by the BGI is as shown in Table II. The label component is the symbolic name of the mode that the BGI supports and is prototype in graphics.h.

1.11.3 INITIALIZATION OF THE GRAPHICS SYSTEM

The file graphics.h is a must for all programs that use the graphics functions. This file contains all of the data structures, constants and function prototypes necessary to support the BGI tools. Before running any graphics program you have to link it with the graphics library, graphics.lib.

The graphics system can be initialized by calling the function initgraph. The declaration for initgraph is void far initgraph (int far driven int far mode, char far path-for driver).

First, a memory is allocated for a specified graphics driver and the graphics driver is loaded. The function 'initgraph' initializes the graphics system to a specified mode indicated by mode. The last argument, path-for-driver, determines the directly path that initgraph searches in order to locate the specified graphics driver.

In all the programs implemented here a common structure for initialization is used. First the drive argument is set to HERCMONO since all the programs are implemented on HGA.Mode is set to the constant DETECT. This is a kind of automode selection. The mode selected is the mode which defines the greatest resolution possible for that graphics adapter. You can also use the autodetection feature for selecting the driver. Using the autodetection feature enhances the portability of the graphics program.

The graphics system is shut down by calling the function closegraph. This function also restores the screen to the state it was in before the graphics system was called.

Table-1 : The Files Included with the BGI

File	Description
Graphics.lib	The main graphics library.
Graphics,h	The graphics header file that must be included in all graphics programs.
Goth.chr	The font driver for the gothic character set.
Litt. chr	The font driver for the small character set.
Sans.chr	The font driver for the sansserif character set
Trip.chr	The font driver for the triplex character set.
Att.big	The driver for the AT and T graphics adapter.
Cga.bgi	The driver for the CGA graphics adapter.
Egavga.bgi	The driver for the EGA and VGA graphics adapters.
Herc.bgi	The driver for the Hercules Graphics adapters.
Ibm 8514.big	The driver for the IBM 8514 graphics adapter.
PC 3270,bgi.	The driver for the PC 3270 graphics adapter.

Table 2 : Adapters and modes supported by the BGI

Adapter (Driver)	Mode	Resolution	#Colors	#Pages	Label
CGA	0	320X200	4	1	CGAC0
	1	320X200	4	1	CGAC1
	2	320X200	4	1	CGAC2
	3	320X200	4	1	CGAC3
	4	640X200	2	1	CGAHI
EGA	0	640X200	16	4	EGALO
	1	640X350	16	2	EGAHI
EGA64	0	640X200	16	1	EGA64LO
	1	640X350	4	1	EGA64HI
EGAMONO	0	640X350	2	1	EGAMONOHI
VGA	0	640X200	16	2	VGALO
	1	640X350	16	2	VGAMED
	2	640X480	16	1	VGAHI
MCGA	0	320X200	4	1	MCGAC0
	1	320X200	4	1	MCGAC1
	2	320X200	4	1	MCGAC2
	3	320X200	4	1	MCGAC3
	4	640X200	2	1	MCGAMED
	5	640X480	2	1	MCGAHI
HERC	0	720X348	2	2	HERCMONOHI
ATT400	0	320X200	4	1	ATT400C0
	1	320X200	4	1	ATT400C1
	2	320X200	4	1	ATT400C2
	3	320X200	4	1	ATT400C3
	4	640X200	2	1	ATT400MED
	5	640X400	2	1	ATT400HI
PC3270	0	720X350	2	1	PC3270HI
IBM8514	0	640X480	256		IMB85140
	1	1024X768	256		IMB8514HI

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