

SYNTHESIZING OF HUMAN-LIKE GESTURES AND ACTIONS USED IN THE WORLD TODAY

Case Study: **Computer Animation created by use of 3D and 2D
computer graphics.**

By

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Bachelors of Computer Science
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DECLARATION

STUDENT

I do hereby declare to the best of my knowledge that this graduation project is my original work and that it has never been submitted to any University or any other institution. The literature and citations have been referenced and acknowledged in text, footnotes and bibliography.

Student's Signature.....

Date.....28th/08/2009.....

SUPERVISOR

This is to certify that this project was presented by
..... and carried out under close supervision.

Supervisor's Signature.....

Date.....29/08/09.....

ACKNOWLEDGEMENT

I would first of all like to thank God for giving me this opportunity in my life to have learnt a lot from this course, as well as from this project. I also thank God for imparting me with knowledge that assisted me in preparing and developing this project.

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LIST OF ACRONYMS

CGI	Computer-generated imagery
ENIAC	Electronic Numerical Integrator And Computer
SEAC	Standards Electronic/Eastern Automatic Computer
ERMA	Electronic Recording Machine Accounting Project
3D	3 Dimensional
2D	2 Dimensional
SGI	Silicon Graphics Inc
CBT	Computer- based Training courses.
PC	Personal computer
CPU	Central processing Unit
Cels	Celluloid
CD-ROM	Compact Disk-Read Only Memory
SGI	Silicon Graphics Incorporated
DVD-ROM	Digital Video Disk-Read Only Memory
USB	Universal Serial Bus

ABSTRACT

Chapter one covered the general definition of what computer animation is, and what it comprises of, that is, 2D as well as 3D computer graphics. It also sighted how animation is of importance today. The background mentioned the evolution of computers right from the time they were discovered or invented up to the current technology of computers. It also mentioned the different generations that computers went through up till the most recent technologies today, specifically sighting first, second, third, fourth and fifth generation computers, mentioning the different technologies used and changed. The problem mentioned is about the lack of skilled animators of a high caliber. Chapter one also talked about the specific aims and objectives of the study, sighting the general aim as studying computer animation techniques. The scope would also cover new applications of computer animation in a multimedia Web environment in terms of content creation and consumption as well as the achievements that computer animation has brought about to the world today.

Chapter two was about different authors, scholars and lecturers from institutes who shared their points of view of what they thought about Computer Animation as well as its other branches, namely multimedia, computer graphics. The literature review also included brief descriptions as well as examples along with pictures. The different authors also shared what types of hardware and software they usually used. The review looked at Jessica K. Hodgins, James F. O'Brien, and Robert E. Bodenheimer of the College of Computing and Graphics, Visualization, and Usability Center, Georgia Institute of Technology, Atlanta as they shared their view on Animation. Tay Vaughan of *Multimedia Making it Work*, 1993 shared his views on Multimedia, what it comprised of, as well as its applications, hardware and software required.

Parent R and Hodgins J.K from Ohio State University, shared their views on animation, saying that it could bring the dullness of the features to life, and they too talked about the different hardware and software used as well as the impact of animation in the world today. They specifically mentioned the different techniques used, describing each of them in detail with clear examples. The Cornell University Program of Computer Graphics described a lot on computer graphics and the different techniques used too. They also provided different pictorial representations to explain easier. Chapter two generally looked at 2D and 3D animation, multimedia, computer animation, 2D and 3D computer graphics.

Chapter three looked at the methodology of Computer Animation sighting it as a very wide topic to research on since it consisted of many sub branches. It also stated that the goal with this project was not to go so in depth and into details, but to outline an overview of what computer animation is about and what an individual is required to know before he/she can venture into that branch of science. This chapter also outlined the data collection methods. It also outlined the prototype that was created, being a flying wasp. The prototype required some programs to be installed on the viewer's personal computer before it could be viewed.

Chapter four covered the implementation point of view. It consisted of a brief description of what the software requirements were as well as what the hardware requirements were in order to create an animation. It also included a brief description of how the prototype was created using the different programs and how it was implemented.

Chapter five looked at the researcher's recommendations about computer animation, giving an overview of what one would require in order to create an animation as well as the conclusion on the project and what was learnt from the project.

CHAPTER ONE: INTRODUCTION

1.0 Overview

Computer animation (or CGI-animated) is the art of creating moving images with the use of computers. It is a subfield of computer graphics and animation. It is created by means of 3D computer graphics, though 2D computer graphics are still widely used for stylistic, low bandwidth, and faster real-time rendering needs. The target of the animation is the computer itself, but sometimes the target is another medium, such as film. It is also referred to as CGI (Computer-generated imagery or computer-generated imaging), especially when used in films.

To create the illusion of movement, an image is displayed on the computer screen then quickly replaced by a new image that is similar to the previous image, but shifted slightly. This technique is identical to how the illusion of movement is achieved with television and motion pictures.

In most 3D computer animation systems, an animator creates a simplified representation of a character's anatomy, analogous to a skeleton or stick figure. The position of each segment of the skeletal model is defined by animation variables, or Avars. In human and animal characters, many parts of the skeletal model correspond to actual bones, but skeletal animation is also used. Animation has historically been produced in two ways. The first is by artists creating a succession of cartoon frames, which are then combined into a film. A second method

is by using physical models, e.g. King Kong, which are positioned, the image recorded, then the model is moved, the next image is recorded, and this process is continued.

1.1 Background

The evolution of computers started way back in the late 1930s. Binary arithmetic is at the core of the computers of all times. History of computers dates back to the invention of a mechanical adding machine in 1642. ABACUS, an early computing tool, invention of logarithm by John Napier and the invention of slide rules by William Oughtred were significant events in the evolution of computers from these early computing devices.

In the evolution of computers, their first generation was characterized by the use of vacuum tubes. These computers were expensive and bulky. They used machine language for computing and could solve just one problem at a time. They did not support multitasking. It was in 1937 that John V. Atanasoff devised the first digital electronic computer. The Harvard Mark I of 1944 was a large-scale electromechanical computer with less programmability. It was another step forward in the evolution of computers.

The U.S. Army's Ballistics Research Laboratory came up with the Electronic Numerical Integrator And Computer (ENIAC) in 1946. It came to be known as the first general purpose electronic computer. However it was required to be rewired to change its programming thus making its architecture inflexible. It was known as the stored program architecture or von Neumann Architecture. All the projects of developing computers taken up thereafter have been using the von Neumann Architecture. The U.S. National Bureau of Standards came up with Standards Electronic/Eastern Automatic Computer (SEAC) in 1950. Diodes handled all the

logic making it the first computer to base its logic on solid devices. Till the 1950s all computers that were used were vacuum tube based.

In the 1960s, transistor based computers replaced vacuum tubes. Transistors made computers smaller and cheaper. They made computers energy efficient. The use of transistors marked the second generation of computers. Computers belonging to this generation used punched cards for input. They used assembly language. Stanford Research Institute brought about ERMA, Electronic Recording Machine Accounting Project, which dealt with automation of the process of bookkeeping in banking.

The use of Integrated circuits ushered in the third generation of computers. Small transistors placed on silicon chips, called semi conductors. This increased the speed and efficiency of computers. Operating systems were the human interface to computing operations and keyboards and monitors became the input-output devices.

Intel produced large-scale integration circuits in 1971. During the same year, Micro Computer came up with microprocessor and Ted Hoff, working for Intel introduced 4-bit 4004. In 1972, Intel introduced the 8080 microprocessors.

In 1974, Xerox came up with Alto workstation at PARC. It consisted of a monitor, a graphical interface, a mouse, and an Ethernet card for networking. Apple Computer brought about the Macintosh personal computer January 24 1984.

The fifth generation computers are under development. They are going to be based on principles of artificial intelligence and natural language recognition and will be based on all aspects of multimedia animation. Developers are aiming at computers capable of organizing themselves. The evolution of computers still continues.

1.2 Problem statement

“3D computer animation is a growth area for the foreseeable future and is recognized by the film and games industries to be a core element of their most successful products. There is a constant increasing demand for professional computer animators of a high caliber; however there is a lack of highly skilled, professionally-trained animators”

Human society lives through an interaction between its entities and their environments, and in our daily lives, we interact with other people and objects to perform a variety of actions that are important to us. Thus, computers and computerized machines have become an important element in our society, and they influence the way we communicate, the way we perform actions and the way that we interact with our environment. Thus the need for computer animation arises. As the world evolves, so will technology evolve, for example, advertisements on television work with animation, as well as education nowadays. So, with the high demand for animation, it is important for the lay man to realize that it is also important to know what computer animation is all about and have an idea of how to go about computer animation.

By the end of this project, one should be able to understand what computer animation is about, what its importance is in the world today, as well as the different methods and techniques used in designing animations.

1.3 Aim and Objectives

The general aim would be to study computer animation methods for creating computer generated animated characters which perform human-like actions as well as to study the

hardware and software used in conjunction with the different techniques and methods used in computer animation to produce life-like gestures and actions.

1.3.1 Specific Objectives

- i) To design a prototype that will use computer animations during the learning process.
- ii) To test the prototype that has been created.

1.4 Justification of the study

The major importance of the study was to study computer animation methods for creating computer generated animated characters which realistically perform human-like action, hence coming to the conclusion of what computer animation is about as a whole, its history and where it is of importance in today's world.

This study would bridge the gap between computer professionals today and their implication that computer animation is something out of this world which cannot be done by any person, and that there are many fields in which computer animation can be used, for example, in the learning fields, taking this study as an example, as well as other fields like film industry, software packages, and so on.

Most of us are aware of 3D animation features and techniques. We also know that they are widely employed in entertainment sectors in different ways. 3D animation in general refers to the art of creating and modifying the images. The entry of 3D animation has brought a sort of

revolution in past decades in the animation sector. Its importance and popularity cannot be ignored. There is hardly any area where it has not played its part. With 3D animation, you can expect perfect images and at a record time. The impact created is simply outstanding. The illustrations and pictures created cannot be described in words. The final products can generally be viewed from different perspectives. It is also an excellent tool to communicate fast and present complex ideas into virtual reality.

Of late, many companies have left their footmarks in the 3D animation industry. Each of these companies has their own software products in the market highlighting their unique features. Computer animation is the secret weapon of a select group of smart manufacturers and engineering firms who use it to win major contracts for their companies against tough international competitors. Industrial manufacturing in the western world is under siege for a variety of reasons, ranging from cheap labour to currency fluctuations to political interference. Therefore it is more important than ever to make full use of technologies like 3D computer animation to market products, designs, and systems. One of those advantages, overlooked by many industrial manufacturers, is the robust development of computer animation.

The future of 3D animation is bright. Constant innovations and cutting edge technologies have ensured that the viewing of pictures, sketches, films and so on will never be the same again. One area where 3D animation is yet to make a mark is in photorealistic animation of humans.

1.5 Scope of the study

This Computer Animation project investigated new applications of computer animation in a multimedia Web environment in terms of both content creation and consumption. Following the trajectory of the price-performance curve, computer animation projects can increasingly migrate to more widely available Intel platforms. This project aided to explain the benefits of

production and delivery of professional computer-generated animation designed to meet exacting quality and specifications of the advertising and entertainment industries.

This project looked at the achievements that computer animation has brought about to the world today, that is, educational, political, industrial or entertainment and how it would be able to evolve in the years to come.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

The literature review looked at different authors, scholars and lecturers from institutes who gave their point of view of what they thought about Computer Animation, Multimedia with respect to computers, and 3-Dimensional as well as 2-Dimensional graphics.

The review handled all aspects of animation, namely, the definitions of multimedia, computer animation as well as computer graphics. It also included a brief description of what they are as well as brief examples.

The review also included the types of hardware and software that is usually used as well as pictorial examples to give you a better idea of what computer animation is all about.

2.1 2D and 3D Animation

According to Jessica K. Hodgins, James F. O'Brien, and Robert E. Bodenheimer of the College of Computing and Graphics, Visualization, and Usability Center, Georgia Institute of Technology, Atlanta, state that Animation is the production of consecutive images, which, when displayed, convey a feeling of motion. Animated images are almost magical in their ability to capture our imagination.

Traditionally, animation was created by drawing images of the characters for each frame in the action. At the start of the production, the animator is given storyboards, which are sketches

depicting the sequence of major actions and illustrating the expressions of the characters. The animator also works from a specific soundtrack, which determines the timing of the piece. Regardless of the medium, the challenge for the animator is to create images that impart expressiveness and life to the character. The most basic computer animation tools assist the process of traditional animation by automatically generating some of the frames of animation. Animation tools have also been developed to composite together multiple layers of a scene in much the same way that layers of cells are used in hand animation. Other more powerful techniques make use of algorithms that render an image from a geometric description of the scene. These techniques change the task from drawing sequences of images to using computer tools to effectively specify how images should change over time.

In addition to providing tools that give the animator new capabilities, the computer also creates new applications for animation. Computer animations can be generated in real-time for use in video games, marketing, education, advertising and so on.

A wide variety of techniques are used in the process of creating a complex computer animation such as Disney and Pixar's Toy Story (www.toystory.com). These techniques can be grouped into two main classes: two dimensional (2D) and three dimensional (3D). Although there is some overlap between the two classes, 2D techniques tend to focus on image manipulation while 3D techniques usually build virtual worlds in which characters and objects move and interact.

2.1.1 Two-dimensional Animation(2D)

Two-dimensional (2D) animation techniques contribute a great deal to computer animation by providing the tools used for sprite-based animation, blending or morphing between images,

embedding graphical objects in video footage, or creating abstract patterns from mathematical equations. The impact of 2D techniques can be as spectacular as the addition of the alien character E.T. to a shot of the moon or as subtle as the erasing of lines around matte boxes for the Fighters in Star Wars. The most common form of 2D animation is sprite animation. A sprite is a bitmap image or set of images that are composited over a background, producing the illusion of motion. They are usually small with respect to the size of the screen. For example, to animate a rabbit hopping across a meadow, the animator would create a sequence of images showing poses of the rabbit hopping. This sequence of images would then be composited of one image per frame onto a background image of the meadow. Sprite-based animation can be done extremely quickly with current graphics hardware, and thus many elements of the scene can be moving simultaneously.

Morphing refers to animations where an image or model of one object is metamorphosed into another. In Michael Jackson's music video *Black or White*, the animators at Pacific Data Images (www.pdi.com) created morphs between people with strikingly different facial characteristics. Morphing is remarkable because it provides a startling yet convincing transformation of one image into another. Unfortunately, morphing is labor intensive because the key elements of each image must be specified by hand, although automatic feature detection is an area of active research.

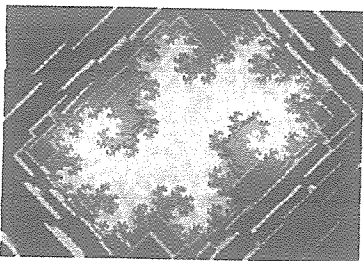


Figure 1: Image created from fractal equations.

The abstract image in this figure was created by using a type of complex mathematical equation known as a fractal. Image courtesy of Daryl H. Hepting.

Mathematical equations are often used to create abstract motion sequences. When the values of the mathematical functions are mapped to color values and varied with time, the motion of the underlying structures can be quite beautiful. Morphing and the generation of abstract images from mathematical equations can be generalized for use in 3D. All of these 2D techniques can be used either on their own to create an animation or as a post-processing step to enhance images generated using other techniques.

2.1.2 Three-dimensional Animation(3D)

Three-dimensional animation involves constructing a virtual world in which characters and objects move and interact. The animator must model, animate, and render the 3D scene. Briefly stated, modeling involves describing the elements of a scene and placing them appropriately. Animating specifies how the objects should move in the 3D world. Rendering converts the description of the objects and their motion into images. Modeling and rendering are, for the most part, independent of their role in the animation process but a few necessary modifications are described below.

To animate motion, the user needs both a static description of an object and information about how that object moves. One common way to specify this additional information is to use an articulated model such as the one shown in Figure 2. An articulated model is a collection of objects connected together by joints in a hierarchical, tree-like structure. The location of an object is determined by the location of the objects above it in the hierarchy. For example, the motion of the elbow joint in a human model will affect not only the position of the lower arm but also the position of the hand and fingers. The object at the top of the hierarchy, or the root of the tree, can be moved arbitrarily to control the position and orientation of the entire model.

Water, hair, clothing, etc, are among the systems that have been successfully modeled as deformable objects.



Figure 2: An articulated model of a human male:

The structure of the joint hierarchy is shown on the left. The graphical model used for rendering is shown on the right. Image courtesy of the Graphics, Visualization and Usability Center, Georgia Institute of Technology.

Systems that are modeled well by particle systems include water spray, smoke, and even flocks of birds.



Figure 3: A diver entering pool:

These images show the combined use of an articulated model, a deformable model, and a particle system. Images courtesy of the Graphics, Visualization and Usability center, Georgia Institute of Technology.

Thus, it comes to the conclusion that it is very interesting to use 2D and 3D animation to show different kind of simulations and images, making it a very creative field of study. It also comes to show that in the near future, we would be able to create images by the swift move of the human hand, with the help of different multimedia. The world is evolving, and so should we.

2.2 Multimedia

According to *Multimedia Making it Work*, by Tay Vaughan. Osborne McGraw Hill, 1993 he stated that Multimedia was the bringing together of text, graphics, animation, video, audio and

interactivity within the confines of a computer screen. Long touted as the future revolution in computing, multimedia applications were, until the mid-90s, uncommon due to the expensive hardware required. Nearly all PCs are capable of displaying video, though the resolution available depends on the power of the computer's video adapter and CPU.

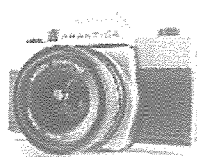
Multimedia includes a combination of text, audio, still images, animation, video, and interactivity content forms. Multimedia is usually recorded and played, displayed or accessed by information content processing devices, such as computerized and electronic devices, but can also be part of a live performance. Multimedia also describes electronic media devices used to store and experience multimedia content.

Examples of individual content forms combined in multimedia:

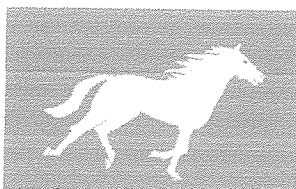
The above information is about multimedia and computer animation with respect to the different media available to support them respectively.



Audio



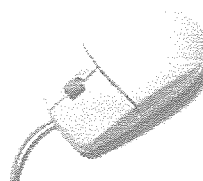
Still Images



Animation



Video Footage



Interactivity

Multimedia may be broadly divided into linear and non-linear categories. Linear active content progresses without any navigation control for the viewer such as a cinema presentation. Non-

linear content offers user interactivity to control progress as used with a computer game or used in self-paced computer based training. Hypermedia is an example of non-linear content. Multimedia presentations can be live or recorded. A recorded presentation may allow interactivity via a navigation system. A live multimedia presentation may allow interactivity via an interaction with the presenter or performer. Multimedia presentations may be viewed in person on stage, projected, transmitted, or played locally with a media player. A broadcast may be a live or recorded multimedia presentation. Broadcasts and recordings can be either analog or digital electronic media technology. Digital online multimedia may be downloaded or streamed. Streaming multimedia may be live or on-demand. Multimedia games and simulations may be used in a physical environment with special effects, with multiple users in an online network, or locally with an offline computer, game system, or simulator.

Enhanced levels of interactivity are made possible by combining multiple forms of media content. Online multimedia is increasingly becoming object-oriented and data-driven, enabling applications with collaborative end-user innovation and personalization on multiple forms of content over time. Examples of these range from multiple forms of content on Web sites like photo galleries with both images (pictures) and title (text) user-updated, to simulations whose co-efficient events, illustrations, animations or videos are modifiable, allowing the multimedia "experience" to be altered without reprogramming. In addition to seeing and hearing, Haptic technology enables virtual objects to be felt. Emerging technology involving illusions of taste and smell may also enhance the multimedia experience.



Virtual reality uses multimedia content. Applications and delivery platforms of multimedia are virtually limitless.

VVO Multimedia-Terminal in Dresden
(Germany)



WTC

Multimedia finds its application in various areas including, but not limited to, advertisements, art, education, entertainment, engineering, medicine, mathematics, business, scientific research and spatial temporal applications. Much of the electronic old and new media used by commercial artists is multimedia. In addition, multimedia is heavily used in the entertainment industry, especially to develop special effects in movies and animations. Multimedia games are a popular pastime and are software programs available either as CD-ROMs or online. Some video games also use multimedia features.

In education, multimedia is used to produce computer-based training courses (popularly called CBTs) and reference books like encyclopedia and almanacs. A CBT lets the user go through a series of presentations, text about a particular topic, and associated illustrations in various information formats. Edutainment is an informal term used to describe combining education with entertainment, especially multimedia entertainment.

Software engineers may use multimedia in Computer Simulations for anything from entertainment to training such as military or industrial training. Multimedia for software interfaces are often done as a collaboration between creative professionals and software engineers.

In the Industrial sector, multimedia is used as a way to help present information to shareholders, superiors and coworkers. Multimedia is also helpful for providing employee

training, advertising and selling products all over the world via virtually unlimited web-based technologies.

In mathematical and scientific research, multimedia is mainly used for modeling and simulation. For example, a scientist can look at a molecular model of a particular substance and manipulate it to arrive at a new substance. Representative research can be found in journals such as the Journal of Multimedia.

In Medicine, doctors can get trained by looking at a virtual surgery or they can simulate how the human body is affected by diseases spread by viruses and bacteria and then develop techniques to prevent it. Tay Vaughan does conclude to say that there still lies a lot ahead in the future, and technology cannot evolve without multimedia.

2.3 Computer Animation.

According to Parent R and Hodgins J.K from Ohio State University, they stated that it would not be an exaggeration to say that animation can bring the duldest of the features to life. It has the magic of injecting energy and emotions into the most seemingly inanimate objects. Over the years the advancement of technology has made animation, a very attractive and much sought after component of multimedia.

Animating is moving something that cannot move on its own. Animation adds to graphics the dimensions of time, which tremendously increase the potential of transmitting the desired information. In order to animate something the animator has to be able to specify directly or indirectly how the 'thing' has to move through time and space.

It is interesting to note that the concept of animation has been a focus of study and research for a long time. Resources indicate that as far back as in 1824 Peter Roget presented a paper titled

"The persistence of vision with regard to moving objects" to the British Royal Society. Later in 1887 famous scientist Thomas Edison started his research into motion pictures. Two years later he announced his kinetoscope which projected a 50ft length of film in approximately 13 seconds.

Winsor McCay is considered by many to have produced the first popular animation. He used rice paper to draw images each one slightly different from the other. Later John Bray (1910) used translucent cels (short for celluloid) in compositing multiple layers of drawings into a final image as well as the use of grey scale (as opposed to black and white) drawings. Later in 1915 Fleischer patented 'rotoscoping.' Rotoscoping is drawing images on cells by tracing over previously recorded live action.

Many such innovative ideas were put to test before Walt Disney burst onto the scene with his film "Alice in Wonderland" in which live action was combined with cartoon characters. Later in 1928 Walt Disney created the first cartoon with synchronized sound called "Mickey Mouse." Some of the innovative techniques used by Disney were the use of storyboard to review the story, the use of pencil sketches to review motion and the multi-plane camera stand. Multi-plane camera stand is a powerful technique, which allows a sort of parallax effect, moving the backgrounds at different rates as the observer pans across an environment to create an illusion of depth and zooming. (Parent 1998). In 1964, the scene of animation shifted to computers for the first time when Ken Knowlton, working at Bell Laboratories started developing computing techniques for producing animated movies.

The University of Utah is said to be amongst the earlier pioneers in computer graphics. In the late sixties Chuck Csuri of The Ohio State University did some initiatory work in computer animation as a member of the Computer Graphics Research Group. In the early 80s, the research group became the Advanced Computing Center for Art and Design and continues to produce computer animation. Since then the scene of computer animation has remained

dynamic with new ideas and path-breaking innovations. Some of the current activity centers include; University of Toronto's computer Science Department, UC San Diego's Department of Computer Science and Engineering University of North Carolina's Computer Science Department and MIT's Media Lab and MIT's Lab for Computer Science.

2.3.1 Computer Animation Techniques

As is evident from the history, animators have used and invented a variety of different animation techniques. Traditionally most of the animation was done by hand. All the frames in an animation had to be drawn by hand. Since each second of animation requires 24 frames (film), the amount of work required to create even the shortest of movies, can be tremendous. Some of the traditionally used methods are described below.

- **Key Frames**

In this technique a storyboard is laid out and then the artists draw the major frames of the animation. These major frames are in which a lot of changes take place. They are the key points of animation. Later a bunch of artists draw in the frames in between. This technique is, of course, very time and effort intensive.

- **Cel Animation:**

In this technique each character is drawn on a separate piece of opaque paper. Then, at the time of shooting animation the different characters are overlaid on top of the background in each frame. This is relatively a less tedious process, as the artists do not have to draw in entire frames but just the parts that need to change such as individual character.

- **Rota scoping:**

Rota scoping is a technique where images are copied from a moving video into an animation. The animator draws the motion and shape of the object by referring to the video as opposed to imagining in his head. With the help of the rot scoping one can animate some complex scenes that would be hard to visualize otherwise. The disadvantage is that one will have to hunt for the exact video that one wants to animate.

Broadly, the computer animation falls into three basic categories: key framing, motion capture, and simulation.

- **Key framing**

The significance of the term "Key framing" can be traced back to traditional hand animation technique. Key framing requires that the animator specify critical or key positions for the objects. The computer then automatically fills in the missing frames by smoothly interpolating between those positions. The characters for a movie called Toy Story made in 1995 were designed through key frame animation. It's believed that each character had as many as 700 controls. Key framing requires that the animator has a well thought out plan of how the moving objects are going to behave over time as well as the talent to express that information through key framed information. The continued popularity of key framing is a function of the degree of control that it allows the animator to exercise over the subtle details of the motion.

- **Motion Capture**

Another technique is Motion Capture, in which magnetic or vision-based sensors record the actions of a human or animal object in three dimensions. A computer then uses these data to animate the object. This technology has enabled a number of famous athletes to supply the actions for characters in sports video games. Motion capture is pretty popular with the animators mainly because some of the commonplace human actions can be captured with

relative ease. However, there can be serious discrepancies between the shapes or dimensions of the subject and the graphical character and this may lead to problems of exact execution.

- **Simulation**

Unlike key framing and motion picture, simulation uses the laws of physics to generate motion of figures and other objects. Virtual humans are usually represented as a collection of rigid body parts. These models though physically plausible are only an approximation of the human body. With more research and complex models the simulations are becoming increasingly life like. Simulations can be easily used to produce slightly different sequences while maintaining physical realism while in other animations like key framing or motion capture a mere speeding up or slowing down the playback can spoil the naturalness of motion. Secondly real-time simulations allow a higher degree of interactivity where the real person can maneuver the actions of the simulate character. In contrast the applications based on key framing and motion select and modify motions form a pre-computed library of motions. One drawback that simulation suffers from is the expertise and time required to handcraft the appropriate controls systems.

2.3.2 Computer Animation Hardware and Software

Hardware and software are two of the major factors that determine the quality of computer animation that is produced. As both of these components work in conjunction with each other it is important to make the right choice for a product that is of lasting quality and accuracy.

- **Hardware**

Hardware comes in many shapes, sizes, and capabilities. Some hardware is specialized to do only certain tasks while other hardware are equipped for a variety of things. Some of the commonly used hardware is:

➤ **Silicon Graphics Inc.(SGI)**

The SGI platform is one of the most widely used platforms for quality computer animation productions. SGI computers operate using the wide spread UNIX system. Produced by Silicon Graphics these computers are extremely fast and produce excellent results. They come in a variety of types, ranging from the general purpose Indy to high power Indigo Extreme that is used for animations. Onyx is another type, which is suited to the complex calculations involved in rendering. Some of the software like Wavefront, Alias, and SoftImage are run on SGI's.

➤ **PC's**

PC's are very versatile machines combining flexibility and power. PC's have proven to be very useful for small companies and businesses as platforms to do computer animation. Applications such as 3DStudio and Animator Studio are used on PC's to make animations.

➤ **Macintosh**

Mac's were originally designed for graphic and desktop publishing and hence are pretty useful platforms for producing computer graphics and animation software. Some of these applications that work well on Mac's are Adobe Products like; Photoshop and Premiere and Strata with Strata Studio Pro.

• **Software**

Some of the popular software packages used by the companies, schools and individuals all around the globe include some of the following;

➤ **3Dstudio Max**

The successor to 3DStudio 3.0, 3DStudio Max runs under Windows NT as well as Windows XP. It is entirely object-oriented, featuring new improvements, such as volumetric lighting, space warps, and all new redesigned interfaces.

➤ **LightWave3D**

Light Wave 3D is another high end PC 3D computer software package. Originally developed for the Amiga platform, it's considered the best 3D product for the PC. This software has been used for quite a few television productions such as Babylon 5 and Sea Quest.

➤ **Adobe Premiere**

Adobe Premiere is a tool that is used to composite Digitized video, stills, and applies a variety of transitions and special effects. Adobe Premiere runs both on Macintoshes and PC Windows.

➤ **Animator Studio**

Animator Studio is a cell animation program from AutoDesk. Animator runs on Windows. It has a multitude of features that minimize the animation creation time.

➤ **Elastic Reality**

This is one of the top of the line programs used for morphing. Elastic Reality runs on Mac's and SGI's. One of the distinctive features of Elastic Reality is that it uses splines as opposed to points to define the morphing area. Elastic Reality allows to morph video as well as still images.

➤ **SoftImage**

SoftImage is one of the three top most computer animation software packages. SoftImage is used in many top production studios around the country and around the world.

➤ **Director**

Born in the world of CD-Rom creation and developed in-house by Macromedia, Director is treated as one of the grandfathers of multimedia. Director was originally VideoWorks

Interactive, the first in a new breed of multimedia authoring applications designed for the Apple Macintosh back in the 1980s. It was later released for DOS/Windows in 1994. Since 1995, the Director with its Shockwave Player has become all-platform. With its flexible programming language, Lingo, Director continues to be the flagship product of Multimedia.

➤ **Adobe Flash Animation**

A Flash animation or Flash cartoon is an animated film which is created using Adobe Flash animation software and often distributed in the .swf file format. It can be created in Flash or with other programs capable of writing .swf files. The term Flash animation not only refers to the file format but to a certain kind of movement and visual style which, in many circles, is seen as simplistic or unpolished. However, with dozens of Flash animated television series, countless more Flash animated television commercials, and award-winning online shorts in circulation, Flash animation is enjoying a renaissance.

2.4 2D and 3D Computer Graphics

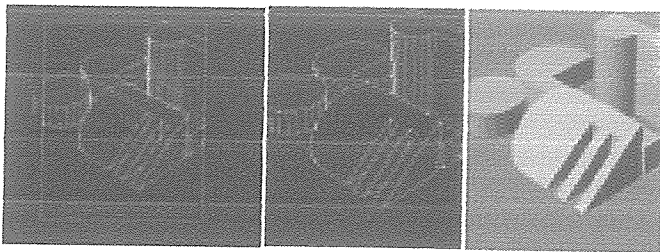
According to the Cornell University Program of Computer Graphics, the term computer graphics includes almost everything on computers that is not text or sound. Today almost every computer can do some graphics, and people have even come to expect to control their computer through icons and pictures rather than just by typing.

“Here in our lab at the Program of Computer Graphics, we think of computer graphics as drawing pictures on computers, also called *rendering*.” The pictures can be photographs, drawings, movies, or simulations -- pictures of things which do not yet exist and maybe could

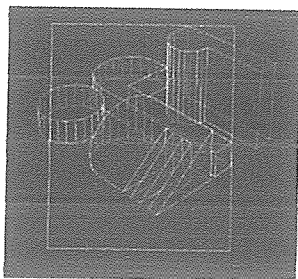
never exist. Or they may be pictures from places one cannot see directly, such as medical images from inside your body.

They stated that they spend much of their time improving the way computer pictures can simulate real world scenes. Images on computers should not just look more realistic, but also to be more realistic in their colors, the way objects and rooms are lighted, and the way different materials appear. They call this work "realistic image synthesis", and the following series of pictures will show some of our techniques in stages from very simple pictures through very realistic ones.

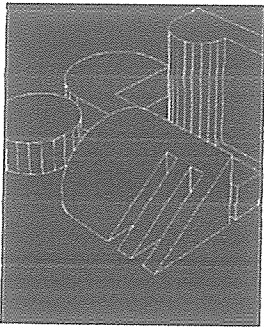
Object Rendering



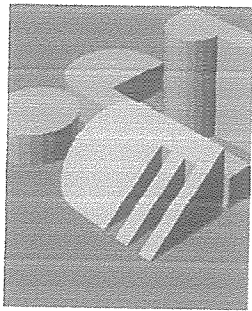
Computer graphics uses several simple object rendering techniques to make models appear three-dimensional.



This first image shows how a set of geometric objects can be displayed, or rendered, on the computer. A model of the object is created to store the locations, or coordinates, of corner points. Each side of an object is treated as a flat surface bordered by three or more outlined edges. The computer is used to calculate how each object appears in perspective view, and then to draw the outlines on the screen. This image is drawn in what is called wireframe mode, as if the object had been assembled as a framework of straight wires.

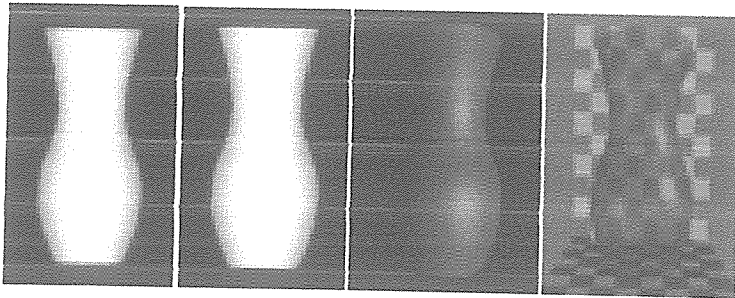


By a process called hidden line removal, only the portions of the edges visible to the viewer are drawn. The effect simplifies understanding complex scenes by eliminating overlapping lines, and makes objects look solid.

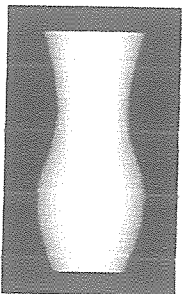


Using shading on the object surfaces visible to the viewer further improves our ability to interpret their shapes and positions.

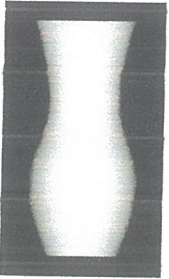
Shading



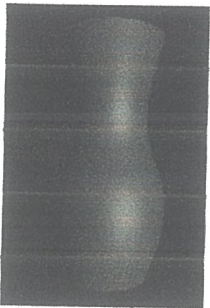
Shading techniques extend the realistic appearance of objects and introduce features such as transparency and textures.



This vase has been modeled as a symmetrical pattern of vertically-oriented surfaces - tiny flat patches which approximate the round shape of the vase. In this image, each tiny surface is shaded separately with a different gray value based on its orientation to the light source.



By introducing a technique called Gouraud shading, we can smooth out the appearance of the vase and hide the individual surfaces from view. The shading is varied on each surface in proportion to values calculated at the edges and from neighboring surfaces.



Phong shading improves the apparent realism of the rendering still further by introducing highlights. The way light reflects from real surfaces depends on how shiny the surface is and on the angle you are looking from. Most surfaces are not shiny, but have a duller or "matte" or "diffuse" appearance.

The surface of this vase is just shiny enough to reflect some light directly to the viewer at certain angles, but around the sides the appearance is much duller. Light hitting the vase at flatter angles is scattered more evenly in all directions.



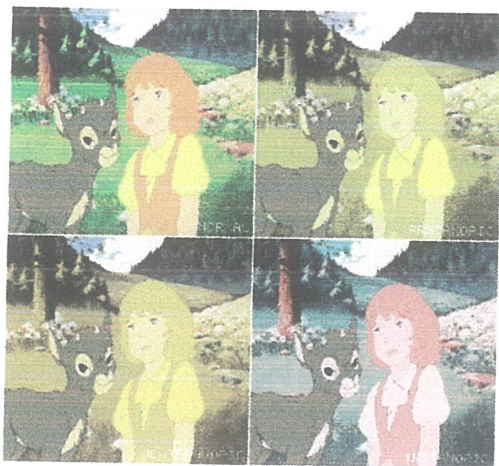
In this last image the shading technique has been extended to let some light pass through the vase - for transparency. Note that the reflection highlights are still there, even if they are less visible. These shading techniques (and more) have all been incorporated into the generalized rendering technique called ray tracing.



Color

Computers don't create color exactly the way we see it. Computers typically display color in three

components - red, green, and blue. When combined, these three colors make the full-color image seen in the upper left of this image.



By controlling color display, we can simulate on the computer different kinds of color blindness. Computers don't create color exactly the way we see it. In general, computer graphics is the computer-based generation of digital images mostly from two-

dimensional models (such as 2D geometric models, text, and digital images) and by techniques specific to them.

2.4.1 2D Computer Graphics

2D computer graphics are mainly used in applications that were originally developed upon traditional printing and drawing technologies, such as typography, cartography, technical drawing, advertising, etc.. In those applications, the two-dimensional image is not just a representation of a real-world object, but an independent artifact with added semantic value; two-dimensional models are therefore preferred, because they give more direct control of the image than 3D computer graphics (whose approach is more akin to photography than to typography).

2D computer graphics started in the 1950s, based on vector graphics devices. These were largely supplanted by raster-based devices in the following decades. The PostScript language and the X Window System protocol were landmark developments in the field.

2D graphics are very important in the control peripherals such as printers, plotters, sheet cutting machines, etc.. With the resurgence of 2D animation and its booming popularity, software like Toonz Harlequin, CelAction, Anime Studio, Toon Boom Animation, Animaker and Adobe Flash have emerged as the new tools of choice for both amateur and professional animators. Additional software is being developed to aid and speed up the process of digital 2D animation, specifically in the area of automatic coloring and in-betweening. One such example is Cacani, developed by Singapore's NTU.

2.4.2 3D Computer Graphics

3D computer graphics (in contrast to 2D computer graphics) are graphics that use a three-dimensional representation of geometric data that is stored in the computer for the purposes of performing calculations and rendering 2D images. Such images may be for later display or for real-time viewing.

Despite these differences, 3D computer graphics rely on many of the same algorithms as 2D computer vector graphics in the wire-frame model and 2D computer raster graphics in the final rendered display. In computer graphics software, the distinction between 2D and 3D is occasionally blurred; 2D applications may use 3D techniques to achieve effects such as lighting, and primarily 3D may use 2D rendering techniques.

3D computer graphics are often referred to as 3D models. Apart from the rendered graphic, the model is contained within the graphical data file. A 3D model is the mathematical representation of any three-dimensional object (either inanimate or living). A model is not

technically a graphic until it is visually displayed. Due to 3D printing, 3D models are not confined to virtual space. A model can be displayed visually as a two-dimensional image through a process called 3D rendering, or used in non-graphical computer simulations and calculations.

The process of creating 3D computer graphics can be sequentially divided into three basic phases: **3D modeling** which describes the process of forming the shape of an object, **layout** and **animation** which describes the motion and placement of objects within a scene, and **3D rendering** which produces an image of an object. Thus, as a conclusion, it can be seen that computer graphics depend on 2D as well as 3D as its backbone.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

Computer Animation was a very wide topic to research on since it consisted of many sub branches. However, the goal with this project was not to go so in depth and into details, but to outline an overview of what computer animation is about and what an individual is required to know before he/she can venture into that branch of science.

As history can put it, computer animation was introduced way back in the 1960's with short films. the internet was mainly used as a research tool, mainly reading through EBooks (books that are actually published, but can be viewed/read online) as well as reviews written by some scholars along with examples gave an idea of what computer animation is, and what multimedia as well as 3D and 2D computer graphics plays as an important role in being able to design a prototype based on animation.

There are many views on computer animation in the world today, and these views would prove that it is not so difficult to evolve with technology, let alone the fact that this project was costly since some of the software had to be paid for before they could be downloaded.

Many researchers have researched about computer animation and its importance today, and it can be noted that all of them agree that computer animation plays a very important role in computers today and in the future to come.

The researcher was able to look through some modules online that had animated modules/images, that pictured what computer animation is, and how it works, and also did include a few examples in the literature review.

3.1 Data Collection Methods

A simple prototype was designed, using 3DMax, artoonix, Fcc, FotoMorph6, SDAV6, to mention but a few. The prototype is an outline of a wasp flying in mid air.

In order to be able to produce the prototype for this project, it was important to be able to think of many ideas that would fit an animation, as well as be able to choose the appropriate one that would fit that specific animated sequence. There was also the need to look for a specific topic which would be able to design an experimental animation that could educate on what that topic was about.

With regards to the hardware used, multimedia like still cameras, text, audio as well as other computer peripherals like mouse, flash disks, DVD-ROM were used. All the software was downloaded from the internet, and research was carried out on scholars who had written reviews as well as authors who had published many books. All the programs downloaded were run on a personal computer and a prototype was executed that would showcase exactly how computer animation works.

3.2 Definition of Prototype used

A prototype was created using 3D max, artoonix and fotomorph. The prototype was a short one, of about 3 seconds, but it showcased how an animal could be created and how it could be given the freedom of movement. The prototype showcased a wasp flying towards the screen.

CHAPTER FOUR: IMPLEMENTATION

4.1 Software Requirements

The main software requirements were the operating system on the personal computer to be Windows XP, since most of the animation programs run on that operating system. Some of the software programs that were needed to design the prototype were 3D Max that supported volumetric lighting, space warps, and all new animation movements. Animator Studio was also a software used that was needed to design the animation, though it was used very minimally. Flash was also another software used as it also assisted in creating the animation.

Artoonix was another type of software used, and this software basically used the principle where frames were created, and each frame showed a sequence of the animation. Each frame was timed, and delayed so that there was a flow in the sequence of the frame.

Adobe Flash CS4 was another software that was extensively used. Its main purpose was to design the figure of the wasp itself and animate the wings of the wasp to move.

4.2 Hardware Requirements

In order to design the prototype, there was need for specific hardware requirements. One of the main hardware requirements was a personal computer, in this case, an Intel Pentium IV

computer. Along with the personal computer were other requirements like a DVD-ROM (digital video disc-read only memory), and flash disk on which to save some of the sample sequences. Other hardware requirements were the hardware that interacted with the personal computer like the mouse, keyboard, and printer. There was need for a modem that would plug in on the computer's USB and this modem was used as an internet interface. A simcard for MTN Uganda as the service provider was inserted into the modem and thus became the provider of the internet.

The personal computer had Windows XP as its operating system, hence making it a fast powerful computer with an operating system that would support most of the animation programs.

4.3 Prototype

The prototype designed was a wasp flying against a blue background. The sequence of the animation lasted about 3 seconds. With 3D max software, the wasp was created such that it would flap its wings continuously. Using this software, a plane for the wasp's wing was created by adjusting the *Pivot Point* of the plane from *Hierarch*→*Affect Pivot* only.

The texture and colour of the wings were applied using opacity mapping. The wasp's wing had to be mirrored from tools→*mirror* so that it would have two identical wings instead of one. The body of the wasp was then created using *lathe*.

To animate the wasp the *Auto Key* had to be enabled, and the *time slider* had to be changed to 10 frames whilst rotating the left wing slightly downwards.

The animation had to be looped so as for the wasp to have wings that move simultaneously like a flying wasp. The *Curve Editor* was enabled from *Graph editors*→*Curve Editor*. All keys were

selected from the graph and from the button *Parameter Curve Out-of-range-type*; the two buttons *Ping Pong* were enabled.

The '*Y*' *Rotation Parameter* was selected for each wing that was created. And the *Arrow* marks in the middle of the panel were selected on the right and left panels. After clicking the arrow marks, click *connect*, and once connect was selected, the wasp was flapping its wings.

Adobe Flash software was also used to modify the animation that was created using the 3D Max animation software. The file that was created and saved as a PNG file, and hence had to be imported to Adobe Flash by choosing File→Import→Import to Library. There are two import options, either one can import to the Stage or the Library. The Stage is the main animation area for the movie being created with Flash. The Library is a bank of assets or graphics that are part of the project but not necessarily on the Stage. After importing to the library, when you click OK, the wasp sequence is imported to Flash. To see the imported file, click the Library tab. When the files are imported, the design is automatically converted to a graphic called *Go.png*.

To position the graphic on the Stage, drag and drop the *Go.png* asset from the Library panel to the Stage. Position the object in the upper left corner. In order to make the animation that would move the wasp from the upper left corner to the lower right corner, the object needed to be *tweened*. When using the *tween* option, one needs to specify in Flash where on the Stage the object in the animation should start and end. Flash will automatically fill in the frames between the start and end points that are defined. A motion *tween* needed to be created, and to do this, right-click the object in Flash and select *Create Motion Tween*.

The Timeline represents how the animation looks and behaves from the time it starts moving until it arrives at its destination. The Timeline is broken up into frames, or individual points in time, that display the animation. In the Timeline, the red indicator is the *playhead*, which shows what frame

you are currently displaying in the Flash application. Now at the end of the *tween*, the Go graphic needs to be at the lower right corner of the Stage. To change its location, simply drag and drop the graphic to the desired location. Move the Go symbol to the lower right corner of the stage.

After the object is dropped, a line can be noticed with dots appearing from the graphic's starting location (the origin) to the final location (the destination). That line is called the motion path.

Now that the destination has been set, click and drag the playhead to show the animation on the Timeline. Click and drag the playhead to frame 1, and then press Return to play the animation in Flash. The object moved from the upper left to the lower right. It can be previewed in Flash Player.

To preview in Flash Player, Choose Control > Test Movie from the main Flash menu. A new window appears that displays the animation. The duration is the amount of time that the animation runs. The duration of the *tween* is 24 frames. With a default frame rate of 24 frames per second, the animation would run for one second. To change the duration, simply drag the end of the *tween* to either lengthen or shorten the duration. For the animation to play for two seconds at a frame rate of 24 frames per second, it was lengthened to 48 frames by moving the mouse pointer to the end of the *tween* in the Timeline. When the mouse icon changed to a left-right arrow, click and drag the *tween* to the right to extend it to frame 48. Once the mouse button is left, the animation updated itself to represent the new desired duration. Thus the prototype was designed to last for two seconds.

CHAPTER FIVE: CONCLUSION

5.1 Recommendations

The researcher would highly recommend that in order to design an animation, the first piece of hardware that would be required would be to have a personal computer which is an Intel Pentium IV with a high processing speed. One would be required to have the internet as a research field in order to download the various types of software that assist in designing an animation. Depending on the type of animations to be created, there would be need for some types of multimedia to be used, like text, still images if files were to be imported, audio to add to the animations, and many more. One of the main requirements of animation is creativity and patience. One would need to have some kind of creativity in order to be able to build ideas that would be interesting, and along with that would be the patience to sit and create these ideas step by step, frame by frame until the desired result is achieved.

One would require to have a general knowledge of most of the software that play an important role in the animation, however this can be achieved by looking through the help files of the software and help tutorials in order to understand how to use the software. The researcher would be astonished to realize that it is not about writing codes and algorithms to design animations, because most of the programs that assist in animation are already designed to assist such that the software just provides the animator with basic options on how to manipulate the animation without getting into the details about how those options are coded.

5.2 Conclusion

It can be therefore concluded that technology is evolving, and so is the world. Now that technology is evolving, science is reaching limits that it has never reached before, bringing about the need for computer graphics and animation in all sectors of life, for example in education, military, business, engineering, entertainment, advertising, etc.

Research on graphics shows that it can also be used in the medicine sector, for example when scientists want to perform actions like cloning, and so on.

It can also be noted that nowadays, there is a high demand for computer animators in most walks of life, though it is difficult to get them because the majority of the population that take on courses in the computer field over see this section of computer science, sighting it as a sector that is not marketable and that is really difficult. Thus, nothing is impossible to learn, and that it is good to have an idea of these kinds of branches of computers in order to be a step ahead of other scholars.

To conclude to the above, computer animation is predicted to be something that will be a venture where a huge amount of money can be invested and huge returns made.

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