

Graphic Synchronization with Audio WAV Files

by

Farhanah binti Othman

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Information Technology)

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CERTIFICATION OF APPROVAL

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Approved by,

(Dr. Abas bin Md. Said)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

July 2004

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

FARHANAH BINTI OTHMAN

ABSTRACT

This project deals with matter regarding to the application that combines the computer graphic and the audio elements. The objective of this project is to create an application that synchronizes the movement of the graphic with the audio tunes. The emphasis is placed on the aims at recognizing specific tunes through the graphic movements. The application is meant to assist the users in identifying and distinguishing the variety tunes in an audio file specifically the WAV file format. The main features of the application are that 1) it plays audio with the WAV file format and 2) it displays a computer graphic 'stickman' that moves according to the tunes. The scope of study is the process of how tune recognition works and how it can be synchronized with the graphic motion. It basically focuses on the graphic visualization of an audio. For this project, I basically follow the waterfall methodology but I have adjusted the phases in it to appropriately suit my project tasks which consist of six (6) main processes. The finding will be more on the issues of how 1) to understand the underlying concepts of integrating graphic and audio in single application, 2) to extract the WAV audio file into specific tunes and 3) to synchronize the graphic element with the audio beat or tune. Basically, by using the graphic-audio combination, the project will be able to visualize and differentiate the tunes specifically and accordingly.

ACKNOWLEDGEMENT

In the name of ALLAH, most gracious, most merciful.

First and foremost, I thank ALLAH SWT for the guidance and wisdom to this far in this report presentation. With His mercy alone, I successfully completed the project with prosperous.

Here, I would like to thank my supervisor; Dr. Abas bin Md. Said for the tremendous support and utmost collaboration in making a success of my Final Year Project: "Graphic Synchronization with Audio WAV Files". Thanks a lot for the long sessions and advices that made me revised and reevaluated the content of the project. It was your understanding and patience that have made me able to achieve the objectives of this project. I really hope that the experience shared will be the most precious asset for me to be prepared in the real working life.

My special gratitude also goes to my personal contact person that has helped me very much in this project. She is Nurul Hidayah binti Mohd. Yusoff. Thank you so much for your guidance and assistance in opening my eyes to see the way to work this project out. Without your help, I might have lost direction and ideas for the project.

Furthermore, I also would like to send my special thanks and love to my parents and family wherever they may be. Without their financial and emotional support, encouragement and trust, I would not be here today and I would never be able to go through the hard times alone.

A bouquet of thanks to my wonderful friends for their help and support especially Fadhlina Abdul Rahman, Maria Mustapa, Tuan Kasmawati Tuan Abdullah and Nor Azerin Ramli. Not forgetting Nabil Fikri Khairullah and Odham Neimad@Bakar for the technical guidance with my software problems. I will always remember the assistance and what all of you have done through my project completion.

Last but not least, I do really hope that this project would fulfill the pertaining requirements and bring the new environment and method in graphic and audio world. I have put my best foot forward and I hope that my effort will be paid.

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CHAPTER 1

INTRODUCTION

Chapter 1 consists of basic information of the project which is the background of study, the problem statement, and the objective and scope of study of the project. This section will describe the overall research that has been made for the purpose of developing the application.

1.1 BACKGROUND OF STUDY

Microsoft graphic project team pointed out that; “We believe that interactive three-dimensional graphics and animation will be an important part of future user interfaces directed toward business, consumer, and entertainment applications. Thus, our research addresses a wide range of topics in three-dimensional graphics and animation.” [1]

Even a giant software company like Microsoft agreed that graphic and animation is the important element as user interface for conveying messages to people in the future. It is undeniable that even nowadays, people prefer the image and graphic information presentation rather than traditional textual form. In today’s world of modern technology, information is no longer confined to textual descriptions; thus, it is not difficult to find homepages with background music that use photos and animations to convey information.

As the technology evolves, people’s preferences toward the information presentation also change. People nowadays enjoy listening to the sound with graphic animation. In other words, while listening to the played sound, they can watch graphic moving along with the sound. The modern technology has made this possible. The audio data can be used to manipulate graphic shape, color, motion, and camera view. Applying audio data to one or more of the above attributes in concert with different geometries can result in many unique and interesting visual effects.

1.2 PROBLEM STATEMENTS

The most critical step to approaching any problem is finding and understanding all of the resources necessary to determining a correct solution. For this project, the requisite skills or information include: a good understanding of C++ (or C) programming, OpenGL programming and a good understanding of how to write code that will properly access and display audio data ported from an audio player.

Another critical aspect of this project is to really understand the underlying concepts of graphic animation and audio integration. By understanding the concepts and theories of the integration, I, then, need to address the problem of how to combine these two (2) elements. This issue requires me to find out the suitable tools and techniques to be used in order to synchronize the graphic visualization with the audio tunes.

The significance of the project is that this application is designed to add a visual component to music that seamlessly compliments to the listener's auditory experience. On the other hand, it helps to assist the listeners to recognize the different levels and characteristics of audio WAV files.

1.3 OBJECTIVES AND SCOPE OF STUDY

This project concerns with the application that integrates two (2) media elements; graphic and audio. The main purpose of this project is to synchronize the graphic animation with the various audio tunes. There are also several other project objectives that have been identified in order to guide me in developing the right application and building the application right. Below are the other objectives that I intend to achieve at the end of the project.

1. To do research on the concept of combining the audio with the graphic animation.

2. To do research on how to synchronize the graphic movement with the audio tunes.
3. To extract the WAV file format into the specific tunes.
4. To show the different tunes by displaying different movement of graphic animation.
5. To understand the underlying concepts of graphic and audio integration.
6. To display the graphic visualization according to various audio tunes.

Basically, the project scope of study focuses on the concepts of integrating the graphic animation with the audio WAV file format. The study intends to find out the techniques used to combine the graphics and audio in one (1) application. Thus, indirectly, it also uncovers the characteristics of WAV file format.

CHAPTER 2

LITERATURE REVIEW AND/OR THEORY

Chapter 2 comprises of facts, data, relevant theories and findings on graphics and audio especially those related and concerns on WAV file format.

This project can use the audio data provided by Winamp to dynamically influence or completely determine the resulting graphical display. The audio data can be used to manipulate graphic shape, color, motion, and camera view. Applying Winamp audio data to one or more of the above attributes in concert with different geometries can result in many unique and interesting visual effects.

2.1 WAV File Format

Sound files store sound in files on your computer, which then allow the user to listen, download, upload or convert the files. WAV, RealAudio, MP3, and QuickTime are just a few of the many types of sound files.

2.1.1 What is WAV file format?

The WAV format is an uncompressed copy of a CD audio track that preserves CD-quality Redbook audio. Although this is the purest form of audio, it also takes up a significant amount of hard drive space. WAV file format is a file format for storing digital audio (waveform) data. It supports a variety of bit resolutions, sample rates, and channels of audio. [2]

WAV files were developed jointly by Microsoft and IBM. Wav files are now the de facto standard for PC's. WAV sound files end with a .wav extension and can be played by nearly all Windows applications that support sound. [6]

The WAVE file format is a subset of Microsoft's RIFF specification for the storage of multimedia files. A RIFF file starts out with a file header followed by a sequence of data chunks. A WAVE file is often just a RIFF file with a single "WAVE" chunk which consists of two sub-chunks: a "fmt" chunk specifying the data format and a "data" chunk containing the actual sample data. Call this form the "Canonical form". [4]
(Please refer Appendix 1: Figure 1)

2.1.2 WAV file structure

A wave file is a collection of a number of different types of chunks. There is a required format chunk which contains important parameters describing the waveform, such as its sample rate. The data chunk, which contains the actual waveform data, is also required. All other chunks are optional. Among the other optional chunks are ones which define cue points, list instrument parameters, store application-specific information, etc. [3]

All applications that use wave must be able to read the 2 required chunks and can choose to selectively ignore the optional chunks. A program that copies a wave should copy all of the chunks in the wave, even those it chooses not to interpret.

There are no restrictions upon the order of the chunks within a wave file, with the exception that the format chunk must precede the data chunk. Some inflexibly written programs expect the format chunk as the first chunk (after the riff header) although they shouldn't because the specification doesn't require this. Here is a graphical overview of an example, minimal WAV file. It consists of a single WAV containing the 2 required chunks, a Format and a Data Chunk. [3]

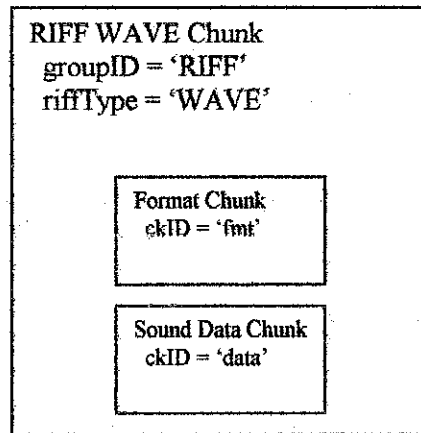


Figure 2: WAV File Structure

2.2 Graphics Animation

Driving applications include the need for rapid prototyping tools for 3D modeling, the need for more sophisticated scientific visualization tools that can present concepts, techniques, and algorithms as well as data, and the need of geographically-separated groups to more effectively work in a shared visual, spatial, and auditory environment.[7]

A group of Mississippi State University Researchers pointed out that, “Visualization is a way to display data in an easily understandable form. Visualized data provides viewers new insights into a dataset. Current display technologies are able to build fully interactive immersive virtual environments in which the viewers have a sense of presence in the graphic images. [8]

Such immersive visualization systems have the potential to aid in the examination of forest inventory data which contain various measurement variables in a complex spatial context. A successful visualization system is able to display meaningful information for viewers in a usable manner. Graphic image representation and desired photo reality depend on the intended purpose of the system.’ [8]

In computing, graphic is the presentation of information which is not in character form. It also can be interpreted as the picture information as distinct from textual. Some characters may be constructed in graphic form. These are considered to be graphics.

Animation is the creating a timed sequence or series of graphic images or frames together to give the appearance of continuous movement. Animation also refers to any visual movement effect created automatically. This definition of animation includes video and animated images. Animation techniques include 1) graphically displaying a sequence of snapshots within the same region, 2) the series of snapshots may be provided by a single resource or from distinct resources 3) scrolling text and 4) displacing graphical objects around the viewport. [9]

CHAPTER 3

METHODOLOGY/PROJECT WORK

Chapter 3 consists of information on the methodology adopted and the flow of overall project work. Tools that are needed and going to be used throughout the project development will be discussed and explained in this section.

3.1 Project Work

In order to complete this project, I have identified the project work and tasks to be done. There are six (6) major tasks in this project which are 1) research and findings, 2) problem analysis, 3) graphic design, 4) audio extraction, 5) audio-graphic integration and 6) application implementation. The phases or processes in the methodology are still the same as from the beginning of the project. There has been no addition or modification to the processes or tasks involved in this project.

In research and findings phase, my task would be to do research and study on the given topic by referring to any reading materials and information resources. All the results and findings from the research will be used to proceed with the next stage. This initial stage is very important because it determines the understanding of the required work to be done, the software and hardware requirements needed and above all, the underlying concepts of integrating graphics and audio elements. At this early phase, I have browsed and searched through the journal, theses, project results and documentations from various group of people such as the group of university students, group of researchers and group of multimedia laboratory workers.

In the second major task, I identify the topic problems, analyze them and find the right solutions to solve the problems. With the information and data obtained from the first stage of the project tasks, I use them to clearly and precisely identify what is really the issue and problem arises from the given project topic. The information and data gained help me to figure out the right solution for the problem identified. The solutions may

vary as the project requirements change. I may not find the best solution for this project but at least I can provide the good and right solution to it. In order to develop the solution correctly, I need guidelines to follow and targets to achieve. So, I identify and develop several objectives of the project that are to be achieved at the end of the project development.

Next will be the graphic design phase. At this point of time, I design and sketch the graphic output required. As for this project, the graphic part is presented by the simple graphic animation program called 'The Stickman'. This application is then realized by writing the correct source codes, installing the required software and development kits, and testing the program as a single application.

The fourth major task will be the audio extraction process. This task will involve the extraction of WAV audio file into specific tunes. At the beginning of the project, I decided to extract the audio file into smaller chunks so that it could be categorized according to the specific tunes such as high or low beats. However, as the project progress, the final product of this project will only play the single audio file without any specific tune extraction.

The next step will be the integration of graphic and audio into one (1) application. This is where I combine the graphics part and the audio part into a single standalone application. Finally, the last stage is where I implement the application and do the testing for any source code errors, debugging and so on. These development phases with their estimated duration to complete are presented in the Gantt chart for a better review and as my guideline to task completion. *(Please refer Appendix 2: Figure3)*

3.2 Methodology

The Software Development Life Cycle is a phased approach to analysis and design that holds that systems are best developed through the use of a specific cycle of analyst and user activities. [5] Generally, there are seven (7) phases in software development life

cycle: 1) identifying problems, opportunities and objectives, 2) determining information requirements, 3) analyzing system needs, 4) designing the recommended system, 5) developing and documenting software, 6) testing and maintaining the system and finally, 7) implementing and evaluating the system. (Please refer to Appendix 3: Figure 4)

So, for this project, I basically follow the waterfall methodology but I have adjusted the phases in it to appropriately suit my project tasks. Below is the graphical presentation of my methodology for this project.

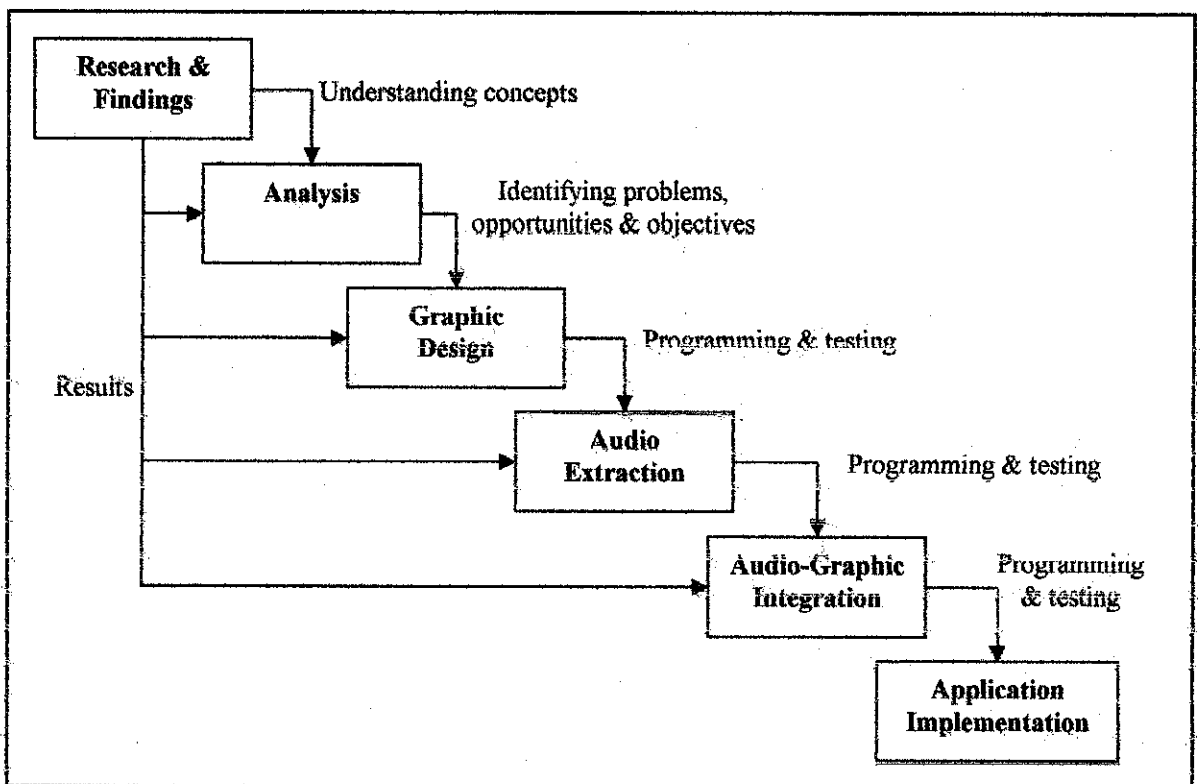


Figure 5: Project Methodology

3.3 Tools Required

In order to develop a usable and working application, I have identified the hardware and software requirements for the project.

3.3.1 Hardware Requirements

For the hardware requirements, basically, my project requires the minimum computer processor of Pentium III, 800 MHz and 128 SD-RAM and 3D sound speakers.

3.3.2 Software Requirements

For the software requirements, in order to be able to do the project successfully, the project needs to have an audio/video player such as Windows Media Player or Winamp to play the audio files included. For the programming part, the developer should at least use any of these three (3) programming software packages: C Language, C++ Language or Java Language programming software. Furthermore, the additional Software Development Kits are needed in this project in order to be able to define the classes and functions to be used in the source codes. The two (2) most important Software Development Kits the programmer must have are OpenGLSDK and OpenALSDK.

CHAPTER 4

RESULTS AND DISCUSSION

Chapter 4 compiles the results and the current findings of the project work. There has been several interesting information, obtained from articles and online resources. The results of the project that has been obtained are discussed in this chapter. What I theoretically understand from the research and study is then conducted practically through the development of the prototype. How it actually can influence and aid my own research is clearly outlined in the results and discussion chapter.

4.1 Results

From all the findings and studies been made based on my project, I finally understand the fundamental concept of WAV file format. This includes its characteristics, its format, its compression type and several other aspects. Currently, I am able to include the WAV file format in the source codes of my standalone multimedia application. The insertion of the WAV audio files has made possible for the program to play the songs or the particular audio files included. Currently, the WAV file format attached to the standalone application are two different songs with different beats, where one of them is a little bit slower than the other. When the program is executed, the application would play the whole song non-stop, unless the users close the program's window.

After a deeper study and research on the project's scope, I have learned a lot of new things which help me in achieving the objectives of my project. At the earlier stage of the project development, I have encountered some issues that are complicated and these issues have led me to project delay. The most complicated issue that arises is to find the way to integrate the graphics animation and audio files. This issue requires me to clearly understand the underlying concepts of the graphic and audio integration.

First, I have found a software called StripWAV which I thought is used to strip or divide the WAV file format into smaller chunks. After I have tried the software and have the hands-on experience of using it, only then I realized that it is not what I thought earlier. To be really sure and confident that the software is not the one that I have searched for, I tried using it with several audio WAV files.

It is clearly shown that the software is actually used to remove the noise in the WAV file format. When I imported a WAV file format and did the 'stripping' process of the file, the output remained the same as input, only that it is much clearer after the noise removing. It is far away from what I expected to get where the WAV file format is divided into smaller chunks of audio tunes.

Later on, after several more days and weeks spent to search for suitable software for the project, particularly to extract the WAV file format into recognized tunes accordingly, I found a sample project called Genu Project. It is developed for solid modeling interface using the C++ programming language.

The project is actually an attempt to combine the audio and graphic element in one (1) program. This means that the program is using only one source codes platform to combine those two (2) media elements. The output of the program is a standalone multimedia application which displays two (2) computer-generated geometry shapes that are moving by themselves, without any user input. At the same time, the viewer can hear sounds being played at the background. The program also allows the user to move the geometry shapes by pressing the keyboard and the shapes will move from left to the right, backward and forward. Below is the snapshot of the sample standalone application from the Genu Project.

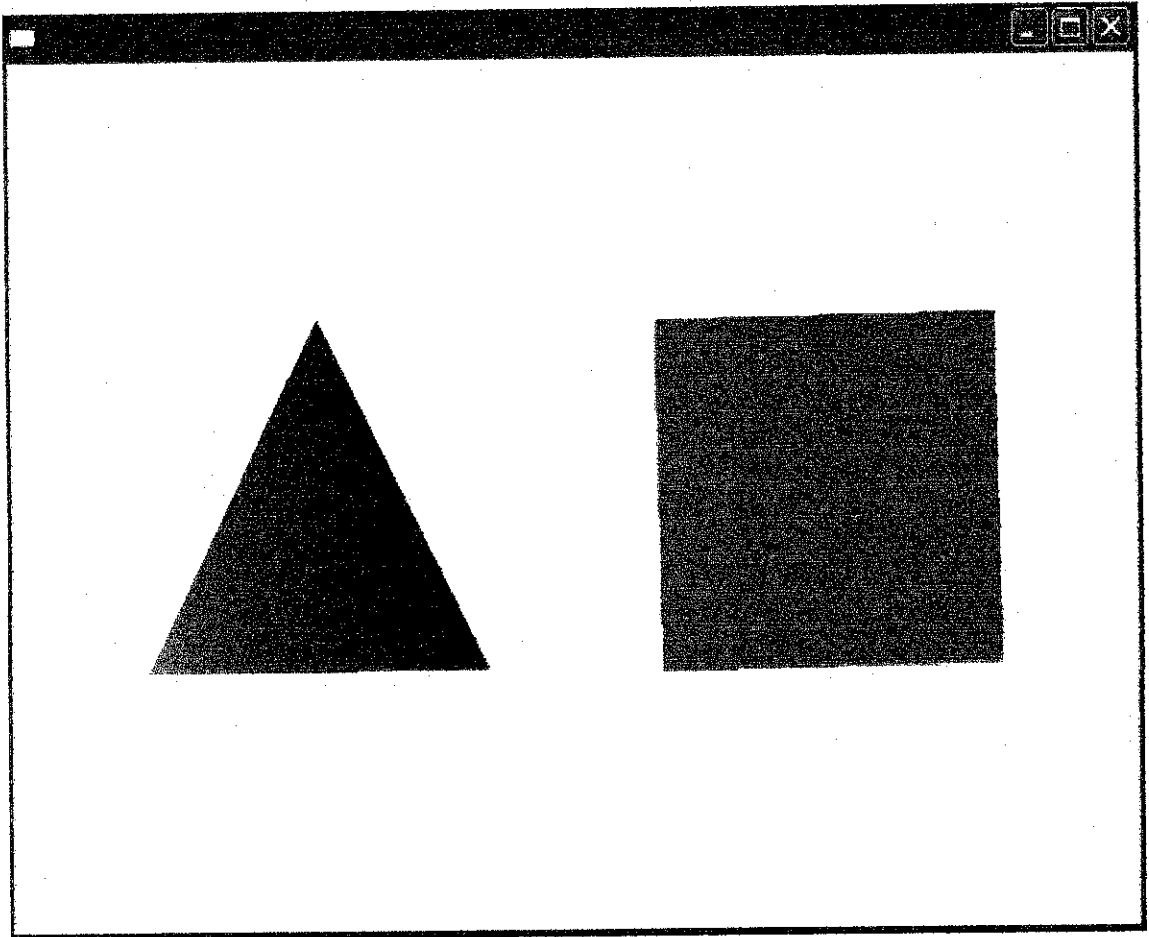


Figure 6: Genu Project: Solid Modeling Interface

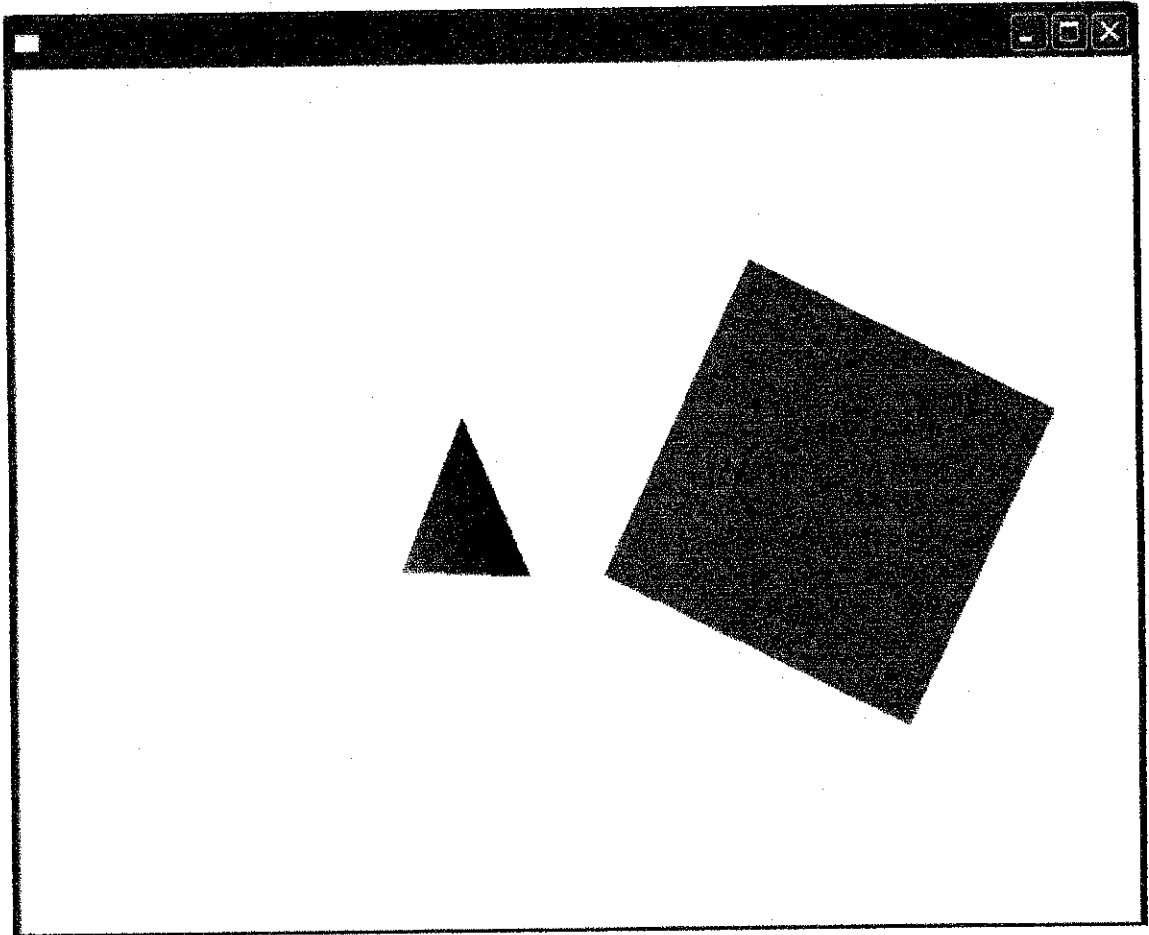


Figure 7: User's Keypress Up: Graphics moving backward

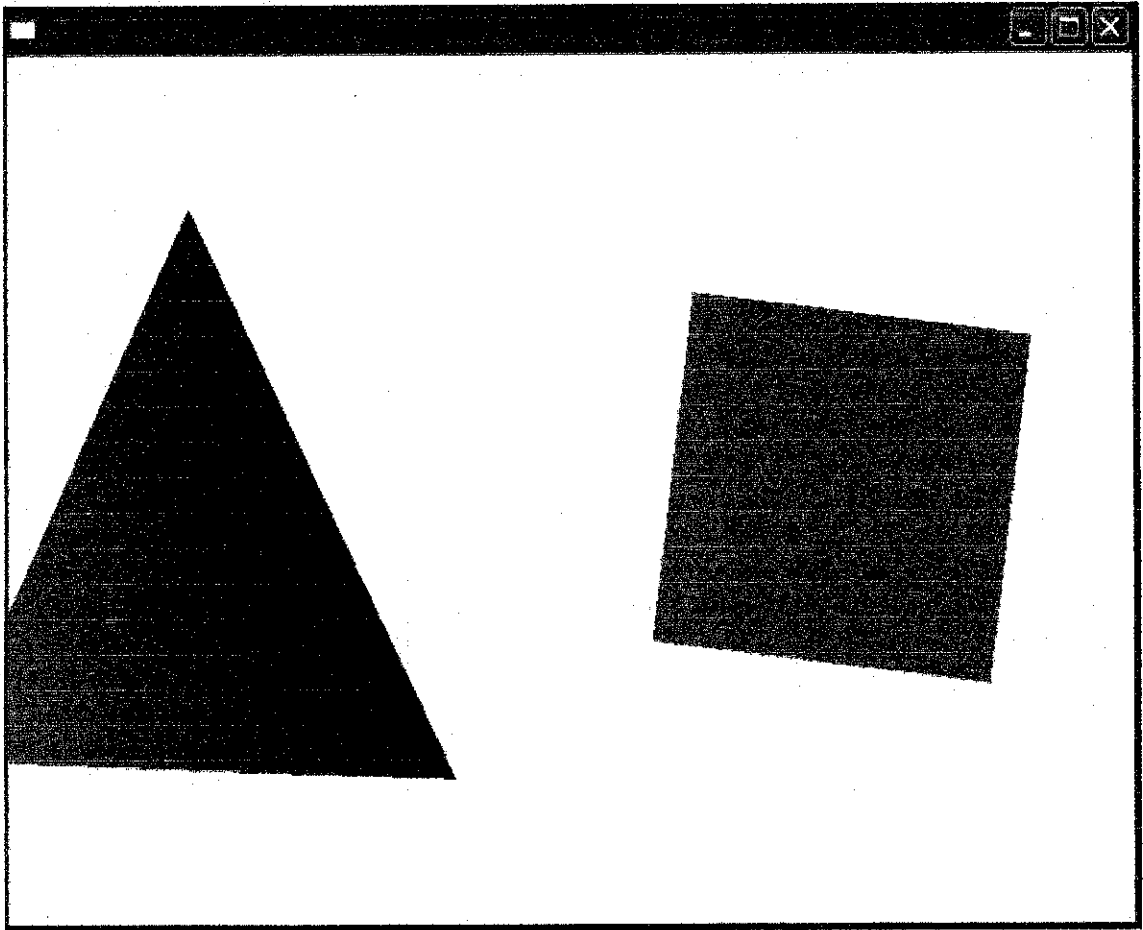


Figure 8: User's Keypress Down: Graphics moving forward

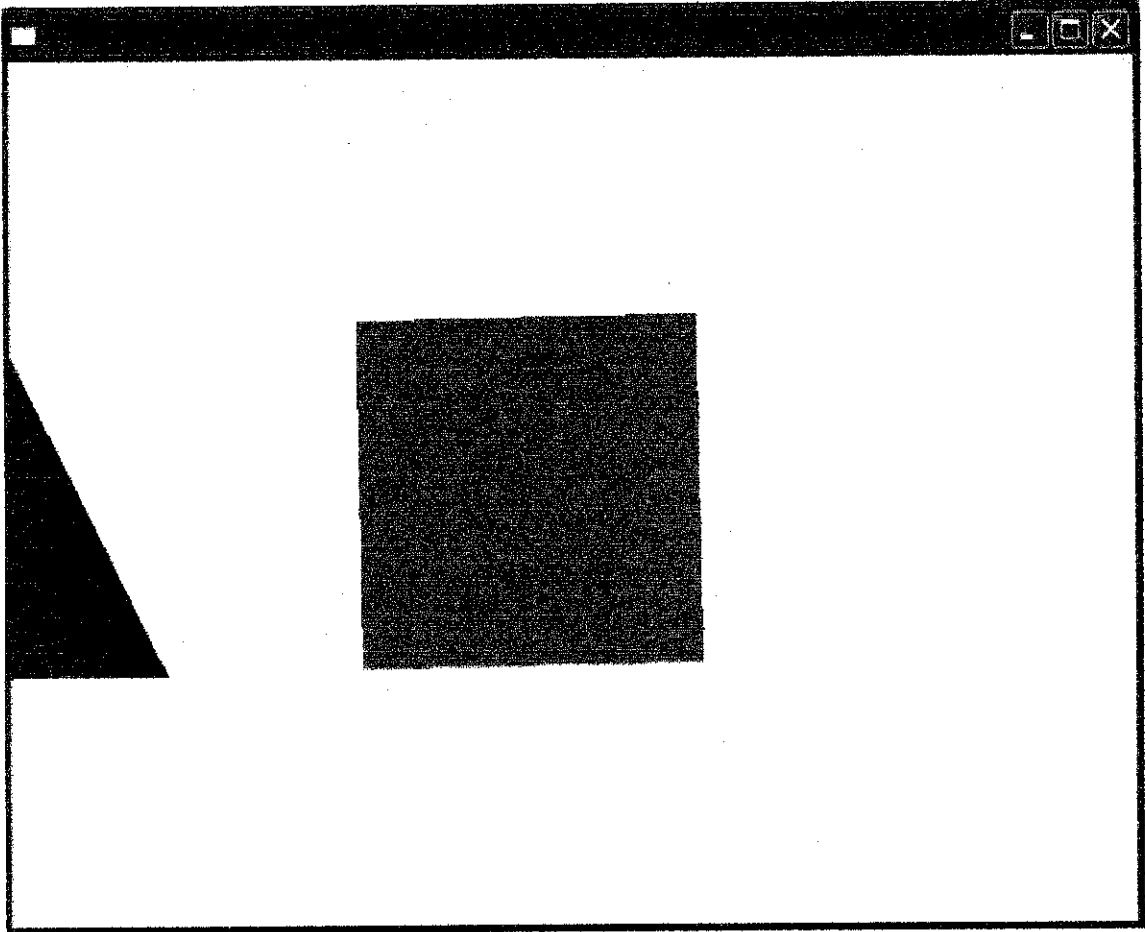


Figure 9: User's Keypress Left: Graphics moving to the left

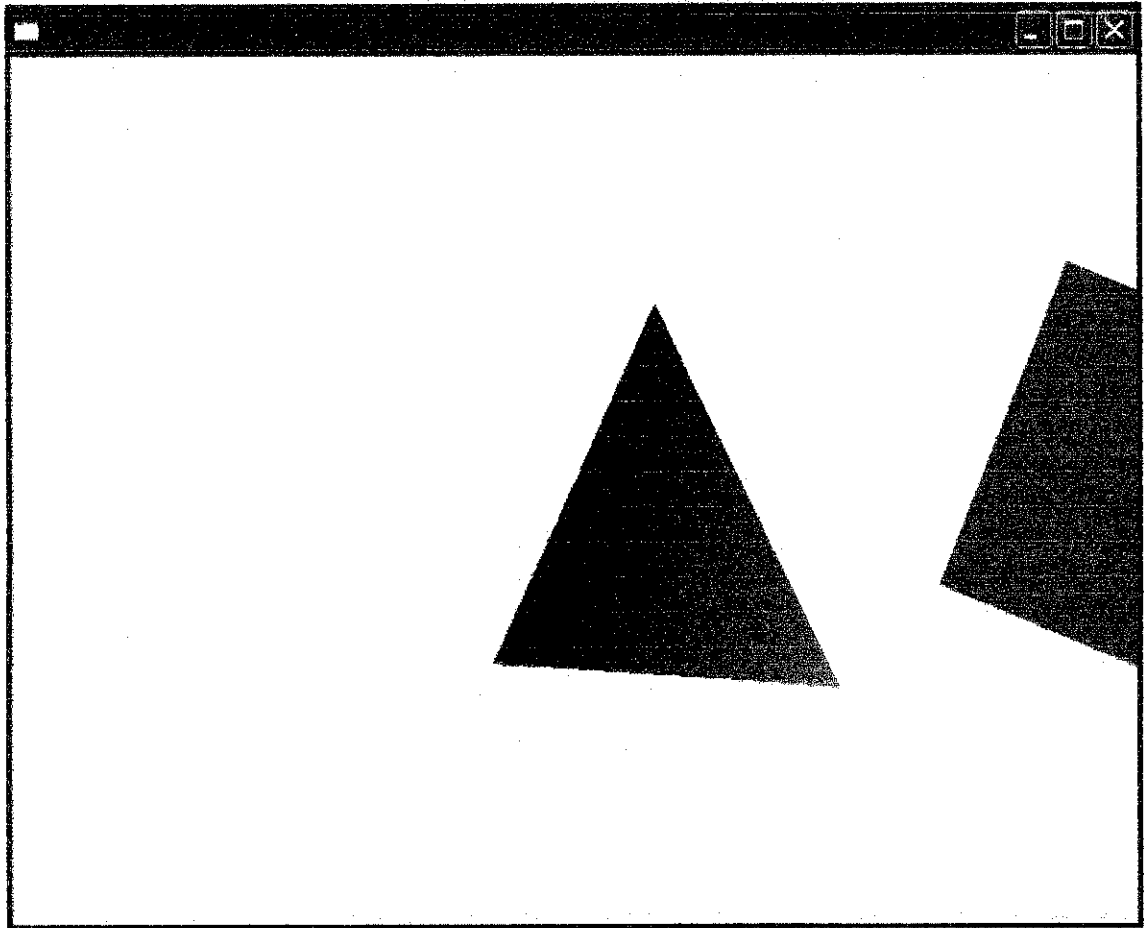


Figure 10: User's Keypress Right: Graphics moving to the right

I finally decided to use the same concept as the Genu Project in combining the audio and graphic element. Using the same underlying concept of the program, I applied it to my own project. Genu Project has provided me the tools and functions that make it possible for me to integrate the audio file format with the computer graphics. With this, one of my objectives has been achieved.

In Genu Project, it uses the C++ programming language to construct the source codes. It also uses the OpenGL and OpenAL library files and combines them in order to build the application. By using the defined classes in the Genu Project, I construct my own source codes to develop my project. The additional C++ library files which are used in my project are to enable me to construct the source codes for graphic animation and to insert audio files in it. The OpenGL is specially used to design computer graphics from the simple geometry shapes to a 3 dimensional objects. While the OpenAL is specially

used to insert, include or attach the any audio files to the program. It also enables the program to play, pause or stop the audio files.

However, my program is very much different from the Genu Project where I enhance more on the graphic part. Instead of using the basic geometry shapes, I use a simple 'stickman' which symbolizes the human or robot. The 'stickman' does not merely moving on its own but it actually moves according to the audio tunes being played. This conforms to another objective of my project which is to synchronize the computer graphic animation with the audio files. Furthermore, the 'stickman' is motioning automatically without any help from the user input to determine the directions of its movements.

Hence, the output of my project is the standalone multimedia application which displays the computer graphics 'stickman' moving by its own. While at the same time, the user can hear the audio being played at the background.

I am still in the process of learning and searching on how to really synchronize the computer graphics animation with the audio file format. There are few adjustments and modification to enhance it but it is still in research. I need to figure out the way to correct all the source codes errors which I encountered while doing it. Even though the computer graphics movements could not be synchronized exactly with the whole single song being played, I am sure it can be done by using several sample of recognized tunes with high and low beat differences. Below is the snapshot of the output of my project and what I have done so far for this area of research.

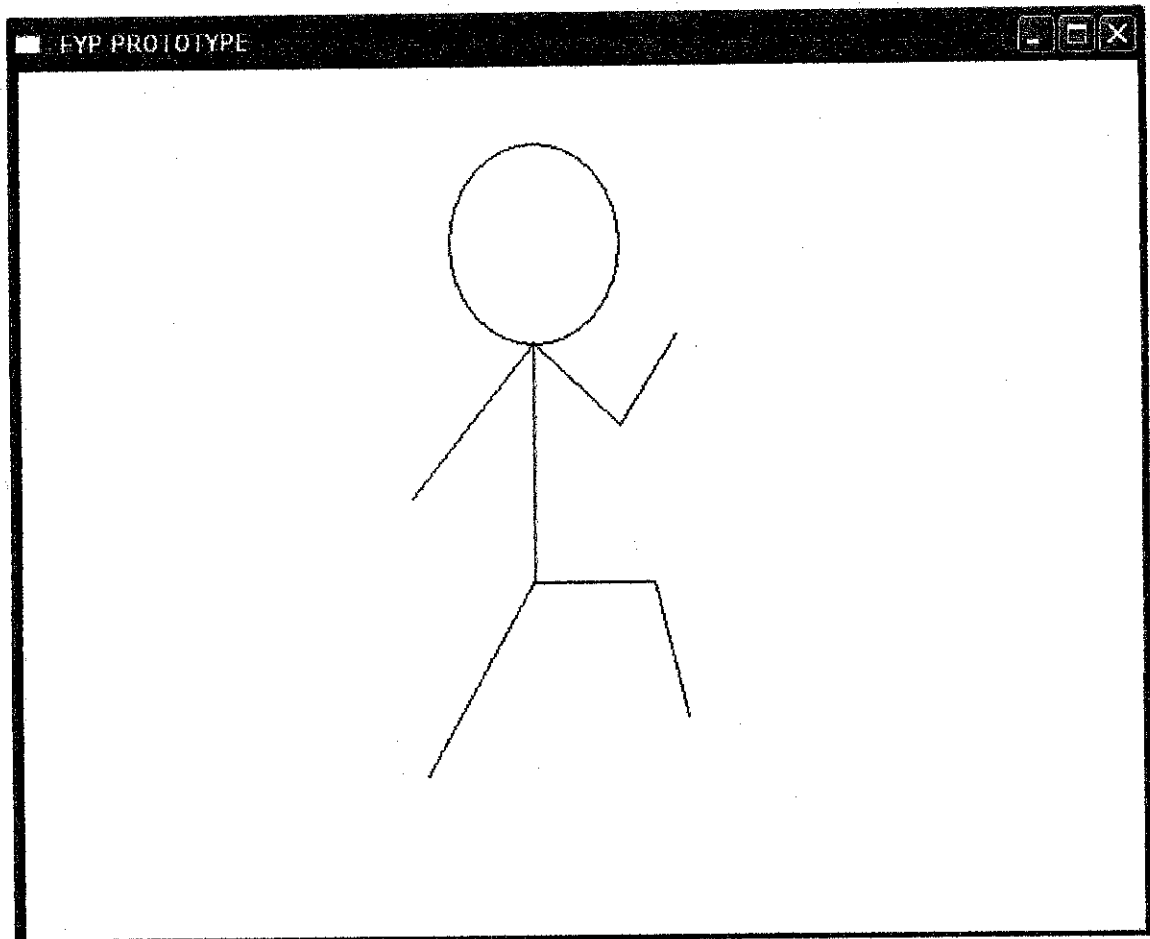


Figure 10: Project's Output

4.2 Discussions

Paperwork and also different studies have been made by different level of people from all over the world about this topic. Their researches have contributed to my project's research and its completion. Their researches have yet to comply with my research as certain elements of it were might and might not be adaptable. The way they understand the underlying concepts of graphic and audio integration might be different. The tools and techniques being used in order to synchronize the computer graphics movements and audio files differ from one person to another.

The research I have done mostly lingers around the integration and synchronization of the computer graphics movements and audio files, particularly the WAV file format.

My research is to find the way of extracting the WAV file format into several or smaller recognized tunes. In the study also shows me the example of slightly the same program which I attempt to develop. Although the outputs are different but the concepts, tools and techniques used are still the same. The automatic and user input commands demonstrate the variability of the program's outputs and the computer graphics animation.

Researches and studies made through the online resources, journals, reference texts and other related media have actually helped to strengthen my position in researching for the purpose of my project. The findings have resulted in an extraordinary experience I have ever felt. Educating while applying what I have found into hands-on application has assisted me to proceed my project's development phases towards its completion. Deeper understanding of the source codes structure is very crucial so that I will be able to manipulate the overall source codes structure and classes used throughout the project development. Practical activity such as the modification and alteration of the source codes also need to be done in order to see the various outputs of the program.

Earlier I have been advised to understand and study more on the underlying concepts of graphics and audio integration. At the beginning, I did face some obstacles in obtaining the exact and correct research findings regards to the desired concept. However, after a lot of time consumed to collect the relevant and necessary data, I managed to eliminate the problems. Furthermore, I faced the difficulty of finding the right and suitable software to be used to extract the WAV file format. Anyhow, despite the wrong software found and used, I learnt how to eliminate the noise from the WAV file format for clearer sounds.

Much progress can be seen and realized after the proper study and research has been made pertaining to the project. I would say that I am on the right track of completing the project. It is a step closer to what I wanted to achieve in the goal of this project which is to combine and synchronize the computer graphics animation and audio WAV files.

This project is very essential in understanding the concept, tools and techniques of graphics and audio integration. I have learnt a lot from this project.

CHAPTER 5

CONCLUSION

5.1 Conclusions of the Project

As for the conclusion, the aim of this project is to add a visual component to music that seamlessly compliments to the listener's auditory experience. The project's basic objectives are to combine the graphics and audio files, to synchronize the computer graphics animation with the audio files and to extract the WAV file format into several recognized tunes.

The findings of different materials have helped to boost the project realization and highlight its significance in relation with its objectives. Although there is still certain objective which has not be able to achieve but it can be bring forward for the future enhancement of the project to any person who will be doing or continuing the same project later on.

This project is to be the benchmark and guidelines for the next project developer to venture in depth regards to this research area of synchronizing graphics animation and audio tunes. This project has contributed to the small portion of advanced multimedia world and its technology.

5.2 Future Recommendations

Computers give artists creative options they have never had before. Technological development in computers and the media lead to the emergence of computer graphics or computer Arts. Many illustrators and artists now use digital tools to create computer art. Because of today's computer technology, there are new fields such as web design, computer animation, graphic design and digital media. Computer graphics is also used in such diverse areas as engineering, business, industry, art, entertainment, advertising, and education.

Computer Graphics or Digital art is no different than traditional art painting. The only difference is the use of medium. Digital Artists use computers as their canvass and computer arts software as their tools. Computers now allow artists to express themselves in new and exciting ways.

The internet also plays a strong role in computer graphics. Artists are now using the web as an advantage to use their talent. The computer arts are also essential in digital gaming, virtual reality, cyberspace, multimedia and simulations. As computer technology develops it is expected that computers arts will also expand and evolve.

Although the project is completed, there are still some propositions that can be made and implemented in the future for this prototype module. Due to time constraint and the fact of low and limited knowledge on subjects matter area, it is difficult to accomplish other important aspects that can be included in this project for a better productivity.

What I have done is the basis for future development, as I have provided the information and initial study on how the graphics animation and audio files can be integrated and then the graphics movements can be synchronized with the audio tunes or beats. Besides that, I inspire the graphics and audio developers to further enhance the existing audio visualizations by synchronizing the computer graphics movements according to specific audio high or low tunes.

It might be complicated and complex to make the full system work as accurate as we want it to be, however I would say that my project development is the stepping stone for other future work. In the future, students whom are interested to continue this research paper should create more complex and challenging multimedia integration besides the graphics animation and audio files combination. Perhaps after this, they will try to synchronize the graphics with other types of audio files such as .mid, .mp3 and .rm.

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APPENDIX 1
(Figure 1: The Canonical WAVE File Format)

The Canonical WAVE file format

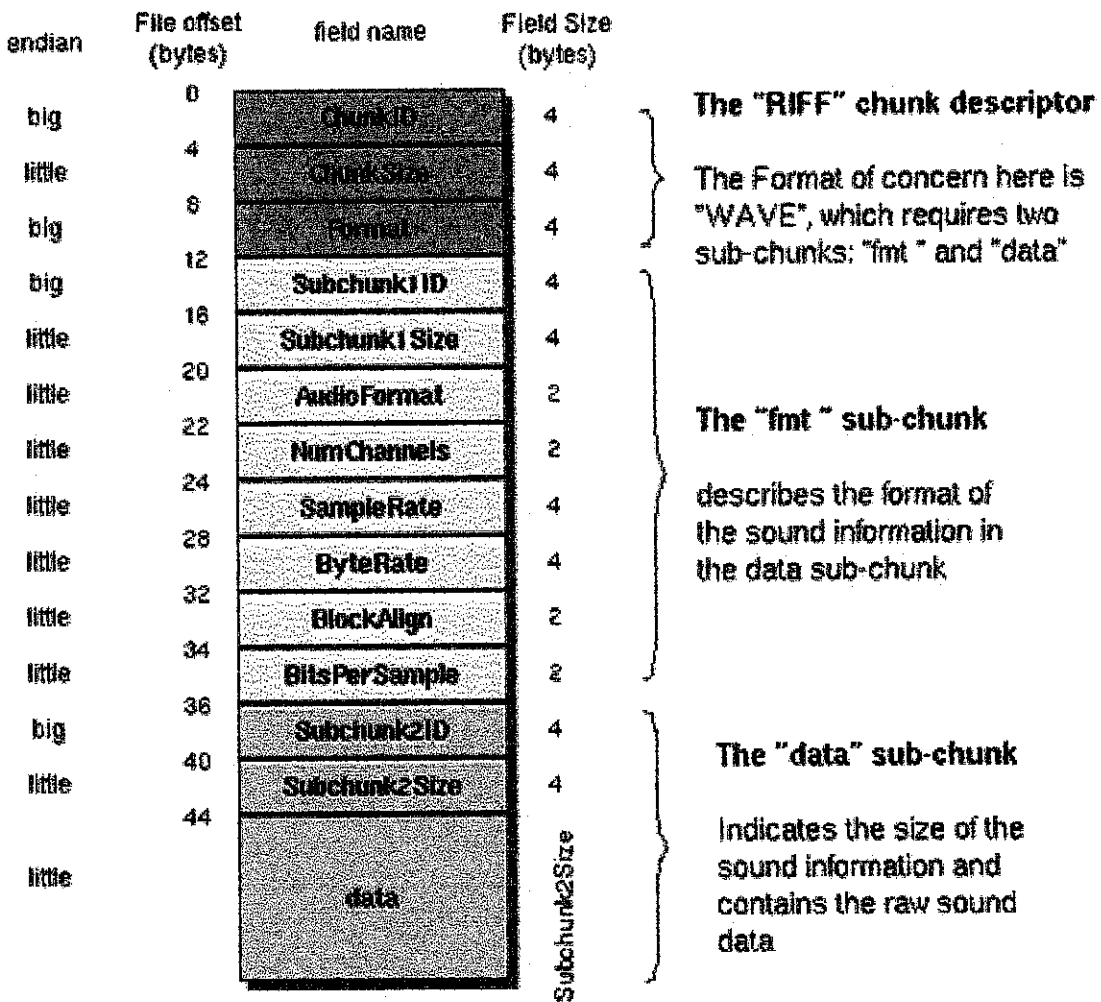
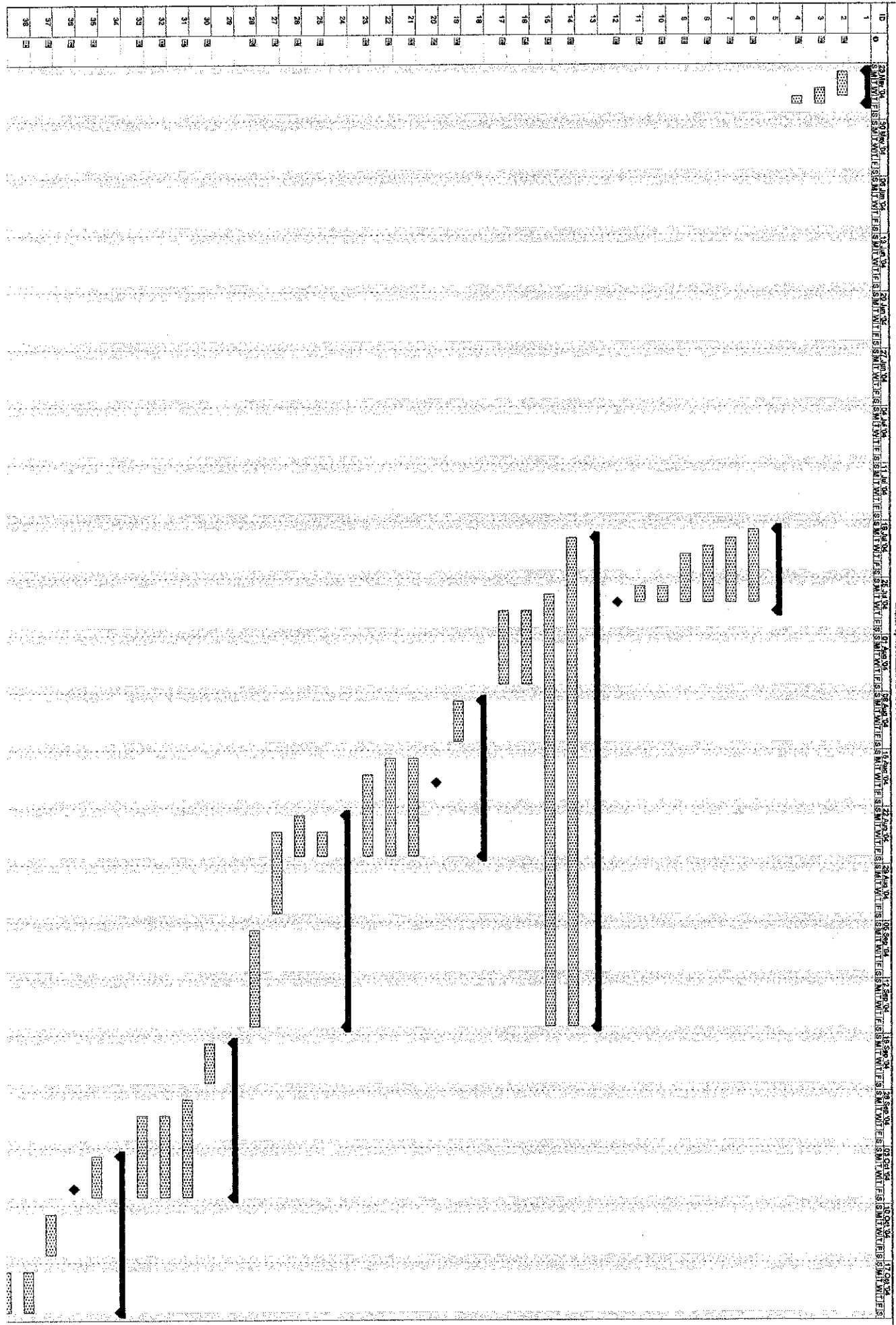


Figure 1: The Canonical WAVE File Format

APPENDIX 2
(Figure 3: Project's Gantt Chart)



APPENDIX 3
(Figure 4: System Development Life Cycle)

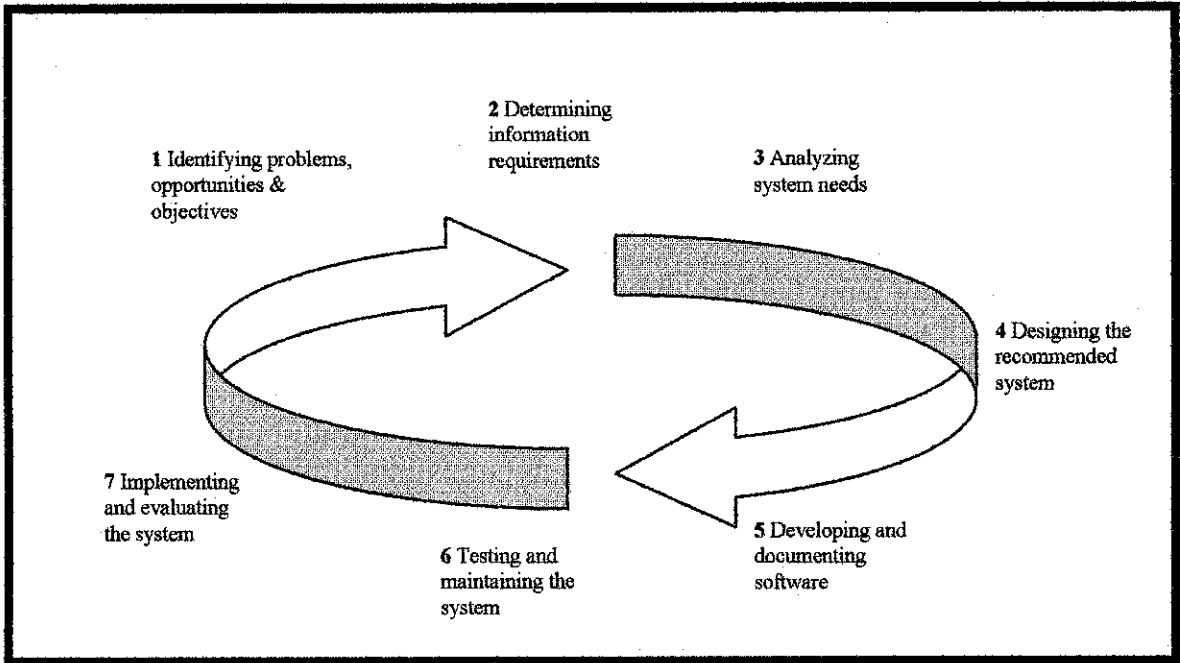


Figure 3: System Development Life Cycle