

# **Image-based Modeling 2-Dimension to 3-Dimension model**

By

Nor Nadia Binti Abu Hashim  
6487

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

JAN 2008

Universiti Teknologi PETRONAS  
Bandar Seri Iskandar  
31750 Tronoh  
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

**Image-based Modeling 2-Dimension to 3-Dimension model**

by

Nor Nadia Binti Abu Hashim

A project dissertation submitted to the  
Information and Communication Technology Programme  
Universiti Teknologi PETRONAS  
in partial fulfilment of the requirement for the  
BACHELOR OF TECHNOLOGY (Hons)  
(INFORMATION AND COMMUNICATION TECHNOLOGY)

Approved by,

---

(Dr. Abas Md Said)

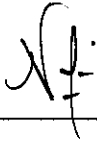
UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2008

## 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.



---

NOR NADIA BINTI ABU HASHIM

## **ABSTRACT**

The objective of the report is to reflect the progress done in order to develop the final year project. This project main objective is to study the process of conversion of a two-dimensional image, in this case digital images into its corresponding three-dimensional image presentation and then come out with the solution to do so. The scope of the project will focus on a digital image of an object with smooth or even surface as the input for the application and as a result, the image will be converted into its corresponding three-dimensional image. The project also focused on having as a solution that enables the conversion of the images using the lowest cost possible, which preferable from the current tools available as they are quite expensive. The methodology used for the development of the project is a modified version of waterfall methodology. Some project activities are by doing more research to know in depth about two-dimensional image and also three-dimensional image, using OpenGL in Visual Studio C++ environment framework. As a conclusion, the project is basically to build an image conversion system with a two-dimensional image as an input to be converted into a three-dimensional image.

## **ACKNOWLEDGEMENT**

It was a great pleasure to express my gratitude to all of whom had aid and supports me throughout this final year project. At most priority would be to Allah, with His blessing, I managed to go through the period of completing this paper.

I also would like to thank my supervisor, Dr. Abas Md. Said, for the guidance and support that he had shown and provided for this final year project.

Besides that, I also would like to express my gratitude to my family, especially my parents for their support and motivation. Then, I also would like to express my appreciation to my friends for their support.

And lastly, to all that had help in contributing something from the very beginning until this final year project comes to its end. Thank you very much again to everyone involved either directly or indirectly.

# TABLE OF CONTENTS

<b>LIST OF TABLES.....</b>	<b>vii</b>
<b>LIST OF FIGURES.....</b>	<b>viii</b>
<b>CHAPTER 1: INTRODUCTION.....</b>	<b>1</b>
1.1 Background of Study.....	1
1.2 Problem Statement.....	2
1.2.1 Problem Identification.....	2
1.2.2 Significant of Project.....	4
1.3 Objectives and Scope of Study.....	4
1.3.1 Objectives.....	4
1.3.2 Scope of Study.....	5
<b>CHAPTER 2: LITERATURE REVIEW / THEORY.....</b>	<b>7</b>
2.1 Literature Review.....	7
2.1.1 Carnegie Mellon Project Review.....	7
2.1.2 Photogrammetric Modelling.....	8
2.2 Theory.....	8
2.2.1 3D Graphics.....	8
2.2.2 Stereopsis.....	10
2.2.3 Digital Image.....	12
2.2.4 Depth Value.....	13
<b>CHAPTER 3: METHODOLOGY.....</b>	<b>14</b>
3.1 Research Methodology.....	14
3.1.1 Plan.....	15
3.1.2 Design.....	15
3.1.3 Implementation and Prototype.....	17
3.1.4 Testing and Evaluation.....	17
3.2 Project Activities.....	17
3.3 Key Milestone.....	18
3.4 Tools.....	22
<b>CHAPTER 4: RESULTS AND DISCUSSION.....</b>	<b>23</b>

4.1 Microsoft Visual C++ .....	23
4.2 OpenGL .....	23
4.3 Result .....	24
<b>CHAPTER 5: CONCLUSION AND RECOMMENDATION .....</b>	<b>25</b>
5.1 Conclusion .....	25
5.2 Recommendation .....	25
<b>REFERENCES .....</b>	<b>26</b>

## **LIST OF TABLES**

Table 1: Milestone for Week 1 - Week 7 (Semester 1).....	18
Table 2: Milestone for Week 8 - Week 14 (Semester 1).....	19
Table 3: Milestone for Week 1 - Week 7(Semester 2).....	20
Table 4: Milestone for Week 8 - Week 14(Semester 2).....	21



## LIST OF FIGURES

Figure 1: X, Y and Z axis in 3-D .....	9
Figure 2: Left eye's image; side object shift to right.....	11
Figure 3: Right eye's image; side object shift to left.....	11
Figure 4: Two eyes converge; object appears to be at the center.....	11
Figure 5: Stereo view.....	10
Figure 6: Project development methodology.....	14
Figure 7: 2D to 3D architectural design.....	16
Figure 8: An example of output.....	24

# 1 CHAPTER 1: INTRODUCTION

## 1.1 Background of Study

Image Processing is defined as a form of information processing in terms of which the input is an image, such as photographs or frames of video while the output is not necessarily an image, but can be for instance, a set of features of the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

Typical image processing operations are like geometric transformations such as enlargement, reduction, and rotation, color corrections such as brightness and contrast adjustments, conversion to a different color space, registration (or alignment) of two or more images, combination of two or more images into an average, blend, difference, or image composite, image editing and digital retouching, image restoration to increase the quality of a digital image and many others.

When discussing about images, it is inevitable for people to perceive the presentation of the word differently. Images are unique, in which they can be in varieties of forms. Two of the forms are in terms of two-dimensional images and three-dimensional images.

The three-dimensional image is different in comparison of a two-dimensional image. Two-dimensional image refers to an image that has only two dimension of measurement, which is usually the width and height of the image. An example of this kind of image is a piece of paper with drawing or doodles on a table. Three-dimensional image, on the other hand, bring a meaning of the object been displayed has three dimension of measurement instead, which are the width, height and depth. A book on a table would be an example of a three-dimensional image.

Although three-dimensional image is perceived as something that have three dimensions of measurement, the three-dimensional images are flat when viewed through the computer screen in comparison to the example given for a three-dimensional image beforehand. The image viewed through the computer screen is considered as three-dimensional image due to the factors such as the lighting, colors or lines that gives the image with the attributes of a three-dimensional image.

According to Wikipedia definition, 2D 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. The word may stand for the branch of computer science that comprises such techniques, or for the models themselves. 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..

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.

## **1.2 Problem Statement**

There have been some research and projects had and planned to be conducted based on the field to manipulate images in order to use them in many applications. This final year project also is based on image processing to find a solution and the best way to create an application that enables conversion of images in different dimensions. The application will require an input of a digital image and the output of the program should be a three-dimensional image.

### **1.2.1 Problem Identification**

In earlier years, when digital world does not exist yet, drawing and sketch which is achieved manually is used to manipulate the way scenery and images appear on canvas. When technology comes into the picture, people have come out with solutions to manipulate images in a very different way altogether. The usage of digital camera to capture images in two-dimensional presentation opens a new set of interesting topic to be explored.

Although there are a few works and research has been done in terms of this kind of conversion topic, the methods used in those applications and proposals are varies. Basically the problem is that it is rather complicated in order to convert a two-dimensional image into a three-dimensional image. These two presentations of image have different features and characteristics that make each of the presentations unique.

The digital images used in order to test the program also can have different features itself, possibly due to the surrounding. Even the usage of the same object in digital image can have variety of difference that might effect the modelling of its three-dimensional presentation. For example, the lighting surrounding the object when the digital image is taken might affect the image.

Besides, based on the research that have been made in prior, although there are some software products have been created that enable the conversion of the images, the systems used high technology tools that are expensive in their development. This final year project will hopefully managed to overcome this problem by keeping the cost low but with the desired result.

Added to the knowledge that in order to convert an image that is flat to something which looks real enough will takes a lot of research starting with the idea to know more in depth regarding the two images. Therefore it is a must for this FYP to be done in order to obtain the knowledge on how to convert this two dimensional image to a three dimensional image.

### **1.2.2 Significance of Project**

The goal of this project is to create an application that enable the conversion of a digital image to its corresponding three-dimensional image presentation.

There are a lot of applications in which this certain characteristic and function will be useful to be in use. One of the circumstances that can gain benefits from this type of conversion is in real estate application. Real estate refers to a term that encompasses land along with anything permanently affixed to the land. For example, the program can be use to view buildings layout on a land area for real estate.

Other than that, digital images also can be use to construct game applications that use real objects to be transferred into three-dimensional objects in the game view display. So, using this program enable real objects captured into digital images to be used in constructing a game application.

The project also aims to provide better understanding and more information regarding computer graphics development. It is important to study ways in which the conversion could take place using an image and in return, produces a good quality of three-dimensional model out of the system.

## **1.3 Objectives and scope of study**

### **1.3.1 Objectives**

One of the objectives of this project is to come out with a program that can convert two-dimensional image into a three-dimensional image. It is some sort of a processing image function in which the input is a digital image to be altered in order to come out with its corresponding three-dimensional presentation.

Other than that, this project is inspired by the knowledge and challenge to come out with a solution that is best to be applied in the requirement set up for this application. There are a lot of applications out there that introduced several of ways to manipulate images. This project will take this into motivation in order to come out with the conversion application.

Besides that, the research for the project will also focus on finding ways in order to do this conversion system without using expensive tools like what most related software products developed by other companies uses. This is in order to keep the cost for the project low but still get the desired output.

Aside from that, this project will also focused on the study of other factors that might effect the presentation of images in two dimensional form and the result of in the three dimensional form after the conversion is done.

### **1.3.2 Scope of study**

The scopes of studies involved would focus more into the research on each of the image characteristics to understand in depth about the two images. The idea of the project is to come out with an application that support the conversion of two-dimensional image that have even surface such as a square that can turn into a cube as its corresponding three-dimensional image presentation.

Besides that, study and research will be done in order to construct a three-dimensional image presentation by using C++ language with OpenGL in Microsoft Visual Studio .NET environment framework. A conversion system prototype will be designed and implemented solely on images using C++ with OpenGL. It will load the image and manipulate it in order to come out with the resulting three-dimensional image representation.

This project is relevant to the study of image processing as well as the study of technology enhancement. Besides that, the research area is also relevant to the study of Computer Graphics and Computer Vision. Other than that the project also touches the concept of two-dimensional and three-dimensional image presentations. The project also uses the concept of stereopsis.

## **2 CHAPTER 2: LITERATURE REVIEW/ THEORY**

### **2.1 Literature Review**

#### **2.1.1 Carnegie Mellon Project Review**

This literature review is based on a press release entitled Carnegie Mellon Researches Teach Computers to Perceive Three Dimensions in 2-D Images on June 13, 2006. The method they use is to teach computers on how to spot visual cues that differentiate between vertical surfaces and horizontal surfaces in photographs of outdoor scenes using machine learning technique.

Machine learning makes system capable of autonomous acquisition and integration of knowledge. The technique enables computers to learn from experience, analytical observation and other means.

The machine learning program develops statistical association between certain shapes, shading and other characteristics typical of each orientation on the pictures that have different vertical and horizontal surfaces that is showed to the computer for this purpose. This program also enables the computer to recognize the objects in the pictures based on real world constraints. Examples of these constraints are the fact that most objects are on the ground and that the skies colour is blue.

The methodology used by this system will need another expert system which offers the functionality to sort the entire digital images that it have been shown to and identify the similar pictures by making statistics based on those pictures in order to use it to perceive the digital image characteristics. By using this statistic, the digital image can be converted to its equivalent three-dimensional image presentation.



## **2.12 Photogrammetric Modelling**

Please refer to Photogrammetric Modelling and Image-Based Rendering for Rapid Virtual Environment Creation paper by Charalambos Poullis\*, Andrew Gardner and Paul Debevec. The objective of this paper is to propose on a new approach for modeling and rendering existing architectural scenes from a sparse set of digital image photographs.

They use photogrammetric modeling techniques to recover and identify the geometric representation of the architecture. This modeling method enables the computer to perceive the parameters of a hierarchical model in order to reconstruct the architectural scene. Facade v2.0, an easy-to-use interactive modeling program which originally is software package for image-based modeling and rendering is implementing the concept of this photogrammetric modeling technique allows the user to construct a geometric model of a scene from digital images.

Other than that the researches also apply the usage of image-based rendering and view-dependent texture-mapping method in their solution. This method comes in useful in order to interpolating between the available photographs of the scene depending on the user's point of view when the process to color the surface of the model using multiple images combined together.

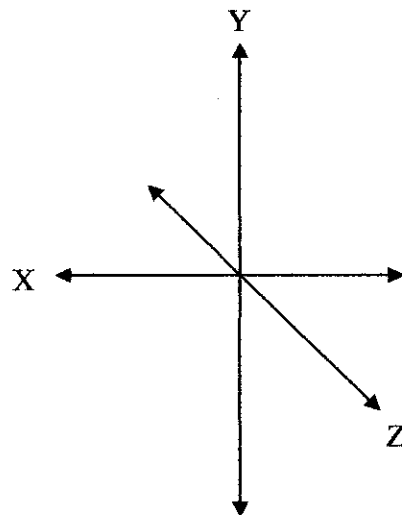
## **2.2 Theory**

### **2.21 3D Graphics**

According to Mark Giambruno, a 3D space is a mathematically defined cube of cyberspace inside the computer's memory. Cyberspace differs from real physical space because it's a mathematical universe that can exist only inside the computer. In addition, the system's software and user can manipulate this virtual space to simulate anything imaginable.

Due to the attribute of 3D space that is vast, it has its own sort of built-in Global Positioning System called coordinates. Coordinates is a unique set of three numbers that defined a point, which is the smallest area that can possibly be occupied. An example of coordinated 0, 0, 0, which define the centre point of cyberspace universe called the origin point. Each number represents the value of X, Y and Z respectively. There are three sets of values because they are related to the three-dimensions, which are the width, height and depth.

Following this, come the term of axes, in which defined as an imaginary line in cyberspace that defines a direction. A direction is the dimensions mentioned before with signposts that point to them. Please refer to Figure 1 to view the standard axes in 3D programs.



**Figure 1: X, Y and Z axis in 3-D**

X refers to the width value that run horizontally (left to right and vice versa). The “height” axis, Y is vertical that goes from top to bottom and vice versa. The Z-axis, on the other hand, is related to the depth that travels from the front to the back of the cyberspace and vice versa or towards and away from the viewer’s perspective.

## 2.22 Stereopsis

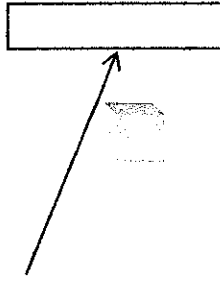
According to Mel Slater, Anthony Steed and Yiorgos Chrysanthou, with our eyes, we see the world in three dimensions. Each eye received a slightly different view of the world and the visual system fuses these into one three-dimensional stereo view. The difference in the two images is called the binocular disparity.

One of the ways in which we can prove this statement is by looking at something with the left eye closed and the other is opened. Then do the same process again, this time with the left eye opened and the other is closed. This is parallel to the term of stereopsis. Stereopsis is the process in visual perception leading to perception of stereoscope depth (sensation of depth that emerges from the fusion of two slightly different projections of the world of two retinas. The difference between two eyes' images which is the result of eyes' horizontal separation is referred to as binocular disparity as mentioned before, or also can be called as retina disparity.

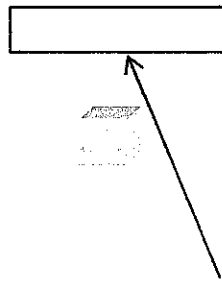
Stereopsis appears to be processed in the visual cortex in binocular cells having receptive fields in different horizontal positions in the two eyes. Such a cell is active only when its preferred stimulus is in the correct position in the left eye and in the correct position in the right eye, making it a disparity detector.

In a situation of when a person stares at an object, the two eyes converge so that the object appears at the center of the retina in both eyes. Other objects around the main object appear shifted in relation to the main object.

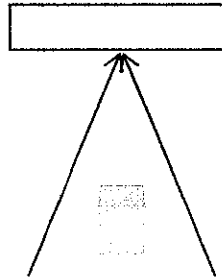
Please refer to Figure 2 to view the image shift when looking from the left eye while the right is closed, Figure 3 to image shift when looking from the right eye while the left is closed and Figure 4, to view the image when looking with both eyes.



**Figure 2: Left eye's image; side object shift to right**

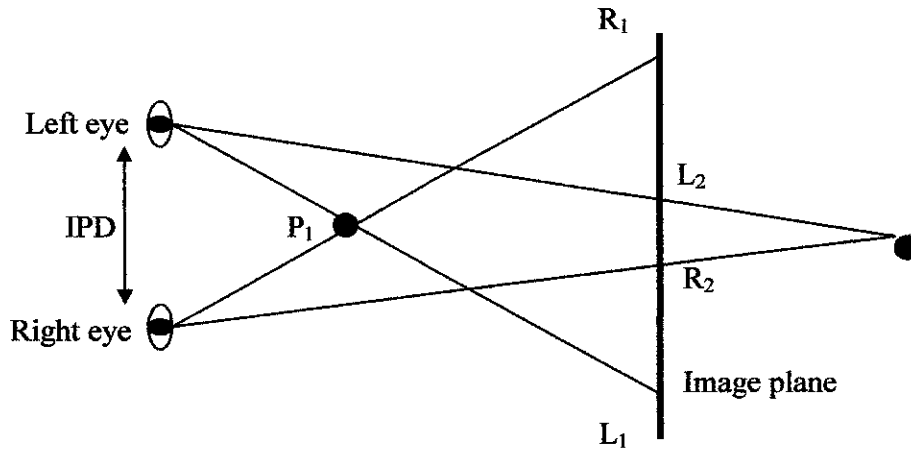


**Figure 3: Right eye's image; side object shift to left**



**Figure 4: Two eyes converge; object appears to be at the center**

Also according to Mel Slater, Anthony Steed and Yiorgos Chrysanthou, the diagram to show a schematic view of a left and right eye and an image plane on which points in the scene are to be projected can be viewed in the Figure 5 below.



**Figure 5: Stereo view**

The IPD is the interpupillary distance between the two eyes. Point  $P_1$  is on the near side of the image plane and projects to point  $R_1$  for the right eye, and  $L_1$  for the left eye.  $P_2$  is on the far side of the image plane and projects to  $R_2$  and  $L_2$  respectively. The projected image points of a single scene point are called homologous.

### 2.23 Digital Image

According to Wikipedia, a **digital image** is a representation of a two-dimensional image using ones and zeros (binary). Depending on whether or not the image resolution is fixed, it may be of vector or raster type.

This final year project will use a digital image in terms of pictures taken using a camera as an input for the system. Then this image will be manipulated in order to come out with the resulting three-dimensional image representation. It is fairly important to research in depth regarding digital image in order to ease the development of the system.

According to Jonas Gomez and Luiz Velho, the elements of a digital image are essentially the pixel coordinates and the color information at each pixels. These two elements define the spatial resolution and color resolution of the image. The number of components of the pixel is the dimension of the color space in question. Thus, each pixel in monochrome image has a single component. The gamut of a digital image is the set of colors of the quantized color space. A monochrome image whose gamut has only two colors is called the bilevel image or bitmap and if got more than two levels is called grayscale image.

An image can be processed and work separately by its component. By doing this, it can simplifies considerably certain operations that needed to be done. A bitmap is an array of pixels values which is used to define an image. It can have different bit depth and resolutions and represent in terms if rows and columns of dots in a graphic image seen through the computer screen.

According to Edward Angel, color in computer graphics is based on what has become known as the three-color theory. Using the additive color model, color is formed from three primary colors that are mixed the desired color. The color can be matched by adjusting the intensities of the primary color.

### **2.24 Depth Value**

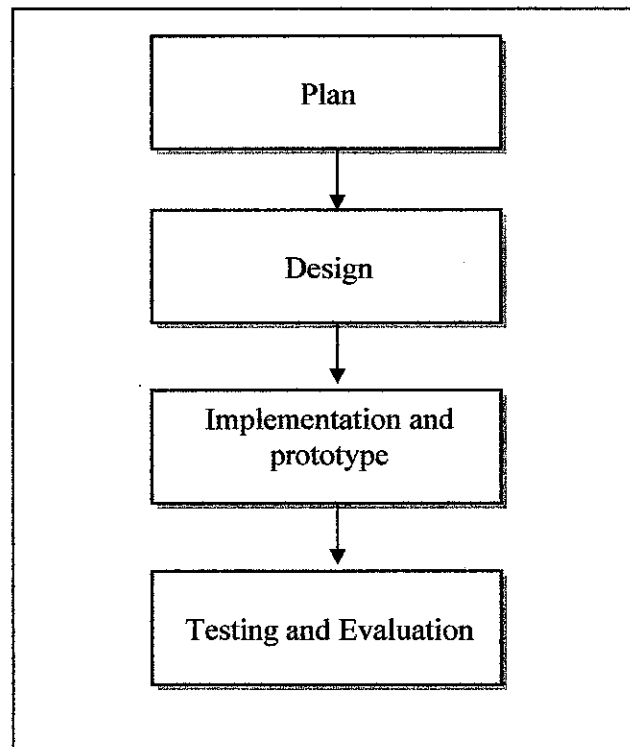
As mentioned before, a two-dimensional image is different from a three-dimensional image in terms of an addition value of a -dimensional image called the depth. In order to convert a two-dimensional image to a three-dimensional image, the depth value, which is the Z-axis of the image, must be added to the image.

### 3 CHAPTER 3: METHODOLOGY/PROJECT WORK

#### 3.1 Research Methodology

There are several types of methodologies that can be used in order to develop projects. Examples of those methodologies are spiral methodology, agile development methodology, waterfall methodology, prototyping methodology, and many more. These methodologies are unique and have certain strength and weaknesses that make them suitable only to be used by certain projects.

The methodology used in order to create this conversion system is based on waterfall methodology. Please refer to the figure below that shows the waterfall methodology diagram that has been modified to suit the project criteria. The methodology involves several phases, in which will be explained in detail in the following pages.



**Figure 6: Project Development Methodology**

### **3.11 Plan**

Planning is a very essential aspect not only in our everyday life but also in developing projects. A project that is not planned well might not develop according to requirements, which usually have certain constraints and agreement like time, features of the program result, cost and many more. This would likely to lead into a lot of problems to arise in the future.

Thus, the first step in order to complete this project is to plan. This phase will take note on several aspects which might not be very visible in the early development process and to come out with a schedule of every project activities based on the requirements given.

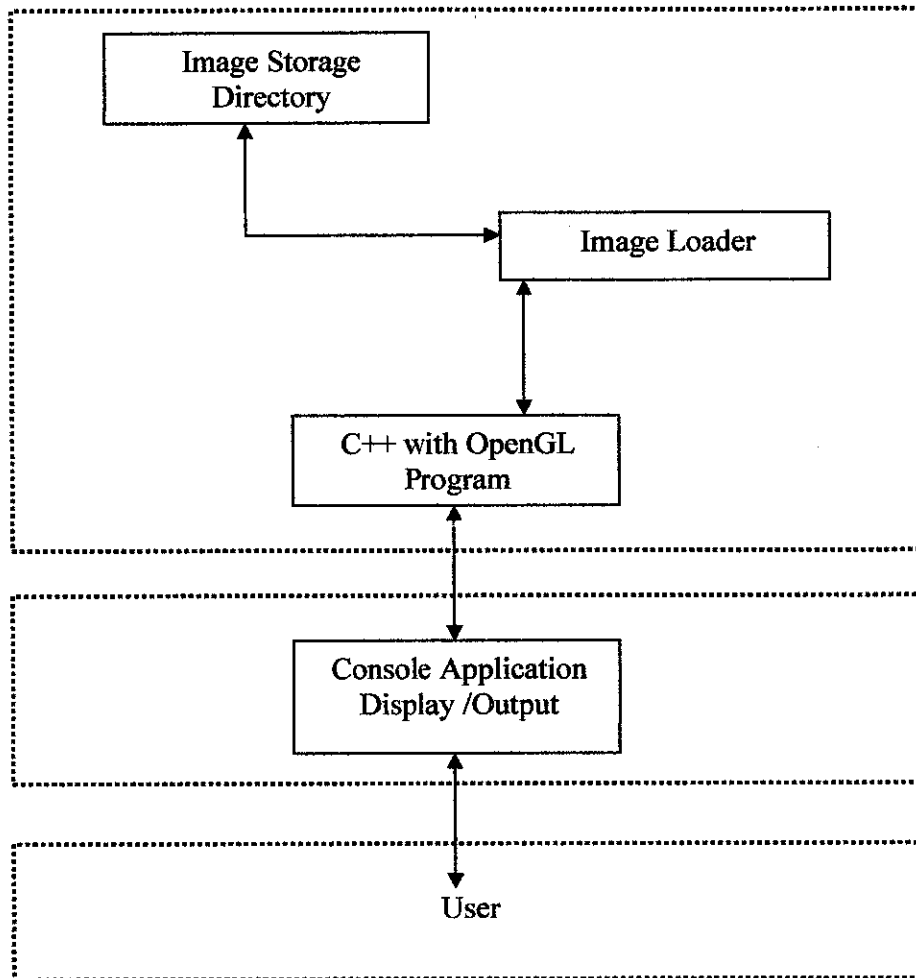
Creating a program not only centred on having the project completed but also having it completed under requirements that have been agreed upon. The planning will alert the developer to have full control of the time of development and aware of any deliverables that need to be submitted along the development phase. Keeping it on schedule also means that it will be completed on time and in the expected amount of cost.

This phase also defined the problem statements and goals that the project should have and also where the project definition and specification is being analyzed in order to come out with ways to complete the project successfully. This is usually where the gathering information and research are conducted in order to have understood more in depth about the project. The information can be gathered through the articles, discussions, internet and books.

### **3.12 Design**

This phase is where the design for the project is being discussed and conducted. The design for this program will guide the next phase of this development cycle, which is implementation phase.





**Figure 7: 2D to 3D Architecture Design**

Based on the Figure 7 above, the image storage directory is where the image to be used as an input to the program is being kept. The image loader will then load the image to be processed when the user run the C++ with OpenGL program to begin the conversion process. Then the image is being manipulated and the resulting image representation will then can be viewed by the user through the console application display as the output of the program.

### **3.13 Implementation and Prototype**

The implementation phase of the program will focus more on developing the application itself that have been designed according to the requirement in the design phase beforehand. This project will use Microsoft Visual C++ environment framework and OpenGL library to come out with the working application.

### **3.14 Testing and Evaluation**

Testing phase is also one of the important aspects of developing program. The developer can ensure and the program written is working and gives the desired output based on the requirements. This testing phase will use real data testing, in which digital images will be use to complete the testing. By doing this, it can ensure that the program is able to convert a two-dimensional image and produce its corresponding three-dimensional image presentation.

## **3.2 Project Activities**

1. Conduct some research in order to find more information regarding two-dimensional image and three-dimensional image.
2. Study more in depth about tools used and researches and projects done by other people.
3. Do some practical and testing sessions using OpenGL.
4. Try to come out with ideas in order to come out with the conversion system.

### 3.3 Key Milestone

#### 3.31 Key Milestone for Semester July 2007

No.	Detail/ Week	1	2	3	4	5	6	7
1	Selection of Project Topic	■						
	-Propose Topic							
	-Topic assigned to students							
2	Preliminary Research Work		■					
	-Introduction							
	-Objective							
	-List of references/literature							
	-Project planning							
3	Submission of Preliminary Report				●			
4	Seminar 1						■	
5	Project Work				■			
	-Reference/Literature							
	-Practical/Laboratory Work							
6	Submission of Progress Report							
7	Seminar 2							
8	Project work continue							
	-Practical/Laboratory Work							
9	Submission of Interim Report Final Draft							
10	Oral Presentation							

● Suggested milestone

■ Process

**Table 1: Milestone for Week 1 - Week 7**

No.	Detail/ Week	8	9	10	11	12	13	14
1	Selection of Project Topic							
	-Propose Topic							
	-Topic assigned to students							
2	Preliminary Research Work							
	-Introduction							
	-Objective							
	-List of references/literature							
	-Project planning							
3	Submission of Preliminary Report							
4	Seminar 1							
5	Project Work							
	-Reference/Literature							
	-Practical/Laboratory Work							
6	Submission of Progress Report	●						
7	Seminar 2			■				
8	Project work continue	■	■	■	■			
	-Practical/Laboratory Work	■	■	■	■			
9	Submission of Interim Report Final Draft					●		
10	Oral Presentation							●

● Suggested milestone  
 ■ Process

**Table 2: Milestone for Week 8 - Week 14**

### 3.32 Key Milestone for Semester Jan 2008

No.	Detail/ Week	1	2	3	4	5	6	7
1	Project Work							
2	Submission of Progress Report				●			
3	Project Work Continue							
4	Submission of Progress Report 2							
5	Seminar							
6	Project Work Continue							
7	Project Exhibition							
8	Submission of Dissertation							
9	Oral Presentation							
10	Submission of Project Dissertation							

● Suggested milestone  
 Process

**Table 3: Milestone for Week 1 - Week 7**

No.	Detail/ Week	8	9	10	11	12	13	14
1	Project Work							
2	Submission of Progress Report							
3	Project Work Continue							
4	Submission of Progress Report 2	●						
5	Seminar		■	■	■			
6	Project Work Continue	■	■	■	■			
7	Project Exhibition			●				
8	Submission of Dissertation					●		
9	Oral Presentation						●	
10	Submission of Project Dissertation							●

● Suggested milestone  
 ■ Process

**Table 4: Milestone for Week 8 - Week 14**

### **3.4 Tools**

There are a few tools that are required to be used during research, development phase of the project, documentation and any related project work in order for Final Year Project to achieve its intended objectives.

One of the tools required is a set of computer with Windows-based operating system computer. Other than that, it is also must be equipped with Microsoft Visual C++ environment framework and a few applications and programs such as Microsoft Office package tools. Besides that, the project also required a digital camera, Canon PowerShot A430 to provide data and images from on site results as well as from the internet and other references.

## **4 CHAPTER 4: DISCUSSION**

### **4.1 Microsoft Visual C++ .NET**

Microsoft Visual C++ .NET, or Visual C++ for short, is a Windows-based, visual development environment for creating C and C++ applications. It is a part of Microsoft Visual Studio line of products. It is equipped with some features that make it an interesting and suitable product for development process.

It is a product engineered by Microsoft for the C, C++, and C++/CLI programming languages. It has tools for developing and debugging C++ code, especially code written for the Microsoft Windows API, the DirectX API, and the Microsoft .NET Framework.

### **4.2 OpenGL**

OpenGL (Open Graphics Library) is a standard specification defining a cross-language cross-platform API for writing applications that produce 2D and 3D computer graphics. The interface consists of over 250 different function calls which can be used to draw complex three-dimensional scenes from simple primitives.

OpenGL was developed by Silicon Graphics Inc. (SGI) in 1992. It provides some pre-packaged functionality and a library that provides various functionalities in order to manipulate two-dimensional and three-dimensional graphics. It is widely used in CAD, virtual reality, scientific visualization, information visualization, flight simulation and also video games.



### 4.3 Result

The development of the project has been taken into conclusion that there are few aspects that need to be noted off. Firstly, the usage of console application in order to display the output of the system in Microsoft Visual C++ .NET environment framework.

The process of the conversion system starts off with storing two-dimensional digital image in image storage directory. Then, the image loader will load the image into the system in order to use it as an input. After that, the image will be manipulated and transformed into its corresponding three-dimensional representation. Lastly, the result will be displayed in console display of Microsoft Visual C++ .NET environment framework. Please see below for an example of output for the system.

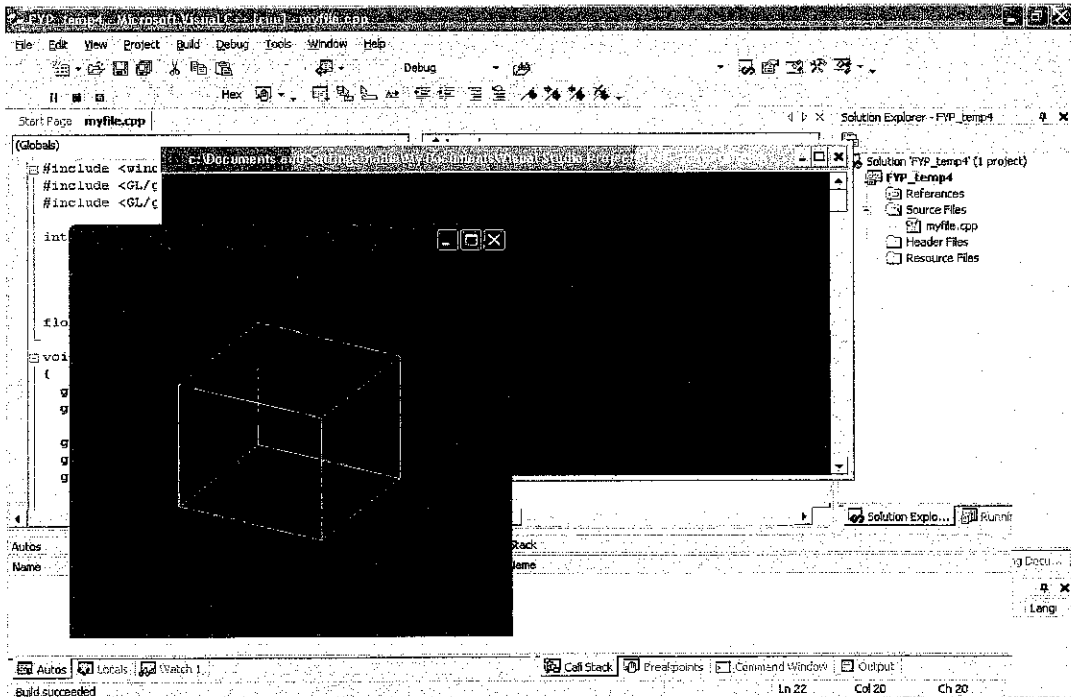


Figure 8: An example of output

## **5 CHAPTER 5: CONCLUSION AND RECOMMENDATIONS**

### **5.1 Conclusion**

The project is basically to come out with a system that enables the conversion of a digital image into its corresponding three-dimensional image presentation.

A two-dimensional image can be converted into a three dimensional image by adding the depth value to it. There are also some factors such as the lighting and colour scheme in which must be taken into consideration when using an image as the input.

By doing more research and developing this project using Visual C++ OpenGL, this project hopefully can achieve its intended objective within appropriate time.

### **5.2 Recommendation for future works**

The project will be using images taken with object that have even surfaces. It will be interesting to further the development of the project using uneven surface and layout as the input image and turn it into corresponding three-dimensional image representation.

## REFERENCES

1. 3D computer graphics <[http://en.wikipedia.org/wiki/3D\\_computer\\_graphics](http://en.wikipedia.org/wiki/3D_computer_graphics)>
2. 2D computer graphics <[http://en.wikipedia.org/wiki/2D\\_computer\\_graphics](http://en.wikipedia.org/wiki/2D_computer_graphics)>
3. Digital Image <[http://en.wikipedia.org/wiki/Digital\\_image](http://en.wikipedia.org/wiki/Digital_image)>
4. Stereopsis <<http://en.wikipedia.org/wiki/Stereopsis>>
5. Byron Spice, Anne Watzman. 13 June, 2006  
<[http://www.cmu.edu/PR/releases06/060613\\_3d.html](http://www.cmu.edu/PR/releases06/060613_3d.html)>.
6. Charalambos Poullis\*, Andrew Gardner and Paul Debevec.  
<<http://www.ict.usc.edu/publications/poullis-facade-asc.pdf>>
7. Mark Giambruno. 2002, "3D Graphics and Animation Second Edition" New Riders Publishing.
8. Tom McReynolds and David Blythe. 2005, "Advanced Graphics Programming Using OpenGL" Morgan Kaufmann Publishers.
9. Jonas Gomes and Luiz Velho. 1997, "Image Processing for Computer Graphics" Springer-Verlag New York, Inc.
10. Richard S. Wright, Jr and Benjamin Lipchak. 2005, "OpenGL SuperBible, Third Edition" Sams Publishing.
11. Mel Slater, Anthony Steed and Yiorgos Chrysanthou. 2002, "Computer Graphics and Virtual Environment" Addison-Wesley Publishing.

12. Edward Angel. 2003, "Interactive Computer Graphics, A Top-Down Approach Using OpenGL, Third Edition" Addison-Wesley Publishing.
13. Don Gosselin. 2002, "Microsoft<sup>R</sup> Visual C++ .NET" Thomson Course Technology.
14. How 3-D Graphics Works.  
<<http://computer.howstuffworks.com/3dgraphics1.htm>>
15. Compute 3D shape and scene from a single image  
<[http://www.cs.ucla.edu/~hanf/compute\\_3d\\_shape.htm](http://www.cs.ucla.edu/~hanf/compute_3d_shape.htm)>
16. OpenGL Programming Guide  
<<http://fly.cc.fer.hr/%7Eunreal/theredbook/chapter03.html>> Addison-Wesley Publishing.