

3D RECONSTRUCTION IMAGE USING SINGLE LOW RESOLUTION
WEB CAMERA

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This Report Is Submitted In Partial of Requirement for the Bachelor Degree of
Electronic Engineering (Computer Engineering)

Faculty of Electronic Engineering and Computer Engineering
University Teknikal Malaysia Melaka

JUN 2014



UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN
KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : 3D reconstruction image using single low resolution web camera

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ACKNOWLEDGEMENT

Bismillahirrahmanirrahim.

Alhamdulillah, thanks to Allah, whom with His willingness to give me this blast opportunity to complete my final year project, as well as publishing this reports to be presented to my wonderful Faculty of Electronic and Computer Engineering, of University Teknikal Malaysia Melaka(UTeM), Insha'Allah. This final year project program is compulsory subject to fulfil the degree requirement.

I wish to appreciate with my gratitude to my supervisor, Dr.Wira Hidayat, we have been through many moments in this one years in order to achieve the objective of this project. He taught and guild me to finish up the project. All of his help and advices are so priceless and unforgettable.

I gracefully acknowledge my classmates and lecturers who assist me and support my work for this period of one year. I express my thanks to them as they always give me a lot of information, knowledge and kindness along the time.

Thank you

ABSTRACT

3D image reconstruction is a technique of reconstructing the 3D model from the series of 2D images of the object. This reconstruction method requires a specific programming algorithm and enhancement method in order to produce a 3D model that resembles the real object. The object to be modelled will be placed at the centre of the plate with suitable background and it will be rotated manually and at the same time the 2D image of the object is captured in every 10 degree angle from 0 to 360 degree. All of these captured images will be processed by using space carving technique with MATLAB software to produce the 3D model. By the end of the study, the parameter of the 3D image reconstruction algorithm will be optimized by using camera calibration in order to improve the overall systems performance.

ABSTRAK

Pembinaan semula imej 3D adalah teknik membina semula model 3D daripada siri imej 2D objek. Kaedah pembinaan semula memerlukan algoritma pengaturcaraan tertentu dan kaedah peningkatan untuk menghasilkan model 3D yang menyerupai objek sebenar. Objek yang akan dimodelkan akan diletakkan di tengah-tengah plat dengan latar belakang yang sesuai dan ia akan diputar secara manual, dan pada masa yang sama imej 2D objek yang ditangkap dalam setiap 10 darjah sudut daripada 0 ke 360 darjah. Semua ini imej yang ditangkap akan diproses dengan menggunakan perisian MATLAB untuk menghasilkan model 3D. Pada akhir kajian ini, parameter algoritma pembinaan semula imej 3D akan dioptimumkan dengan menggunakan penentuan kamera untuk meningkatkan prestasi sistem secara keseluruhan.

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LIST OF ABBREVIATIONS

2D	-	2 Dimensions
3D	-	3Dimensions
WWW	-	World Wide Web
SFS	-	Shape from Silhouette
USB	-	Universal Serial Bus
PC	-	Personal Computer
TIF	-	Tagged Image Format
PPM	-	Portable PixMap
RGB	-	Red Green Blue
Fc	-	Focal length
Cc	-	Principle length
Kc	-	Distortions

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CHAPTER 1

INTRODUCTION

In this chapter, the overall description and the purpose of the entire project is explained briefly and compact. This includes why and how the project is done. The chapter start with background and continue with project overview, project scope, problem statement, aim and objectives, scope of work and thesis plan.

1.1 BACKGROUND

3D images become a particularly attractive topic to the world currently. Nowadays, it becomes a main point for professional designers as another challenging skill that they needed to enhance their work by mastering it. Moreover, it important in real world such as applications of 3D models, robot navigation, computer graphics, and computer games, virtual reality inspection, TV/film special effects, navigation, and object identification [1].

Additionally, 3D really fascinates the users in the field of investigation, medics, architects, realistic film making, and preservation architecture for archaeological field. This 3D object reconstruction always used in the area of engineering, medical, product design and artistic design.[2]. In the past decade,

notable researchers undergo various experiments to achieve accurate and the best 3D renovate.

Actually, this is not new, the affordability of technology that rapidly develop make several achievement in the field of image processing from 2D to become 3D, acknowledge to keep occur and progress. These include many experts' scientist and researchers in the areas of graphics, computing, geometry that strengthen the theory they study about the 3D reconstruction.

In fact, many methods have been created even in the form of various updated software currently available on the World Wide Web (WWW) for consumers to download in order to diversify and take advantage of the current technology of today.

This case study is important in many fields, especially from the point of academic, marketing, computing and design. Numerous efforts have been made to keep the progress in developing and understanding more about the system of the 3D construction concept that can be applied by the community.

Now, researchers are just focusing on the upgrading and diversification techniques through the study, with more budgets and the support needed from the latest technology. In fact, it can bring surreal or unique ideas into reality or implied in the virtual world. The human ability to look at things in a stunning way is the reason why researchers are very obsessed in making something that can be described in the real world. For example, 3D movies are the latest trend for film lovers and it is very prevailing and entertaining.

Despite the advantages of the multiple views in much direction, which are very exciting, 2D approaches is more understandable and reliable compared to 3D, such as painting, or artwork made by artist, comic maker. In fact, the high cost of development for research, tools, and processing further will complicate efforts in the field of 3D.

Aspects about functioning properly, maintenance, and damage reducing for machines must be considered into account for anyone who wants to open up business

marketing in this area. Back to the software, which is more easily applied, the accuracy of the approach is still an issue for consumers. This is because the computation of each angle, interference rays of light, colour, and texture of an object can dispute these 3D reconstruction capabilities.

As a fact, even though it is use as a study material for academics and experts, who understand how the software assisted them in their studies for the future. Even so, essentially from a single image, we can indeed produce a 3D model, through specific data entry and by only use of low resolution picture in a restricted environment objects.

It should also be take into consideration about the difficulty to identify something like heat, humidity and other factors around the object image. So, a detailed study needs to be done, to achieve more satisfactory outcomes.

In addition, 3D image requires large data storage and processing to get an accurate result. Therefore, the engineers, graphical, and experts in the matrix world need to make a detailed study to realize the dream of this 3D reconstruction.

The main point of this study is to focus on a small limited object to make 3D reconstruction. Due to the weakness that has been noted, as researchers, many key points need to be considered, any hindrance to reach the study will be discussed.

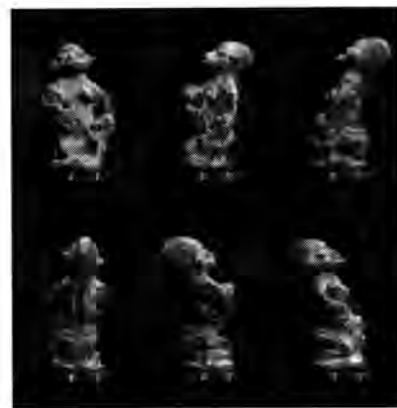


Figure 1.1 : Image Acquisition [3]

With only a low-resolution camera, a metric approach, for each pixel point to be taken into account to establish the algorithm for reconstruction. Moreover, 3D reconstruction of the scene from the multiple images is underlying problem in computer vision [1]. Figure 1.1 show the first step of the 3D reconstruction image by applying image Acquisition, which is contain the image in real world into the digital format.

The techniques that we want to approach are like taking photographs of objects from every angle around the object. Each degree is taken into account to generate and analyze the proceedings of each photo that obtained and stored properly to be processed later. We treat the picture in sequence, before combined. This image will be fixed and be connected through certain process anxious to be 3D model.

Referring to Figure 1.2, the model images acquired are arrayed in sequence so that, the algorithm that we need to make up, can program every picture's information, and then lined up in every degree of rotational to fit on the original position of the model.

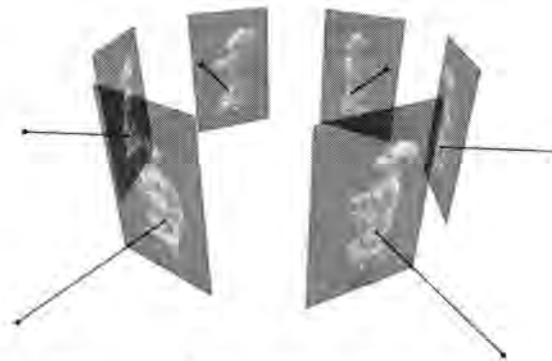


Figure 1.2 : Camera Calibration [3]

This calibration is the most importance part before reconstruction. Every single angle and views need to follow the alignment in order to program it later. These adjustments are really importance since it holds the value of the camera metrics used for reconstruction method algorithm.

Calibration is the process of matching up between the images with the camera view that used to capture the image of the object model. Further explanation will be making at Chapter 2 later.



Figure 1.3 : 3D reconstructions [3]

Ancillary tasks are needed in this study where to extent the possibility to avoid or minimize damage to the 3D image model. So, of course the object must be in synchronize with the movement of the camera around the object, to produce a good result.

While in Figure 1.3, the result of the 3D reconstruction by using a method picked, in Figure 1.4, the process proceeded by texture mapping. The object model is mapped with the original colour, texture, and any information hold at the image.



Figure 1.4 : 3D texture mapping [3]

But before that, we need to make sure an adjustment for every single image that been captured by camera, and computed them and analyze according to their position, and angle. Data acquisition brings main idea about how the overall picture is analyzed and recombines. In Figure 1.5 is the result of reconstruction before refinement, which the result is in the correct position for every image view.



Figure 1.5 : Both silhouettes and projection matrices are correct [3]

If not, this is the result that we will face, referring to Figure 1.6. Where the 3D model is slightly deflected from the right spot, make a shape unrecognized same as the original object. Thus, our objective couldn't be achieved. Calibration is so importance to make this 3D reconstruction. Moreover, our algorithm and flow to make the process of reconstruction need to be improved every time, so that the good result can be analysed.



Figure 1.6 : Both silhouettes and projection matrices are incorrect [3]

From overall process, the camera need to capture at most from the entire angle around the object model parallel without any blocking, and crooked. And then the image must be saved in sequence. The image could be calibrated in the right position and the reconstruction can be done in the right moment. Given on set of images of a scene captured from multiple calibrated cameras, the goal is to recover the unknown 3D structure using these images and the knowledge of the camera geometry [1].

1.2 PROJECT OVERVIEW

This project is about to develop 3D image reconstruction method which is a technique of reconstructing the 3D model from the series of 2D images from 360 degree around the object. These reconstruction methods are capable of combining as many as 2D images as possible into a single 3D image and visualize it.

There were many methods to make a 3D image reconstruction. But in this project, we focus only in limited model object. The process at first required an input data of images that to be used for the reconstruction. Most of it is an object of small model such as stuff animal, figurine, and etc.

This several images are captured from several different views, and then recombine them all by using a reconstruction method. To accomplish this, processing using software, programming and running code is needed to make the 3D image output.

Based on this theory, MATLAB software is one of main tool in the programming part. It consist image capturing, input data controller, and algorithm of processing the data into producing the output result. Combining with image capture device such as web camera with low resolution, MATLAB code will control the number of image to be capture in the given times for several angles.

This web camera must be connected to the laptop that contains MATLAB so that the entire image is safely located at data storage and reconstruction process can

be run. Camera calibration is needed to ensure the combination image is based on the distance, focal point between camera and the object.

In order to capture several images from difference angle, we need something to move the camera, or move the object in 360 degree in front of the camera. At first, the idea is to move the camera around the object with certain mechanism that work in certain degree of freedom. Robot arm is one of our targets, since it can hold the camera and make rotational around the object with help of servo motor, in the correct direction.

Unfortunately, this technique required high cost of material and construction, plus required more time to make and study the angle of rotational. So, we assume to note that, the object is the one that should rotate, while the position of camera is fixed.

1.3 PROBLEM STATEMENT

Conventionally, the 3D image reconstruction from 2D images using the camera is done in such a way that the camera is moving horizontally or vertically toward the object. In our proposed method, the camera is attached statically, and the object need to be rotate in many angle to make versatility for 2D images to be captured especially to render the surface that cannot be seen from the limited point of view.

Most of the research are using high cost camera [2]. This will bring up several disadvantages in the real world. By using a single low cost and low resolution web camera, this project tries to overcome this problem. Other method is by using such a high technology like a laser scanner and medical magnetic resonance [2], but it just rise up the same problem which is the increase in cost.

Furthermore, most of the researches using costly software, and difficult algorithm, which involve long time study. So in this project, we are using MATLAB software since this software is using a lot of mathematical calculation, which can be