3D Reconstruction of Uniform Curved Object Model From 2D Images

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Abstract *- In this research we proposes a method to reconstruct the 3D uniform curved images from 2D images. Reconstruction method use the stereo vision algorithm (rotation and translation between the two cameras) and shading algorithm to enforce integrability to various faces of the 3D object. The theorem of the stereo vision were simulates the human's eyes to calculate the object's depth information. After apply the stereo vision algorithm, we just involve the rotation model and differentiate the each face of the uniform 2D circular object. Now estimate the feature points on every face to calculate the light intensity on each face. Finally integrate the each modified face of 2D uniform circular object to reconstruct the complete 3D uniform curved object's model.*

Keyword: *Stereo vision algorithm, Shading algorithm, Rotation model and Uniform Circular 2D Object.*

I. Introduction

Image processing is the growing field with lot of applications in our daily life. Image processing has been extended from 2D (2-Dimensional) image to 3D (3-dimensional image. Due to advancement in technology we are able to convert the 2D images to 3D images. 2D images are the images that only deal in 2 dimensional space using the X & Y (horizontal and vertical) axis i.e. image has only two dimensions and if turned to the side becomes line. 3D images add 'Z' dimension. Third dimension allows the rotation and depth of the image. So the difference between 2D and 3D image is the depth information. So in reconstruction of 3D image process we have to extract the exact depth information of a 2D image[1]. One of the method to calculate the depth information is by using stereo vision algorithm. The theorem of the stereo vision simulates the human eyes. Stereo vision[7] used two cameras to capture object's 2D images. According to the geometry relationship between the two cameras the system is able to calculate the depth information from the images. We can extend this theorem for using three or more cameras [4]. This theorem calculates the depth information by substitute the gray value of each pixel into the model. The Photometric Stereo theorem improves the Shape from shading theorem to receive more surface information. The Photometric Stereo theorem use one camera and one projector. The projector illuminates the object from several directions. We use the data from the all images and diffusion model to calculate the gradient of the surface for reconstructing the 3D model. Now by using stereo vision algorithm we can reconstruct 3D images from 2D images which are non circular in shape[4].

This paper is based on stereo vision algorithm with the shading and rotation model to calculate the projection of the 2D image to reconstruct the complete 3D uniform circular object model.
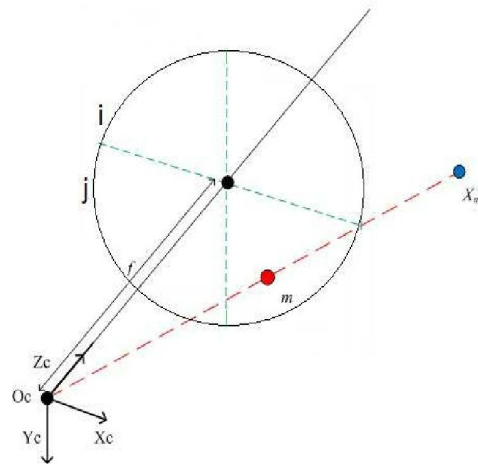
II. Projection Perspective

Fig.1

Perspective projection simulates the human eyes to project the image onto the 2D image. 'f' is the focal length of the camera. According to the pinhole camera model we are able to build up the projection matrix. The parameters of the matrix are composed by the camera intrinsic parameter. If X_m is a point in the real world, then m is the projection point that X_m be projected onto the 2D image. The transform matrix of the points Xm and m as shown in equation (1). fx, fy are horizontal and vertical focal length of the camera. r is skew factor, uo, vo are coordinate center of the image.

$$Xm = \begin{vmatrix} fx & Y & uo \\ 0 & fy & vo \\ 0 & 0 & 1 \end{vmatrix} m \qquad (1)$$

III. Stereo Geometry

Stereo vision is a method of determing the 3D location of objects in a scene by comparing images of two separate cameras. The stereo vision simulates the human eyes to calculate the depth information. In a real word an object is projected onto a 2D coordinate space by two cameras[1]. Now rotating the object and capturing the image of each face of the object. This general projection method is shown in figure (2), as below:-
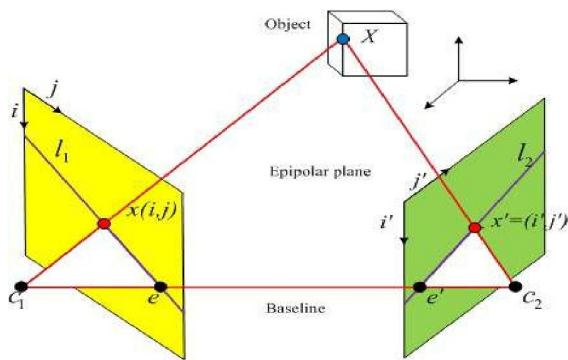

Fig.2

IV. Proposed System

Flow chart for the proposed system is as below:--

Fig.3 Flow Chart of the Experiment

Point X is a point on the object surface in real world. Space point X is projected in the 2D coordinate space by Camera 1 and Camera 2, and the points x and x′ are the projection point. The points C1 and C2 are the projection center points of Camera 1 and Camera 2 as shown in figure 1. The plane composed by X , x, x′. C1 and C2 points is epipolar plane. The line that connects C1 and C2 points is baseline. The points e and e′ on the baseline are epipolar poles[3]. Any point in real world space compose different epipolar plane with two projection plane. But the baseline and epipolar poles were never changed. The lines crossed by the epipolar and projection planes are epipolar lines l1 and l2. Any point on the epipolar plane will be projected on the epipolar lines l1 and l2. According to this rule we can reduce the researching area to find out the projection point the two images.
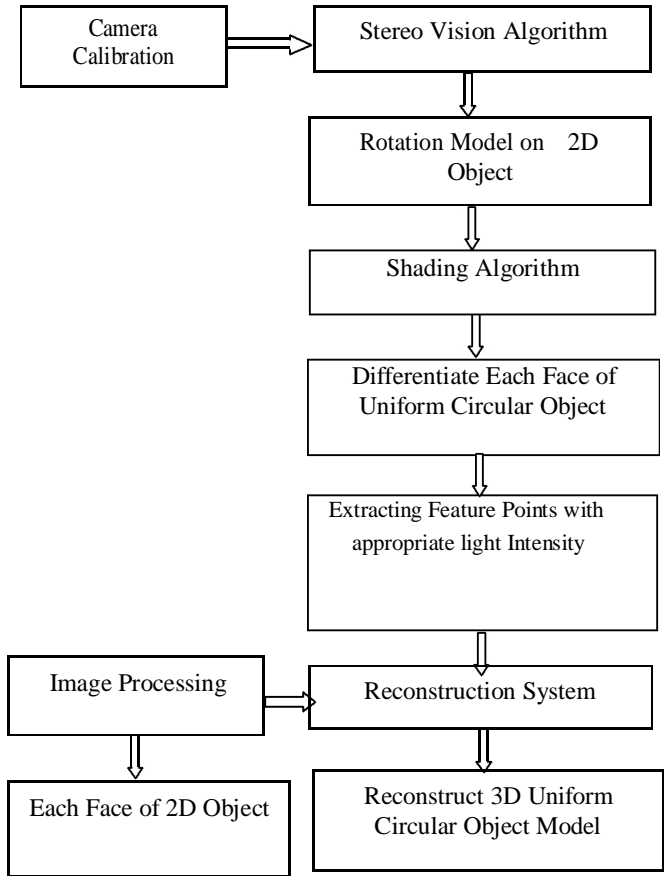
In the stereo vision system we use the focal length of the cameras and the projection center points to recover the projection points to the 3D space. The line function can be defined by the projection point and projection center point. To recover the space point X by solves the two line functions.

The match points on right image can be found out by the feature points on the left image. If there exist a feature point $P_l=(x_l,y_l)$ on the left image and we want to search the match point $P_r=(x_r,y_r)$ on the right image, we can restrict the search area within horizontal[6]. Because the configuration of the cameras we can search the match point $P_r=(x_r,y_r)$ from the feature point $P_l=(x_l,yl_l)$ at the same height. So we search for the point that yr=yl on the right image, and substitute into the function $(x_r,y_r,1)F(x_l,y_l,l)$ to find out the match points that have the minimum value of the function. Then we have four

points that reconstruction required the two match points and the projection center points of the two cameras[5].

This paper includes two cameras to stimulate the stereo vision algorithm. Rotation model rotate the object and by using shading algorithm we just differentiate and analyze the every face of uniform circular object. Extracting feature point on every face and calculate the light intensity depth on 2D uniform circular object. After integrating every face we finally reconstruct the 3D uniform object model.

V. Conclusion and Future Work

This research work purposed is able to reconstruct the 3D uniform circular object model successfully. We can reconstruct the 3D object from 2D uniform circular object. We extract the feature point of object and by using light intensity on each side of object we can easily reconstruct the efficient 3D object model. But it cannot reconstruct the 3D model where we have curved lines which are non-uniform in shapes. As we have various curved line object which are non-uniform in shapes, this method is not appropriate for these 2D objects to reconstruct 3D object model. For these types of objects various efficient shading algorithm shall be analyze to reconstruct the 3D non-uniform circular   object   model.

VI. References

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