SICE-ICASE International Joint Conference 2006
Oct. 18-21, 2006 in Bexco, Busan, Korea

An efficient Method for Reconstruction the Entire view of the Multiple Objects by Pair-wise Registration Technique

Thin Lai Lai Thein, Aye Pa Pa Mya, Myint Myint Sein
University of Computer Studies, Yangon
tllt@wwlmail.com; mlm@wwlmail.com

Abstract

A new approach for reconstructing the entire view of each object from the multiple images is proposed in this paper. The information of the occluded parts of an object is obtained by integrating the information of the parts of each object in successive image frames. The Pair-wise registration technique and color segmentation technique are applied for computing the depth measurements and combining the common part of an object in two images. Not only consideration of the translation displacement but also the rotational displacement for the transformation between two views. The effectiveness of the proposed method can be confirmed through the experimental results.

Keywords: Entire view, Pair-wise registration technique**,** Means square distance**,** panoramic image, camera configuration

1. INTRODUCTION

The reconstruction of 3D objects view of a virtual environment has been paid substantial attention by the researchers. An efficient method for reconstruction the entire view of the multiple objects is proposed in this paper. In our approach the entire view of each object in image is reconstructed individuality. These approach is not only different from arbitrary synthesize view of multiple object but also it can be seen entire view of each object individuality. By integrating the information of visible parts of each object from multiple images, the full view of an object can be obtained. Means square distance approach is applied for determining the corresponding parts of each object in image stream. For computing the depth measurements and combining the common part of an object in two images, we apply the Pair-wise registration technique.

Some authors have been already presented concerning these researches to synthesize the arbitrary view of the image [4, 8, 9, 13]. T.Takahashi et al. [13] proposed a method for rendering views for large-scale scenes. B.Lucas et al. [4] and M.Okutomi et al. [8] to produce the distance map of an object and a scene. In their approach, the linear parallel configuration of cameras system has been used for grabbing the multiple images. M. M. Sein [9, 10] proposed for reconstructing the arbitrary views of a scene contained large-scale object. Arbitrary synthesize view is generated from the image of multiple objects. Especially, a full-view image of the object is reconstructed. Although, each object can't be extract individually. C.Dorai et.al [3] describes a prototype system for automatically registration and integrating multiple views of objects from range data. The results can then be used to construct geometric models of the objects. Y.Chen and G.Medioni [2] avoid the search in the view transformation space by assuming an initial approximate transformation for registration, which is improved with an iterative algorithm that minimizes the distance from points in a view to tangential planes at corresponding points in other views. Soucy and Laurendeau [11] described the view integration technique that reliable view transformations are available and proceeds by building a set of triangulations with the subsets of the common surface segments between all pairs of views, and connecting them to output a global triangulation. Zhang [16] has created a statistical model for classifying outlier point pairs and he uses a heuristic method to set a threshold based on the estimated shape of the Gaussian distribution of the point pair distances.

This paper proposes a method for reconstruction the entire view of multiple objects. In many approach, the image of an object and a scene are nearly flat configuration because of the cameras have been set sufficiently far from the object. Unlike the other virtual view synthesizing system, we acquire the images not only far from the object but also near from the object. Especially, reconstructed view of each object is generated individually from the images of the multiple objects. The region of each object is extract from the images and creates individuality.

Fifth operation stages are performed in this approach. The first stage is the background subtraction and extracting the color information of the foreground object. The second stage is identifying the matching pairs of the image points. The third stage is to exact the information of each object separately based on the HSV color segmentation approach. In the fourth stages the mean of the objects from the common area of their parts can be calculated. The reconstructing the entire view of each object is generated individually in the final stage. This approach can be applied in the field of geometric modeling and 3D model reconstruction. It is also possible to create a new scene by integrating the synthesize views of multiple objects.

The entire view of each object in image is reconstructed based on the pair-wise registration technique and Gaussian method. This paper organizes as following. In section 2, computing the depth measurement of an object is presented. In section 3, we describe Pair-wise registration approach for multiple objects are presented. In section 4, we describe creating the entire view of objects. In section 5 address a few experiments with sampled images of a real scene have been done to confirm the effectiveness of the proposed method. Finally section 6 presents the conclusion.

2. COMPUTING THE DEPTH MEASUREMENT OF AN OBJECT

The 3D position of the each pixel of an object is computed from the depth data. The object's figure can be segmented from the background by the threshold of the depth value. Once the depth data Y_{ij} is obtained, the coordinates of X_{ij} and Z_{ij} are computed from the relation of the camera viewing angles and the center coordinate of image [7].

$$X_{ij} = Y_{ij}(i-a)a\tan\theta, \quad (1)$$

$$Z_{ij} = Y_{ij}(b-j)b\tan\phi$$

where (a,b) is the coordinate of the image center, and θ and ϕ are the horizontal and vertical viewing angle of the camera. The geometrical model is shown in Figure 2.

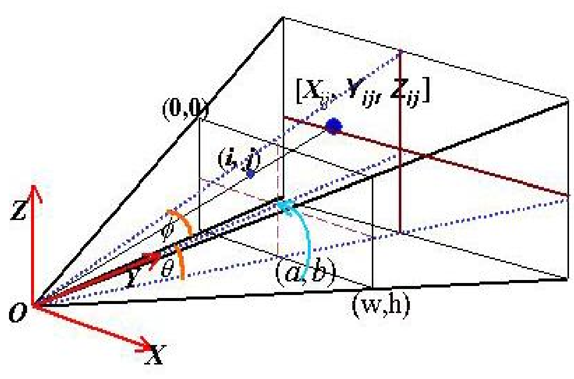


Fig.1 Geometric model of the surface data computation from the disparity image

3. PAIR-WISE REGISTRATION APPROACH FOR INTEGRATING THE PARTS OF EACH OBJECT

The complete 3D model has been obtained by generating the reconstructed parts of the reference object relative to the multiple views. An overlapping technique called the registration algorithm is employed for generating the complete 3D model of an object through the integration of the reconstructed surface parts. As shown in Figure 3, a camera rotates about the object and obtains the stereo image pairs of an object from the different view angle. The accurate transformation matrix is the key of the registration approach. At least three matching pairs of points are needed to guess the initial transformation matrix. Let us consider the registration between two parts of an object. S_1 and S_2 be the two reconstructed surface parts for view1 and view 2, respectively. There relation can be expressed as:

$$S_1 = \boldsymbol{T}S_2, \quad (2)$$

where $\boldsymbol{T}$ contains the scaling and rotation parameters.

$$\boldsymbol{T} = \begin{bmatrix} a\cos(\theta)\cos(\phi) & a\sin(\theta)\cos(\phi) & a\sin(\phi) \\ -a\sin(\theta) & a\cos(\theta) & 0 \\ a\cos(\theta)\sin(\phi) & a\sin(\theta)\sin(\phi) & a\cos(\phi) \end{bmatrix}, \quad (3)$$

where a, θ and ϕ are the scaling and rotation parameters, respectively. The initial translation matrix $\boldsymbol{T}_0$ can be detected from the above relation. The accurate transformation matrix is computed iteratively to minimize the distance between the points of the two surface parts express in the following equation.

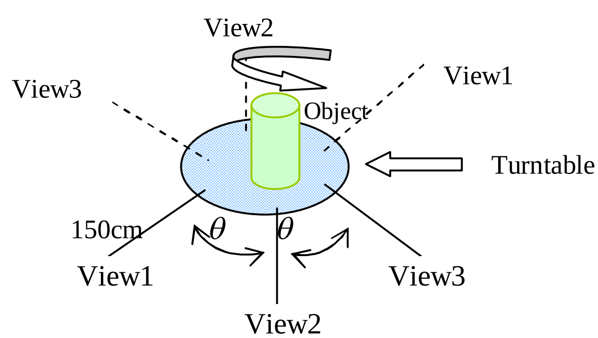


Fig. 2 The camera viewing position

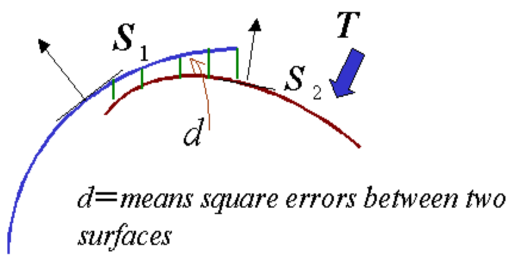


Fig.3 Means square distance errors between two surfaces

$$\varepsilon^k = \sum_i^N \|S_2 - S_1\|^2 (T_i S_2, S_1), \qquad (4)$$

where $\boldsymbol{T}_i = \boldsymbol{T} \circ \boldsymbol{T}_{i\text{-}1}$. The difference δ_i from the (k-1)th to the k^{th} iteration is defined as

$$\delta_i = \frac{1}{\boldsymbol{N}}(\boldsymbol{D}^k - \boldsymbol{D}^{k-1}). \qquad (5)$$

Where $|\delta_i| \le \varepsilon$ and N is the number of the points on the curve. This process is continued until the difference $|\delta_i|$ becomes less than a threshold value ε (>0).

4. CREATING THE ENTIRE VIEW

An algorithm is developed for generating the entire view of an object using the image stream taken from the different camera viewing points. The entire view of each object in image is reconstructed individuality based on the pair-wise registration approach. The general process for the reconstruction the entire view of the multiple object system is as follows:

[**The first stage**], is the extraction of the foreground region that includes noise filtering, the converting of the HSV color image and edge extracting processes.

[**The second stage**] is the information visible parts of each object have been extracted from multiple images by segmentation. We have captured the images running along the linear motion and detecting the correspondence points pairs of the object in multiple images.

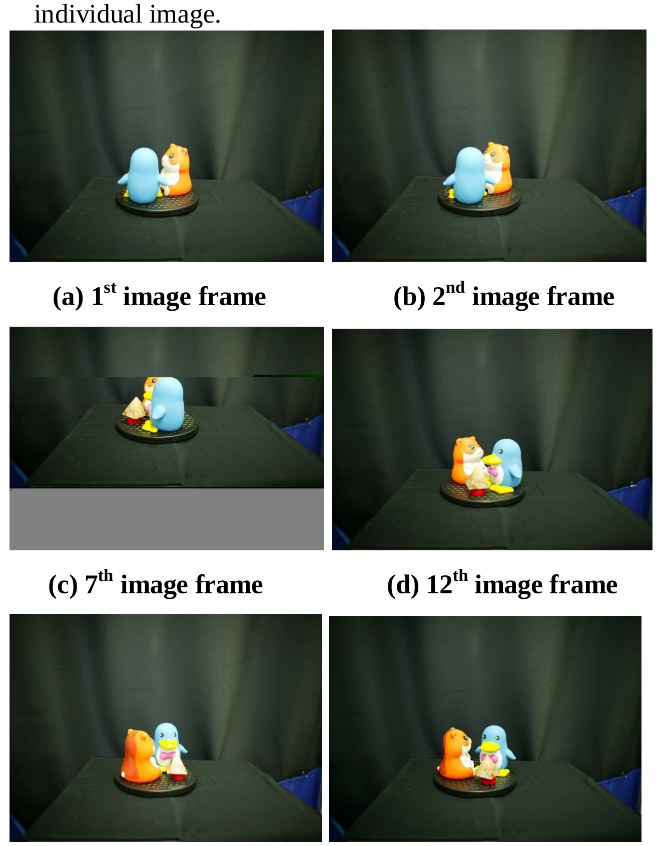
[**The third stage**] is segmenting creating the image for each object when the original image contains more than one object.

[**The forth stage**] is the integration of video stream of each object and then create the 3D information of each image.

[**In the final stage**], the entire view can be obtained by integrating the common parts of image stream.

5. EXPERIMENTS AND RESULTS

When an object is placed on a turntable and is rotating around a single axis, all its points describes 3D circles. The distance between camera and object is fixed to 150-cm. Pentium IV 2.66 MHz processor and 256 MB memory machine is used in this experiment. And MATLAB R2006a version 7.2.0.232 is employed to analyze the data. Firstly, Digital camera is used for our experiment. It consists of two pairs of stereo camera modules. Grabbing images from front by a digital stereo camera and segmented images from video stream are illustrated in Figure4. Figure5 (a) extract the foreground object of an images and Figure5 (b) convert the RGB to HSV color images. Figure 6 shows the reconstructed the individual image.



(a) 1st image frame **(b) 2nd image frame**

(c) 7th image frame **(d) 12th image frame**

(e) 16th image frame **(f) 20th image frame**

Fig. 4 Segmented images from video stream

Fig.5 (a) Extract the foreground object

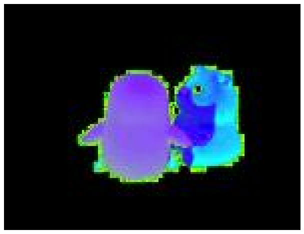


Fig.5 (b) Convert to HSV color images

Fig.6 reconstructed the individual image

6. CONCLUSION

We have presented the recent result on the reconstructing of the entire view of the multiple objects. The reconstructing the entire view of multiple objects is based on the registration approach. In our approach the entire view of each object in image is reconstructed individuality. These approach is not only different from arbitrary synthesize view of multiple object but also it can be seen entire view of each object individuality. By integrating the information of visible parts of each object from multiple images, the full view of an object can be obtained.

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