

## Research on the Fusion of Details Areas

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### ABSTRACT<sup>1</sup>

The curvature of object surface is calculated by the Gaussian curvature of free surface, thus the detail area of object can be obtained. By calculating the calculated azimuth angle of long focal length measurement system and the detail areas, the rotation angle and roll angle can be calculated to additional measure the detail areas. The object model can be obtained by the improved ICP algorithm, which fuse the object detail and original points cloud model. The feasibility and effect has been proved by experimental results.

### INTRODUCTION

Automatically constructing 3-D models of objects have been widely used in many applications. The 3-D coordinate data were acquired from the visual system, 3-D model of scenes and objects were reconstructed to confirm shape, size position of the object in 3-D space. In the previous work, we have achieved the object fast measuring by the short focal-length measurement system. But it loses the expression ability of object in the detail area, so we use the long focal-length measurement system to additionally measure the details of the object. Via the fusion of object detail area with the original point cloud model, we can get the model with the characteristics.

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## CALCULATING THE DETAILED AREAS

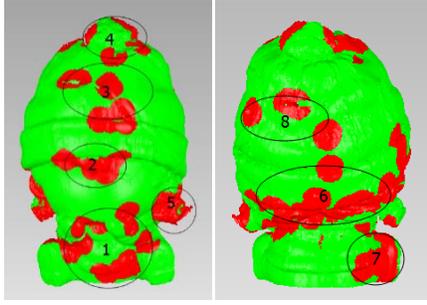
The methods of calculating the Gaussian curvature of Bezier surface [1] and NURBS (Non Uniform Rational B-Splines) surface are different [2]. So different surfaces need to be done by different procedures. The partial derivatives of each order are different. Thus, the calculation cost of the curvature is very high. Kronenberger proposed the method to calculate the free surface with Gaussian curvature [3], it does not need to seek the partial derivative. So the Gaussian curvature of free surface is applicable to arbitrarily surface. Point Cloud Library (PCL) has been employed to calculate the curvature of object surfaces according to the method of calculating the Gauss curvature of free surface. A certain threshold will be set, when the curvature is greater than the threshold is considered to be detailed areas. As shown in Figure 1, in the little girl model, the red points cloud are the detailed areas. The Statistical Outlier Removal filter is used to remove some discrete points. At the same time, Euclidean Cluster Extraction class of PCL has been used to achieve the details of the regional point cloud cluster segmentation. Set distance threshold and the adjacent fine point cloud region is less than the threshold as a class. The sequence diagram of additional measurements is shown in Figure 1.

## CALCULATING THE VIEWPOINT DIRECTION

Taking two points  $O_p(0,0,0)$  and  $P(0,0,100)$  in optical axis of the projector coordinate system. The corresponding coordinate in the platform system is  $O'_p$  and  $P'$ . So the viewpoint direction vector  $\vec{n}$  of the long focal-length measurement system can be expressed as:

$$\vec{n} = \frac{\overline{O'_p P'}}{\left| \overline{O'_p P'} \right|} \quad (1)$$

Through the calculation, the view direction vector of the long focal-length measurement system with respect to the platform system is  $\vec{n} = (-0.0251, 0.9993, -0.0291)$ .



(a)Front side of the little girl model. (b)Back side of the little girl model.  
Figure 1. The little girl model.

## THE CORRELATION OF VIWEPOINT

In Figure 2, the horizontal azimuth  $\beta$  and vertical azimuth  $\varphi$  of the viewpoint vector  $\vec{m} = (m_x, m_y, m_z)$  corresponding to the plane  $\Pi_1$  and  $\Pi_2$  can be summarized:

$$\beta = \begin{cases} \frac{\pi}{2} - \arctan \frac{m_x}{m_y}, & m_y > 0 \\ \frac{3\pi}{2} - \arctan \frac{m_x}{m_y}, & m_y < 0 \\ 0, & m_y = 0 \cap m_x > 0 \\ \pi, & m_y = 0 \cap m_x < 0 \end{cases} \quad (2)$$

$$\varphi = \arctan\left(\frac{m_z}{\sqrt{m_x^2 + m_y^2}}\right) \quad (3)$$

According to formula (2) and (3), the horizontal azimuth  $\beta_1, \beta_2$  and vertical azimuth  $\phi_1, \phi_2$  of the view direction vector  $\vec{n}$  and detailed area can be calculated. So the rotation angle  $\theta$  and roll angle  $\alpha$  of the additional measurements as follow:

$$\theta_i = \begin{cases} -2\pi + \beta_2 - \beta_1, & \beta_2 - \beta_1 > \pi \\ 2\pi + \beta_2 - \beta_1, & \beta_2 - \beta_1 < -\pi \\ \beta_2 - \beta_1, & \text{others} \end{cases} \quad (4)$$

$$\alpha_i = \phi_2 - \phi_1 \quad (5)$$

## EXPERIMENTAL RESULTS

In accordance with the above method, part of the model is shown in Figure 3. The additional measure and the little girl model point clouds have been finished the rough registration by the four element array [4], as shown in Figure 4 (a), two point clouds has a certain overlap region but not exactly coincide. Based on the improved ICP registration algorithm [5], precise registration of the point clouds has been achieved, as shown in Figure 4 (b).

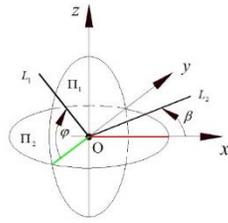


Figure 2. The horizontal azimuth  $\beta$  and vertical azimuth  $\phi$  of the view direction.

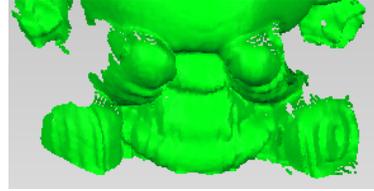
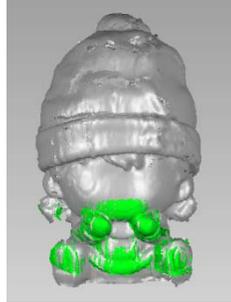
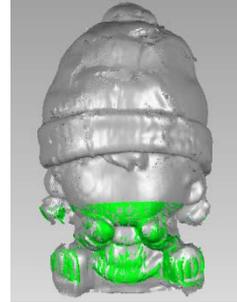


Figure 3. Part of the girl model.



(a) Rough registration of points cloud.



(b) Precise registration of points cloud.

Figure 4. The registration of points cloud.

## CONCLUSIONS

In this work, a new digital strategy has been proposed. The advantage of this method is that the detail areas can be automatically processed, measured, and fused. In short, it can automatically measure the detail areas, and fuse the object detail area with the original point cloud model. Experimental results has shown that the proposed method is effective and feasible.

## ACKNOWLEDGMENT

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