다시점 구조광을 이용한 3D 복원

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3D Reconstruction using multi-view structured light

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Abstract

In this paper, we propose a method of obtaining high density geometric information using multi-view structured light. Reconstruction error due to the difference in resolution between the projector and the camera occurs when reconstruction a 3D shape from a structured light system to a single projector. This shows that the error in the point cloud in 3D is also the same when reconstruction the shape of the object. So we propose a high density method using multiple projectors to solve such a reconstruction error.

1. Introduction

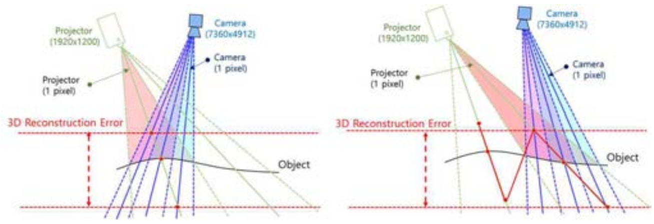

Figure 1. Reconstruction error due to difference in resolution between camera and projector.

An issue in the construction of structured light systems is that geometric information errors arise from differences in resolution between cameras and projectors. While we usually have dozens of mega resolution cameras available, the projector is only a few mega resolution due to limitations in physical technology and commercial usability.

In general, the accuracy of the geometric information to be estimated according to the decoding method of the structured light system depends on the resolution of the projector. As show in Fig.1, the structured light system can decode the entire pixel coordinates of the projector from all the pixels of the image sensor, but the geometric accuracy of the reconstruction object is limited due to the imbalance between the resolution of the camera and the projector. Therefore, various methods have been developed to overcome these problems. One method was to add mechanically moving the projector lens precisely and use a sinusoidal projection method. However, such a method is costly and often results in inaccurate results. Therefore, this study proposes a method of obtaining high resolution geometry information using multiple projectors.

2. Pattern superposition method

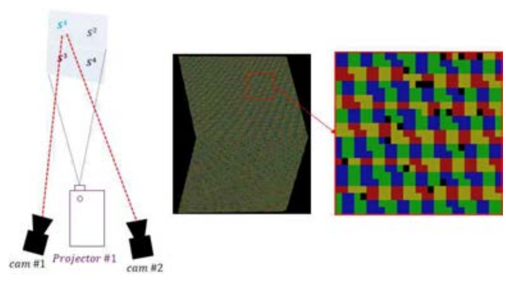

Figure 2. Single Structured light system.

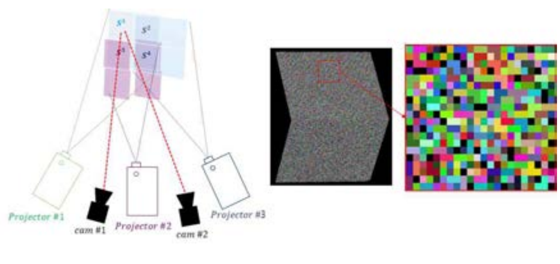

Figure 3. Multi-view Structured light system.

The propose multi-view structured light system searches multiple pixels corresponding to each other in a stereo or multiple cameras by superimposing a plurality of structured light patterns on a static object and sequentially decoding the structured light pattern of the projector. Through the sequential pattern superimposition of projectors 1 and 2 in Figure 3, the minimum area S^3 of the object surface can be uniquely identified by stereo or multiple cameras. Figure 2 shows the result of labeling a pattern in a single projector system, where the surface on which a single pixel is projected is mapped to multiple pixels in the camera. However, figure 3 superposition the patterns of multiple projectors so that one pixel of the projector is identified as a minimum area similar to one pixel of the camera, and the shape of the object can be reconstruction precisely on a stereo basis.

3. Optimize pattern superposition

If the number of projectors is P and the number of cameras is C, the acquired total image is $I = i_{m,n} | i_{m,n} \in P \times C$.

$$f(x_c) = (y_1 \cdots y_n) \quad (1)$$

The function $f : R \rightarrow R^n$ in the equation (1) represents the projector coordinate y_n according to the decoding of the multiple structured light pattern sequentially at the c-th camera coordinates x.

$$A = \left\{ \overrightarrow{p_{xl}} | \overrightarrow{p_{xl}} = f(x_l^s) \right\} \quad (2)$$

s = All pixels of the image from structured light

$$B = \left\{ \overrightarrow{p_{xr}} | \overrightarrow{p_{xr}} = f(x_r^q) \right\}$$

q = All pixels of the image from structured light

$$a_k = \left\{ \overrightarrow{p_l^k} | \overrightarrow{p_l^k} = f(x_l^k) \subseteq A \right\}$$

$$a_k \cap B = \{ a_k | a_k \in A, a_k \in B \}$$

Where and q are all pixels of the image from which the structured light pattern is obtained. Equation (2) simplifies to a multiple projector and stereo camera environment, where the coordinates x_l and x_r of the two cameras show the transformation of a number of sequential projector coordinate vectors $\overrightarrow{p_{xl}} = (y_1 \cdots y_n)$, $\overrightarrow{p_{xr}} = (y_1 \cdots y_n)$ through a function f. Then, the correspondence points of the two cameras can be obtained through the intersection of the sets of the projector coordinate vectors obtained from the respective cameras.

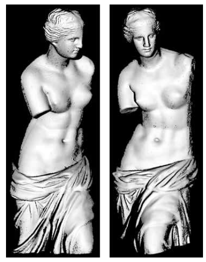

Figure 4. Point-cloud using multi-view structured light.

4. Conclusion

In order to improve the accuracy error due to the difference in resolution between the camera and the projector, the use of multi projector based high density point cloud technique is suggested. Future research will integrate multiple high-density point cloud as TSDF and make mesh using marching cube.

Acknowledge

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