Scene depth reconstruction via the light field in YCbCr color space

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1. Introduction

Depth reconstruction from the light field is now a vibrant research field in the computational imaging. Based on the 4D structure information of light field data, this paper proposes an algorithm with pixel-level precision on YCbCr color space to obtain accurate disparity and provide accurate depth information for 3D surface reconstruction. In this paper, the public HCI standard light field data are used to verify, test and evaluate the reconstruction accuracy.

2. Scene depth reconstruction via the light field in YCbCr color space

The RGB color space is converted to a YCbCr color space by reading all light field views. The results obtained by the region matching method may have certain errors. The optimization of the disparity map includes: (1) optimal parallax fitting to the mismatched disparity by the optimal parallax direction; (2) The disparity of depth-continuous regions are optimized by the TV algorithm. The precise disparity map can be achievd by the optimization, and finally convert the disparity map into a depth map.

2.1 Matching cost function in YCbCr color space

In the YCbCr color space, the objective function of establishing the disparity in the 4D light field is:

$$\hat{E}_1(s)=\sum_{u_i,v_j}\left\|L^{'}\left(x'+\Delta u_i s, y'+\Delta v_j s, u_i, v_j\right)-L\left(x', y', u_0, v_0\right)\right\| \tag{1}$$

2.2 Optimization of disparity map in YCbCr color space

The mismatched disparity can be further processed by storing the minimum matching cost function value in the mismatched disparity set and using the optimal disparity direction for disparity approximation. The best disparity direction is on the Cb, Cr channel of the central viewpoint image, and each direction is as follows:

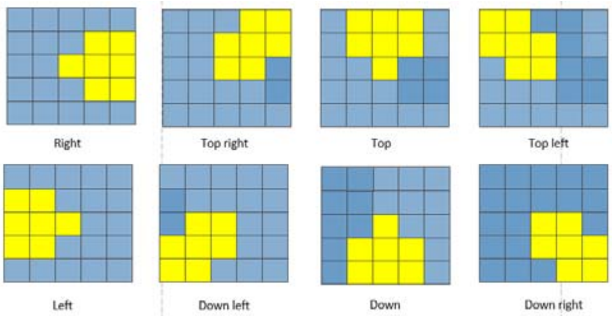


Fig.1 The diagram of the optimal disparity direction selection

In the depth discontinuous boundary region, the depth discontinuous boundary region is obtained and the direction in which the matching features are visible in all views is covered, and an adaptive matching template is applied. For the depth continuous region, because the pixels inside are very similar, and the disparity is considered to be continuous, the TV model can be used to optimize the smooth region.

$$\arg\min_{\mu}\left\{\frac{\lambda}{2}\int_{\Omega}(\mu-\hat{s})^2 dx+\int_{\Omega}\left|\nabla\mu\right| dx\right\} \tag{2}$$

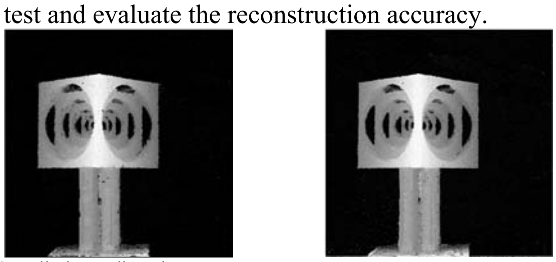
2.3 Depth map reconstruction

Based on the disparity map obtained by the optimization, the depth map of the scene can be calculated by

$$d(x,y)=\frac{FB}{\mu(x,y)+\frac{FB}{Z_0}} \tag{3}$$

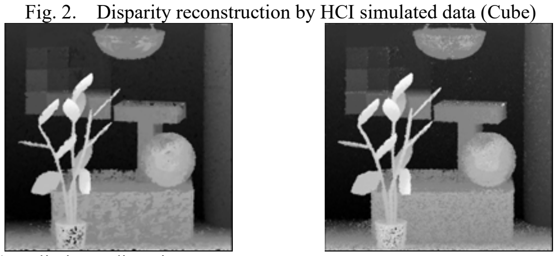
2.4 The experiment of depth reconstruction

In this section, the light field dataset from Heidelberg Collaboratory for Image Processing (HCI) are applied to verify, test and evaluate the reconstruction accuracy.



(a) preliminary disparity reconstructed via YCbCr color space (b) Optimized disparity

Fig. 2. Disparity reconstruction by HCI simulated data (Cube)



(a) preliminary disparity reconstructed via YCbCr color space (b) Optimized disparity

Fig. 2. Disparity reconstruction by HCI simulated data (Mona)

The experimental results show that the depth map with high accuracy can be reconstructed via YCbCr color space and optimization method, in align with high depth resolution in the weak texture and occlusion regions. The accurate 3D surface in the field of view can also be achieved using the depth information reconstructed from the 4D light fieldTable

3. Conclusions

In this paper, the chroma is clustered on the Cb and Cr channels to obtain the depth continuous region, and the depth continuous region boundary is extracted. The adaptive matching template is applied in the depth discontinuous boundary region and the depth continuous region respectively. The method in this paper obtains accurate diaparity and provides accurate depth information for 3D surface reconstruction.

References

[1] T.E. Bishop et al. ICCV, 2009, 1622-1629.
[2] S.J. Gortler et al. ACM SIGGRAPH, (1996), 43-54.