Light field data fusion with large field of view based on feature point tracking

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1. Introduction

To realize the fusion of the multi-view light field data, we proposes a method of light field data fusion with large field of view based on feature point tracking. The fusion of the light field data is achieved by tracking the matched feature points and solving the two-plane parameterized transformation between different perspectives. We applied the public light field data with different perspectives to verify the proposed light field fusion method.

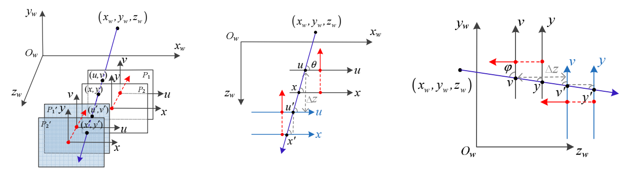
2. Light field data fusion with large field of view based on feature point tracking

2.1 The transformation between the light fields with different perspectives

Based on the tracking the ray, we can derive the transformation relationship between the light fields with different perspectives. When the the light fields with two perspectives have only translational transformation, the transformation formula of the light fields can be obtained as follows:

$$\begin{pmatrix} x' \\ y' \\ u' \\ v' \\ 1 \end{pmatrix} = \begin{pmatrix} 1-\Delta z/a & 0 & \Delta z/a & 0 & \Delta x \\ 0 & 1-\Delta z/a & 0 & \Delta z/a & \Delta y \\ -\Delta z/a & 0 & 1+\Delta z/a & 0 & \Delta x \\ 0 & -\Delta z/a & 0 & 1+\Delta z/a & \Delta y \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ u \\ v \\ 1 \end{pmatrix}. \quad (1)$$

which can be denoted as $\mathbf{L}' = \mathbf{TL}$. Under the translational transformation, the transformation between the light fields under the two-plane parameterized representation is a linear transformation.



(a) The digram of the light field's translation (b) In top view (c) In left view

Fig. 1. Two-plane parameterization of light fields under translational transformation

When the light filed is transformed by rotating around the optical axis, the rotation transformation formula between the light fields is as follows:

$$\begin{pmatrix} x' \\ y' \\ u' \\ v' \\ 1 \end{pmatrix} = \begin{pmatrix} \cos\Delta\gamma & -\sin\Delta\gamma & 0 & 0 & 0 \\ \sin\Delta\gamma & \cos\Delta\gamma & 0 & 0 & 0 \\ 0 & 0 & \cos\Delta\gamma & -\sin\Delta\gamma & 0 \\ 0 & 0 & \sin\Delta\gamma & \cos\Delta\gamma & 0 \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ u \\ v \\ 1 \end{pmatrix}. \quad (2)$$

which can be denoted as $\mathbf{L}' = \mathbf{RL}$.

2.2 Light field data fusion with large field of view

All the matched feature points are used to iteratively calculate the variables of translation and rotation, and the transformation formula is used to calculate the transformed 4D coordinates of the light field. The light fields are converted into the same two-plane light field to achieve the fusion of the multi-view light field data. The fusion of the 4D light field, the objective functional of the overlap regions is as follows:

$$E(x,y,u,v) = E_{color}^2(x,y,u,v) + E_{geometry}(x,y,u,v). \quad (3)$$

2.3 The experiment of light field data fusion

The matching of the feature points of the sub-aperture image can be implemented based on the consistency of the sub-aperture images. The sub-aperture image feature point matching result of the Lawn scene light field data is shown in Fig. 2.

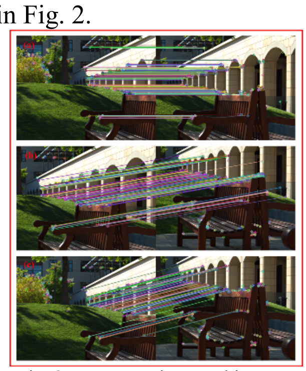


Fig. 2. Feature point matching result of the Lawn scene light field data

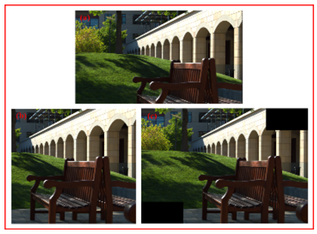


Fig. 3. The center view images of the sub-aperture of the fused light fiel

According to the coordinates of all feature points of the sub-aperture image matching of the Lawn scene, the translation variables are calculated, which are shown in Table 1.

Table 1. The translation variables of Lawn scene light field data

Transform	Δx	Δy	Δz
Lawn_1 →Lawn_2	-157.1729	-0.0362	0.0188
Lawn_2 →Lawn_3	-0.0208	-82.1124	0.0208
Lawn_1 →Lawn_3	-156.9611	-82.1764	-0.0528

Light field fusion can be achieved using translation variables. The center view images of the sub-aperture of the fused light field are shown in Fig. 3.

The experimental results show that the calculated translational rotation variables is consistent with the simulation data. There is no obvious seam and artifact in the fused light field.

3. Conclusions

By tracking the same ray emitted by the feature points, the transformation between the two-plane parametric representations of the light fields with different perspectives is derived, which provides a theoretical basis for the fusion of light field.

References

[1] Levoy M. Computer, 2006, 39(8): 46-55S.
[2] Dansereau D G et al. CVPR. 2017: 5048-5057.