Foreground Object Image Masking via EPI and Edge Detection for Photogrammetry with Static Background

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VIDEO

Contributions

- Foreground image masking algorithm from a single light field image
- Epipolar-plane image (EPI) based masking algorithm without complicated photogrammetry lab system
- Depth-related algorithm is presented instead of specific equipment setup [1] or colour-based algorithms [2,3]
- Refining the mask image by combination of the initial mask image via EPIs and the edge image

Motivation

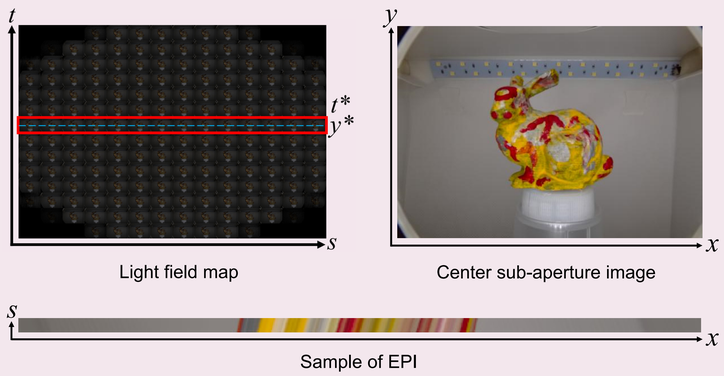
- Rotating the object is simple and suitable for automated small object photogrammetry [1,2,4]
- Static background can confuse the pose estimation, thus fail the reconstruction
- Object-masked image scopes only the region of interest and therefore excludes the background
- Accurate mask images can improve the quality of reconstructed 3D point clouds [1,2]

Dataset

- The Stanford bunny images were acquired by Lytro Illum camera
- A total of 36 light field images were captured by rotating the object with 10 degrees apart
- Ground truth images were manually created
- Our mask images of the proposed method were provided
- Mask images of Lytro software and Jeon's method [5] were obtained from their depth maps
- The dataset is available in the project page SCAN ME

Light field

- Plenoptic or light field camera captures not only the light intensities but also directions of the light rays [6]
- Light field image can be decoded to sub-aperture images with slightly different viewpoints (vertical viewpoint, t; horizontal viewpoint, s)
- Horizontal EPI is the stack of the fixed spatial position, y^*, of sub-aperture images in the same fixed horizontal viewpoint, t^*



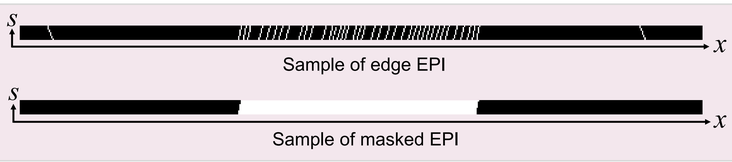
Proposed method

Initial mask:

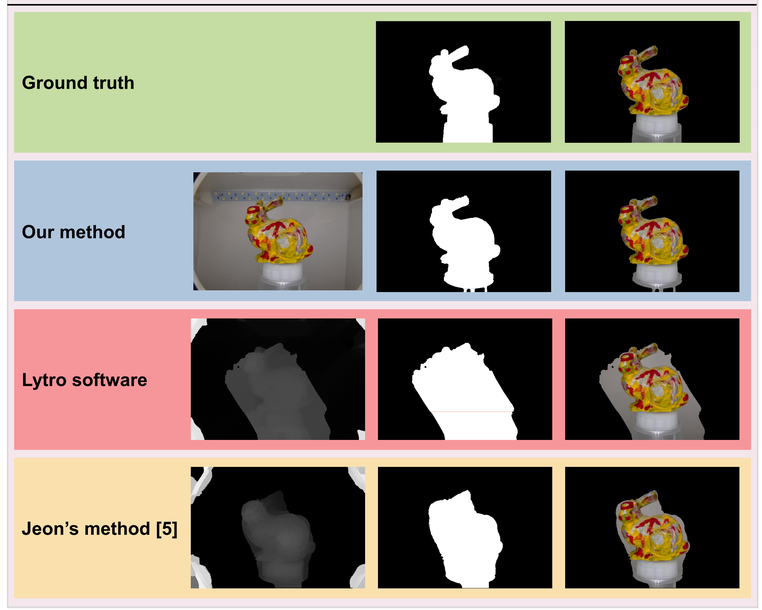
- Sub-aperture images from center horizontal view of the light field image were converted to EPIs, and then edge EPIs
- Thresholding the line slope and masking the object area out of the background
- Masked EPIs were converted back to be the initial mask image

Refine mask:

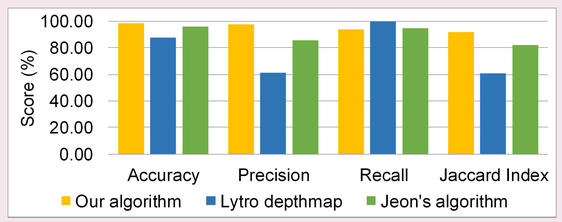
- The initial mask was integrated to the Canny edge image by morphological operations to create the refine mask



Results and comparisons



Sample images of the comparisons between the ground truth, our method, Lytro software, and Jeon's method [5]



Performance metrics of each algorithm

References

[1] Ströbel, B., Schmelzle, S., Blüthgen, N., Heethoff, M.: An automated device for the digitization and 3D modelling of insects, combining extended-depth-of-field and all-side multi-view imaging. ZooKeys (759), 1-27 (2018).

[2] Sosa, G.D., et al.: 3D surface reconstruction of entomological specimens from uniform multi-view image datasets. In: 2016 XXI Symposium on Signal Processing, Images and Artificial Vision (STSIVA), pp. 1-8. IEEE, (2016).

[3] Scharr, H., et al.: Fast high resolution volume carving for 3D plant shoot reconstruction. Frontiers in Plant Science 81680 (2017).

[4] Nguyen, C.V., et al.: 3D scanning system for automatic high-resolution plant phenotyping. In: 2016 International Conference on Digital Image Computing: Techniques and Applications (DICTA), pp. 1-8. IEEE, (2016).

[5] Jeon, H.-G., et al.: Accurate depth map estimation from a lenslet light field camera. In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, pp. 1547-1555. (2015).

[6] Levoy, M., Hanrahan, P.: Light field rendering. In: Proceedings of the 23rd Annual Conference on Computer Graphics and Interactive Techniques, pp. 31-42. ACM, (1996).