

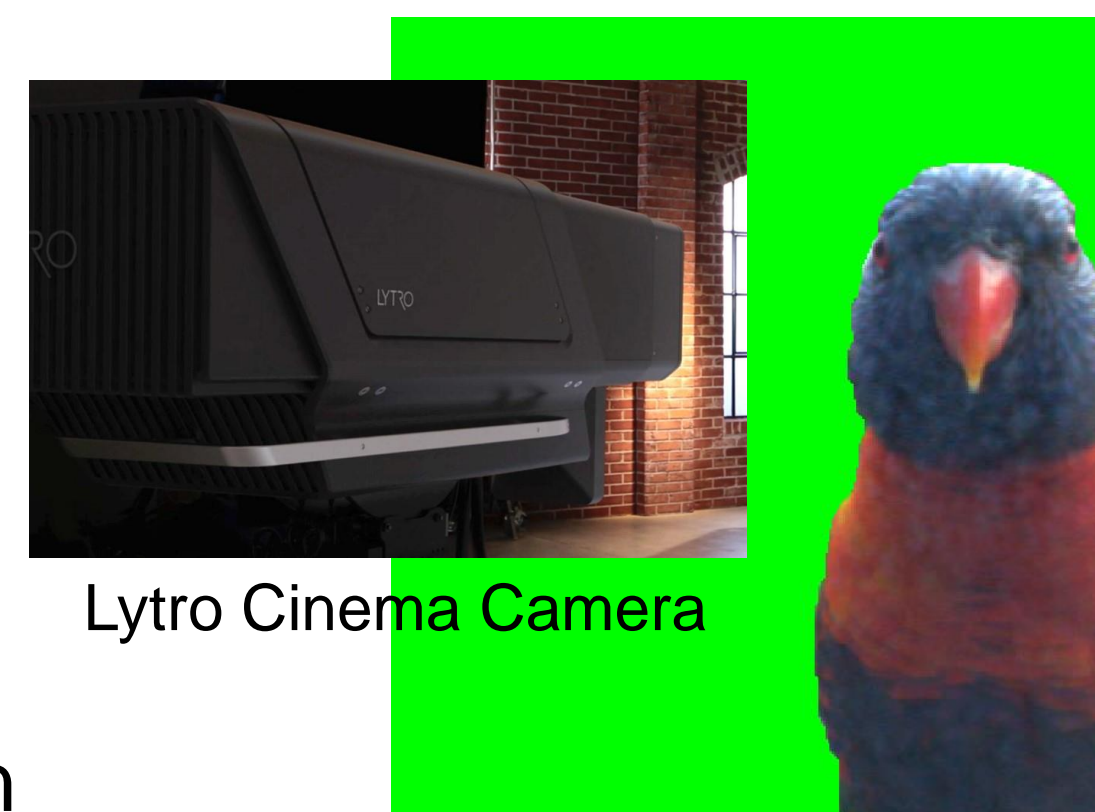
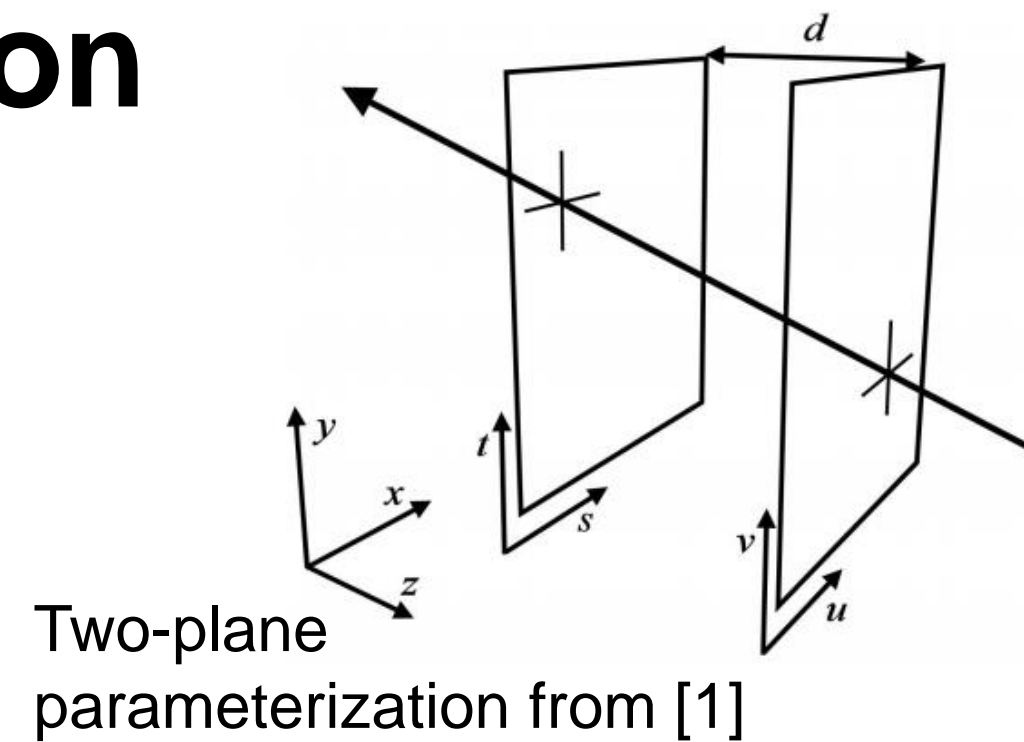
Occluded Edge Detection in Light Field Images for Background Removal

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Motivation

- Light field images contain information about the set of light rays in the scene
- Depth map estimates from this information are an interesting problem, often involving complex iterative algorithms
- A subset of this problem:** finding occluded edges to segment the background and foreground with less computation
- Qualitative, user-selectable foreground can put a Lorikeet on Mars without a green screen



Occluded Edge Detection Methods

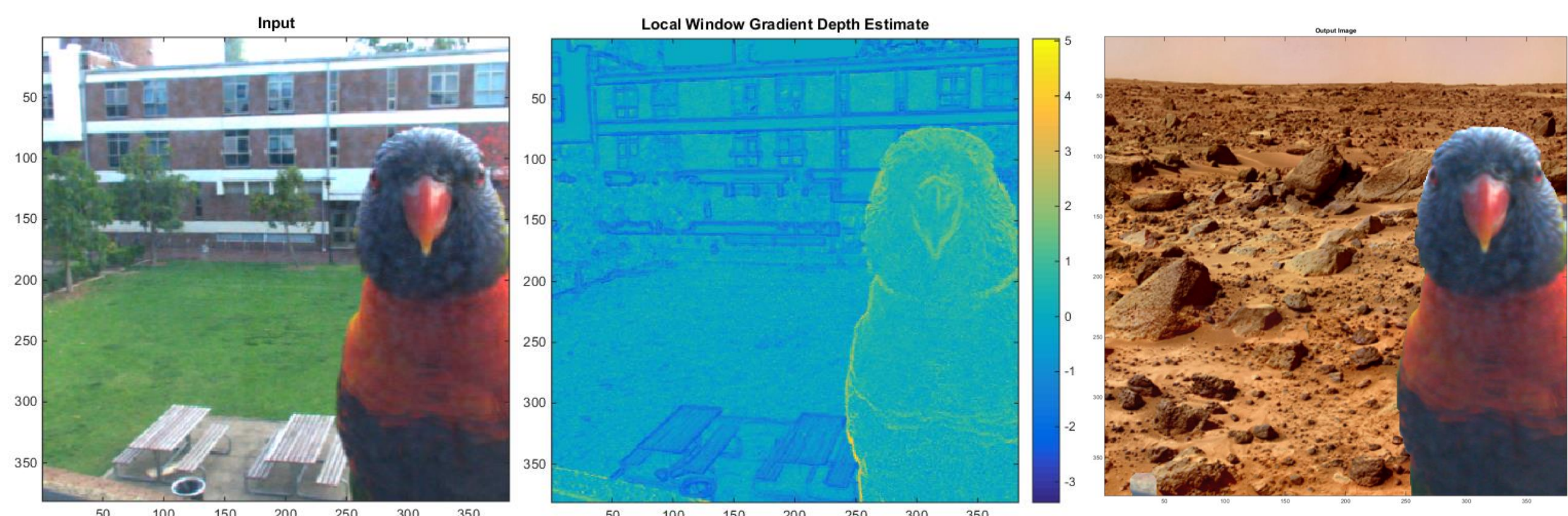
4D Gradient Estimates

- Light field planes have same orientation in (s,u) and (t,v) which can be estimated with 2D gradient
- Gradient slope related to depth
 - Calibrate for depth units
- Combine both gradients across color channels [2]:

$$P_z = \frac{\sum \omega_{su} \text{sgn}(L_s) L_u + \sum \omega_{tv} \text{sgn}(L_t) L_v}{\sum \omega_{su} ||L_s|| + \sum \omega_{tv} ||L_t||}$$

Threshold Depth Estimate

- Compute gradient depth estimate
- Threshold for desired foreground depth
 - Supervised: qualitative selection by user
 - Unsupervised: guess foreground threshold from depth estimate (OtzU)
- Region fill and smooth foreground mask
- Clip image and substitute background



Related Work

- More sophisticated depth estimates improve performance with increased computational cost [3]-[4]
- Light field processing and sample images from Matlab Light Field Toolbox v0.4 by Donald Dansereau



[1] D. Dansereau, and L. Bruton, "Gradient-based depth estimation from 4D light fields," in *Proc. 2004 Int. Symp. Circuits Systems*, 2004.

[2] D. Dansereau. "Plenoptic signal processing for robust vision in field robotics," Ph.D. dissertation, Sch. Aerospace, Mech., Mechatronic Eng., Univ. Sydney, Sydney, Australia, 2014.

[3] T.-C. Wang, et al, "Depth estimation with occlusion modeling using light-field cameras," *IEEE Trans. Pattern Analysis Machine Intelligence*, 2016.

[4] H.-G. Jeon, et al, "Accurate depth map estimation from a lenslet light field camera," *IEEE Int. Conf. Computer Vision Pattern Recognition*, 2015.

Edge Detected Depth Estimate

Increase robustness to low-confidence gradient depth estimates by detecting occluded edges

- Compute gradient depth estimate
- Detect edges from pixel intensity values
- Weight edges based on overlap with depth estimate
- Threshold for desired foreground edge depth
- Region fill and smooth foreground edges
- Clip image and substitute background

