# Analyzing Interfaces and Workflows for Light Field Editing

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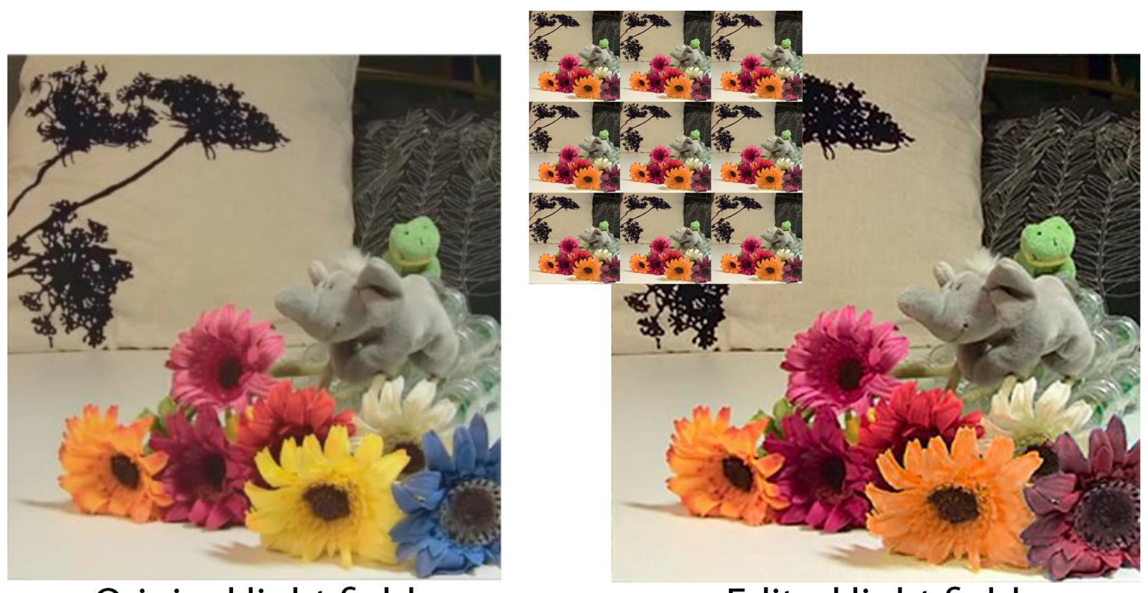
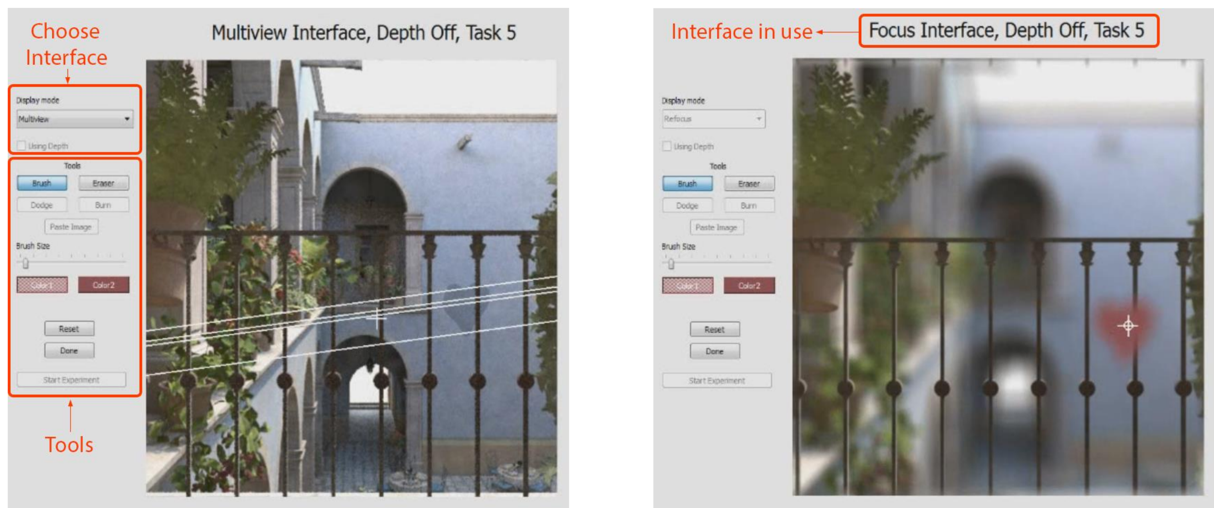
With the increasing number of available light field cameras, this new form of photography is progressively becoming more common. Light fields are 4D representations of a scene, where the two extra dimensions code angular information. While editing traditional 2D photographs is a well-understood process with established workflows, editing light fields still remains an open problem. Jarabo et al. [1] recently identified the most common interaction paradigms (parallax-based and focus-based), and evaluated a set of point-based editing operations on both paradigms, providing valuable insights on the suitability of the interfaces. That work was extended by Masia et al. [2].
We leverage their data to analyze the subjects' preferred workflows for a number of typical scenarios. We perform a state sequence analysis [3] and hidden Markov-chain analysis based on the sequence of tools and interaction paradigms users employ while editing light fields. Based on our analysis we found insights can that can aid researches and designers in creating new light field editing tools and interfaces, thus helping close the gap between 2D and 4D image editing.



Original light field  Edited light field

Example result of a real light field captured with the Lytro camera and edited with our tool.

## Interaction Paradigms and Interfaces



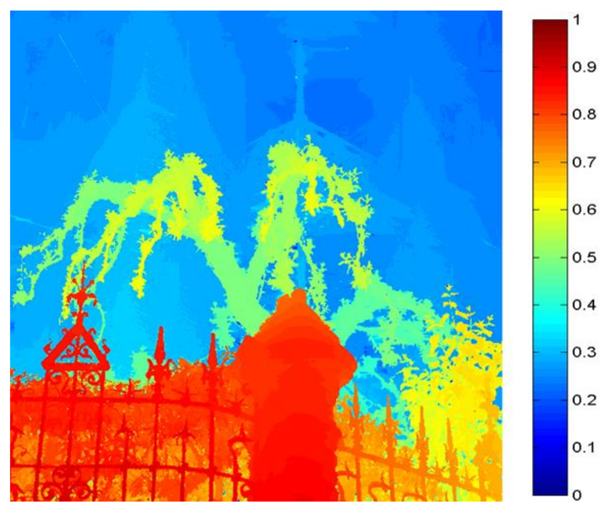

User interfaces for the Multiview (left) and Focus (right) interaction paradigms.

The key aspect is the cue used to specify the position of the edit in 3D space while working on a conventional 2D screen.

**Multiview** uses parallax to specify the depth of edits.

In **Focus**, the depth at which the edit will be placed is specified by means of a shallow depth of field.

Both interaction paradigms provide the possibility of using reconstructed **depth** maps. In this case, the strokes drawn will snap to the nearest surface below them.



Reconstructed light field depth map.

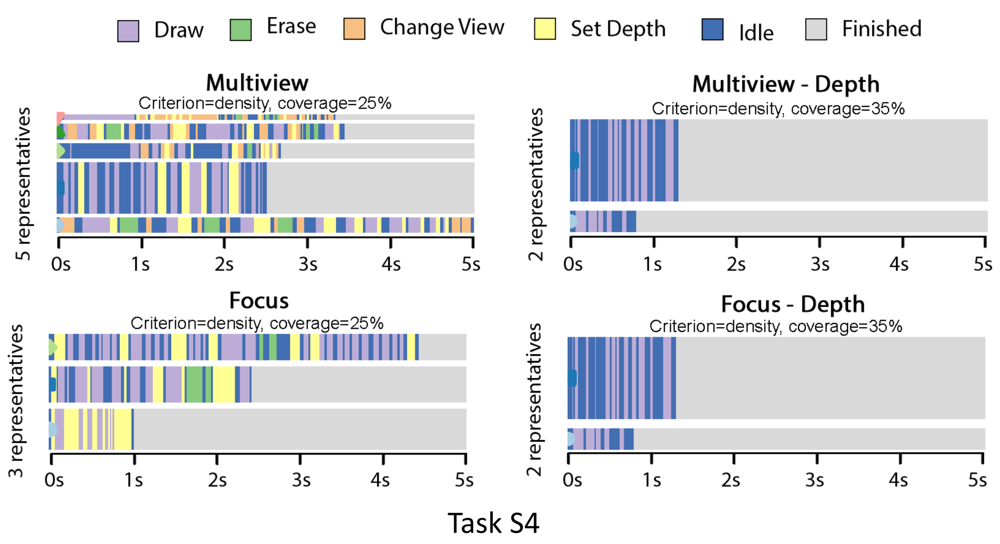
## Experiment 1: Tool Sequence Analysis

- 20 subjects perform five editing tasks on two synthetic light fields
- Each task was solved using the four interfaces in random order

Task S1. Draw on wall

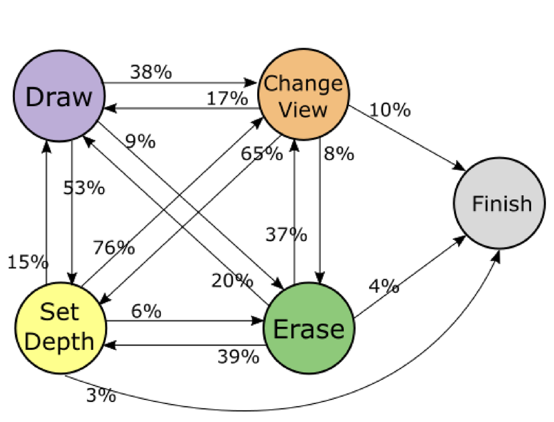
Task S3. Edit highlights

### Representative Sequences

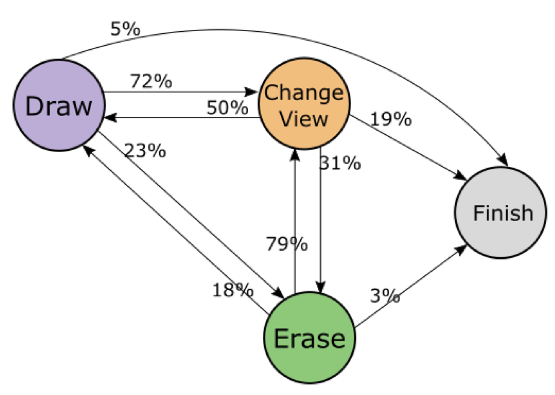



If depth is off, variability among users is higher → increased hesitation and experimenting, the path to completion is less clear.

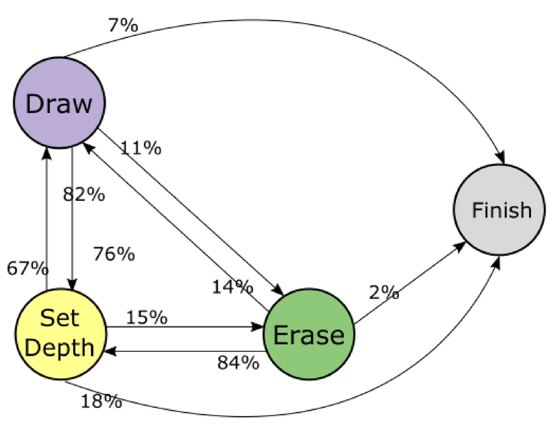
### Effective Tool Transitions



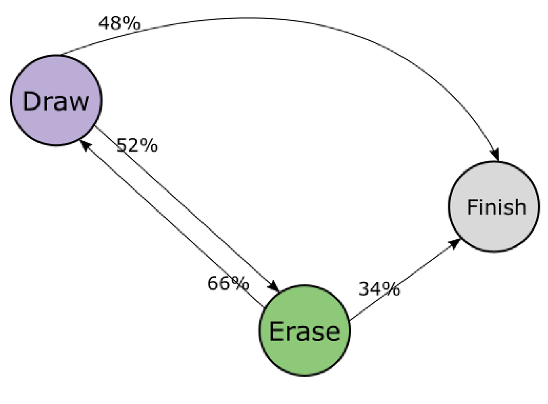

a) Multiview




c) Multiview with Depth




b) Focus



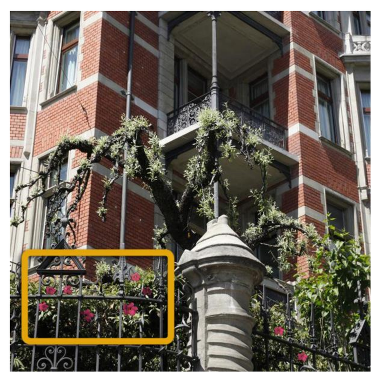

d) Focus with Depth

The workflow is a constant iteration of acting upon the scene (drawing/erasing) and checking the results (set depth / change view).

## Experiment 2: Interface Sequence Analysis

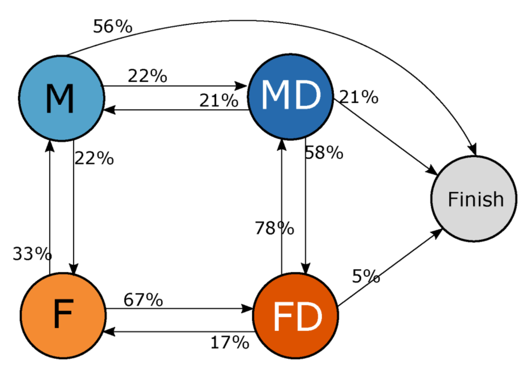
- 10 subjects perform 10 editing tasks on eight real light fields
- Users could choose freely between the four interfaces during each editing task

Task R2. Color nose and eyes

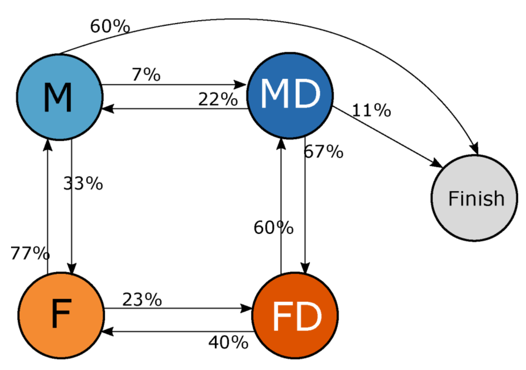


Task R6. Add flowers

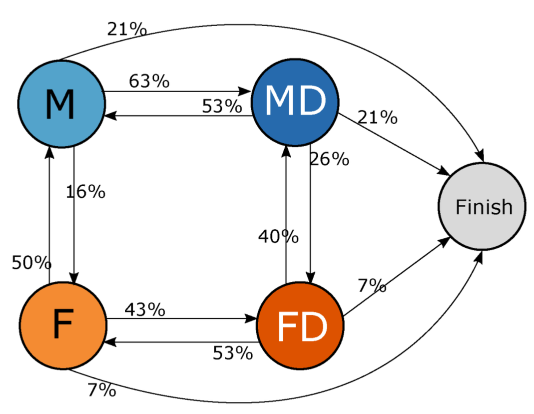
### Effective Interface Transitions



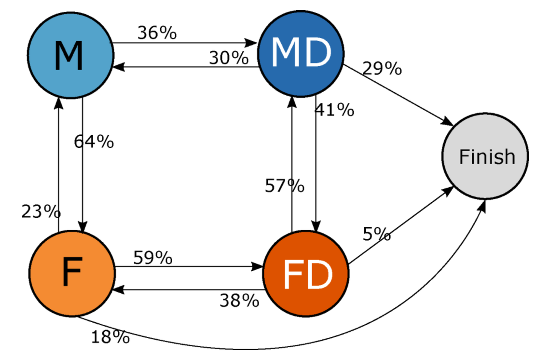
Task R1. Editing surfaces



Task R3. Editing n free space



Task R5. Handling occlusions



Task R10. Complex geometries

Users usually finish editing from the Multiview or Multiview with Depth interfaces → they prefer to use them to check their results

## Conclusions

- We have examined a set of interfaces and tools for light field editing and presented our findings in terms of workflow and preferences for several editing scenarios.
- Users work on a constant iteration of drawing or erasing, and checking the results.
- Users prefer to use depth information while editing and switch to the Multiview paradigm (with or without depth) to check their work before finishing.
- This work provides a solid basis for the development of future light field editing tools and interfaces.

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[1] A. Jarabo, B. Masia, A. Bousseau, F. Pellacini, and D. Gutierrez. How do people edit light fields? ACM Trans. Graphics, 2014.
[2] B. Masia, A. Jarabo, and D. Gutierrez. Favoured workflows in light field editing. In Proc. Of CGVCVIP, 2014.
[3] A. Gabadinho, G. Ritschard, N. Moller, and M. Studer. Analyzing and visualizing state sequences in R with TraMineR. Journal on Statistical Software, 2011.