

## Motivation

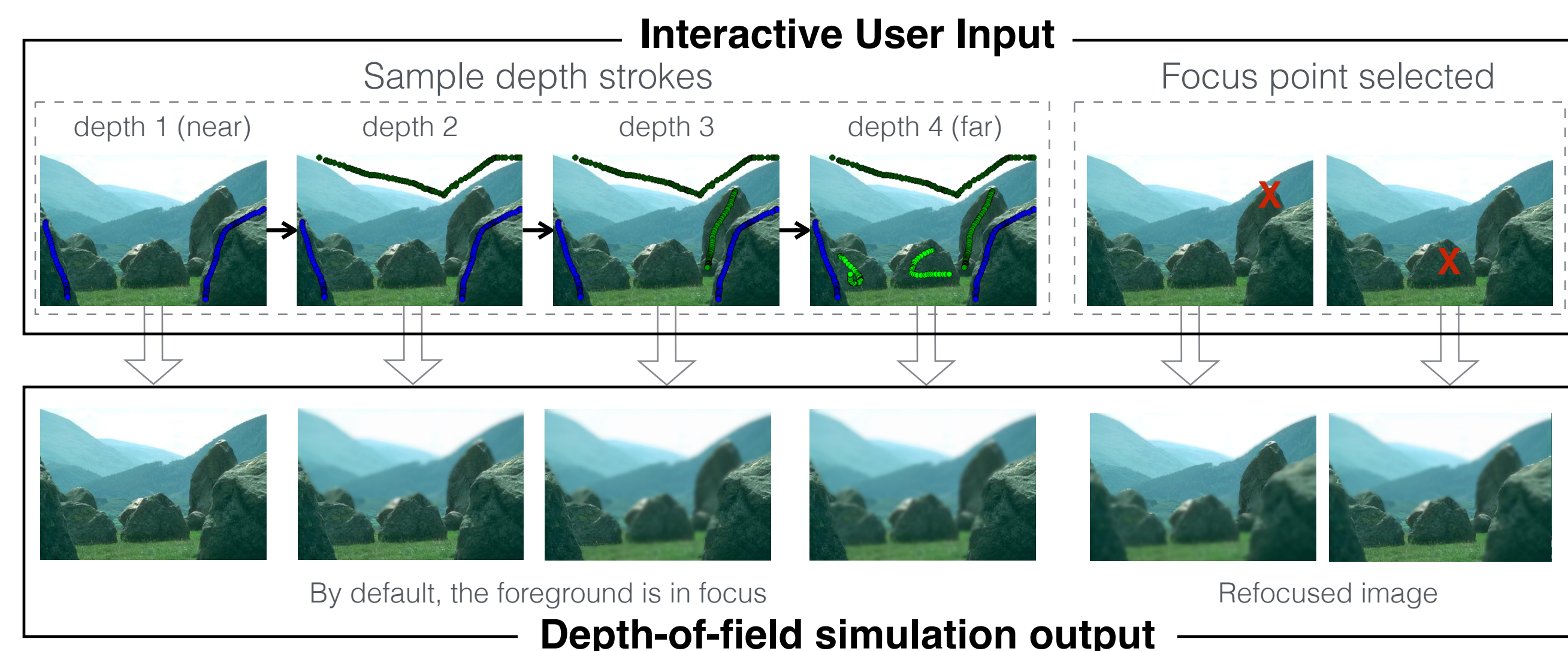
- Many problems in CV can be formulated as a dense image labeling problem
  - Add user knowledge in automatic systems: better solutions
  - Standard dense labeling solutions require a high computational cost
- INTERACTIVE feedback

## Related Word

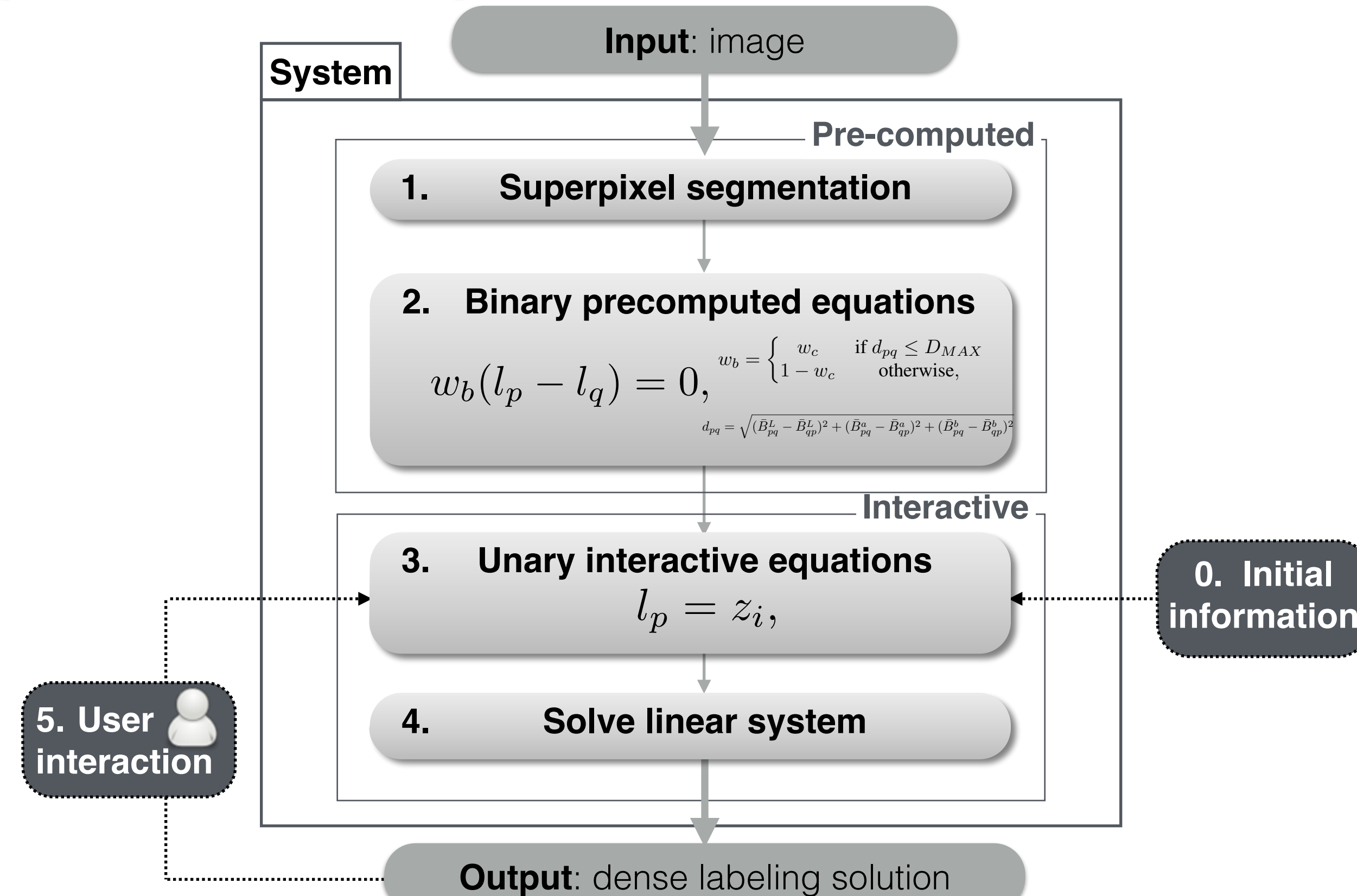
- Markov Random Fields (MRF)
  - discrete labels
  - high execution time for interactive applications
- Random Walks approach
  - one linear system per label
  - discrete labels with seed

## Contributions

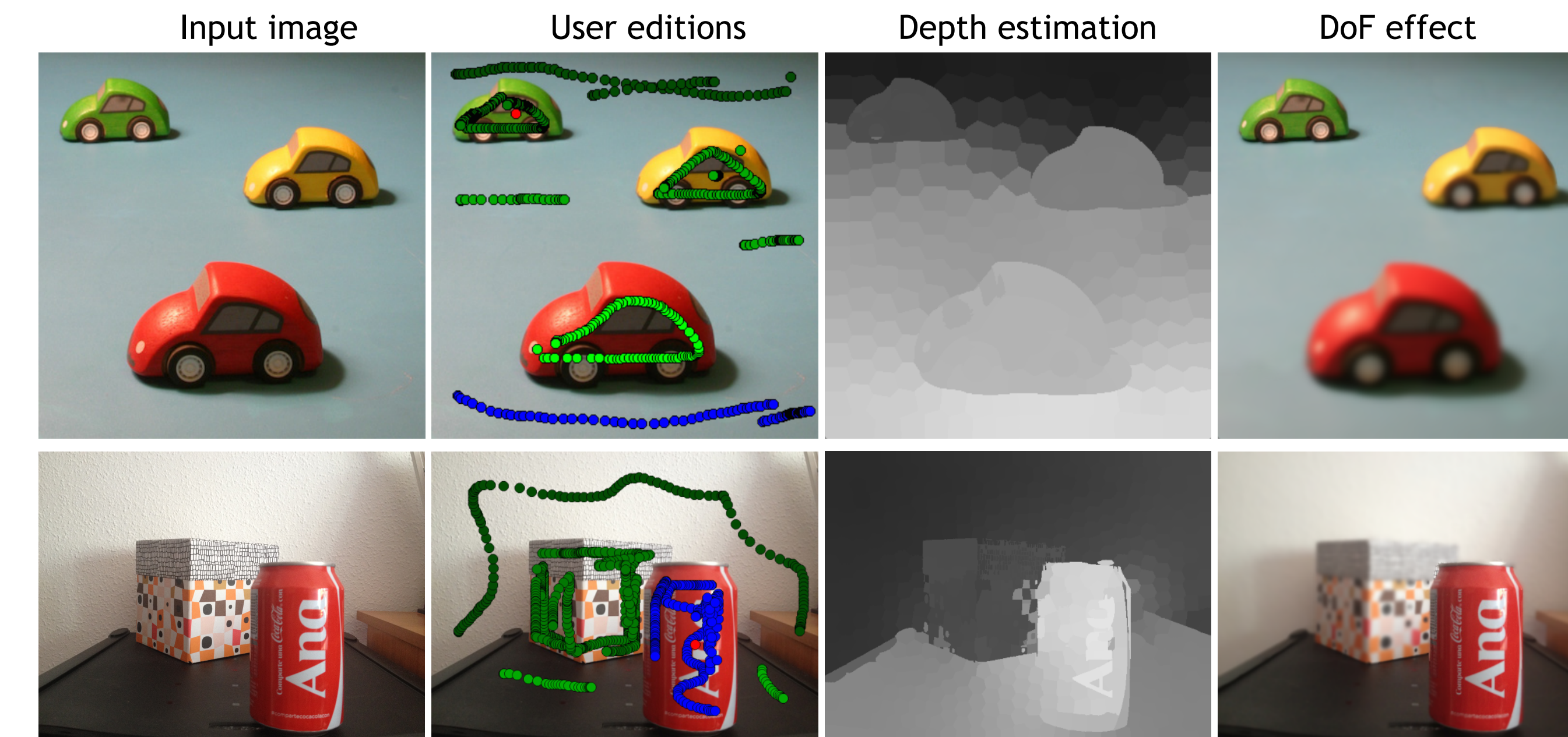
- Efficient dense labeling approach
  - linear least squares formulation
  - superpixels
  - continuous labels
- Interactive application for DoF simulation



## Pipeline: dense depth estimation



## Results



## Evaluation

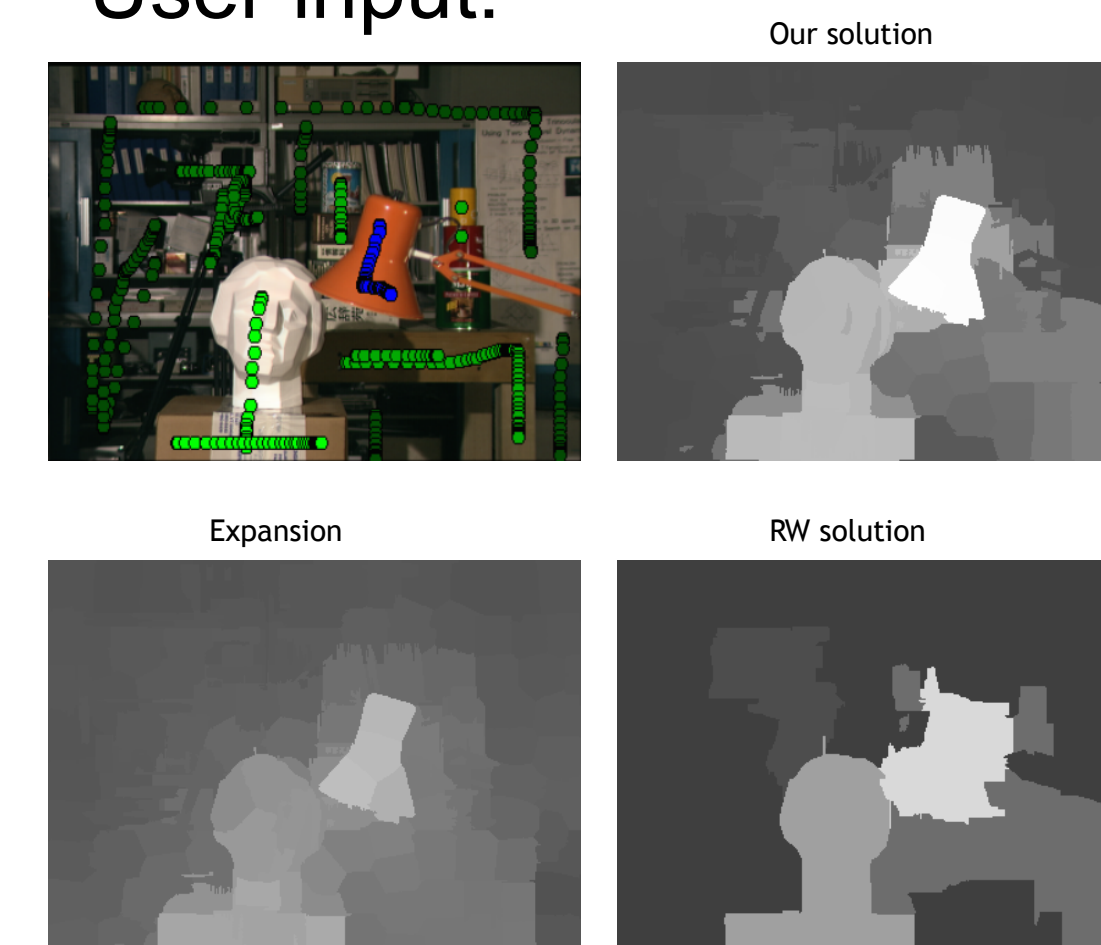
- Execution time:

| Pre-computation stage                        |         |       | Interactive loop                       |        |         |
|--|---------|-------|--|--------|---------|
| 1. Superpixel segmentation (532 superpixels) | 11.59 s | (75%) | 3. Add unary equations (234 equations) | 0.04 s | (0.25%) |
| 2. Add binary equations (1517 equations)     | 3.25 s  | (21%) | 4. Solve system                        | 0.42 s | (2.5%)  |
|  |         |       | 5. Build depth map                     | 0.21 s | (1.25%) |

- Disparity map:

| Method        | Tsukuba<br>#Labels=16 |      | Venus<br>#Labels=20 |      | Teddy<br>#Labels=60 |      |
|---------------|-----------------------|------|---------------------|------|---------------------|------|
|               | time                  | err  | time                | err  | time                | err  |
| ICM [2]       | 0.52                  | 0.12 | 0.46                | 0.10 | 1.90                | 0.13 |
| Expansion [3] | 2.22                  | 0.02 | 6.94                | 0.02 | 19.9                | 0.05 |
| Swap [3]      | 2.25                  | 0.02 | 7.01                | 0.02 | 12.6                | 0.05 |
| TRW-S [6]     | 8.84                  | 0.02 | 115.                | 0.02 | 158.                | 0.05 |
| BP-S [8]      | 1.37                  | 0.02 | 8.69                | 0.03 | 21.2                | 0.05 |
| BP-M [8]      | 13.3                  | 0.02 | *                   | *    | 193.                | 0.05 |
| BCD [4]       | 0.92                  | 0.09 | 1.5                 | 0.17 | 2.76                | 0.08 |
| Ours          | <b>0.01</b>           | 0.12 | <b>0.03</b>         | 0.10 | <b>0.03</b>         | 0.09 |

- User input:



| Method        | Tsukuba<br>#Labels=16 |      | Venus<br>#Labels=20 |      | Teddy<br>#Labels=60 |      |
|---------------|-----------------------|------|---------------------|------|---------------------|------|
|               | time                  | err  | time                | err  | time                | err  |
| Expansion [3] | 6.21                  | 0.05 | 10.7                | 0.12 | 7.17                | 0.19 |
| RW [5]        | 0.36                  | 0.07 | 0.73                | 0.09 | 0.67                | 0.10 |
| Ours          | <b>0.04</b>           | 0.04 | <b>0.07</b>         | 0.09 | <b>0.08</b>         | 0.09 |

## References

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## Acknowledgments

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