

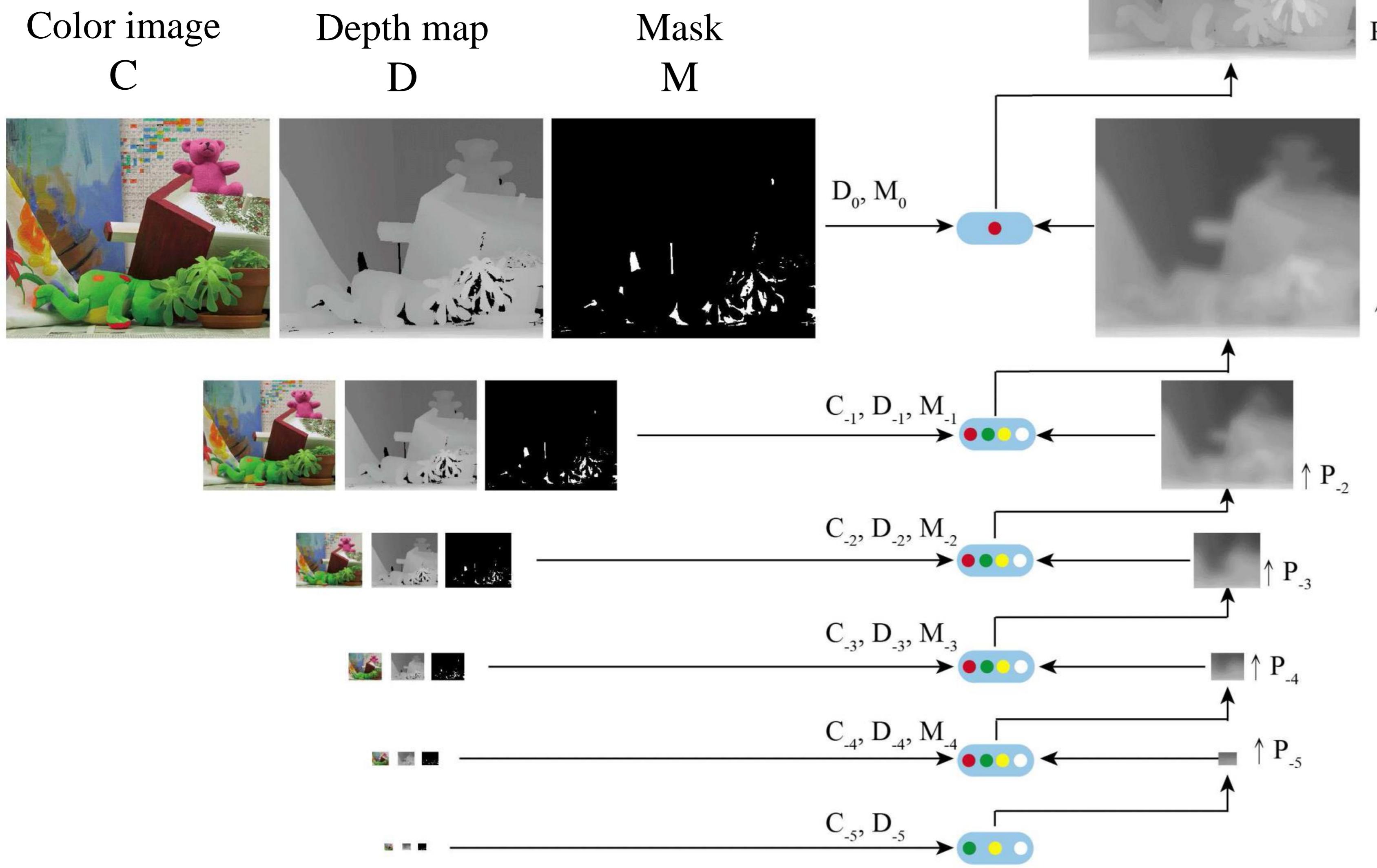


## Why do we refine Depth Map?

- The depth image is very hard to be free from generating **noise** and **holes** due to the acquisition process, such as ToF, Light Coding, Stereo Matching.
- Our approach is based on two observations:
  1. Holes become smaller at coarser resolution.
  2. Color image can deliver information to the depth image.

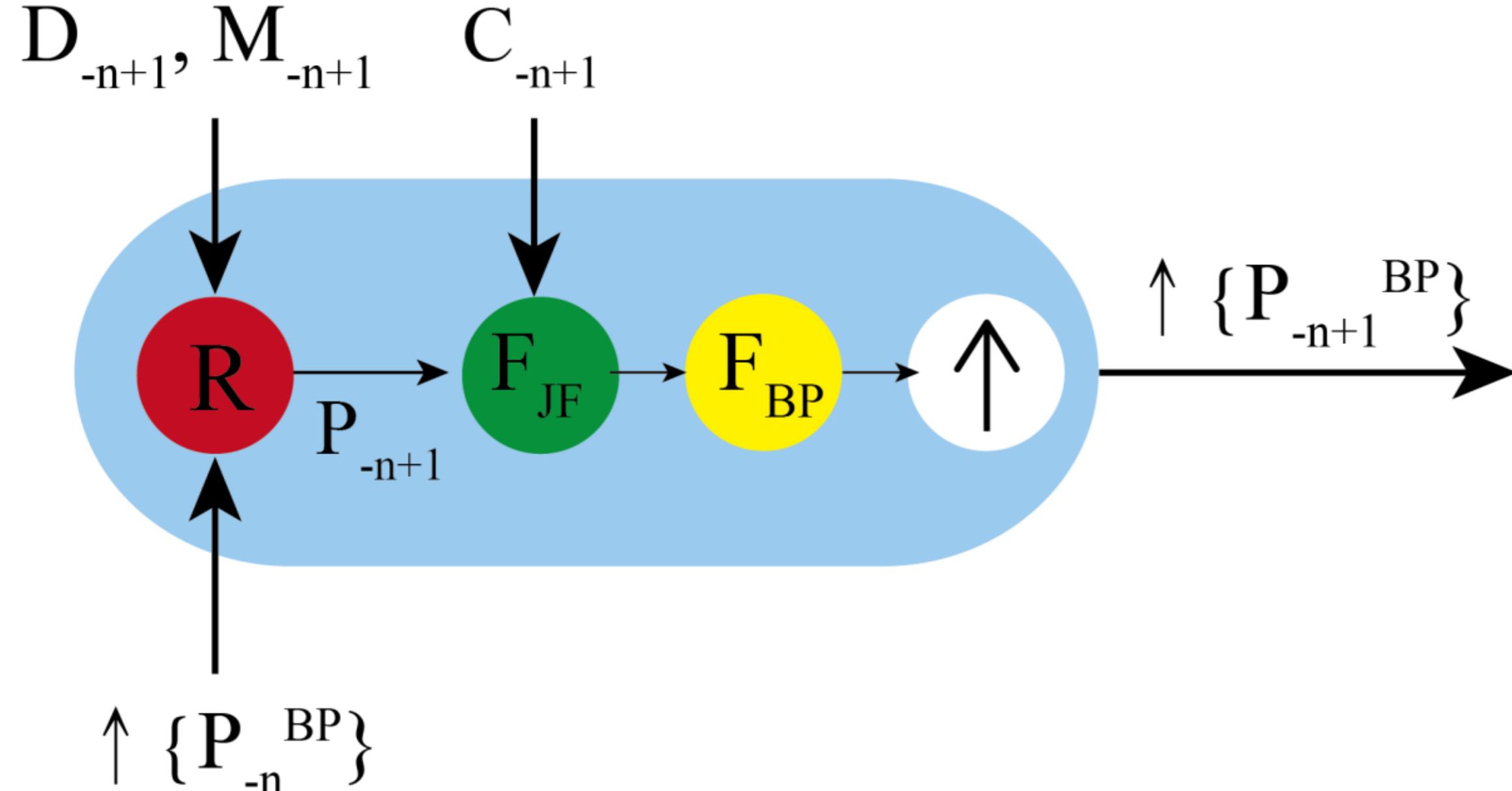


## Our Depth Map Refinement



## Multi-Resolution Image Smoothing

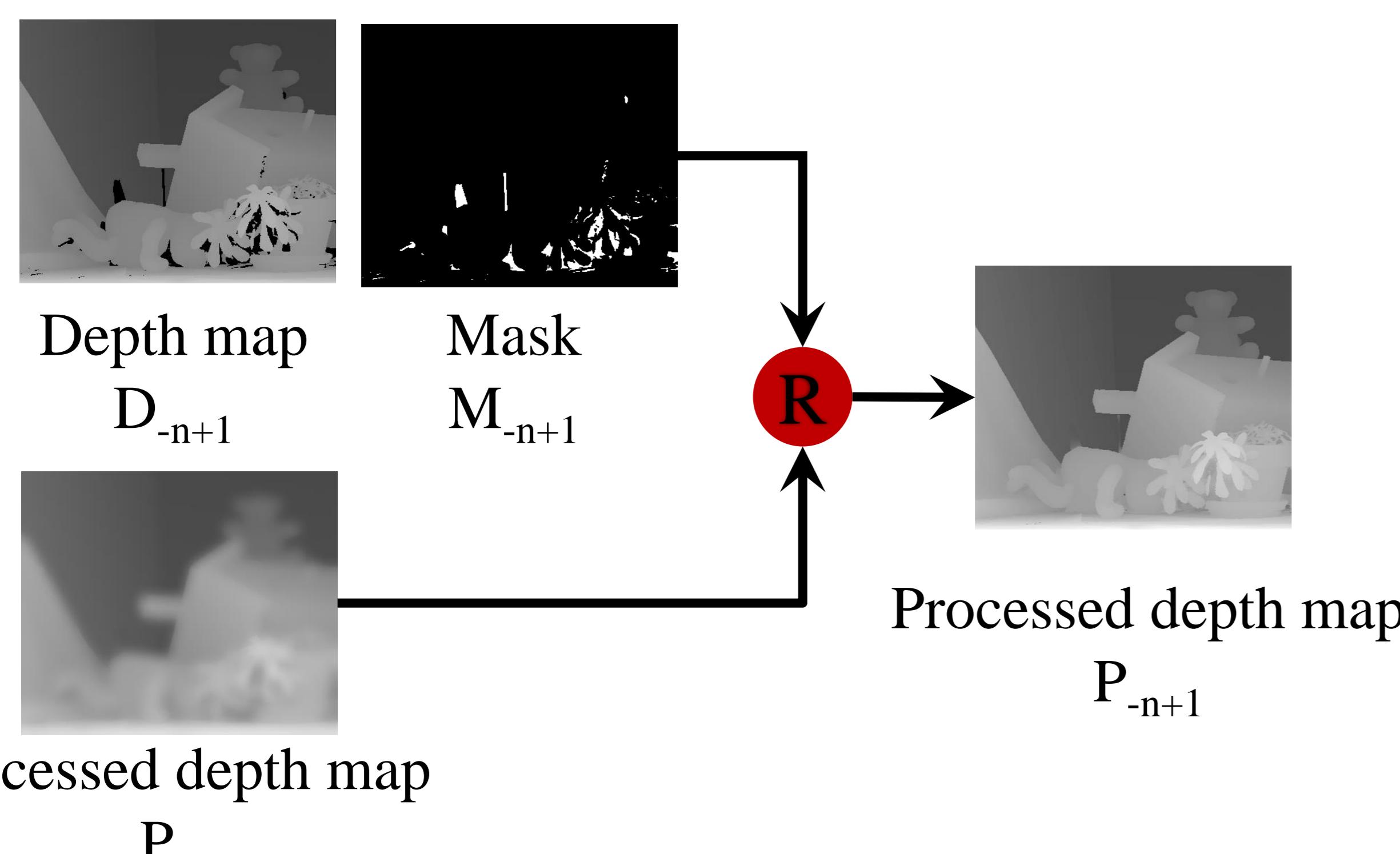
Inside our multi-resolution image smoothing, we adopt a Processing Unit at each resolution.



- Four possible steps in each processing unit:

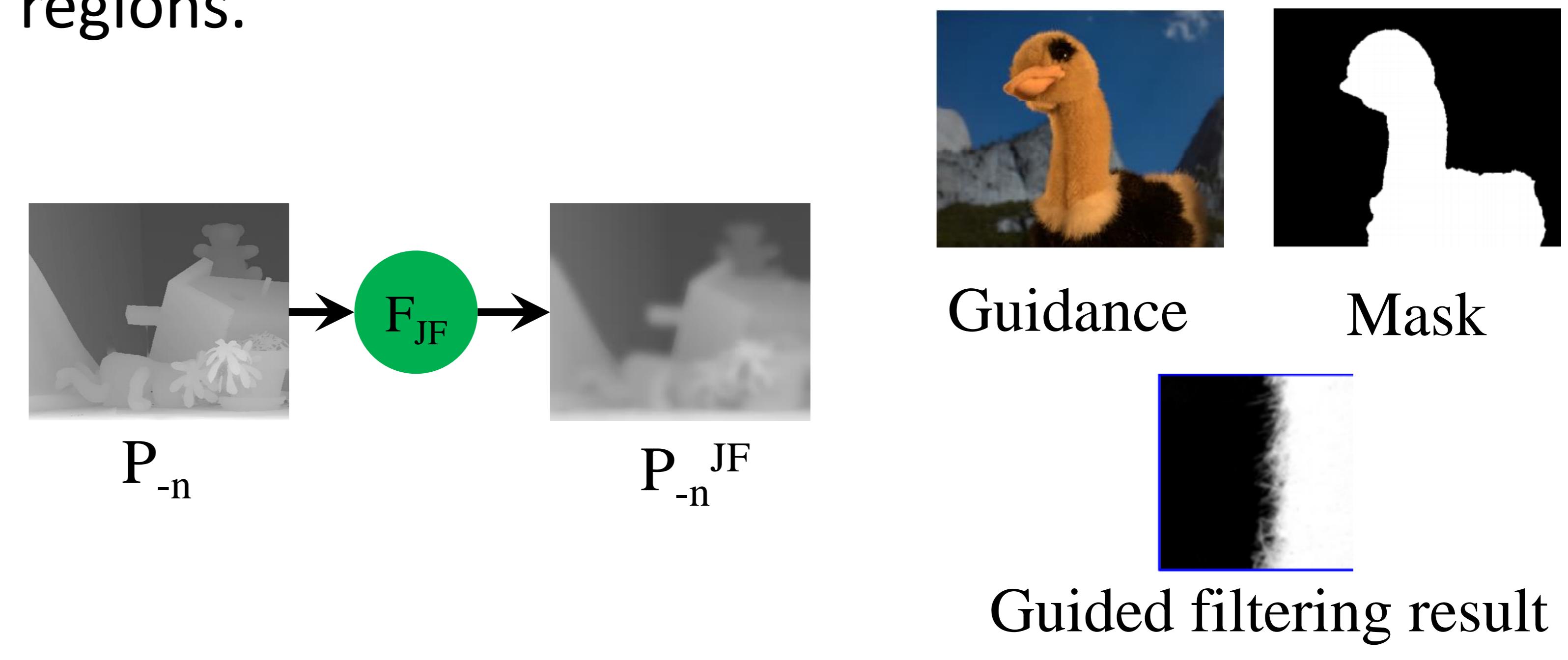
### Step 1: Replacement

We substitutively replace the depth information to the higher resolution according to the higher-resolution mask.



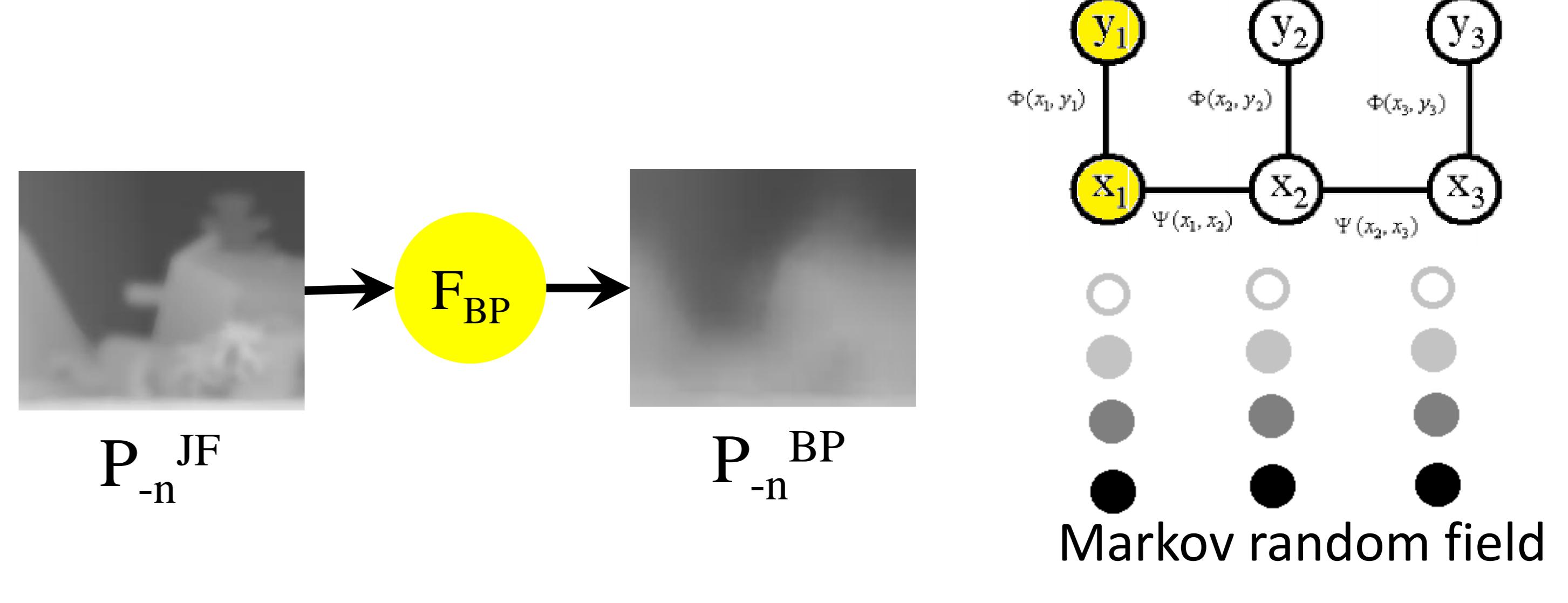
### Step 2: Guided filtering (or other joint filtering)

We adopt the color image as the guidance image to smooth the depth image. The kernel of guided filtering can preserve edges while smooth the missing regions.



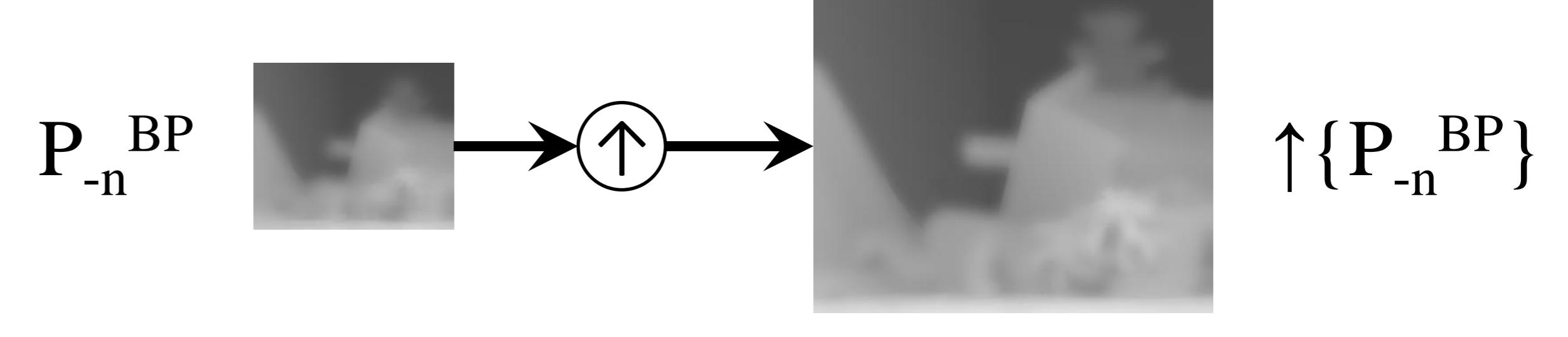
### Step 3: Propagation for image denoising

We furthermore construct a Markov random field to remove the noise of  $P_{-n}^{JF}$  so as to reach better quality.

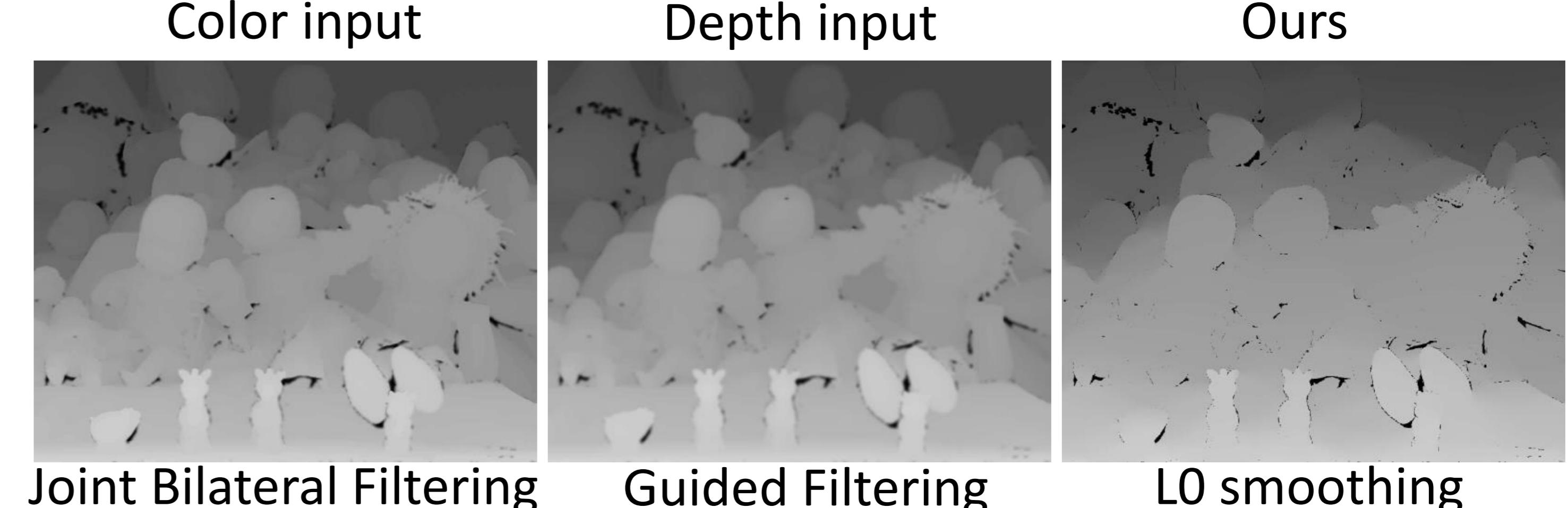
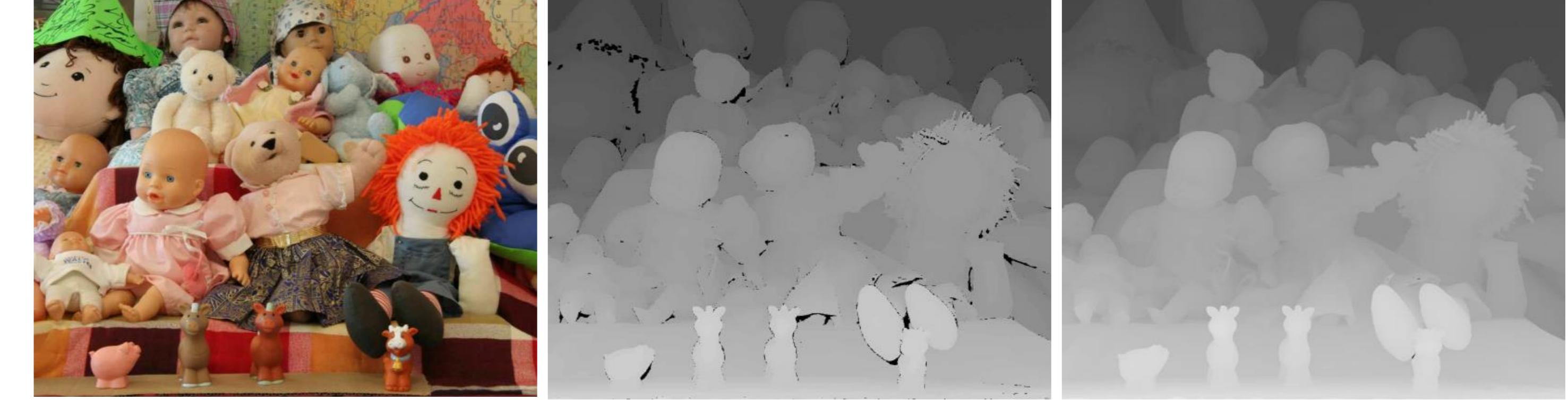
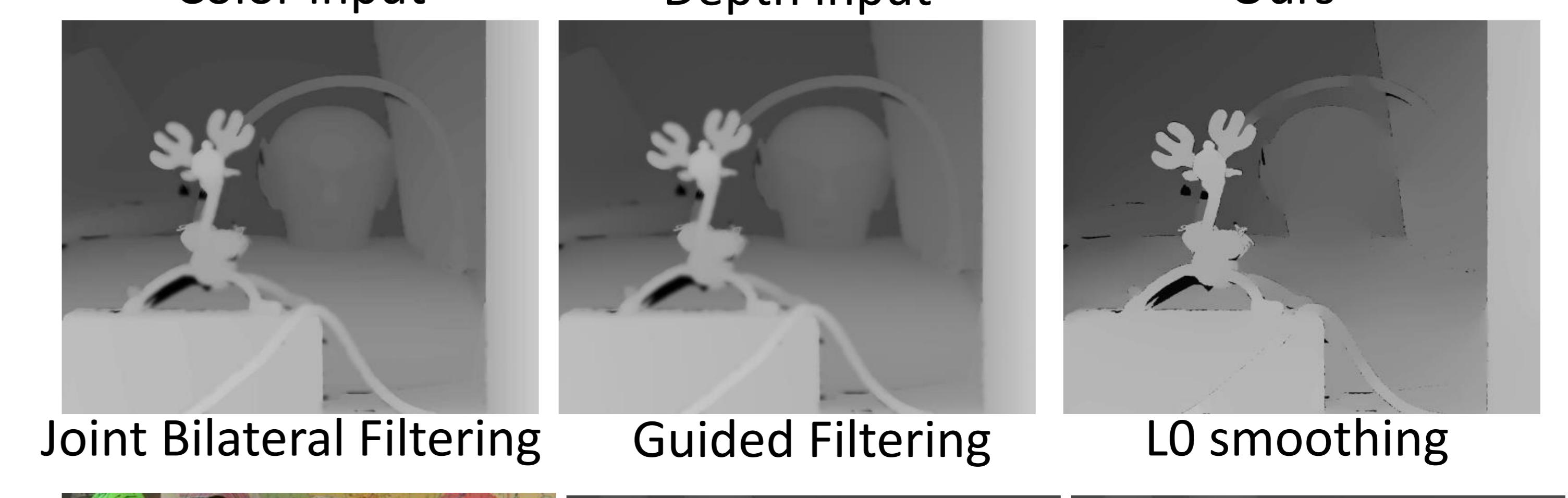


### Step 4: Up-sampling

Afterwards, we up-sample the depth image with the bicubic interpolation.



## Experimental Results



## References

- [1] L. Xu, C. Lu, Y. Xu and J. Jia, *Image smoothing via L0 gradient minimization*, SIGGRAPH Asia, no. 174, 2011.
- [2] K. He, J. Sun, and X. Tang, *Guided image filtering*, ECCV, pp. 1-14, 2010.
- [3] J. Kopf, M. F.Cohen, D. Lischinski and M. Uyttendaele, *Joint bilateral upsampling*, SIGGRAPH, no. 94, 2007.