A simple refinement for depth information predicted with DNN

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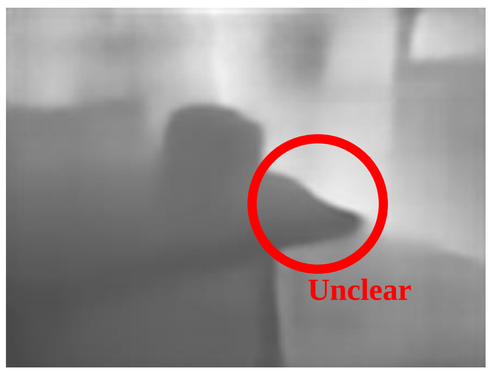
Introduction

Depth estimation/prediction from single-view RGB images is known as an important research subject in computer vision. There are many reports that DNN-based methods work well for depth estimation, however, such a learning-based method sometimes estimates unclear or uncertain depth information especially around edges, even if enough learning has conducted.

We proposes a simple refinement method for initial unclear depth estimated with DNN, by applying image processing techniques.

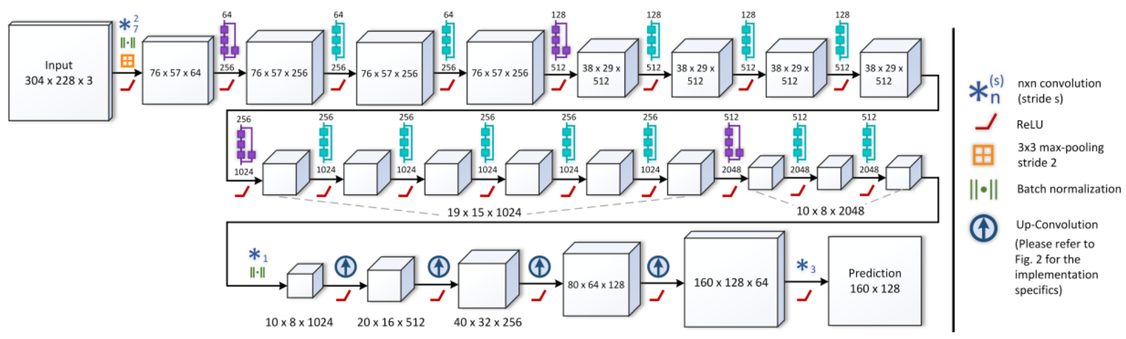
Original RGB Image



Unclear depth estimated with DNN

Initial Depth Prediction

We adopt ResNet-UpProj by I.Laina et al. to estimate initial depth from an input RGB image. This learned network is widely distributed and readily available.



I. Laina et al. “Deeper depth prediction with fully convolutional residual networks, ” arXiv:1606.00373, (2016).

Network structure of ResNet-UpProj

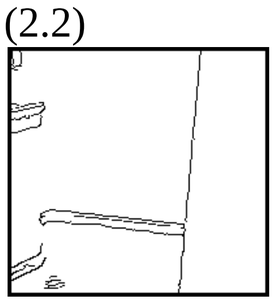
Proposed Method

Edge Refinement

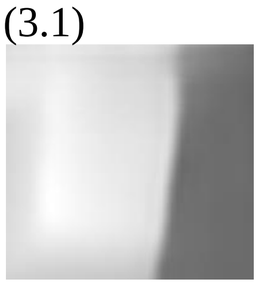
(1)

(2.1)

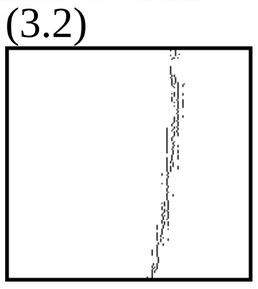
(2.2)



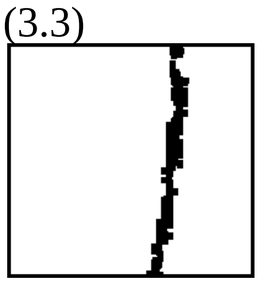
(3.1)



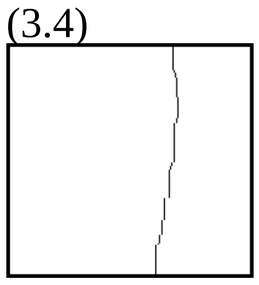
(3.2)



(3.3)



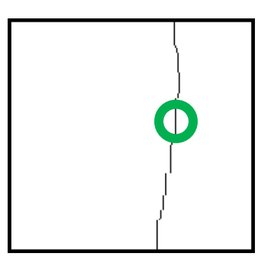
(3.4)



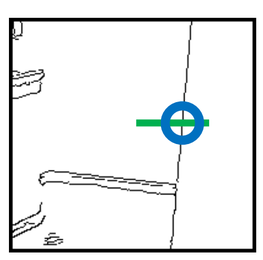
(1) Input RGB Image
(2.1) Enlargement of the red frame in (1)
(2.2) Edges extracted from (2.1)
(3.1) Initial unclear depth prediction with ResNet-UpProj
(3.2) Edges extracted from (3.1)
(3.3) Applying dilation processing twice to (3.2)
(3.4) Applying thinning processing to (3.3)

Depth Refinement around Edges

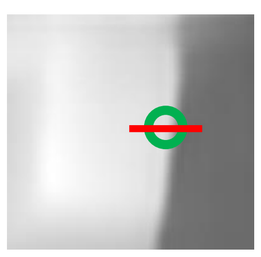
Our refinement procedure is as below: (in the case that the pixel marked by green circle)



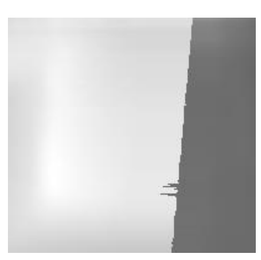
Refined edge



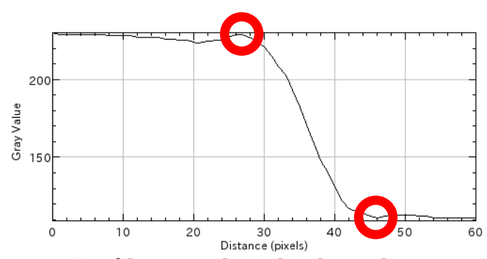
Edges extracted from RGB



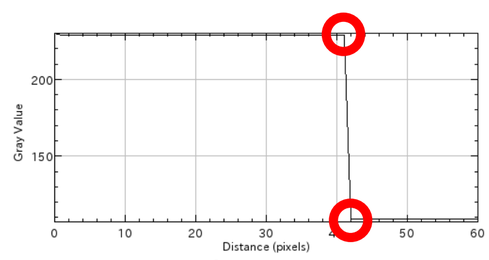
Unclear prediction



Our refinement



Profile in unclear depth prediction



Profile correction

1. Search for the corresponding pixel in the RGB edge image along green line, and find matching pixel marked by blue circle
2. Get profile in unclear depth prediction along red line (which is corresponding to green line)
3. Analyze the profile and referring to the depth value at the red circle position where the slope approaches 0, correct the depth value so that the change in the depth value becomes steep
4. Refine the depth value according to the corrected profile

Experiment

Among the NYU Depth v2 dataset, we visually selected 60 locations where the depth values around edges are relatively clear and considered to be highly reliable and used them for experiments.

NYU Depth v2: Silberman et al. “ Indoor segmentation and support inference from RGBD images, ” In ECCV, 746-760, (2012).

Input RGB | Initial prediction | Our refinement | True depth

	Initial prediction	Our refinement
Average of 60 RMSEs	21.3	18.2

As a result, modifying the depth values with our proposed method can reduce RMSE (root mean square error) by about 14.6%

Conclusion

Our simple approach can decrease about 14.6% of RMSE of depth value estimated.