Seeing Far in the Dark with Patterned Flash Supplementary Material

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1 Network Details

We show the network architecture details in Fig. 1. Blue/white blocks represent features, with the black numbers indicating the number of channels. Arrows with different colors represent different network operations. The network input has 8 channels, 4 for captured patterned flash (PF) image (RAW), 4 for calibrated PF pattern (RAW). The network output has 5 channels, 3 for reconstructed RGB image, 2 for estimated disparities in horizontal and vertical directions. The model has $\sim$ 7M tunable parameters in total. We select the dilations in Atrous Spatial Pyramid Pooling (ASPP) module to be roughly the integer divisions and multipliers of the period in our dot array illumination pattern ($\sim$ 6 pixels).

2 Object Detection with Patterned Flash

We apply another object detection task, low-light car detection, on reconstructed flash images. We use the synthetic Apollo night-time dataset [1] for this task. We first retrain flash image reconstruction models on the Apollo dataset, then we fix the image reconstruction network and train an object detector network with reconstructed images. We use CenterNet as the object detector [2] and only focus on car objects. Qualitative comparisons are shown in Fig. 2. Due to severe information loss in the UF reconstructed images, important objects can be missed by the object detector (e.g., car, lane markings at a long distance), which may lead to accidents in real-world scenarios.

3 Single-shot Flash/No-flash Imaging

When there is sufficient ambient illumination, PF can be used for single-shot flash/no-flash imaging since flash and ambient illumination signals are spatially separated in a PF image. Comparing with conventional double-shot flash/no-flash imaging [5], [3], this supports higher frame-rate and robustness in dynamic scenes. Various flash/no-flash techniques have been proposed, with very different ambient and flash illumination spectrum [6], [4]. In this scenario, we extend our algorithm to jointly reconstruct an ambient image, a flash image, and the scene disparity, as shown in Fig. 3.

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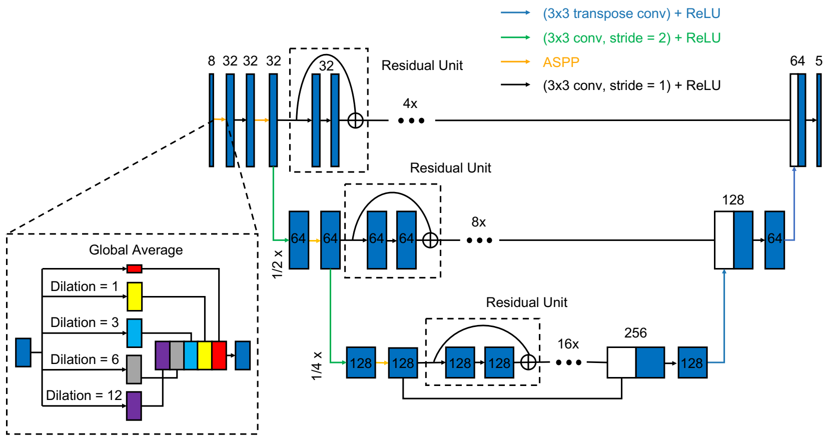

Fig. 1. Network architecture.

References

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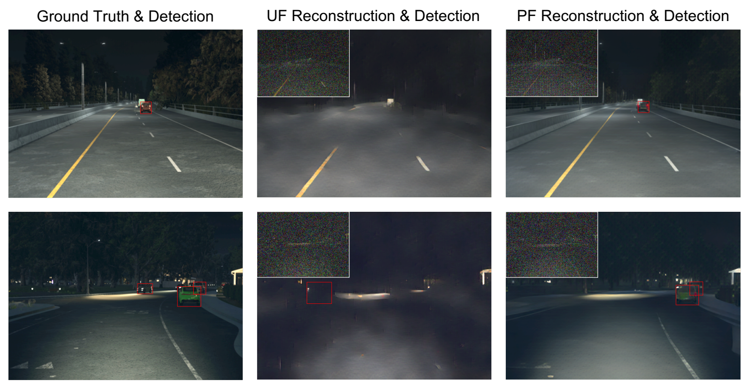

Fig. 2. Car object detection with PF and UF reconstructed images (brightened for visualization. UF and PF captured images are shown in the insets). UF reconstruction is blurry, leading to both false negative (1st row) and false positive (2nd row) in detection, while PF only has one false negative in the two scenes.

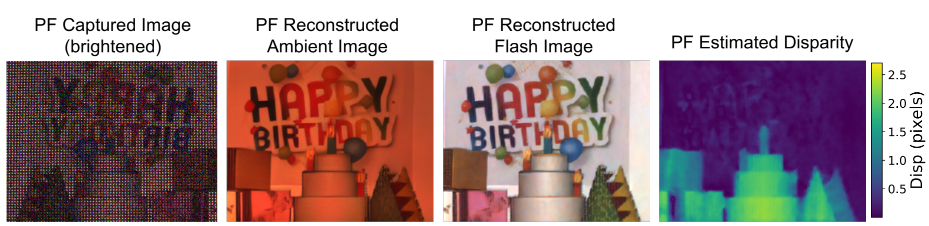

Fig. 3. Single-shot flash/no-flash imaging with patterned flashlight. When ambient and flash illumination have very different spectrum, our method can be used to jointly reconstruct ambient and flash image, and the scene disparity.