

APPENDIX

More visualizations are coming soon. If you are interested, stay tuned, and feel free to leave an issue or an email.

A. Supplementary of Image Matching Visualization

Here, we demonstrate supplementary visualization of image matching in addition to those shown in Fig. 4. In this section, we visualize the false positives (FPs) by conducting a statistical analysis and picking out the representatives based on the frequency of appearance. For each visualization pair, the query (left) image and reference (right) image are matched. All the representative pairs are fairly hard samples, even confusing human recognition. Employing local feature matching methods for loop closure verification is limited by perceptual aliasing, where the local textures are so similar that the local features are indistinguishable. Inspired by this observation, we further dive into the following analysis.

By analyzing most of these pairs, we can conclude that the local feature matching methods focus on the local geometric where global geometric information is missed.

- A typical example is shown in Fig. 8 Weather (d), where on the right side of the road is a flat ground, however, for reference image, there is a structured building. These cases might be solved if we consider the global geometric information or implicitly embed global geometric structure in the local features.
- Another typical example is shown in Fig. 8 Weather (a), where the matches are not evenly distributed. The matches mostly lie on the query's left and the reference image's right parts, which is constrained by the viewing angles. Similar matches should be on the right side, which might not be true when the other part of the image is textureless. However, we can detect if the texture exists via the distribution of the detected keypoints.

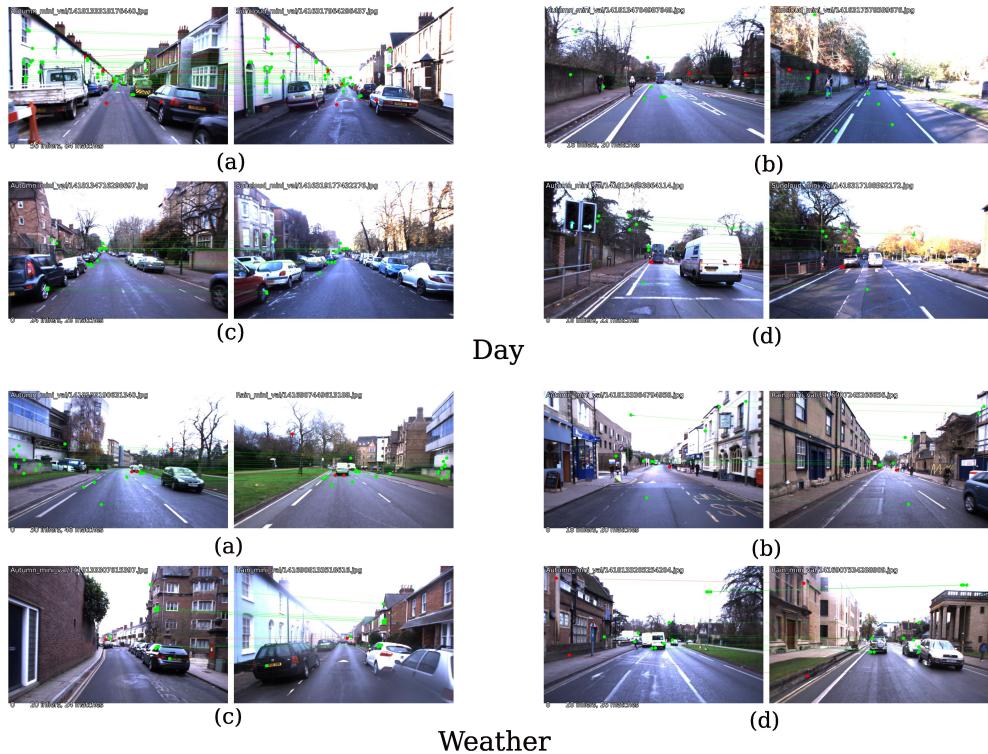


Fig. 8. LoFTR matches of Day and Weather sequences. The inliers (green lines) and outliers (red lines) are highlighted.

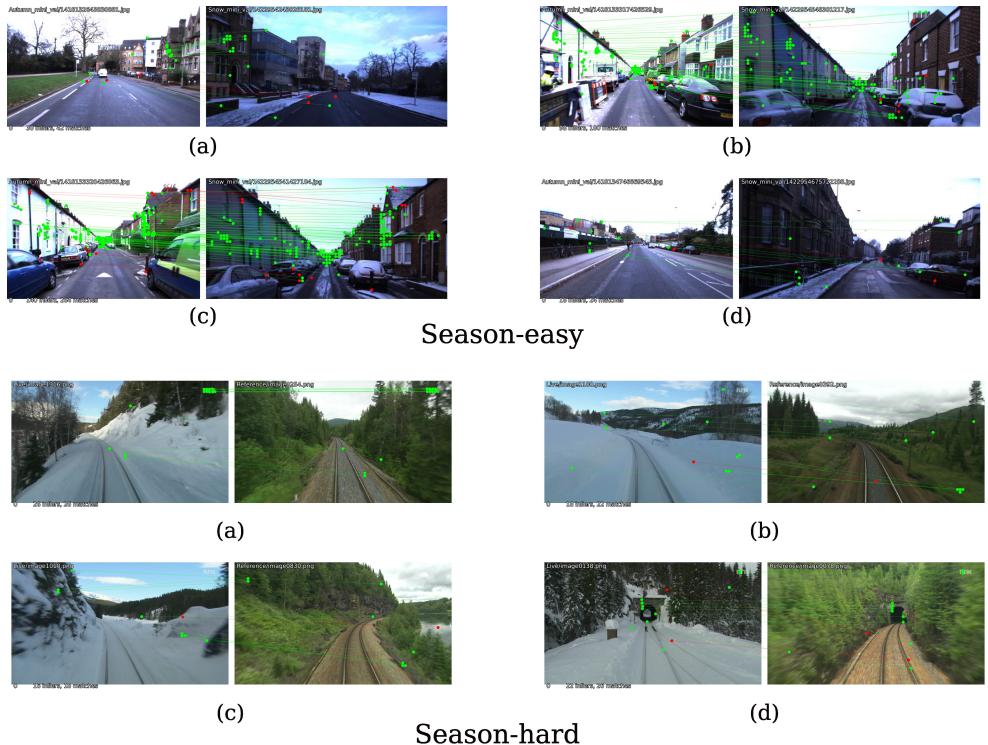


Fig. 9. **LoFTR matches of Season sequences.** The inliers (green lines) and outliers (red lines) are highlighted.

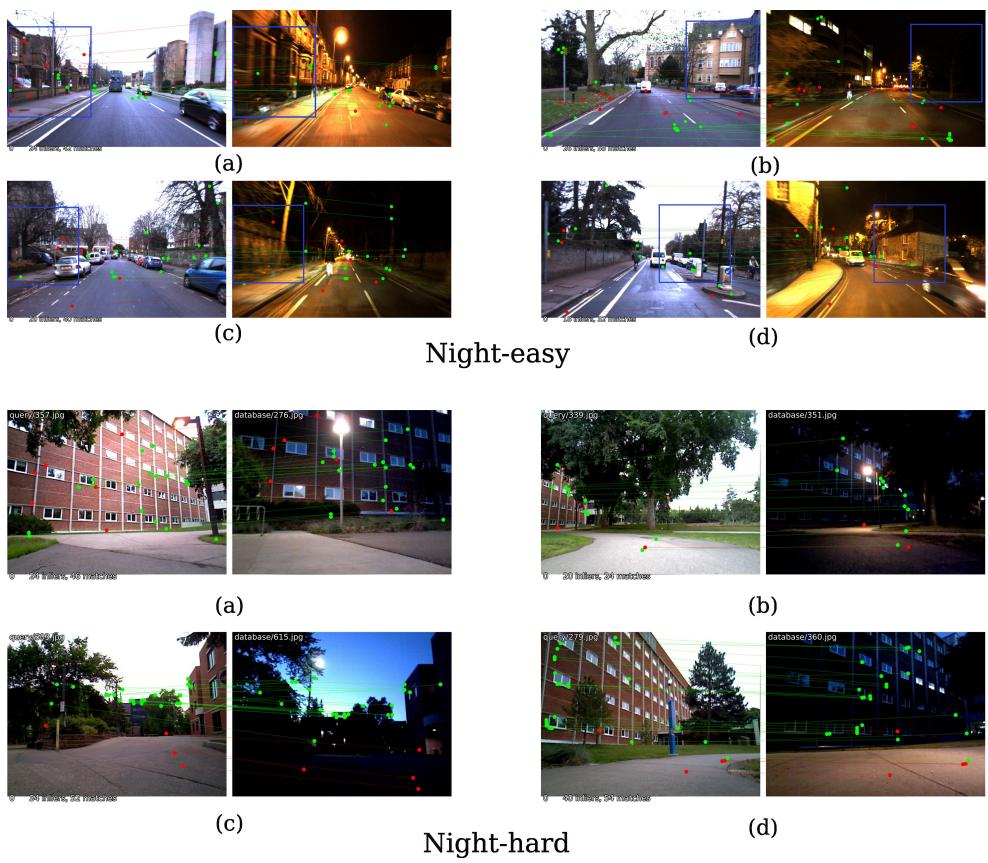


Fig. 10. **LoFTR matches of Night sequences.** The inliers (green lines) and outliers (red lines) are highlighted.

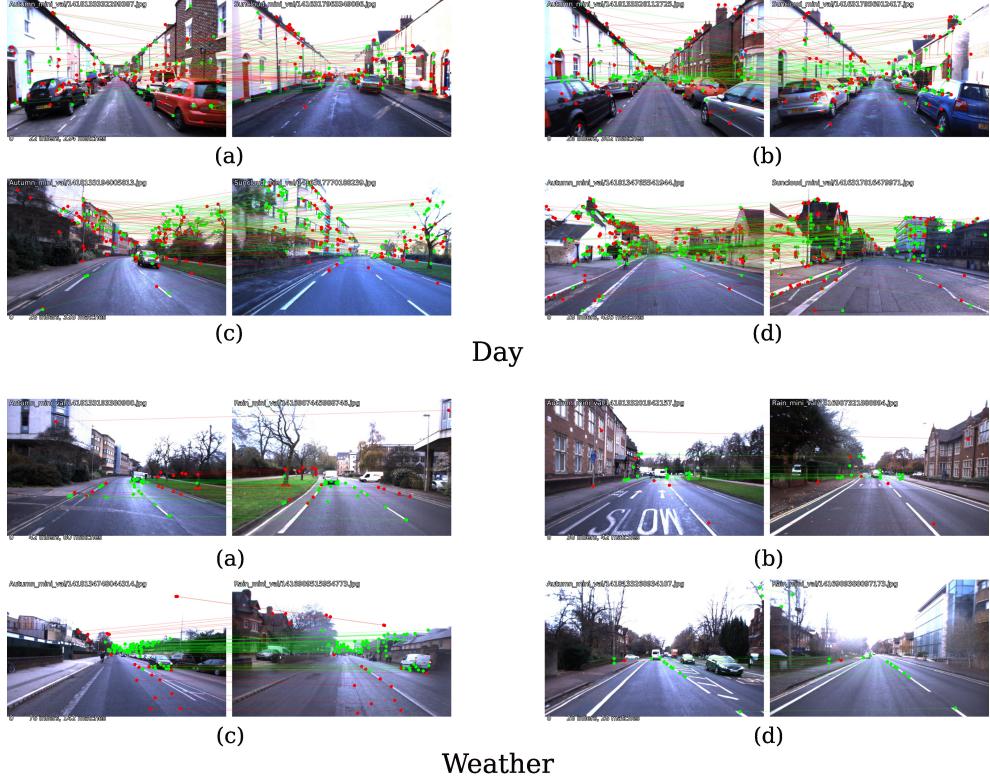


Fig. 11. SP+SG. matches of Day and Weather sequences. The inliers (green lines) and outliers (red lines) are highlighted.

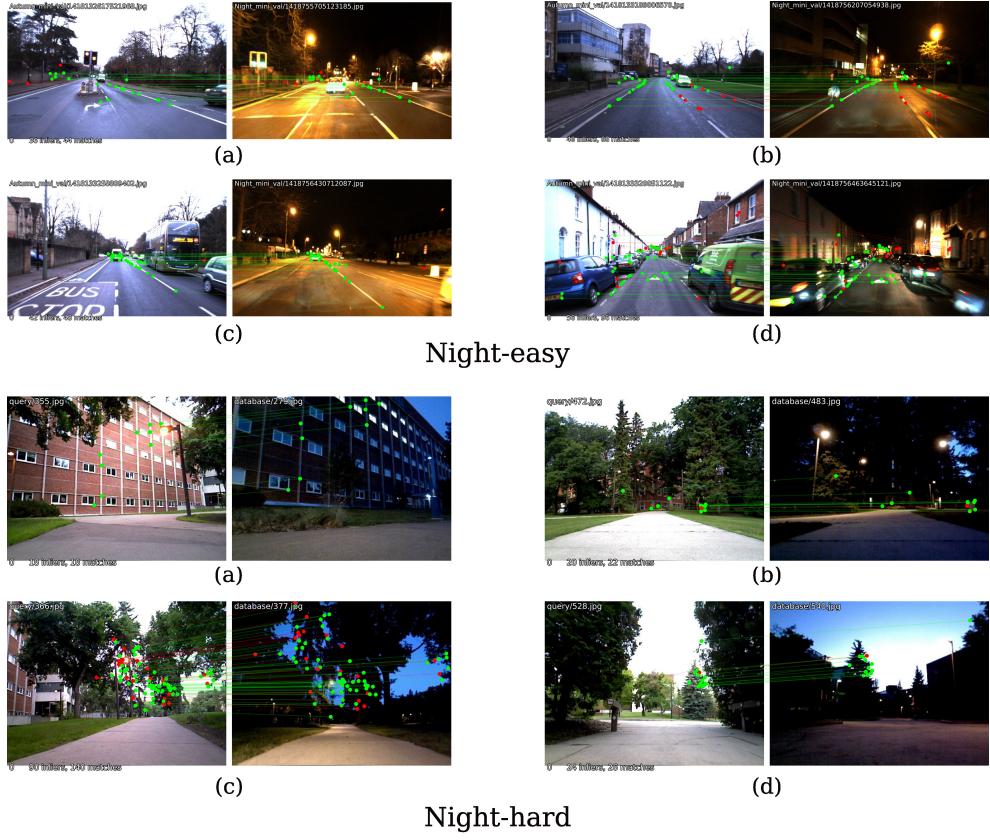


Fig. 12. SP+SG. matches of Night sequences. The inliers (green lines) and outliers (red lines) are highlighted.

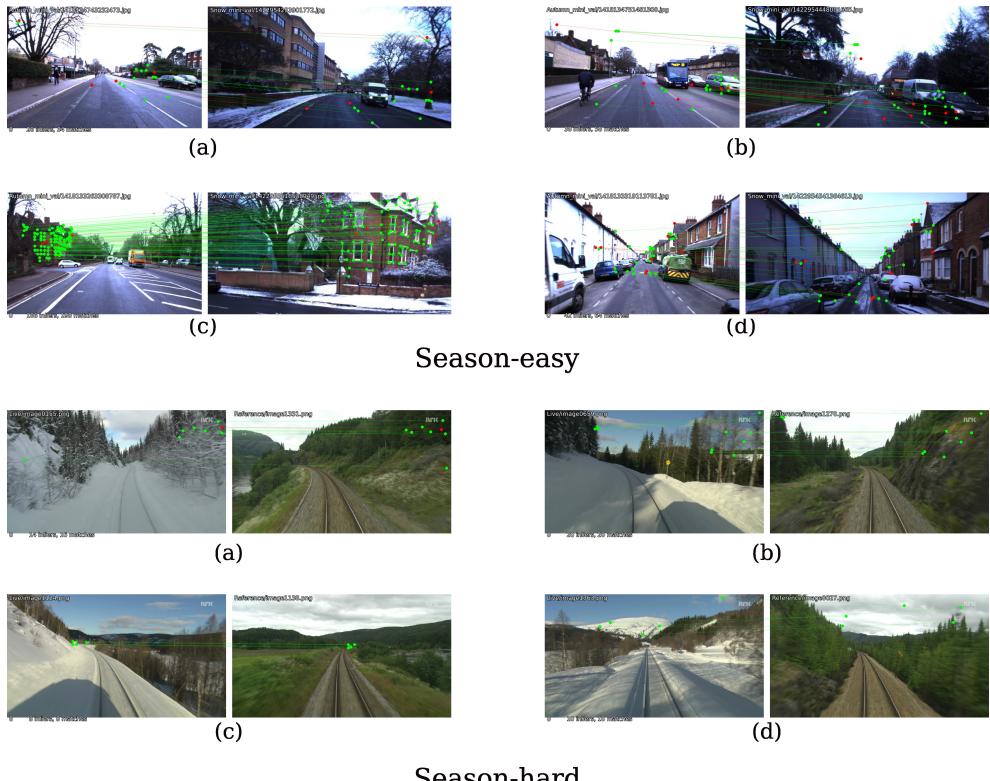


Fig. 13. **SP.+SG.** matches of Season sequences. The inliers (green lines) and outliers (red lines) are highlighted.