Structure-Aware Multiscale Light-Field Depth

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SUMMARY

Multifocus light-field cameras can acquire multiview imagery in a single exposure; however, the concomitant loss of spatial resolution and spatially nonuniform blur poses challenges for accurate depth estimation. In this work, a multiscale, structure-aware light-field depth estimation method (MS-SALF) is proposed. First, to handle view-dependent blur and texture variation across microimages, a blur-aware neighborhood selection mechanism that adaptively chooses matching views by using a multidimensional consistency score is introduced to improve the correspondence reliability. Second, we develop a multiscale, consistency-guided cost computation and structure-aware propagation framework grounded in a unified disparity-plane model. The framework integrates blur-aware weighting, patch reconstruction, and cross-view propagation to reduce boundary disparity discontinuities and topological disconnections. Finally, intraframe virtual-depth fusion and metric conversion are performed by fusing 3D points in a virtual space via multiview consistency and inverse projection, followed by a behavioral model that robustly maps virtual depth to the metric scale. Experiments on the public Raytrix R12 datasets and custom indoor/outdoor scenes captured with Raytrix R32 and HR260 cameras employed LiDAR point clouds as ground truth, and systematic evaluations that used loop-back geometric reprojection error, photometric consistency error, and completeness show that the MS-SALF outperforms representative methods (e.g., Zeller and BLADE), particularly in terms of boundary continuity, resistance to defocus, and low-texture regions. Ablation studies confirm the contribution of each proposed module. The resulting depth maps provide high-quality priors and a stable basis for subsequent light-field 3D reconstruction.