A Noise-Aware Filter for Real-Time Depth Upsampling

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Abstract: A new generation of active 3D range sensors, such as time-of-flight cameras, enables recording of full-frame depth maps at video frame rate. Unfortunately, the captured data are typically starkly contaminated by noise and the sensors feature only a rather limited image resolution. We therefore present a pipeline to enhance the quality and increase the spatial resolution of range data in real-time by upsampling the range information with the data from a high resolution video camera. Our algorithm is an adaptive multi-lateral upsampling filter that takes into account the inherent noisy nature of real-time depth data. Thus, we can greatly improve reconstruction quality, boost the resolution of the data to that of the video sensor, and prevent unwanted artifacts like texture copy into geometry. Our technique has been crafted to achieve improvement in depth map quality while maintaining high computational efficiency for a real-time application. By implementing our approach on the GPU, the creation of a real-time 3D camera with video camera resolution is feasible.

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NAFDU: A New Filter for Noise Aware Depth Upsampling

To address the specific requirements of depth superresolution and denoising for noisy real-time 3D sensors, like time-of-flight cameras, we propose a new multi-lateral noise-aware filter for depth upsampling (NAFDU). It is our goal to preserve the beneficial properties of bilateral upsampling in those areas where the data match our assumptions, and to prevent artifacts in those areas where standard bilateral upsampling is likely to cause erroneous texture copy. Time-of-Flight cameras are a relatively new 3-D sensing sensors that promise to be an alternative to other 3-D sensing systems such as stereo vision systems, laser scanners or structured light. They present several advantages such as simultaneously providing intensity and distance information for every pixel at a high frame rate. Moreover, they are compact, robust to illumination changes and of low weight. A noise-aware filter for real-time depth upsampling. In ECCVW, 2008. [2] R. Crabb, C. Tracey, A. Puranik, and J. Davis. Real-time foreground segmentation via range and color imaging. In CVPRW, pages 1–5, 2008. [3] J. Diebel and S. Thrun. An application of markov random fields to range sensing.