Multi-image Interpolation based on Graph-cuts and Symmetric Optical Flow

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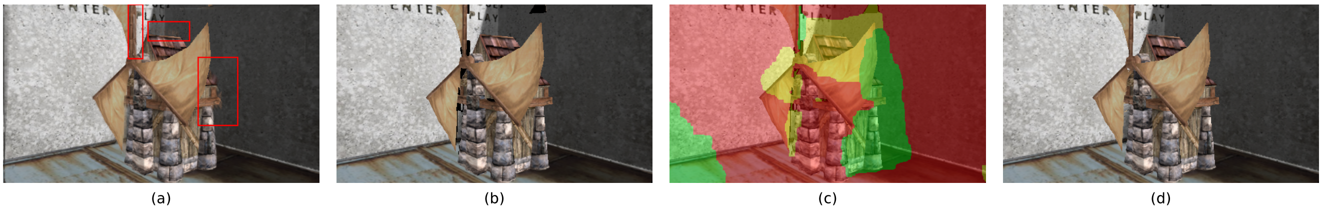

Figure 1: *(a) Scene rendered by adaptively blending four forward-warped images as proposed by Stich et al. The image shows ghosting artifacts (red boxes) and appears blurry. (b) Our proposed graph-cut interpolation algorithm. Black areas indicate holes that are invisible in all input cameras. (c) The image overlaid with the optimal labeling, each color denotes a different source image. (d) Final result, invisible regions are filled by spatio-temporal image inpainting.*

Abstract

Multi-image interpolation in space and time has recently received considerable attention. Typically, the interpolated image is synthesized by adaptively blending several forward-warped images. Blending itself is a low-pass filtering operation: the interpolated images are prone to blurring and ghosting artifacts as soon as the underlying correspondence fields are imperfect. We address both issues and propose a multi-image interpolation algorithm that avoids blending. Instead, our algorithm decides for each pixel in the synthesized view from which input image to sample. Combined with a symmetrical long-range optical flow formulation for correspondence field estimation, our approach yields crisp interpolated images without ghosting artifacts.

Keywords: image-based rendering, video-based rendering, free-viewpoint video, 2D Morphing & Warping

1 Motivation

The synthesis of in-between images from different viewpoints and/or time instants is experiencing a renaissance. Mahajan et al. recently proposed a high-quality interpolation technique that is based on finding an optimal path for a pixel transitioning from one image to the other [Mahajan et al. 2009]. The strength of this approach is that the path framework allows each pixel to transition to the other image somewhere along the path, whenever a good correspondence is found.Further on, each pixel in the interpolated view is sampled from exactly one source image, thus avoiding ghosting or blurring artifacts. A major drawback of this approach is that the path idea can only be applied to two images; a direct extension to multi-image interpolation is not feasible.

Stich et al. recently introduced a spatio-temporal image interpolation approach that generates novel views from four input images [Stich et al. 2008]. This approach is based on adaptively blending four forward-warped images. While this approach also delivers high-quality interpolation results, it suffers from ghosting and blurring artifacts as soon as the underlying correspondence fields are imperfect.

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2 Our Approach

In our approach, we combine the strengths of both approaches and propose a multi-image interpolation algorithm that avoids blending. We proceed as follows: we first forward-warp the input images to the desired target position; in constrast to Stich et al. [2008], the warp mesh is cut open in disoccluded regions. Our algorithm then decides for each pixel in the interpolated image from which forward-warped source image to sample best. To this end, we formulate image interpolation as a labeling problem and solve the resulting optimization problem using graph-cuts [Boykov et al. 2001]. Along those cuts, it is crucial that the forward-warped source images are in perfect correspondence.In the path framework of Mahajan et al., perfect correspondence comes for free by symmetry of paths; in our approach we enforce symmetric correspondence fields by adapting the long-range correspondence estimation algorithm by Steinbruecker et al. [2009] to fulfill this goal. In a last step, parts that are invisible in all input images are filled by inpainting the interpolated sequence using the approach of Telea [Telea 2004], suitably extended to three dimensions. Taken together, our approach yields crisp interpolated images for more than two input images.

References

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