Patch-based Fast Image Interpolation in Spatial and Temporal Direction

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Figure 1. *Comparison of interpolation between our method (red) and Moving Gradient [Mahajan et al 2009] (green)*

1. Introduction

Recently, a plausible interpolation of images has been proposed for many applications such as smooth view interpolation, up-sampling low frame rate video, and making animation from still images. However, producing an intermediate frame from two images is still a challenging task. The moving gradient method enables one to obtain intermediate frames without suffering from blurring or ghost effects, by computing the displacement of each pixel [Mahajan et al 2009]. However, their method requires many iterations of the optimization process for pixel displacements by graph-cut. Hence their method is not suitable for interactive applications. To compute correspondence between two images rapidly, we employ the *PatchMatch* framework [Bames et al 2009], which is a significantly faster method for reconstructing an image from plenty of patches. However, an issue is that it is not necessary to find accurate correspondence in this method, which means that while some patches find appropriate counterparts, the others do not. We employ a greedy approach so that the incorrect correspondences can follow the accurate ones. Finally, we show that significant improvements on computing times are obtained, and that difference of the results between the state-of-the-art approach and our method is negligibly small.

2. Moving Patch

Our framework is divided into 2 parts. At first, the patches of an image correspond to the patches of the other image using PatchMatch bidirectional (i.e. from one image to the other, and in the opposite direction). However, a correspondence is likely to be different from its counterpart. To correct the correspondence, a greedy algorithm described below reduces the gap between two correspondences. Finally, intermediate frames are interpolated linearly using the nearest neighbor offsets in bi-directions. Note that if the corresponding point to $p \in \mathrm{R}^2$ in image A is point q in image B, the nearest neighbor offset $v_{AB}^p \in \mathrm{R}^2$ is written as

$$v_{AB}^p = q - p. \quad (1)$$

We define v_{BA}^p in the same way as v_{AB}^p.

2.1 Patch Modification

The gap g^p of the offset at point p between image A and image B is computed as

$$g^{\mathrm{p}} = p - v_{BA}^{\mathrm{p}+v_{\mathrm{AB}}^{\mathrm{p}}}. \quad (2)$$

If the size of gap $|g|$ is large, correspondence of patches is more likely to be wrong. Therefore, we search adjacent points for optimal offsets at each point so that $|g|$ is lower than the current size of gap. This modification process is analogous to the propagation process of PatchMatch.

3. Results and Future Work

In our method, it takes less than 1 second to produce intermediate frames from 320×240 images using Intel Core i7 2.70GHz, 8GB RAM. It is significantly faster than the previous methods (i.e. Moving Gradients). As shown in Fig.1 and supplemental movies, we demonstrate that our method succeeds in producing intermediate frames without blurring or ghost effect in the same way as those state-of-the-art approaches. Besides, it is shown that our method can obtain intermediate frames in challenging non-rigid interpolation. However, the larger the difference between two images becomes, more incorrect correspondences occur. Addressing this issue will be one of the main goals of our future work.

References

Mahajan, D., Huang, F., Matusik, W., Ramamoorthi, R., and Belhumeur, P. "Moving gradients: a path-based method for plausible image interpolation." ACM Trans. Graphics, 28(3), 2009.

Barnes, C., Shechtman, E., Finkelstein, A., and Goldman D. "PatchMatch: a randomized correspondence algorithm for structural image editing." ACM Trans. Graphics, 28(3), 2009

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