Photo Zoom: High Resolution from Unordered Image Collections

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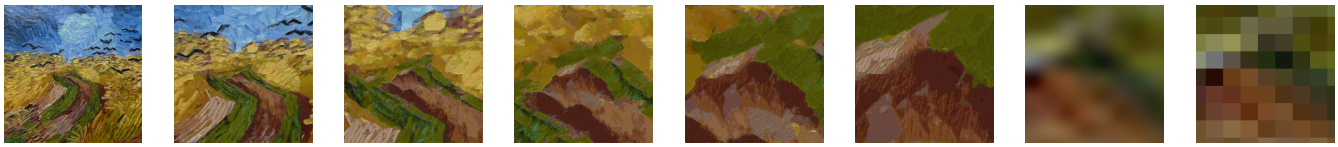

Figure 1: *Our technique allows infinite zooms into images, creating new details at each level. Not only from single images, but also from image collections. From left to right: zoom into an image with original resolution of* 256×256 *using Photo Zoom, bilinear upsampling and nearest neighbor upsampling of the same region.*

Abstract

We present a system to automatically construct high resolution images from an unordered set of low resolution photos. It consists of an automatic preprocessing step to establish correspondences between any given photos. The user may then choose one image and the algorithm automatically creates a higher resolution result, several octaves larger up to the desired resolution. Our recursive creation scheme allows to transfer specific details at subpixel positions of the original image. It adds plausible details to regions not covered by any of the input images and eases the acquisition for large scale panoramas spanning different resolution levels.

Keywords: example-based texture synthesis, super-resolution

1 Overview

Our goal is to rely on multiple photos to add high-resolution details to a chosen input photo. In such a way, a user can improve a holiday snapshot so that it becomes possible to zoom in to take a closer look at interesting parts of the image far beyond the original image resolution. Starting with an unordered photo collection of arbitrary images, our system automatically arranges them in a dependency graph that describes which photograph contains details of another one. The user then chooses any photo and the system seamlessly enhances it with the found details up to the desired resolution, using a synergy between example-based texture synthesis, like [Han et al. 2008], and super-resolution, [van Ouwerkerk 2006].

Our work addresses the following challenges:

- Establishment of reliable correspondences between photographs in unordered photo collections, even if direct feature matching would fail by making use of an automatically created dependency graph using advanced feature matching;
- Artifact free blending of (potentially overlapping) images at different resolutions, taken with different cameras, different focal length, white balancing or color aberrations by a gradient domain blending technique;
- Transfer and detail enhancement by information exchange between photos where no specific details are available through a new multiscale texture synthesis algorithm based on discrete optimization (Fig. 2);

A major difficulty is that human observers are very sensitive to artifacts in real world images. Hence, previous systems opted for user-supported solutions, whereas we present a fully automatic method.

We believe that loosening the restrictions of super-resolution from equivalence to the original image, when downsampled, to similarity to the original image, opens up a new interesting field of research, that has the possibility to overcome limitations of classic super-resolution approaches.

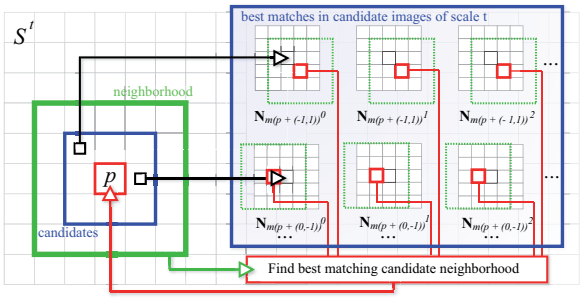

Figure 2: *Optimization procedure: Color values are optimized by improving coherence of neighboring pixels. For each pixel from p's* 3×3 *neighborhood, its* 5×5 *neighborhood is extracted and the best matches are found in the candidate images (*$\mathbf{N}_{m(p)^k}$*, gray grids on the right). The neighborhoods from the shifted center pixel (*$N_{m(p+\Delta)^k-\Delta}$*, dotted region around red pixels on the right) are then compared to p's original neighborhood (*$\mathbf{N}_p$*)and p is replaced with its best match.*

References

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