



بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

آمیختن بدون درزِ تصاویر، مبتنی بر هم‌رنگ‌سازی چند بانده و تبدیل موجک

Seamless Image Fusion Based on Multi-band Blending and Wavelet Transform

Seamless
Image Fusion
Based on
Multi-band
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Transform

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Fathy,
Mozayani

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Definition

Image stitching is a common practice in the generation of panoramic images and applications such as object insertion, object removal and **super resolution**.

Simple Approach

Pasting of a left region from image 1 and a right region from image 2.

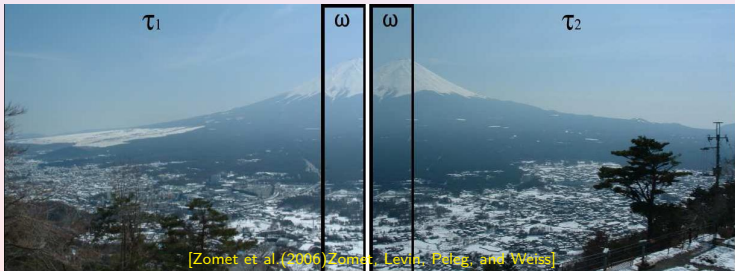




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Simple Approach

Pasting of a left region from image 1 and a right region from image 2.

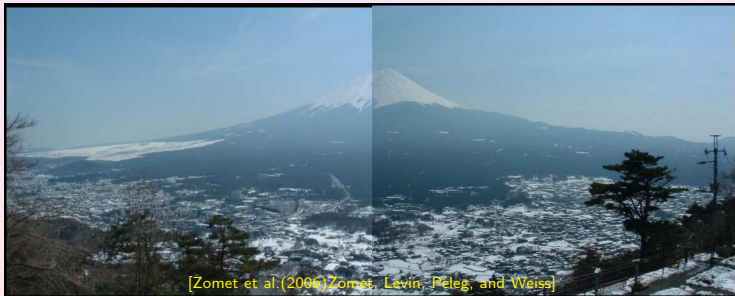




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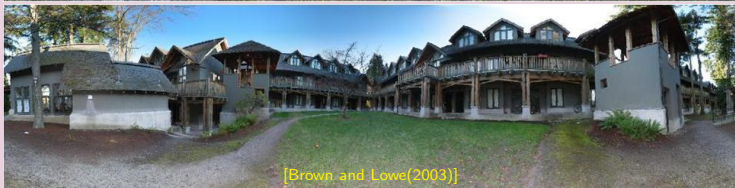
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Definition

Image stitching or photo stitching is the process of combining multiple photographic images with overlapping fields of view to produce a segmented panorama or high-resolution image.



[Brown and Lowe(2003)]



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The Aim of Image Stitching

The aim of a stitching algorithm is to produce a visually plausible mosaic with two desirable properties:

- 1 **Similarity**
Similarity of both images, geometrically and photometrically.
- 2 **Seam Invisibility**



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The Aim of Image Stitching

The aim of a stitching algorithm is to produce a visually plausible mosaic with two desirable properties:

- 1 Similarity
- 2 **Seam Invisibility**

The seam between the stitched images should be invisible.



Stages of Image Stitching

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Stages of Image Stitching

1 Image Registration

Image registration is the process of overlaying images of the same scene taken at different times, from different viewpoints, and/or by different sensors

2 Image Blending



Stages of Image Stitching

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Stages of Image Stitching

1 Image Registration

2 **Image Blending**

combining the sections, considering: Color mapping, Dynamic range extension, Motion compensation, deghosting and deblurring.



Blending Approaches

Seamless Image Fusion Based on Multi-band Blending and Wavelet Transform

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BLENDING APPROACHES:

- 1 Pixel Averaging
- 2 Weighted Pixel Averaging (Alpha Blending, Feathering)
[Uyttendaele et al.(2001)Uyttendaele, Eden, and Szeliski]
- 3 Multi Band Blending Approach of
[Burt and Adelson(1983)]



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[Uyttendaele et al.(2001)Uyttendaele, Eden, and Szeliski]

$$S(i) = H_l(i - \hat{i})A(i) + H_r(i - \hat{i})B(i) \quad (1)$$

- 3 Multi Band Blending Approach of
[Burt and Adelson(1983)]



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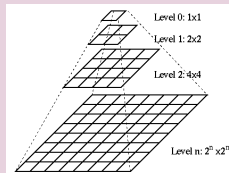
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BLENDING APPROACHES:

- 1 Pixel Averaging
- 2 Weighted Pixel Averaging (Alpha Blending, Feathering)
[Uyttendaele et al.(2001)Uyttendaele, Eden, and Szeliski]
- 3 Multi Band Blending Approach of
[Burt and Adelson(1983)]

Different frequency bands are combined with different alpha masks. Lower frequencies are mixed over a wide region, and fine details are mixed in a narrow region.

GAUSSIAN PYRAMID, LAPLACIAN PYRAMID





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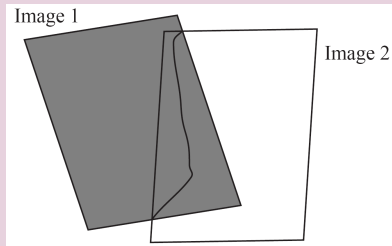
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SEAM FINDING:

- Equal distance, Grassfire Transform.



- Optimum Seam

Search for a curve in the overlap region on which the differences between I_1 ; I_2 are minimal.



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SEAM FINDING:

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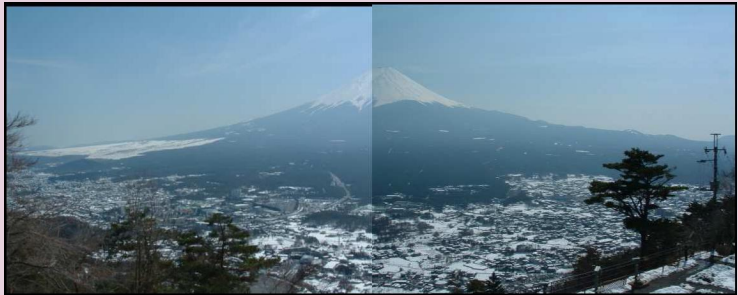
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Disadvantages of Simple Approaches

Produces visible artificial edges in the seam between the images, due to differences in :

- camera gain,
- scene illumination,
- geometrical misalignments.





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Definition

Super-Resolution (SR) techniques fuse a sequence of low-resolution images to produce a higher resolution image. The low resolution (LR) images may be noisy, blurred and have some displacement with each other.

Approaches

Interpolation, Iterated Back Projection, Bayesian, EXAMPLE BASED APPROACHES such as our approach in CSICC 2009 [Amintoosi et al.(2009)Amintoosi, Fathy, and Mozayani].



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Approaches

Interpolation, Iterated Back Projection, Bayesian, **EXAMPLE BASED APPROACHES** such as our approach in CSICC 2009 [Amintoosi et al.(2009)Amintoosi, Fathy, and Mozayani].



Regional Resolution Enhancement

[Amintoosi et al.(2009)Amintoosi, Fathy, and Mozayani]

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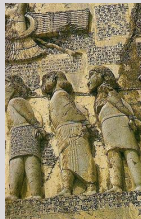
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One LR and three HR images of a portion of bas relief of Darius





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Definition

Image fusion is the process of combining information from two or more images of a scene into a single composite image that is more informative and is more suitable for visual perception or computer processing. [Goshtasby and Nikolov(2007)]

Fusion = Integration = Merging

IMAGE FUSION APPROACHES: [Piella(2003)]

- Weighted Combination
- Color space fusion
- Multi-Resolution Image Fusion



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IMAGE FUSION APPROACHES: [Piella(2003)]

- 1 Weighted Combination
- 2 Color space fusion
- 3 Multi Resolution Image Fusion



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IMAGE FUSION APPROACHES: [Piella(2003)]

① Weighted Combination

② Color space fusion

The simplest technique is to map the data from a sensor to a particular color channel.

③ Multi Resolution Image Fusion



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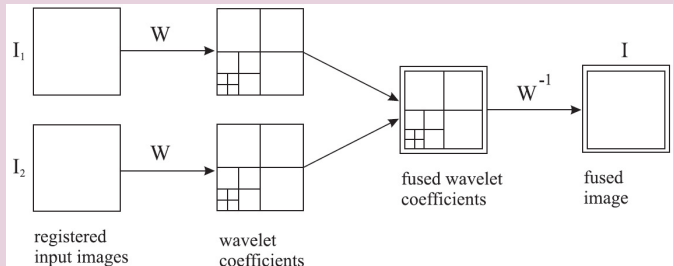
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IMAGE FUSION APPROACHES: [Piella(2003)]

- 1 Weighted Combination
- 2 Color space fusion
- 3 **Multi Resolution Image Fusion**

Wavelet Transform



$$I(\mathbf{x}) = \omega^{-1} \left(\phi(\omega(I_1(\mathbf{x})), \omega(I_2(\mathbf{x}))) \right)$$



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The Original LR Image



The HR Training Image



Transformed of HR Image



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Multi Band Blending vs. Wavelet Image Fusion

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Multi Band Blending



Wavelet Image Fusion



Wavelet Transform + Multi-Band Blending

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The Algorithm

Input: Images A and B and transformation model $\mathbf{W}(\mathbf{x}; \mathbf{p})$.

Output: The fused image S , from Images A and $B(\mathbf{W}(\mathbf{x}; \mathbf{p})^{-1})$ (Transformed of B onto A).

- 1 Compute C , the wavelet fused of A and $B(\mathbf{W}(\mathbf{x}; \mathbf{p})^{-1})$,
- 2 Expand the dimensions of A and C , according to requirements of Multi-band Blending,
- 3 Create mask R , corresponding to $B(\mathbf{W}(\mathbf{x}; \mathbf{p})^{-1})$,
- 4 Erosion of mask R ,
- 5 Create S by combining A and C with Multi-Band Blending approach and mask R .



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Photoshop, Opacity 100



Photoshop, Opacity 70



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Photoshop, Opacity 35



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Visual Comparison

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The Second Example

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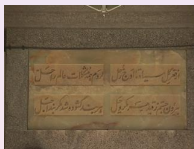
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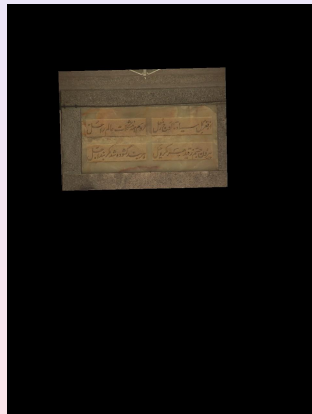
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The Original LR Image



The HR Training Image



Transformed of HR Image



Visual Comparison

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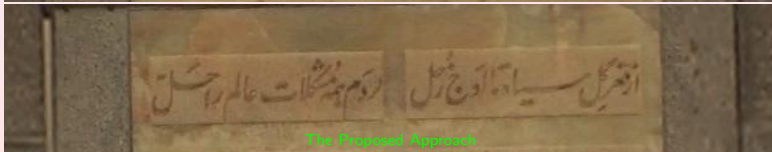
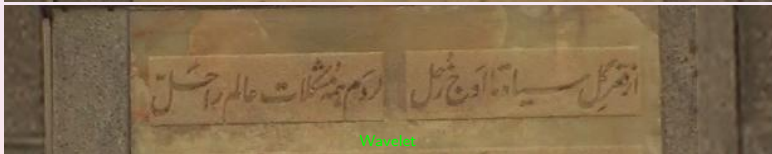
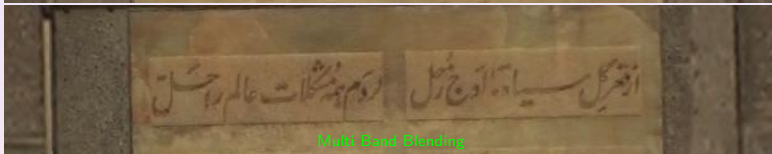
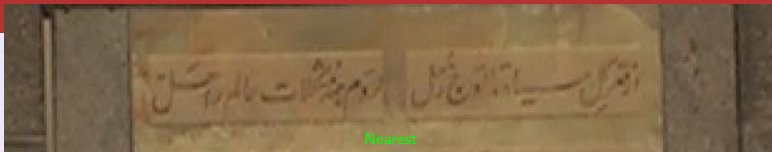
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Each of the Multi-band blending and Wavelet transform for fusing the images in our super-resolution problem have some pros and cons.

With the proposed hybrid approach, the advantages of both of these methods has been used.



References

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Thanks for your attention

And a special thank to XEPersian group.

Any Question?

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