

Bottom-up Segmentation for Ghost-free Reconstruction of a Dynamic Scene from Multi-exposure Images

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Real World Scenes

- ▶ have High Dynamic Range (HDR)
- ▶ are very Dynamic (scenes change continuously)
- ▶ cannot be captured using a single digital snapshot

High Dynamic Range Imaging Problem [Mann & Picard, 1995 and Debevec & Malik, 1997]

- ▶ To capture a dynamic HDR scene using a single digital image
- ▶ Challenges - dynamic scene, limited sensor well capacity, memory
- ▶ Solutions - intelligent sensor design (hardware) and compositing linearized intensity values of multi-exposure images (algorithmic)
- ▶ HDR image generation from Multi-exposure images requires deghosting, Camera Response Function (CRF) and possibly exposure times
- ▶ Common display and printing devices - Low Dynamic Range (LDR)
- ▶ Tone mapping required for display in LDR devices [Reinhard *et al.*, 2005]

Problem Statement

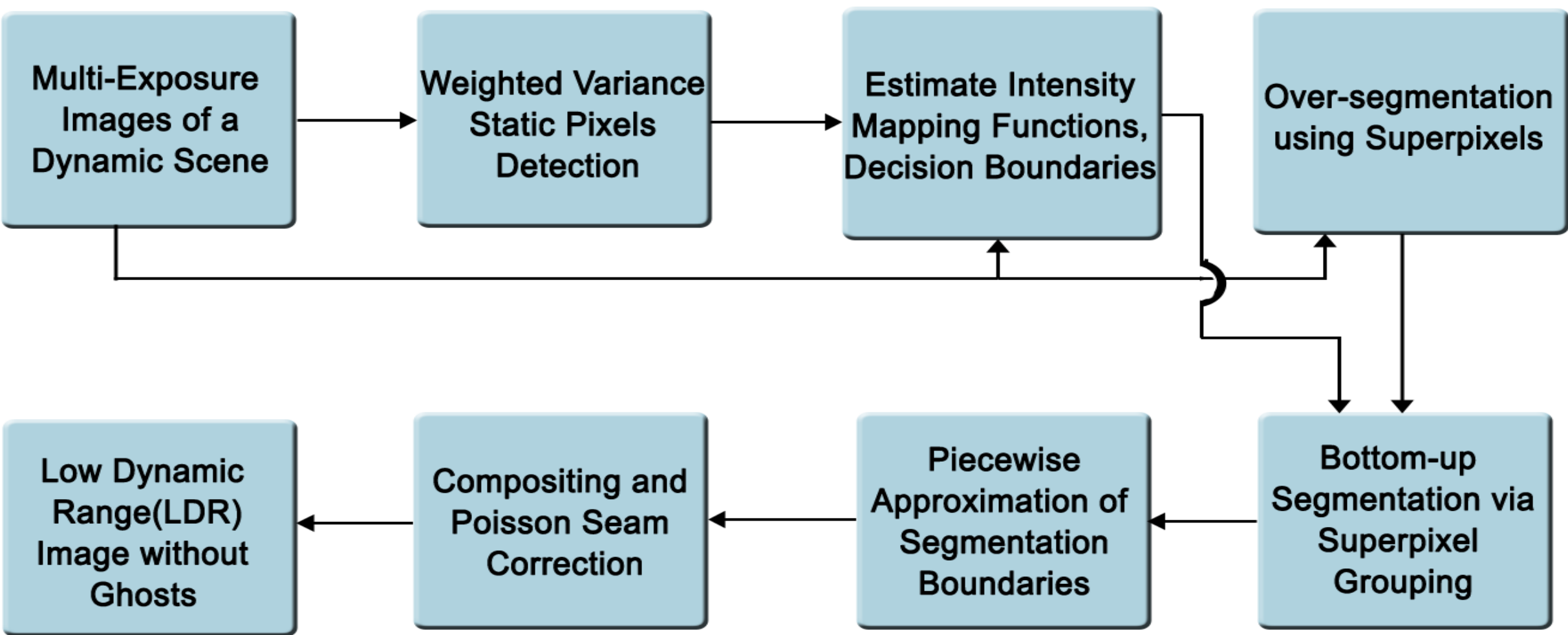
Given a set of multi-exposure images corresponding to a dynamic scene,

$$I_k(x, y) = f(\Delta t_k E_k(x, y))$$

where $E_k(x, y)$ - irradiance values and $I_k(x, y)$ - intensity values of the k^{th} image in the exposure stack with exposure time Δt_k and f is the non-linear CRF, CRF (f) and exposure times (Δt_k) - not known.

Estimate artifact-free LDR image corresponding to the irradiance $E_k(x, y)$.

Proposed Approach



Bottom-up Segmentation via Superpixel Grouping [Ren & Malik, 2003]



LDR Image Results



Multi-Exposure Images of another Dynamic Scene



Images Courtesy: Orazio Gallo, UCSC

LDR Image Results

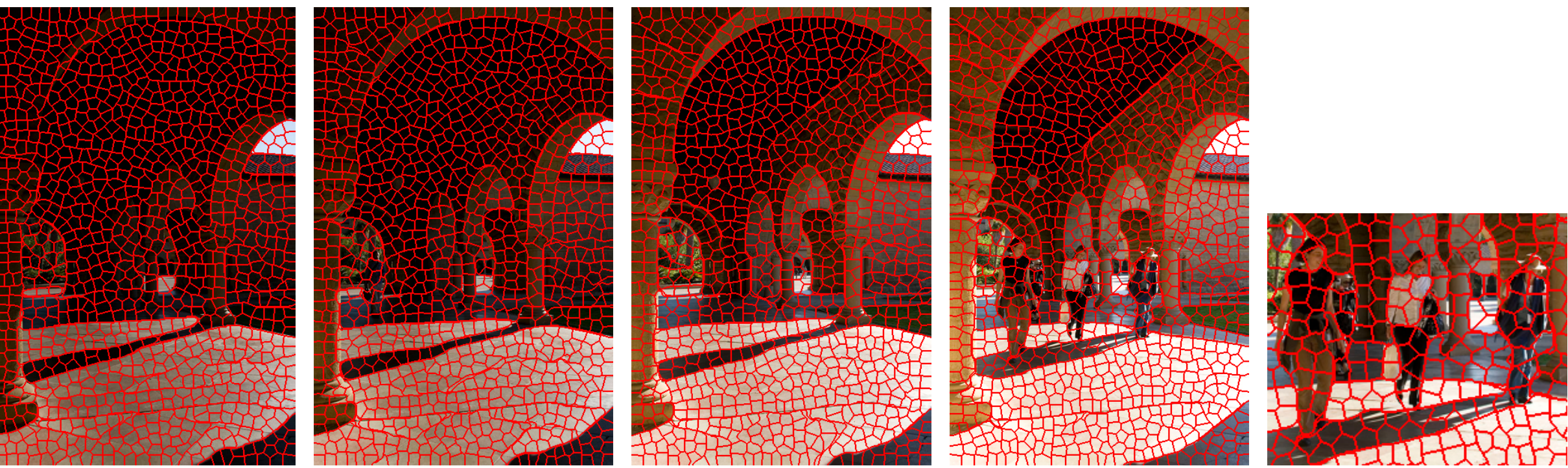


Multi-Exposure Images of a Dynamic Scene

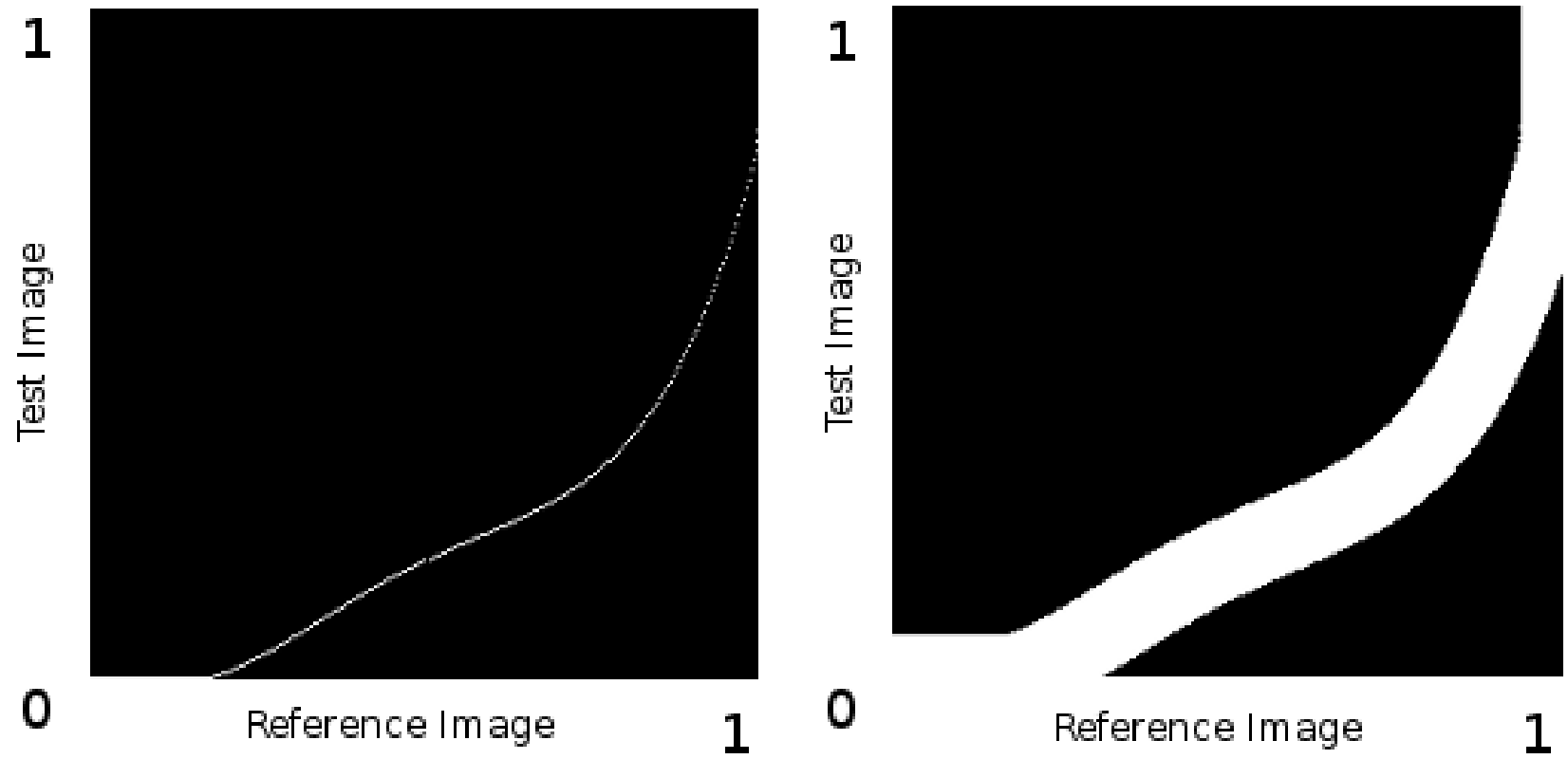


Images Courtesy: Orazio Gallo, UCSC

Over-segmentation using Superpixels [Shi & Malik, 2000]



Intensity Mapping Function and Decision Regions [Mann, 2000]



Comparison

HDR Imaging for Dynamic Scenes	Gallo <i>et al.</i> (ICCP 2009)	Adobe® Photoshop® CS5 (Merge to HDR)	Proposed Approach (ICVGIP 2010)
Multi-Exposure Fusion Method	Artifact-free HDR, then LDR	Artifact-free HDR, then LDR	Artifact-free LDR, then HDR
Camera Response Function (CRF)	Yes	Yes	No
Exposure Settings	Yes	Yes	No
HDR Image Generation	Yes	Yes	No
Tone Mapping (TM)	Yes	Yes	No
Artist/User Intervention	Yes	Yes	No
Quality of LDR Image	Good, Depends on CRF, TM	Good, Artist/User Defined	Excellent 😊

Conclusion

1. Artifact-free LDR image corresponding to a dynamic scene generated assuming no camera/scene information
2. Can be made much faster by using fast over-segmentation techniques
3. LDR image can be made compatible with HDR displays using inverse tone mapping
4. Challenges ahead - Photographic look, Highly dynamic scenes (crowd motion), High contrast

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