High Dynamic Range Image Artifact Compensation

Věra Müllerová

Brno University of Technology, Faculty of Information Technology

To avoid ghosting artifacts in the high dynamic range (HDR) image of a scene affected by a movement, the so-called de-ghosting method needs to be implemented.

This work is part of a research project dealing with the real-time HDR FPGA video camera. This camera captures three different exposures and combines them together in the real-time processing to display the resulting HDR video on common low dynamic range (LDR) monitors. This work suggests two de-ghosting algorithms – Histogram Based Algorithm and Bitmap Movement Detection.

De-Ghosting Methods

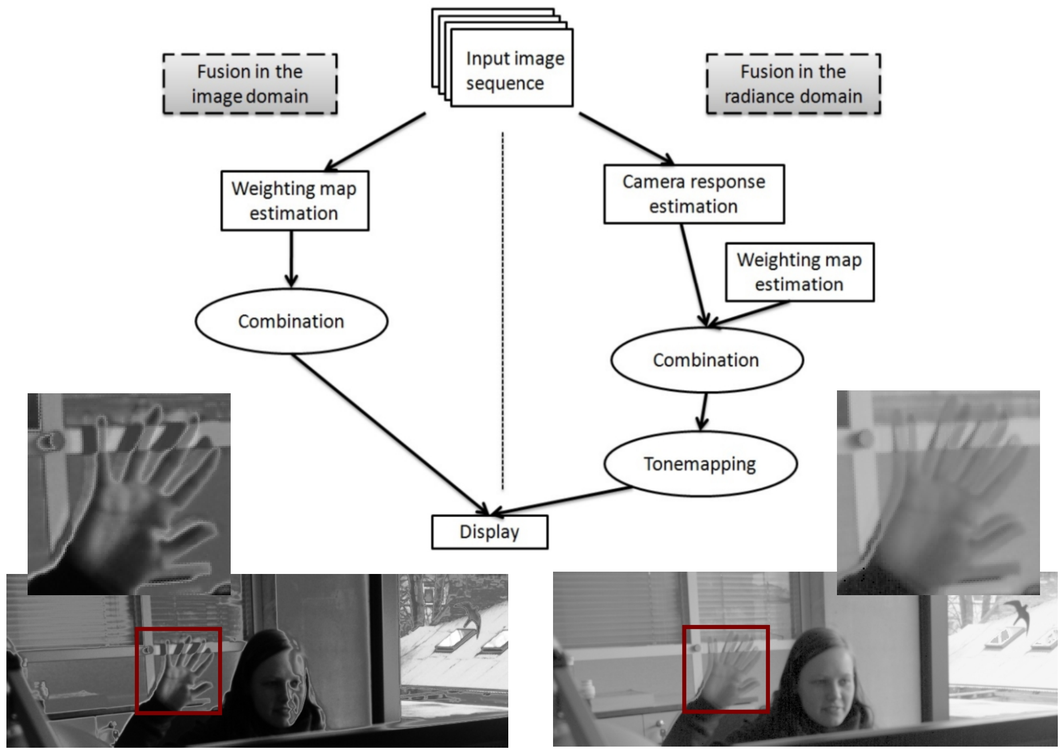
There are already a lot of de-ghosting algorithms that have been developed in the last decade. The following table shows the classification of these algorithms which is based on a few parameters:

- Fusion domain - radiance or image
- Number of exposures needed for good results of the algorithm
- Ghost map detection - if ghost map detection is first computed and number of ghost maps - one or more using one exposure as a reference image
- Thresholds tuning - some input parameters such as a threshold value has to be set automatically or manually, respectively
- Reference image selection - if one of the input images is used as a reference
- Final result with an occurrence of moving object at fixed position or removal of all moving objects

Methods marked by an asterisk follow all desired requirements for the real-time HDR FPGA video camera.

			Method	Variance – *Reinhard et al. [4]*	*Entropy – *Jacobs et al. [5]*	*Prediction – *Grosch [6]*	Pixel Order Relation – *Sidibé et al. [7]*	*Bitmap – *Pece and Kautz [9]*	*Histogram – *Min et al. [11]*	*Patch – *Gallo et al. [14], etc.*	*Graph-Cuts – *Heo et al. [18]*	Optical Flow – *Kang et al. [19], etc.*	Markov Random Field – *Jinno and Okuda [22]*	SVD – *Srikantha et al. [23]*	Density Estimation – *Khan et al. [26]*	Constraint Propagation – *Pedone and Heikkilä [27]*	Gradient – *Zhang and Cham [24, 25]*
Fusion	Radiance domain				X	X	X	X	X	X	X	X	X	X	X	X	X
	Image domain			X	X	X		X	X	X	X	X	X	X			
Ghost detection and removal	Number of exposures	Small (≤ 3)		X	X	X		X	X	X	X	X	X	X			
		Large (> 5)					X								X	X	X
	Ghost map detection			X	X	X		X	X	X	X	X	X	X			
	More ghost maps						X								X	X	X
	Thresholds tuning	Manual		X	X	X		X	X	X	X	X	X	X			
		Automatic					X								X	X	X
	Reference image selection			X	X	X		X	X	X	X	X	X	X			
Final result	Keep moving object at fixed location						X								X	X	X
	Remove all moving objects			X	X	X		X	X	X	X	X	X	X			

The most common and widely used method to obtain HDR images is a multiple exposures fusion. This fusion can be done in a radiance or image domain.

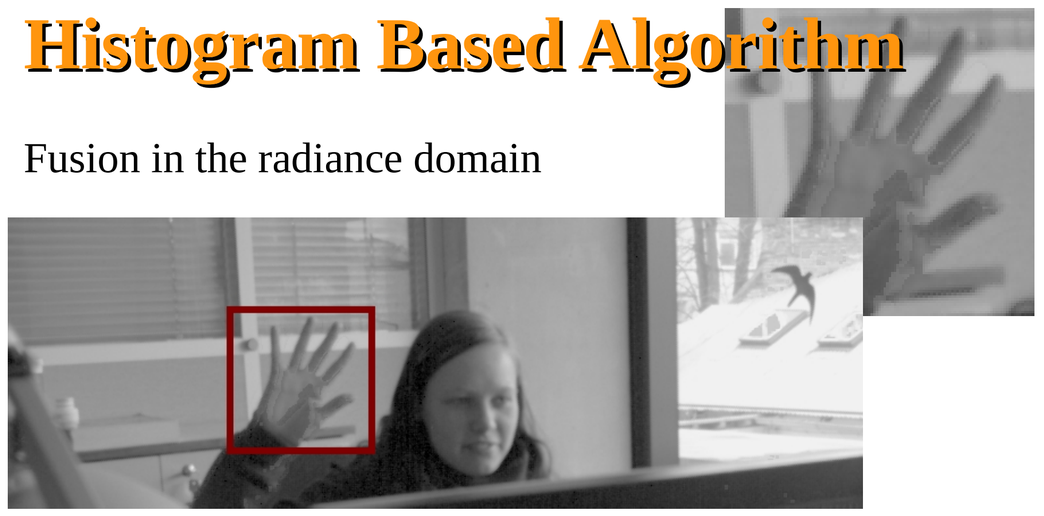


HDR images with ghost artifacts

The following methods are selected from the existing de-ghosting algorithms as the appropriate solutions for the real-time HDR FPGA video camera.

Histogram Based Algorithm

Fusion in the radiance domain



Bitmap Movement Detection

Fusion in the image domain