Removing Camera Shake via Weighted Fourier Burst Accumulation - With Some Theoretical Bounds

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Numerous recent approaches attempt to remove image blur due to camera shake, either with one or multiple input images, by explicitly solving an inverse and inherently ill-posed deconvolution problem. If the photographer takes a burst of images, a modality available in virtually all modern digital cameras, we show that it is possible to combine them to get a clean sharp version. This is done without explicitly solving any blur estimation and subsequent inverse problem. The proposed algorithm is strikingly simple: it performs a weighted average in the Fourier domain, with weights depending on the Fourier spectrum magnitude. The method can be seen as a generalization of the align and average procedure, with a weighted average, motivated by hand-shake physiology and theoretically supported, taking place in the Fourier domain. The method's rationale is that camera shake has a random nature and therefore each image in the burst is generally blurred differently. Experiments with real camera data, and extensive comparisons, show that the proposed Fourier Burst Accumulation (FBA) algorithm achieves state-of-the-art results an order of magnitude faster, with simplicity for on-board implementation on camera phones. Finally, we also present experiments in real high dynamic range (HDR) scenes, showing how the method can be straightforwardly extended to HDR photography. Extensions to video are presented as well. Being a key component of this multi-image alignment, we discuss some new theoretical results on this subject as well. The work on FBA is in collaboration with Dr. Mauricio Delbracio while the theoretical work on multi-image alignment is in collaboration with Dr. Cecilia Aguerrebere, Dr. Mauricio Delbracio, and Dr. Alberto Bartesaghi.