Computational photography

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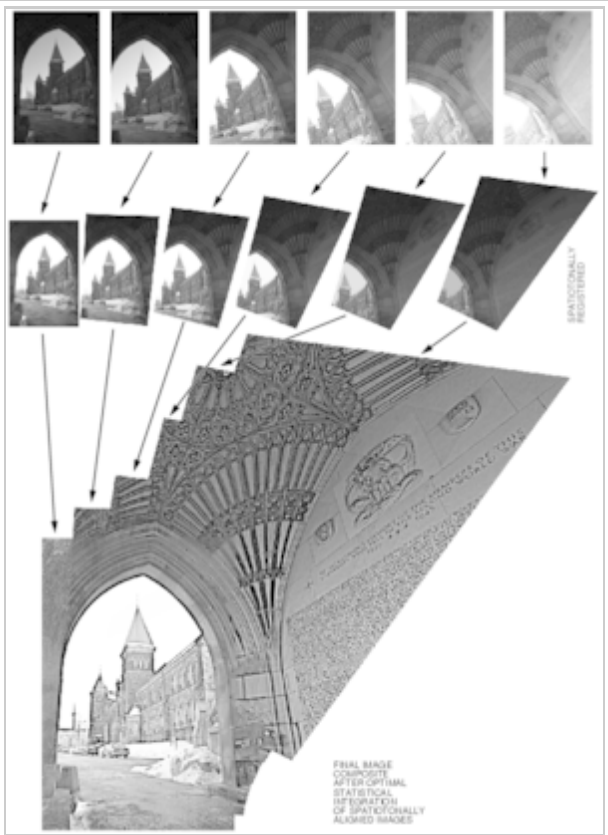
Computational photography or computational imaging refers to digital image capture and processing techniques that use digital computation instead of optical processes. Computational photography can improve the capabilities of a camera, or introduce features that were not possible at all with film based photography, or reduce the cost or size of camera elements. Examples of computational photography include in-camera computation of digital panoramas,[6] high-dynamic-range images, and light field cameras. Light field cameras use novel optical elements to capture three dimensional scene information which can then be used to produce 3D images, enhanced depth-of-field, and selective de-focusing (or "post focus"). Enhanced depth-of-field reduces the need for mechanical focusing systems. All of these features use computational imaging techniques.



Computational ("undigital") photography provides many new capabilities. This example combines HDR (High Dynamic Range) Imaging with panoramics (image-stitching), by optimally combining information from multiple differently exposed pictures of overlapping subject matter[1][2][3][4][5]

The definition of computational photography has evolved to cover a number of subject areas in computer graphics, computer vision, and applied optics. These areas are given below, organized according to a taxonomy proposed by Shree K. Nayar. Within each area is a list of techniques, and for each technique one or two representative papers or books are cited. Deliberately omitted from the taxonomy are image processing (see also digital image processing) techniques applied to traditionally captured images in order to produce better images. Examples of such techniques are image scaling, dynamic range compression (i.e. tone mapping), color management, image completion (a.k.a. inpainting or hole filling), image compression, digital watermarking, and artistic image effects. Also omitted are techniques that produce range data, volume data, 3D models, 4D light fields, 4D, 6D, or 8D BRDFs, or other high-dimensional image-based representations. Epsilon Photography is a sub-field of computational photography.

Contents

- 1 Computational illumination
- 2 Computational optics
- 3 Computational processing
- 4 Computational sensors
- 5 Early work in computer vision
- 6 See also
- 7 References
- 8 External links

Computational illumination

This is controlling photographic illumination in a structured fashion, then processing the captured images, to create new images. The applications include image-based relighting, image enhancement, image deblurring, geometry/material recovery and so forth.

High-dynamic-range imaging uses differently exposed pictures of the same scene to extend dynamic range.[7] Other examples include processing and merging differently illuminated images of the same subject matter ("lightspace").

Computational optics

This is capture of optically coded images, followed by computational decoding to produce new images. Coded aperture imaging was mainly applied in astronomy or X-ray imaging to boost the image quality. Instead of a single pin-hole, a pinhole pattern is applied in imaging, and deconvolution is performed to recover the image.[8] In coded exposure imaging, the on/off state of the shutter is coded to modify the kernel of motion blur.[9] In this way motion deblurring becomes a well-conditioned problem. Similarly, in a lens based coded aperture, the aperture can be modified by inserting a broadband mask.[10] Thus, out of focus deblurring becomes a well-conditioned problem. The coded aperture can also improve the quality in light field acquisition using Hadamard transform optics.

Computational processing

This is processing of non-optically-coded images to produce new images.

Computational sensors

These are detectors that combine sensing and processing, typically in hardware, like the oversampled binary image sensor.

Early work in computer vision

Although computational photography is a currently popular buzzword in computer graphics, many of its techniques first appeared in the computer vision literature, either under other names or within papers aimed at 3D shape analysis.

See also

- Simultaneous localization and mapping

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External links

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Categories: Digital photography | Computational fields of study

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