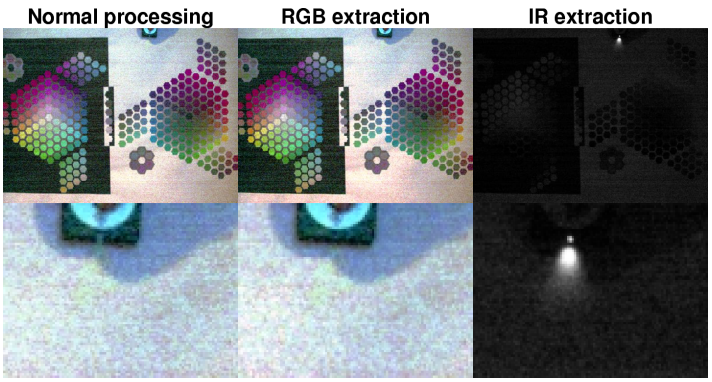
Computational Photography

COMPUTATIONAL PHOTOGRAPHY involves the use of cameras not to directly produce the best looking image on the film or sensor, but to capture the information necessary and use computations to create the desired representation of the scene. For about a decade, our group has been getting more out of *unmodified* commodity digital cameras, often using supercomputers and a GENETIC ALGORITHM (GA). This handout is a simple overview of some of the things we've been doing with digital cameras.... Read more at **`http://aggregate.org/DIT/`**



Spectral Processing of Images

Photons don't come in just three colors. Since 2001, we have developed various methods for extracting enhanced spectral information from images. For example, as shown above, simple processing allowed extraction of a NIR channel, along with RGB, from a single raw image captured with an unmodified Canon G1. Our most recent work involves methods leveraging the idea that color is not a property of a pixel, but of objects in the context of the scene imaged.

Capture Control

Intelligent control of digital cameras – not just webcams – is something that we've been doing for over a decade. Much of the work involves tethered control, but we also have run code directly inside Canon PowerShot cameras using CHDK. For example, one of our Nikon 950 (with 185-degree fisheye lens) has shot over 3 million still images under computer control over a period of more than a decade. Our control is often for surveillance, but also has been used for 360-degree and gigapixel-resolution stitching, HDR (high dynamic range) imaging, etc.

PSFs and Anaglyph Capture

The POINT SPREAD FUNCTION (PSF) of a lens describes the image created for a point of light. Features of the PSF are enlarged in OUT-OF-FOCUS (OOF) portions of an image, and lens BOKEH are primarily determined by the OOF PSF. Understanding, recognizing, and reprocessing OOF PSF is the key to forensic identification of lenses, depth capture, refocus, etc.

For example, we have defined a method whereby a conventional camera with a removable green/magenta filter costing less than $1 can, in a single shot, directly capture an ANAGLYPH image using color to encode left and right views. An anaglyph (such as the flags shown here) can be viewed in 3D using colored glasses, but also can be reprocessed to create full-color stereo pairs, implement refocus, etc.

New Image Processing Methods

We also have been developing new image processing algorithms. For example, one method we have used involves GENETIC PROGRAMMING (GP) on a supercomputer to evolve optimized image filter algorithms. In Spring 2012, we created `DeOrbIt`, a software tool that recognizes and credibly corrects the "white orb" defects caused by a design flaw in the Fuji X10 sensor.

New Sensor Technology

For over a decade, we have been developing technology that would leverage "smart pixels" in image sensors. A variety of benefits can be obtained for both still and video imaging. We are creating technology that could produce very-low-cost camera sensors able to replace film with 1000FPS 500MP.

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