Different(ial) approach to the Photometric Stereo problem

Roberto Mecca

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Auguri Maurizio !

ISTITUTO ITALIANO DI TECNOLOGIA

Photometric Stereo as inverse problem

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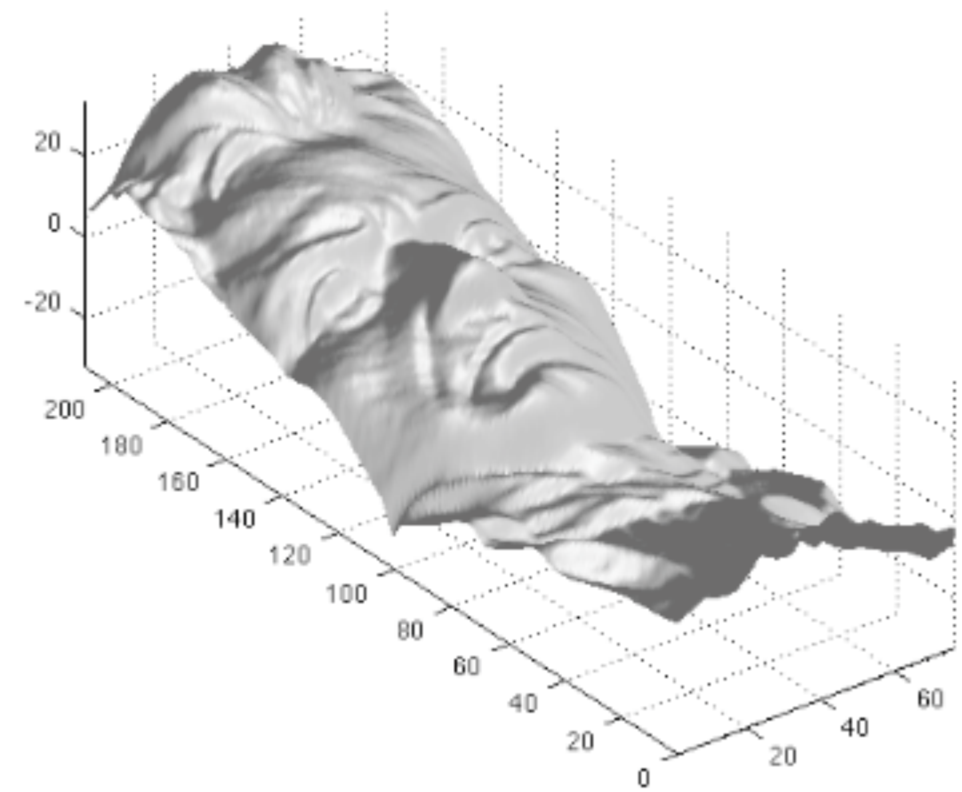

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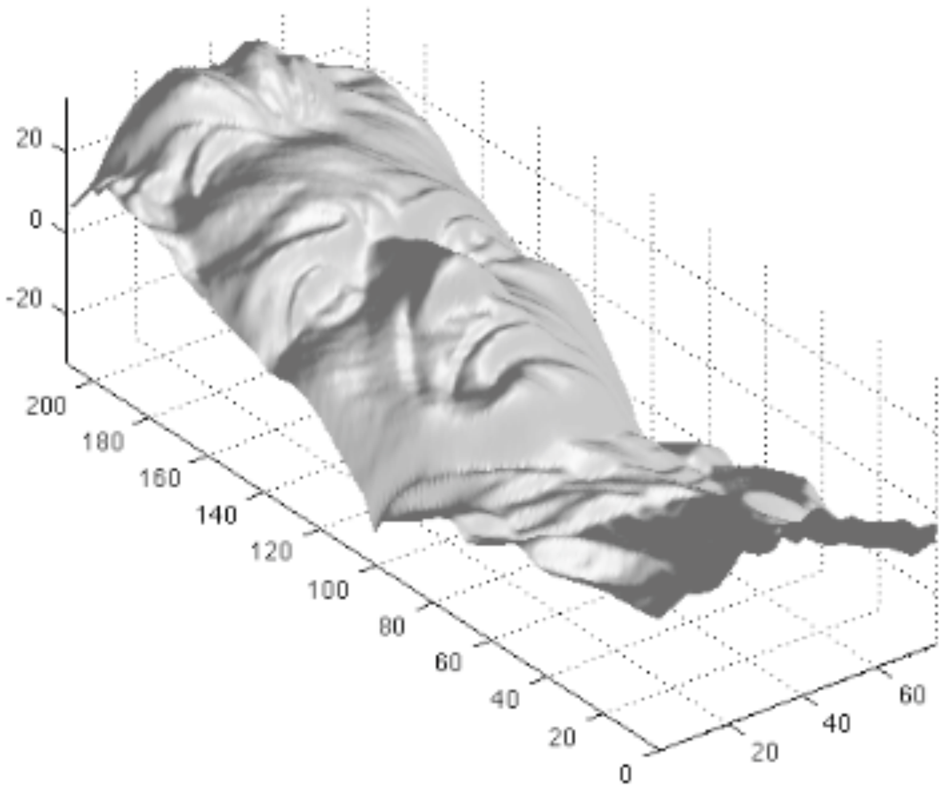

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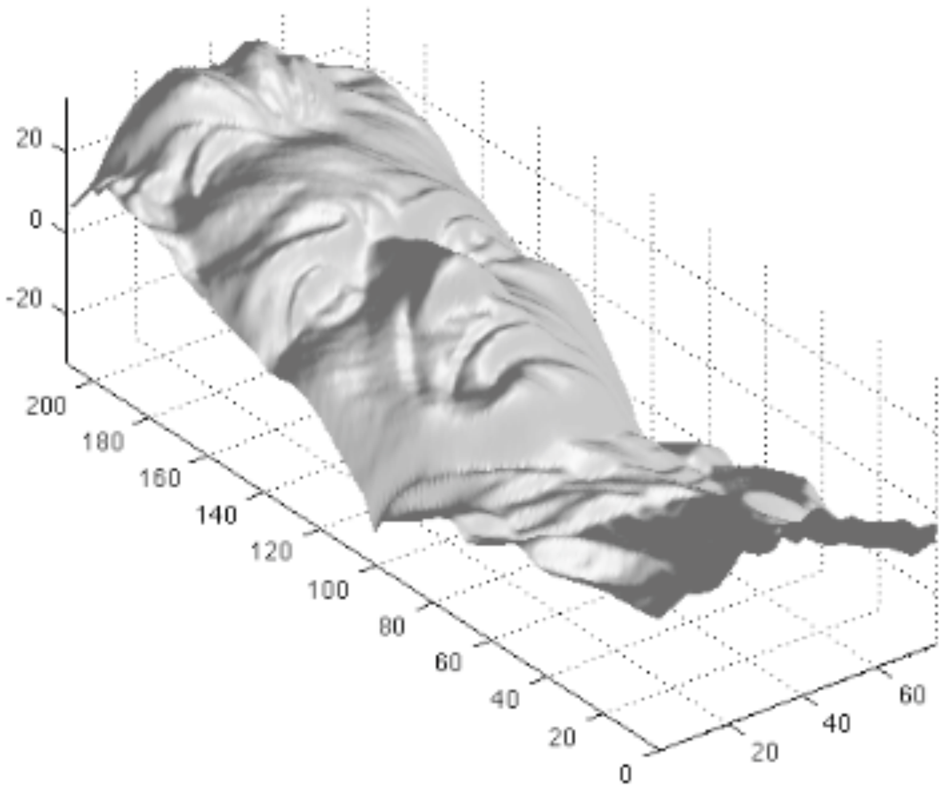

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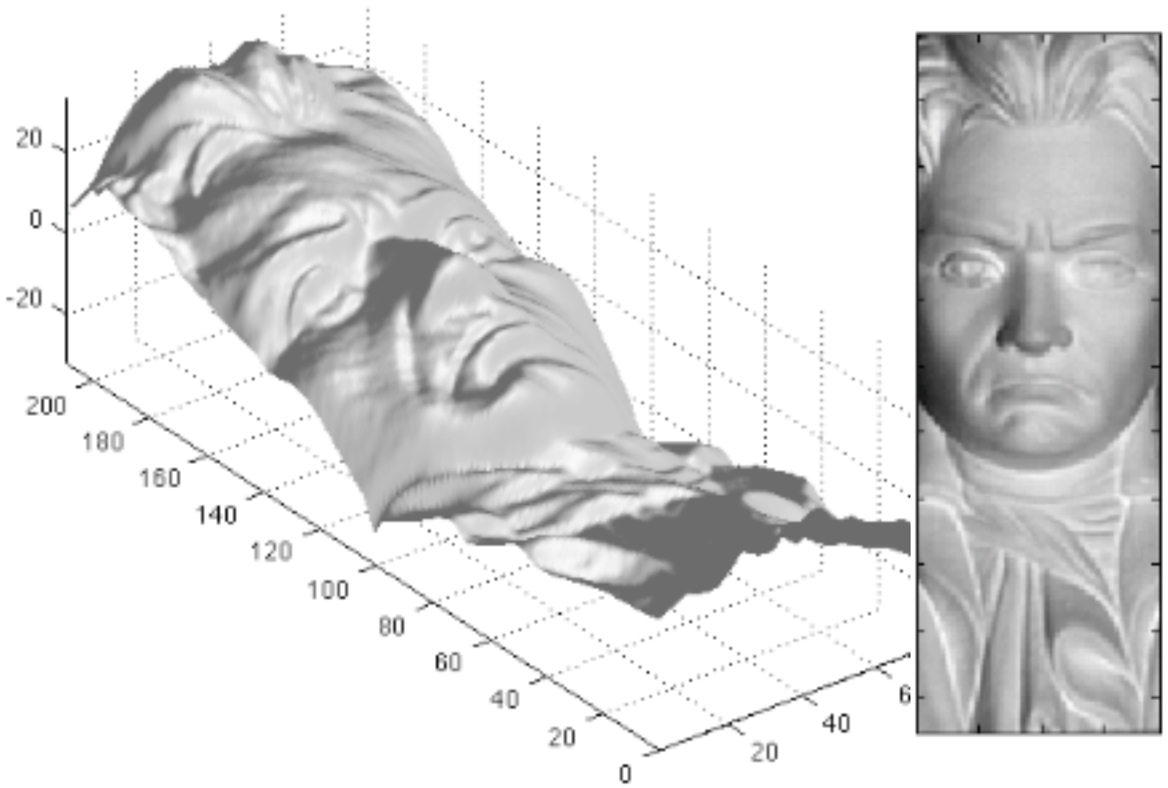

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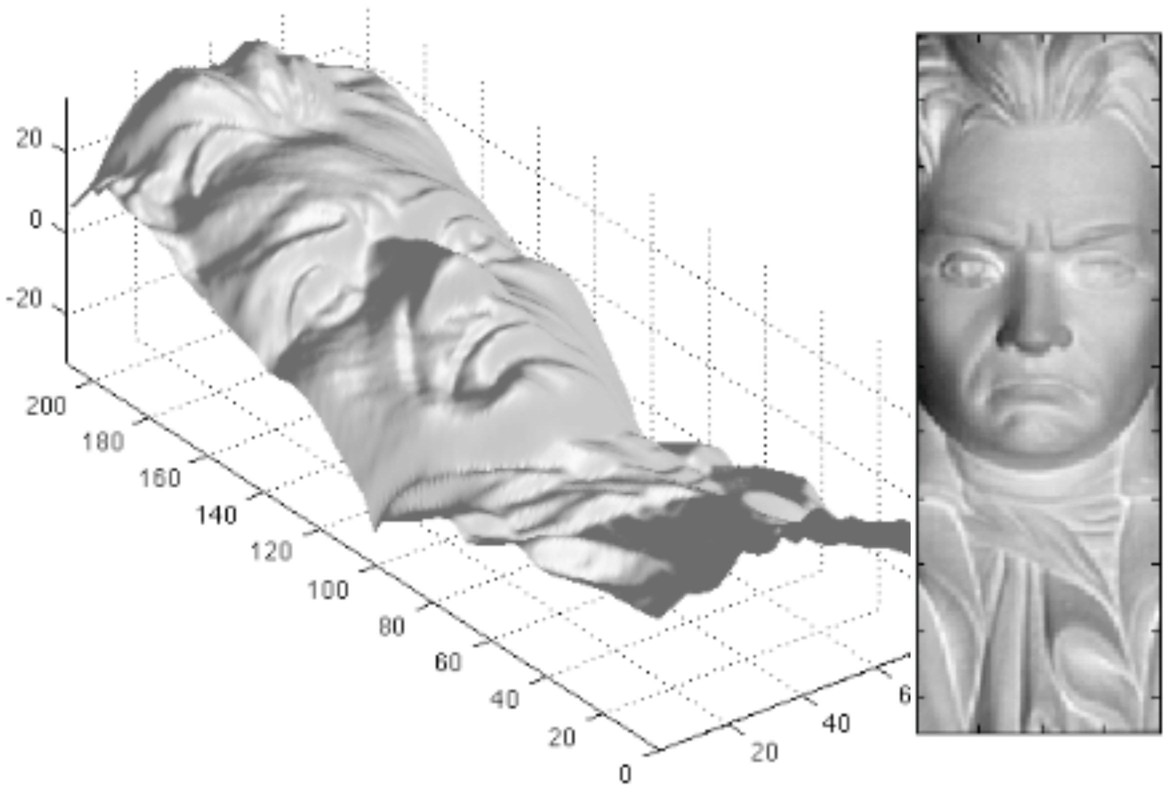

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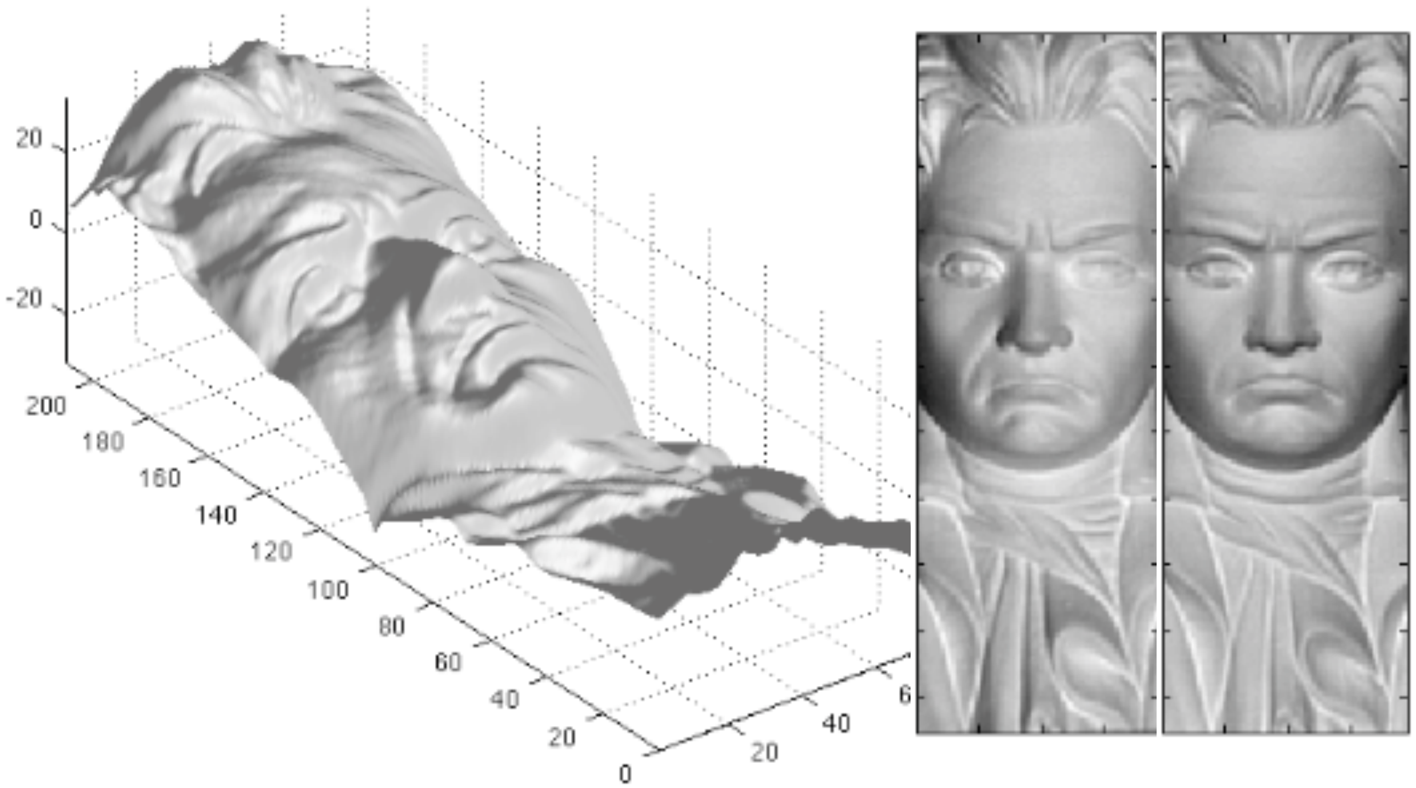

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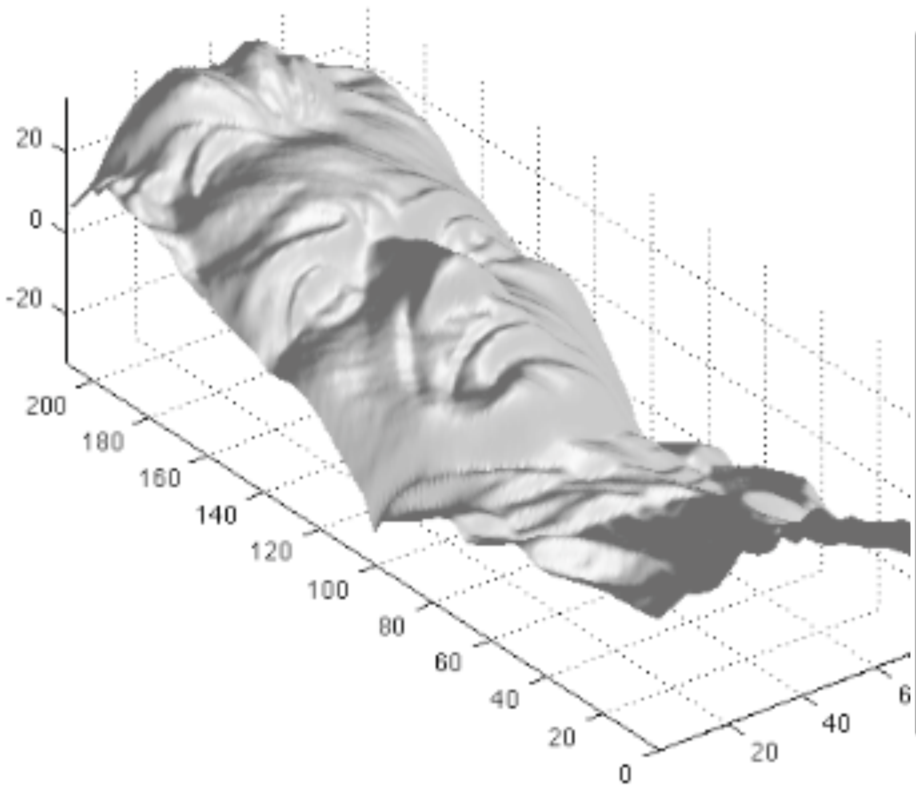

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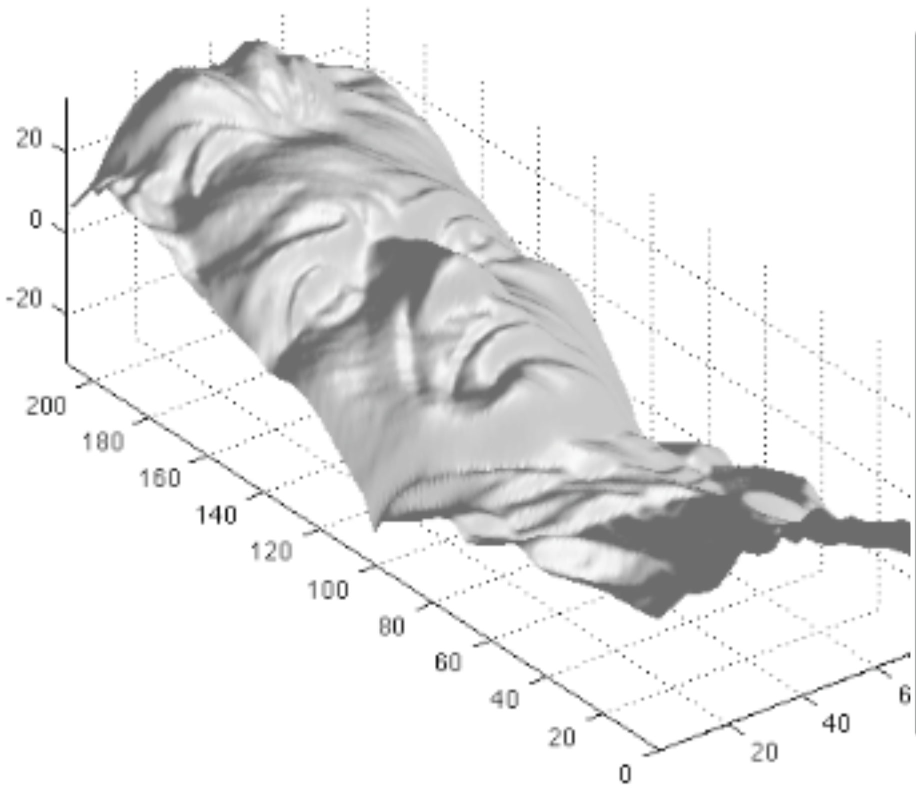

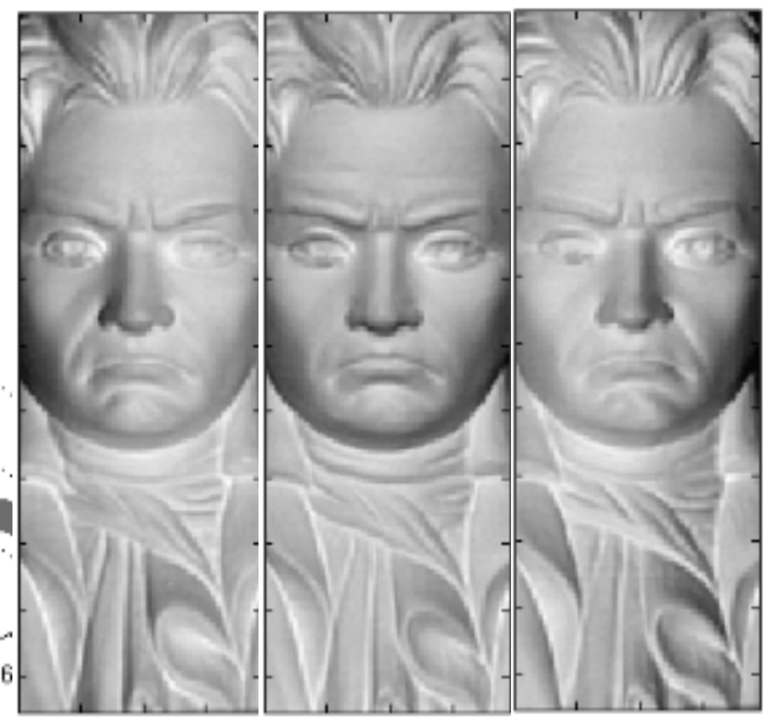

Photometric Stereo as inverse problem

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From traditional to realistic Photometric Stereo

traditional	realistic

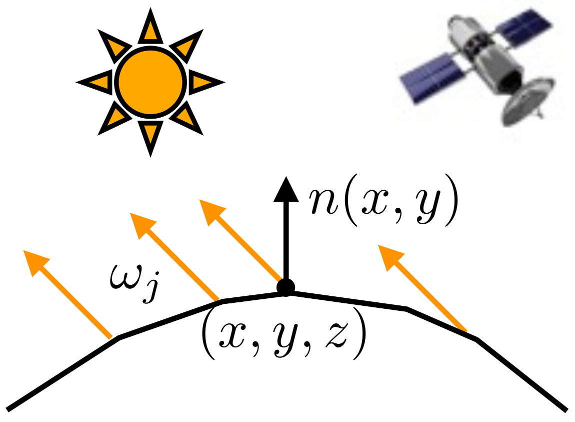
traditional

realistic

schematic working setup

traditional

schematic working setup



realistic

traditional

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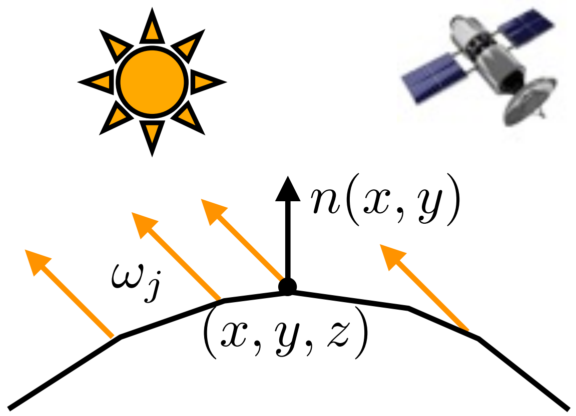
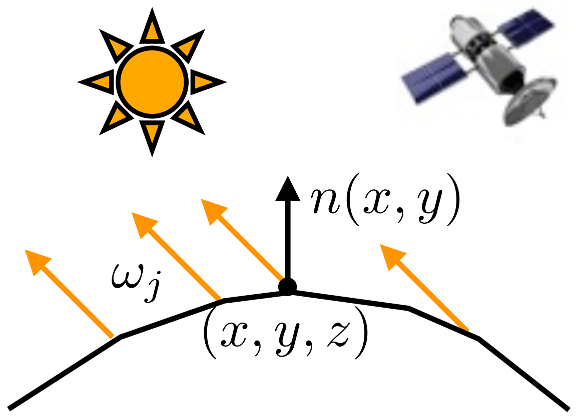


viewing geometry $\overline{n}(x, y) = (-\nabla z, 1)$

traditional | realistic

schematic working setup



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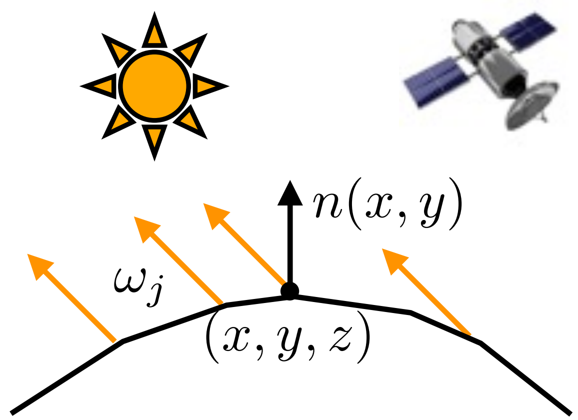

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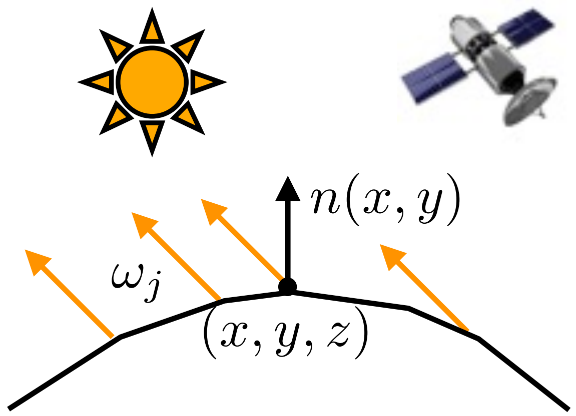

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differential formulation obtained by image ratio of pairs of images $\dfrac{I_i}{I_j}$

$$\begin{cases} b(x,y) \cdot \nabla z(x,y) = s(x,y) & a.e. (x,y) \in \Omega, \\ z(x,y) = g(x,y) & \forall (x,y) \in \partial\Omega, \end{cases}$$

where

$$(b(x,y), s(x,y)) = I_i\omega_j - I_j\omega_i$$

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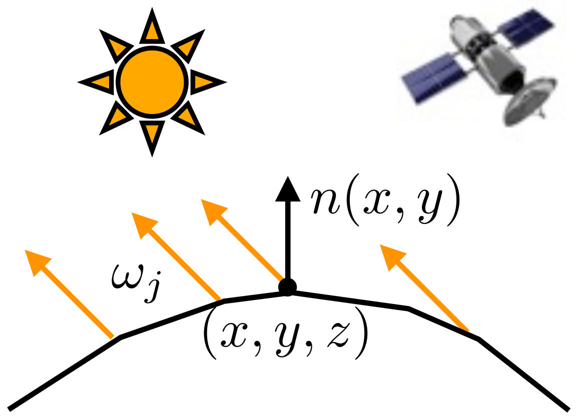

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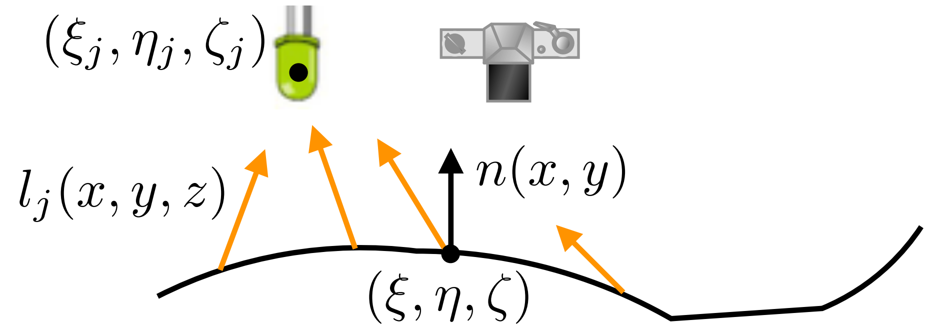

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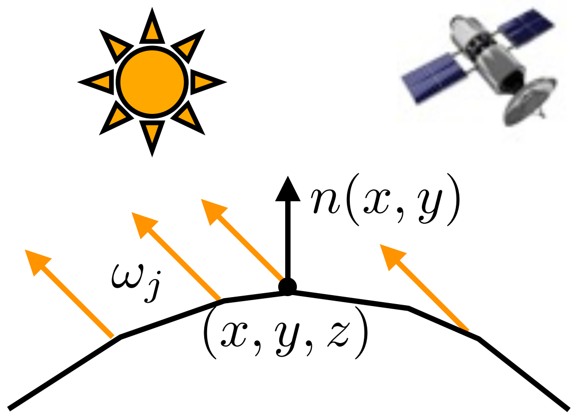

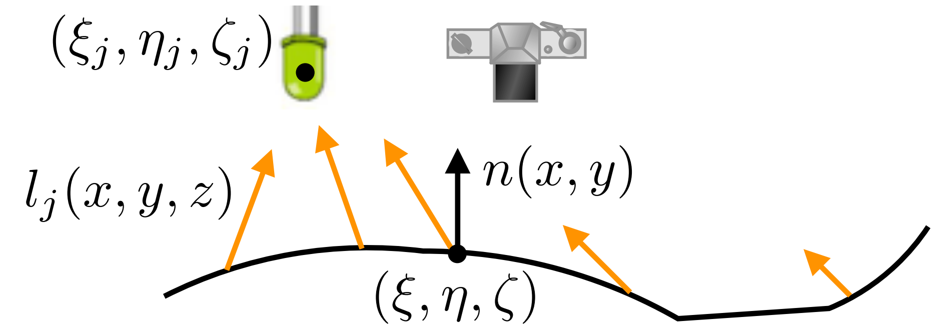

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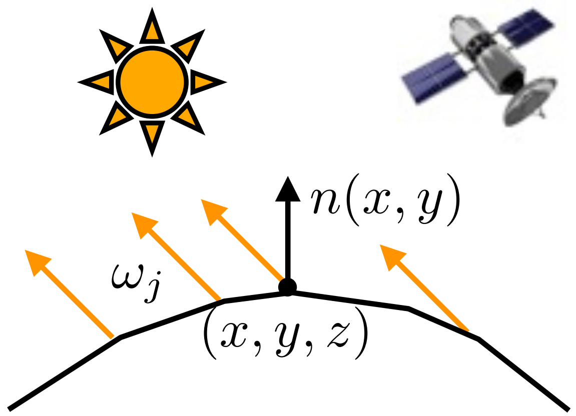

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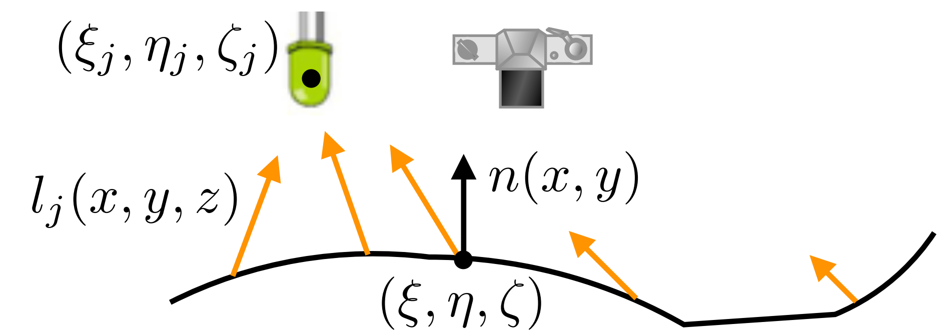

$$\overline{n}(x,y) = \frac{z}{f^2}\big(f\nabla z, z + (x,y)\cdot\nabla z\big)$$

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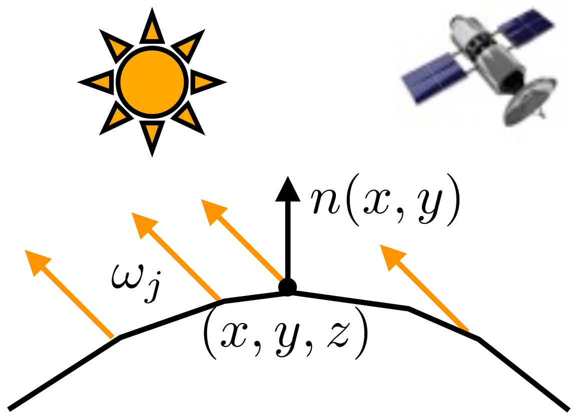

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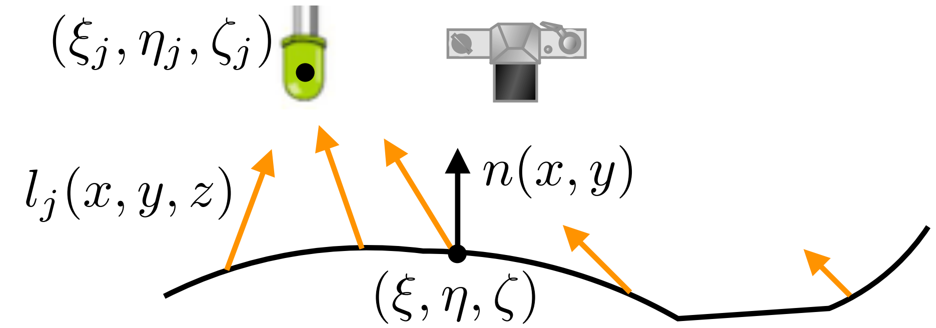

$$\overline{n}(x,y) = \frac{z}{f^2}\big(f\nabla z, z + (x,y)\cdot\nabla z\big)$$

$$\bar{l}_j(x,y,z) = \left(\xi_j + x\frac{z}{f}, \eta_j + y\frac{z}{f}, \zeta_j - z\right)$$

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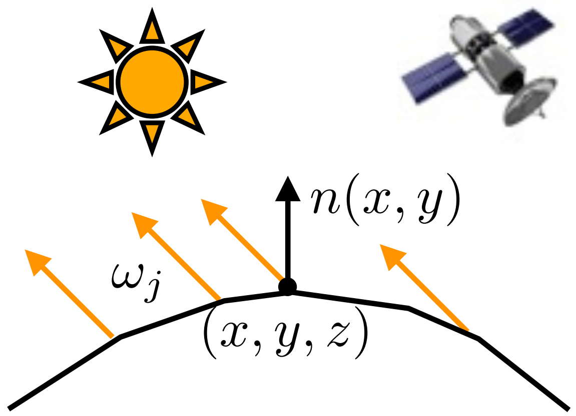

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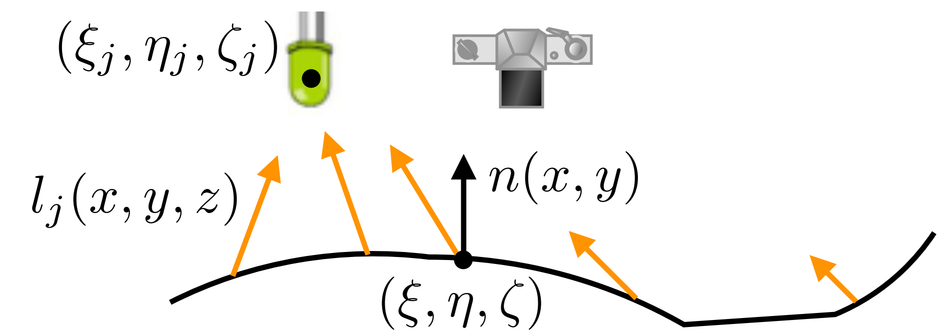

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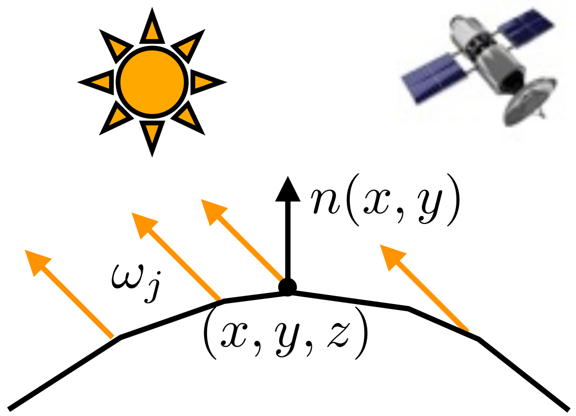

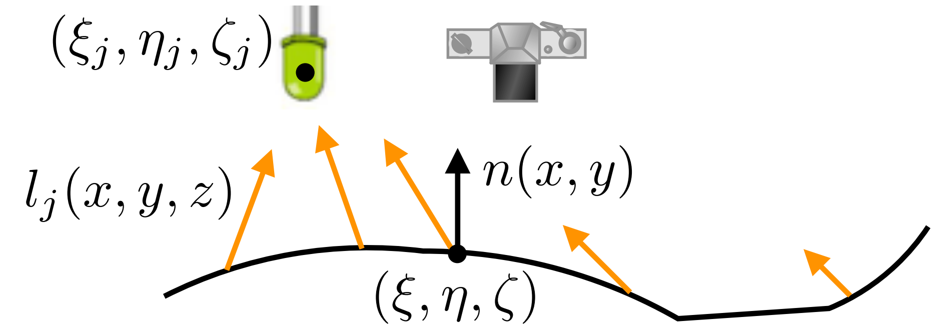

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light propagation

$$\omega_j \in \mathbb{R}^3$$

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irradiance equation

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where

$$(b(x,y), s(x,y)) = I_i\omega_j - I_j\omega_i$$

$$\begin{cases} r(x,y,z)\cdot\nabla z(x,y) = k(x,y,z), & a.e.(x,y) \\ z(x,y) = h(x,y) & (x,y)\in\partial\Omega \end{cases}$$

where

$$r(x,y,z) = \Big(I_i|\bar{l}_i|(f\xi_j - x\zeta_j) - I_j|\bar{l}_j|(f\xi_i - x\zeta_i),$$
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Synthetic case

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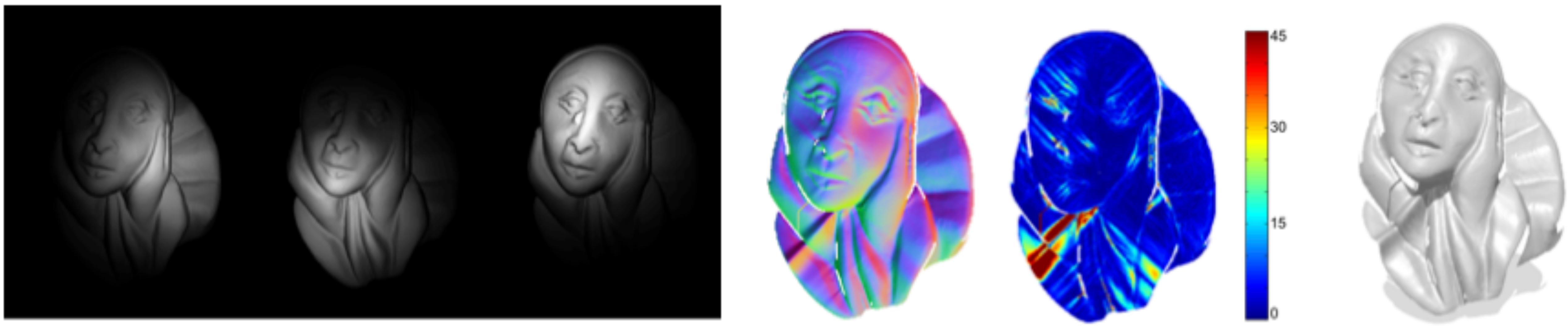

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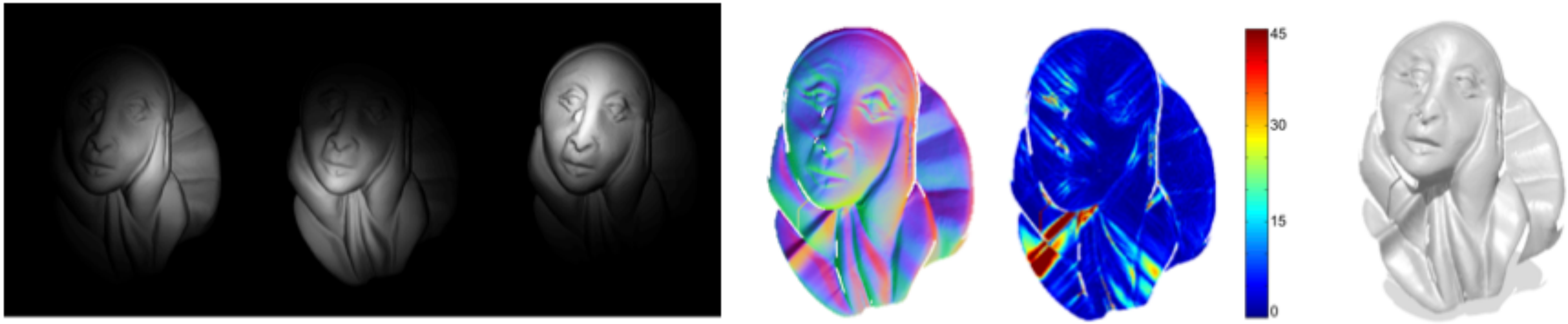
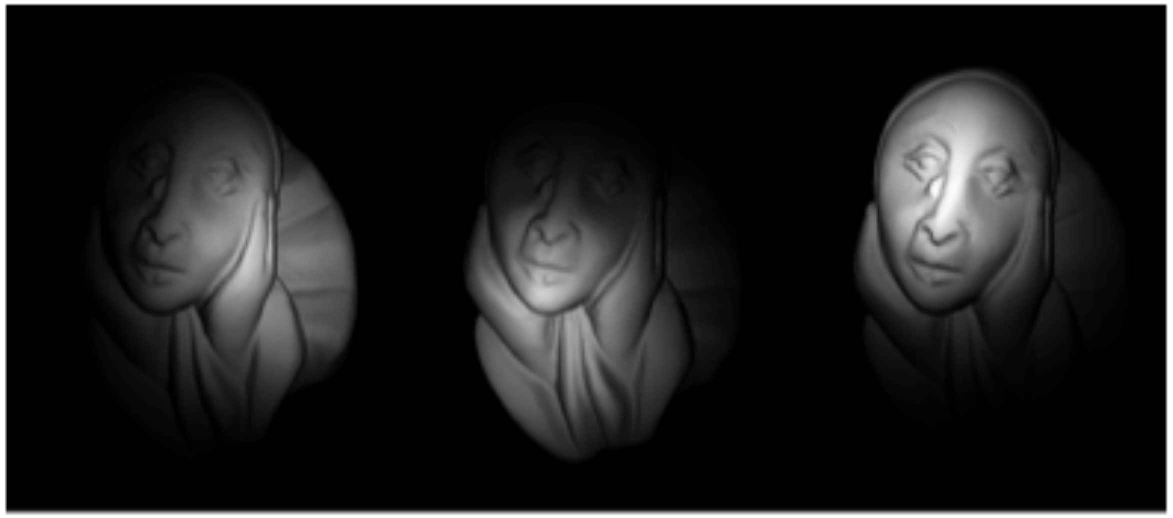
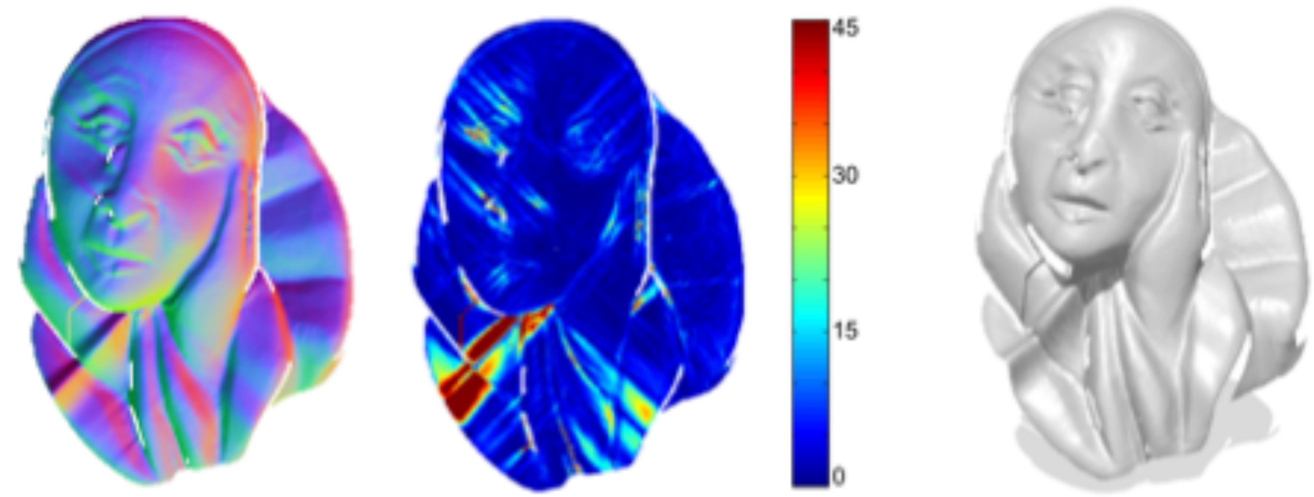


Real case

Synthetic case





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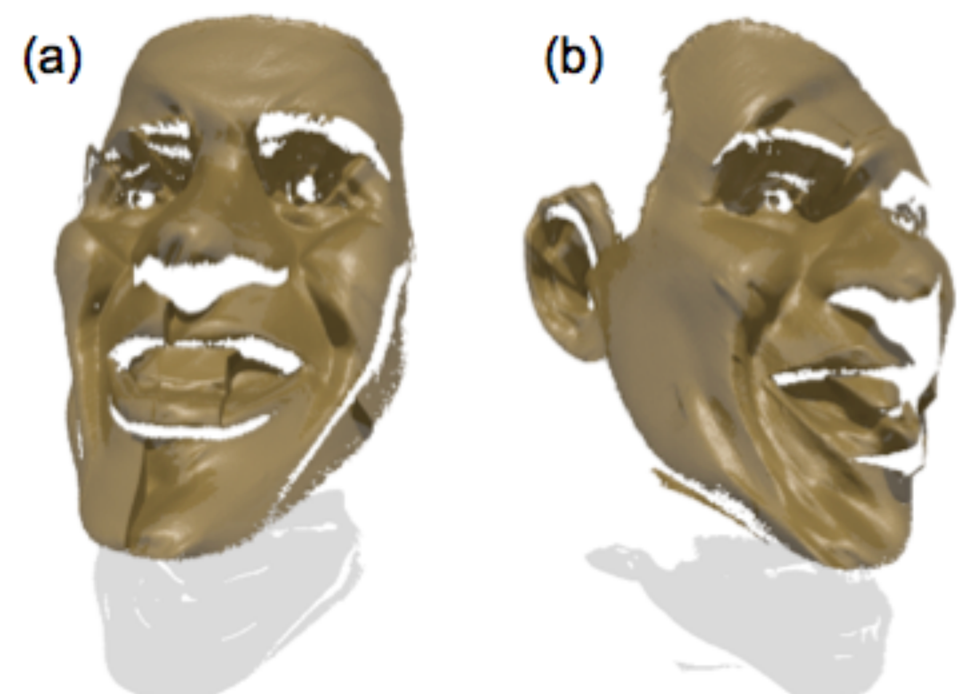

Modern approach to Shape-from-Shading

Color Constancy, Intrinsic Images, and Shape Estimation

Jonathan T. Barron and Jitendra Malik
{barron, malik}@eecs.berkeley.edu

UC Berkeley

Abstract. We present **SIRFS** (shape, illumination, and reflectance from shading), the first unified model for recovering shape, chromatic illumination, and reflectance from a single image. Our model is an extension of our previous work [1], which addressed the achromatic version of this problem. Dealing with color requires a modified problem formulation, novel priors on reflectance and illumination, and a new optimization scheme for dealing with the resulting inference problem. Our approach outperforms all previously published algorithms for intrinsic image decomposition and shape-from-shading on the MIT intrinsic images dataset [1, 2] and on our own "naturally" illuminated version of that dataset.

1 Introduction

In 1866, Helmholtz noted that "In visual observation we constantly aim to reach a judgment on the object colors and to eliminate differences of illumination" ([3], volume 2, p.287). This problem of color constancy — decomposing an image into illuminant color and surface color — has seen a great deal of work in the modern era, starting with Land and McCann's Retinex algorithm [4, 5]. Retinex ignores shape and attempts to recover illumination and reflectance in isolation, assumptions shared by nearly all subsequent work in color constancy

The dataset

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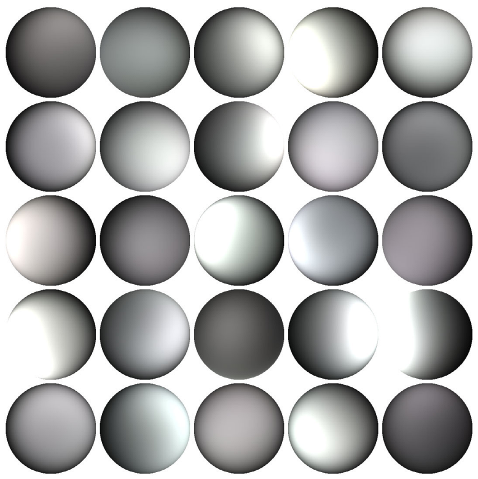

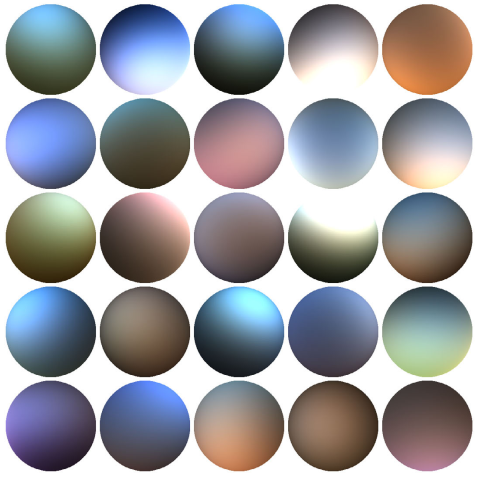

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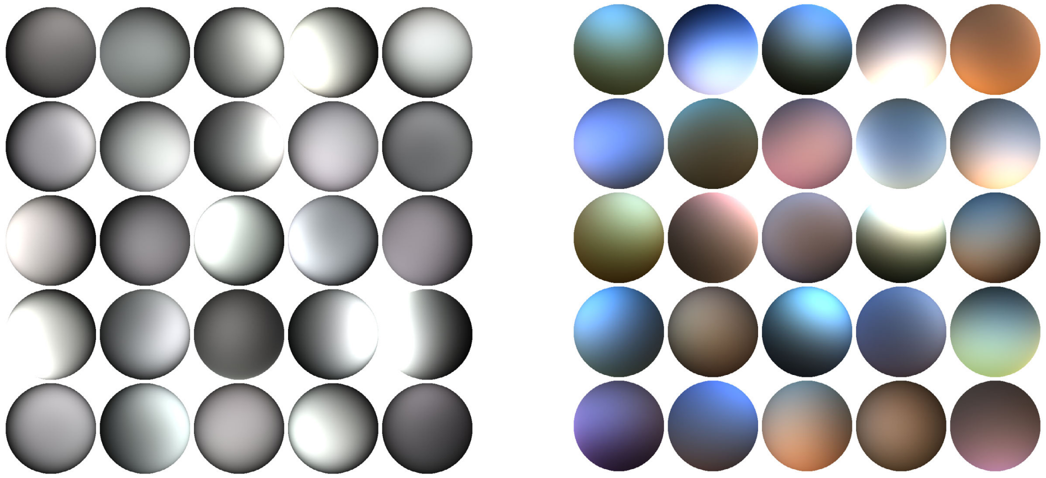

Let's test it !

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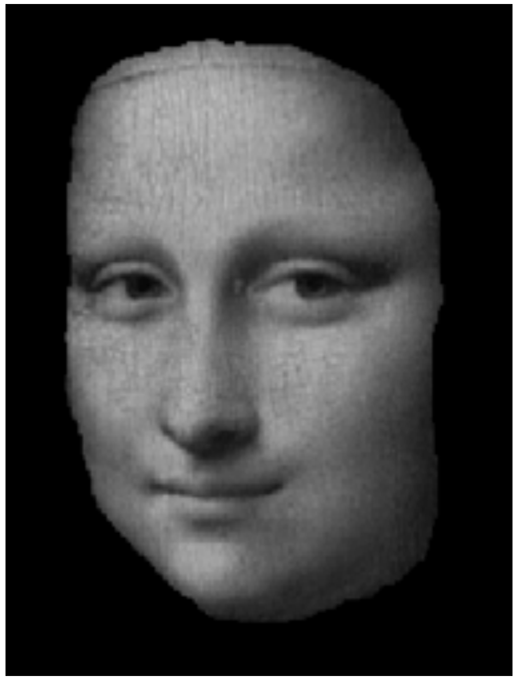

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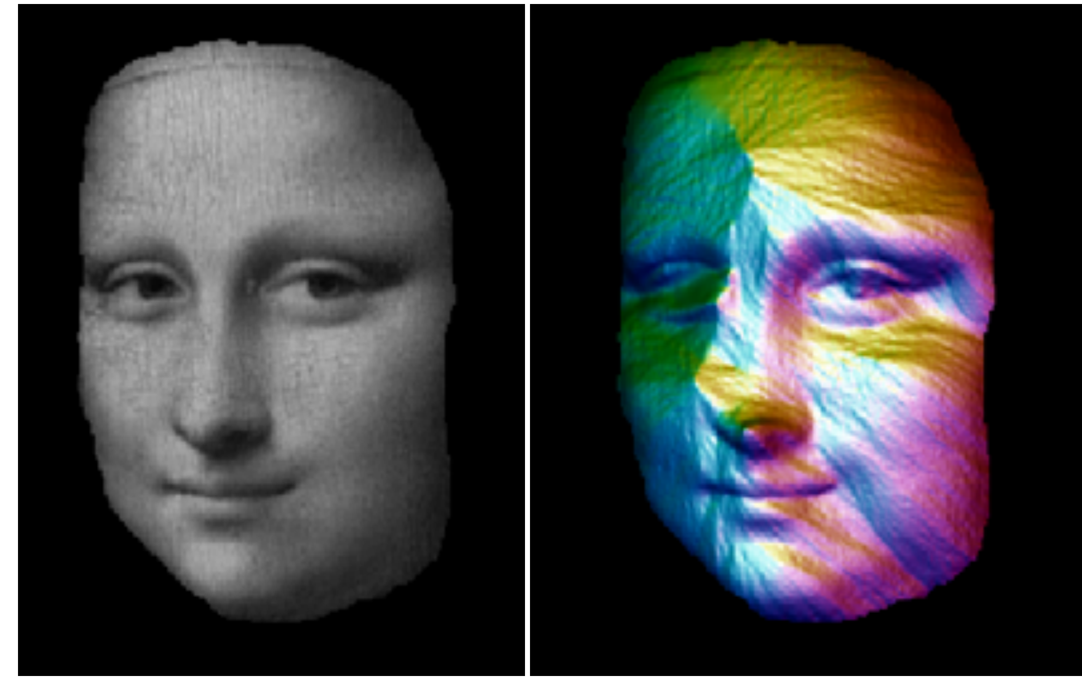

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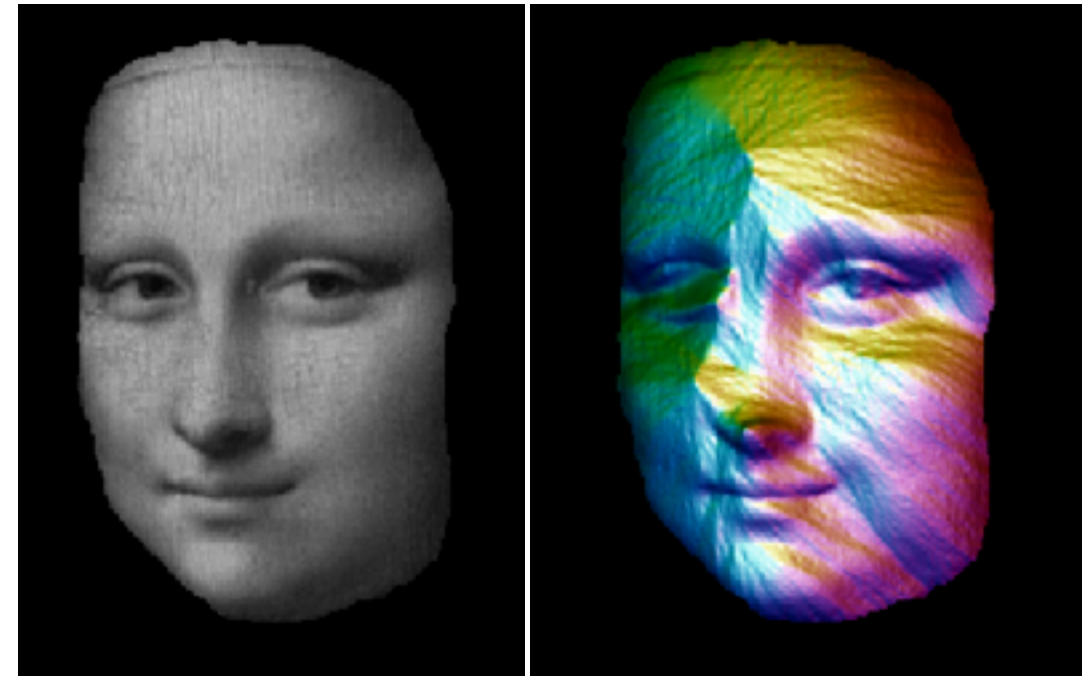

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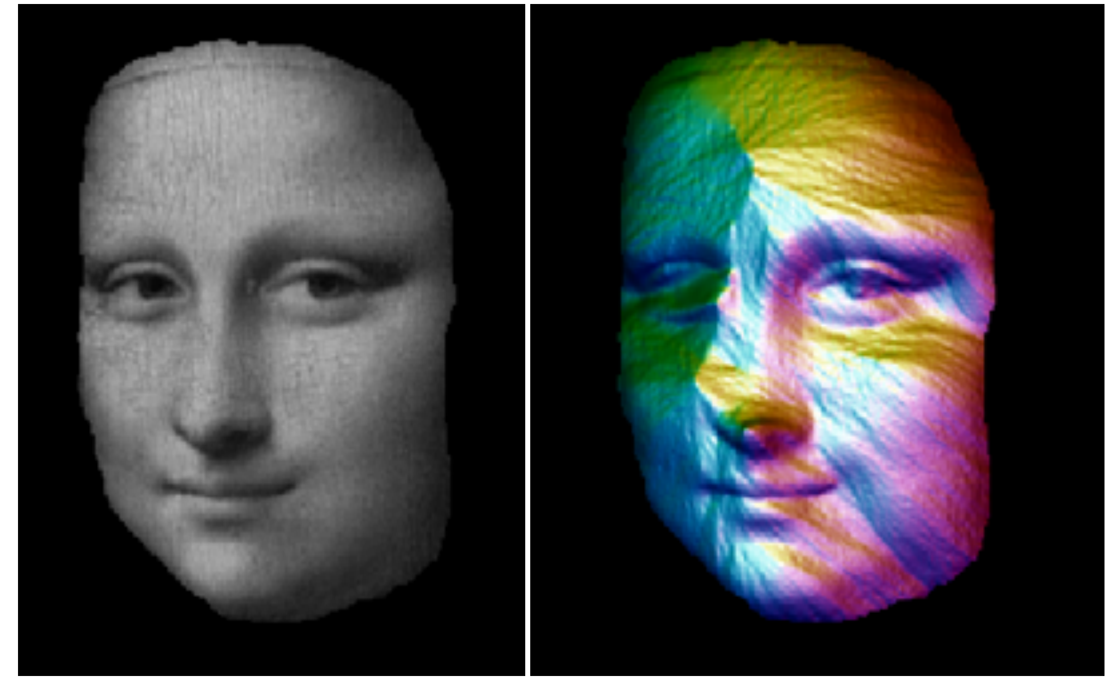

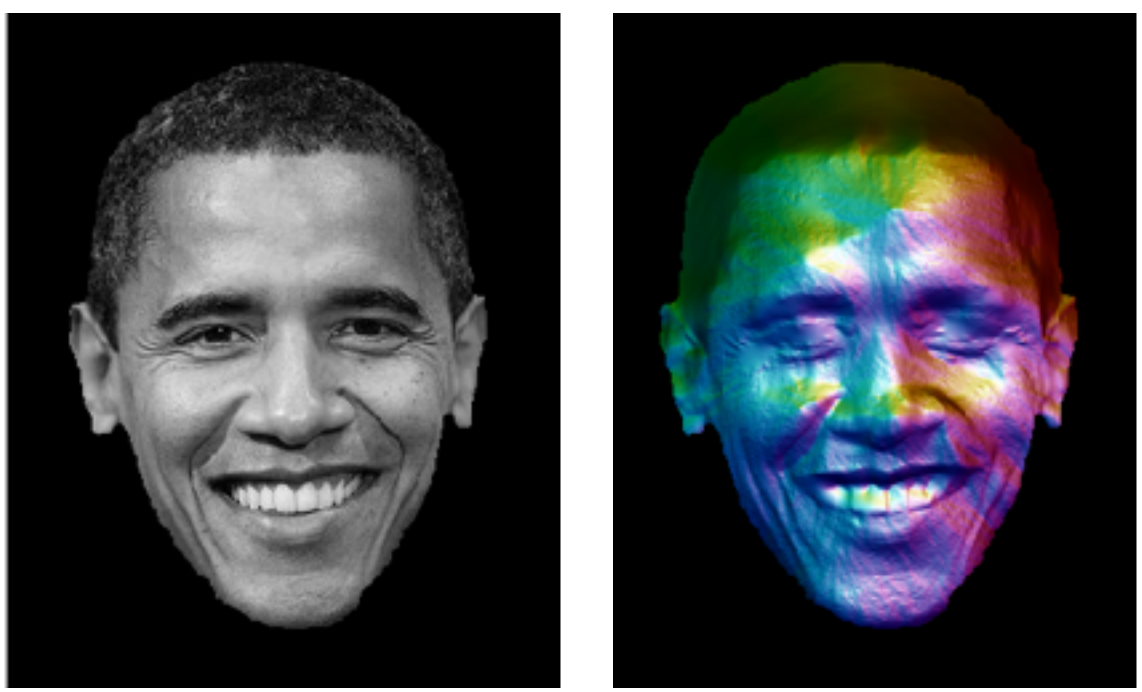

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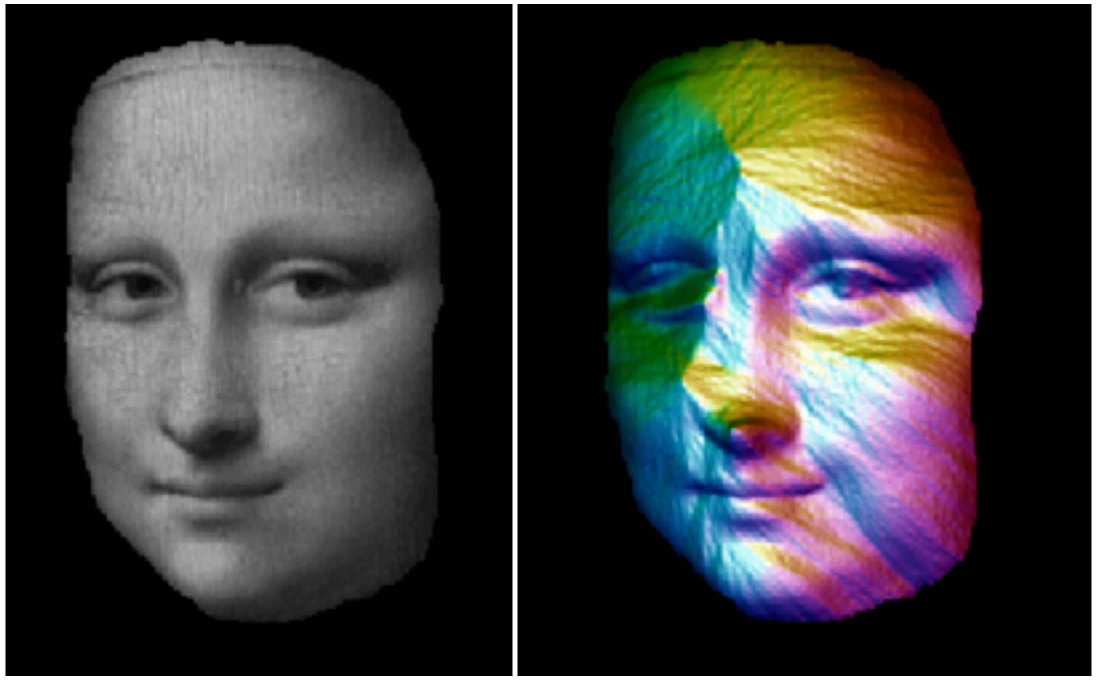

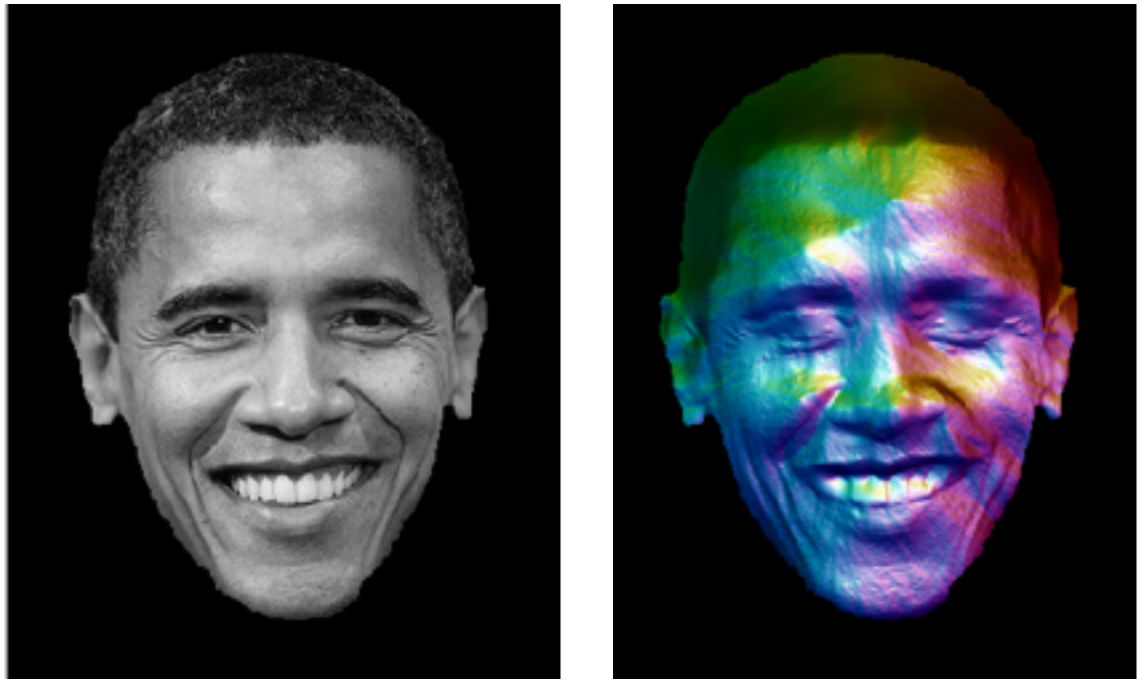

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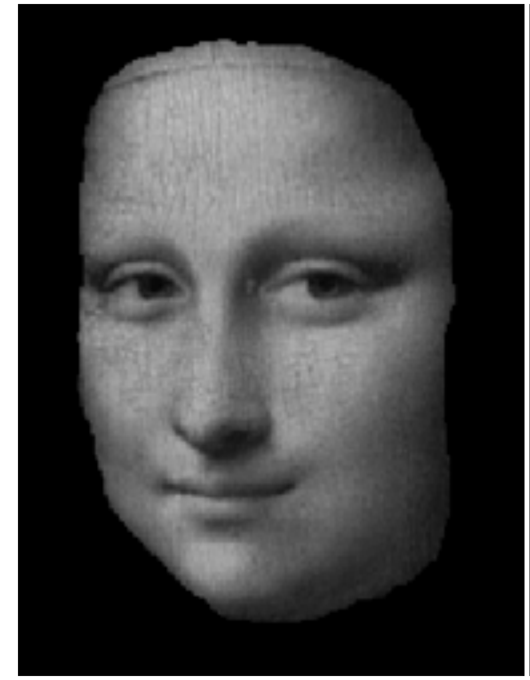




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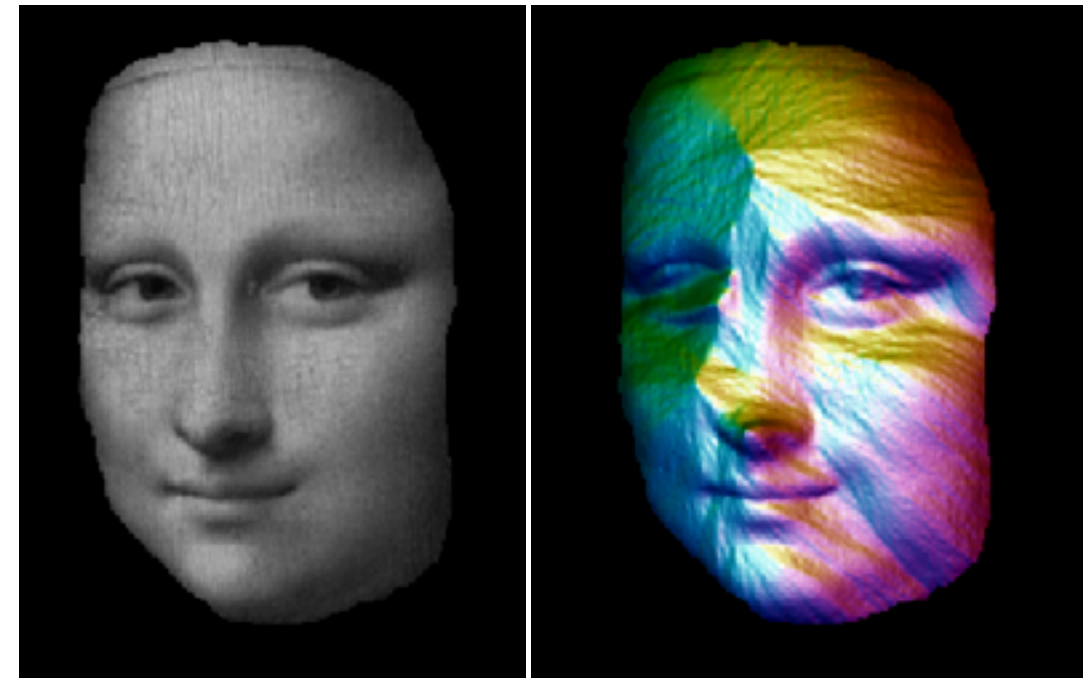

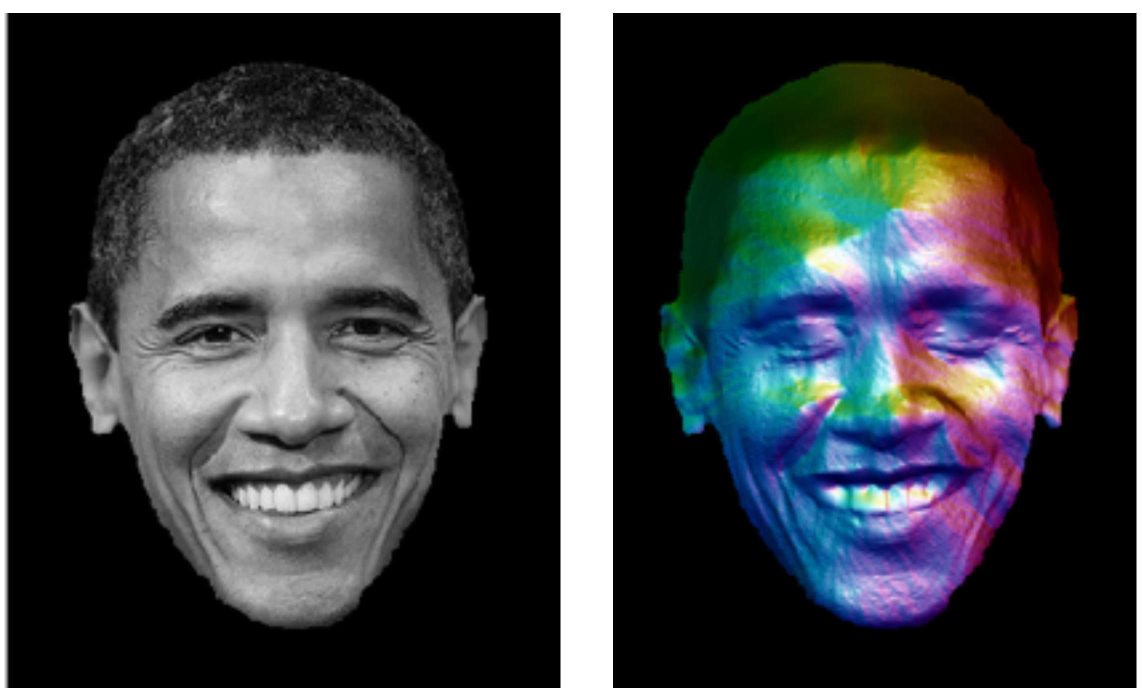

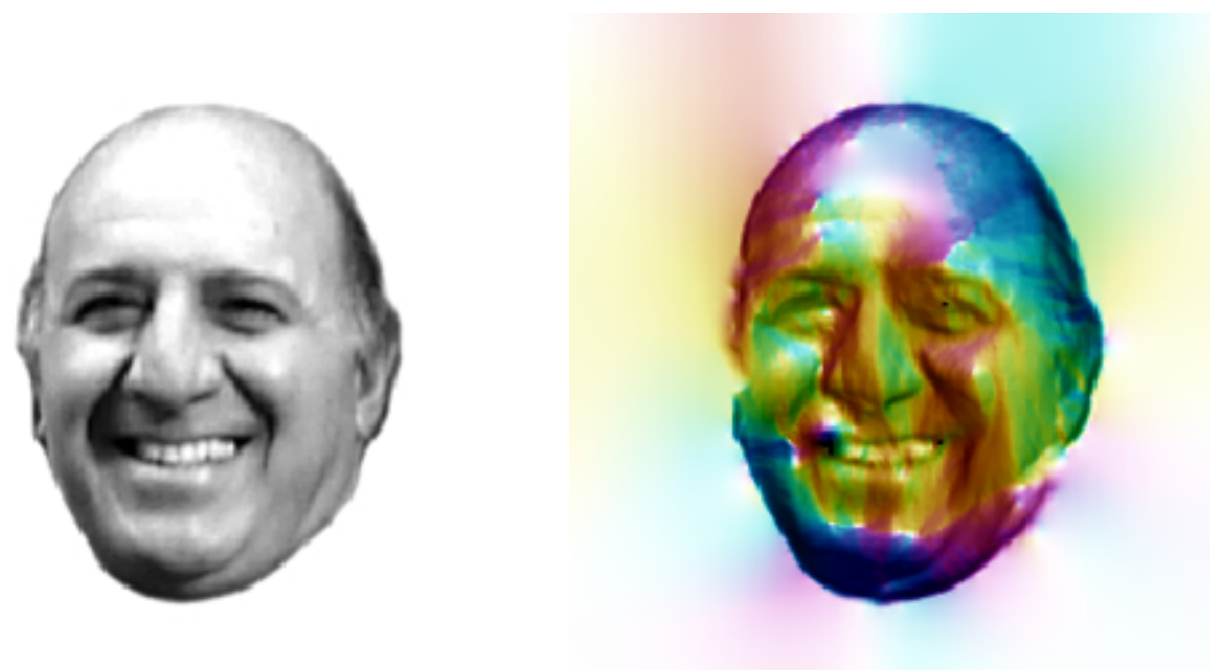

Thank you !