Chapter 2 Light and Shading

Pixel Brightness

(1) $I_{camera}(x) = k\, I_{patch}(X)$

camera Response

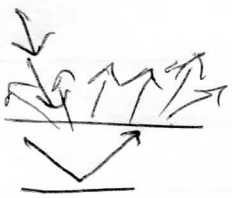
$I_{patch}(X)$: intensity at world patch X

intensity at camera x

(2) Surface Reflection

diffuse : even in all directions

specular : reflects directly



$$I = \rho I_0 \cos\theta$$

albedo, light intensity, angle of light source to surface normal

(3) Illumination

Lambertian + Specular model

$$I(\bar{x}) = \rho(\bar{x})(\bar{N}\cdot\bar{S})\,Vis(\bar{S},\bar{x}) + \rho(\bar{x})A + M$$

diffuse term, ambient, specular

$\bar{N}(\bar{x})$: unit surface normal at $\bar{x}$

$\bar{S}(\bar{x})$: vector pointing from $\bar{x}$ to source

$|\bar{S}| = I_0$

2.2.3 Inferring Lightness and Illumination p.43

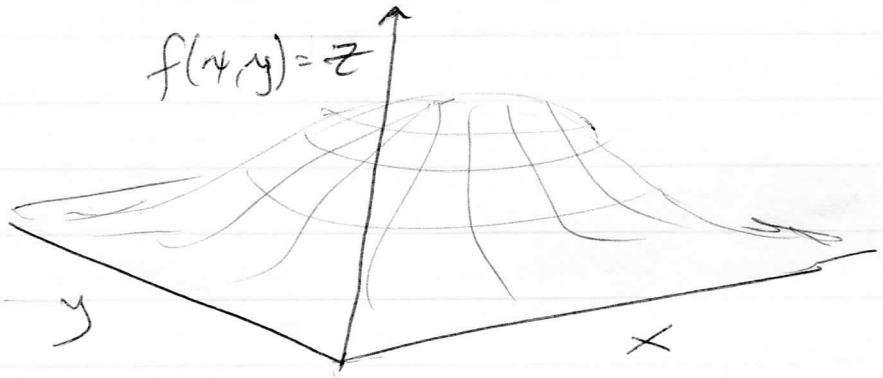
albedo is an intrinsic property of surface

- constant across imaging circumstances

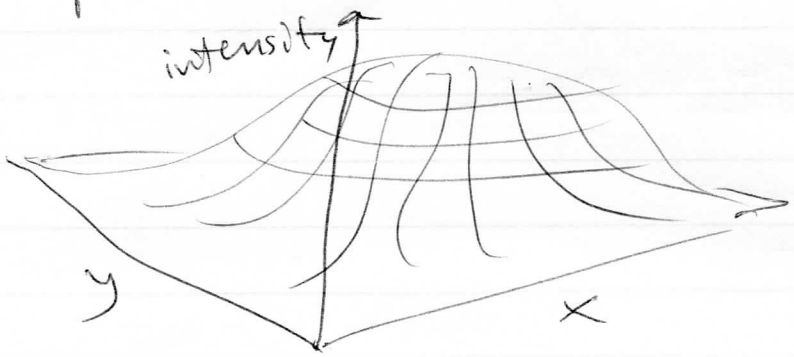
(p.46)

Photometric Stereo

use multiple illuminations to recover ~~[illegible]~~ reflectance ~~radiance~~
Build a depth map for surface:



Note, an intensity image may have the same (qualitative) function:



illuminate surface from different locations

$$B(\bar{x}) = \rho(\bar{x})\, N(\bar{x}) \cdot \bar{S}_1$$

$$I(x,y) = k\, B(\bar{x}) = k\, B(x,y)$$

$$= k\, \rho(x,y)\, \bar{N}(x,y) \cdot \bar{S}_1$$

$$= \bar{g}(x,y) \cdot \bar{V}_1 \quad \Rightarrow \text{where} \quad \bar{g}(x,y) = \rho(x,y)\, \bar{N}(x,y)$$

$$\bar{V}_1 = k\, \bar{S}_1$$

5 images p. 48 of hemisphere

for n sources, $\bar{V}_i$

$$V = \begin{bmatrix} \bar{V}_1^T \\ \bar{V}_2^T \\ \vdots \\ \bar{V}_n^T \end{bmatrix}$$

For each image point, create measurement vector:

$$\bar{i}(x,y) = [I_1(x,y); I_2(x,y); \ldots; I_n(x,y)]$$

So,

$$\bar{i}(x,y) = V\bar{g}(x,y)$$

Obtain $\bar{g}$ by solving system.

Then, albedo $\Rightarrow$ $\rho(x,y) = |\bar{g}(x,y)|$

$0 \le \rho \le 1$ else error

$$\bar{N}(x,y) = \frac{\bar{g}(x,y)}{|\bar{g}(x,y)|}$$

Surface is: $(x, y, f(x,y))$, so

$$\bar{N}(x,y) = \frac{1}{\sqrt{1 + \frac{\partial f}{\partial x}^2 + \frac{\partial f}{\partial y}^2}} \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \\ 1 \end{bmatrix}$$

Assume $\bar{N}(x,y) = \begin{bmatrix} a(x,y) \\ b(x,y) \\ c(x,y) \end{bmatrix}$

Then:

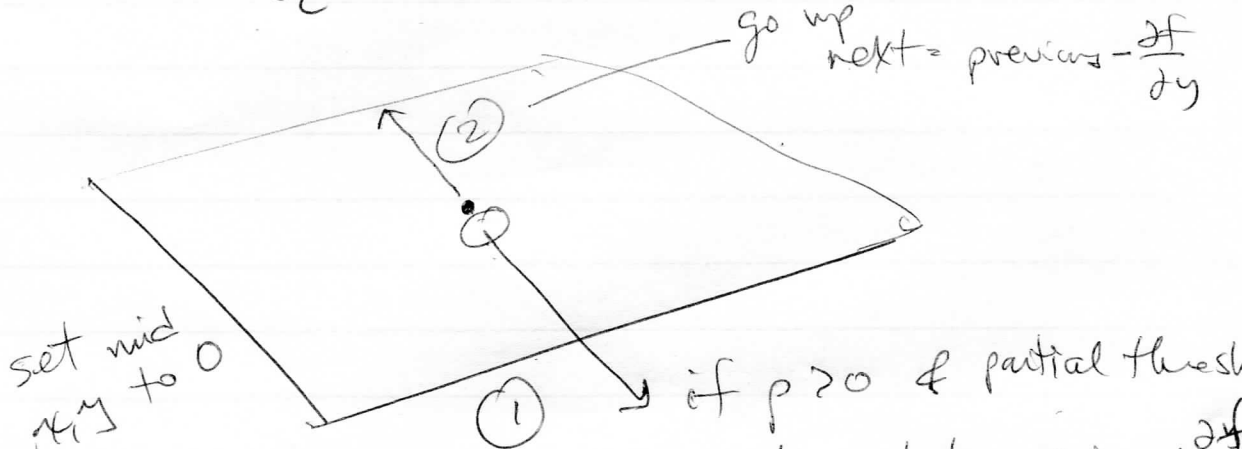
$$\frac{\partial f}{\partial x} = \frac{a(x,y)}{c(x,y)} \qquad \frac{\partial f}{\partial y} = \frac{b(x,y)}{c(x,y)}$$

Can check that data is good since

$$\frac{\partial^2 f}{\partial x \partial y} \overset{\text{should}}{=} \frac{\partial^2 f}{\partial y \partial x}$$

or $$\frac{\partial \left(\frac{a(x,y)}{c(x,y)}\right)}{\partial y} - \frac{\partial \left(\frac{b(x,y)}{c(x,y)}\right)}{\partial x}$$

$$f(x,y) = \oint_C \left(\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}\right) \cdot d\bar{l} + C$$



then move down, given these set next to previous $\frac{\partial f}{\partial y}$