10.2 Radiometry

We must first understand how the reflectance of a particular point in the image is determined. The reflectance of a surface is defined as the amount of light striking a surface. It is the difference between the radiant energy reflected from a surface and the radiant energy absorbed or transmitted by the surface. The amount of light striking a surface is defined as the irradiance. Radiometry is the study of the relationships between the irradiance and the radiometric properties of the scene. The radiometric properties of a scene include the reflectance, transmittance, and absorption of light by the scene. Radiometry is used to measure and analyze the radiometric properties of a scene. Radiometry is also used to estimate the reflectance of a scene from measurements of the irradiance and the radiometric properties of the scene.
The appearance of a surface depends greatly on the light's condition. For example, if light falls on a surface at a small angle of incidence, a small portion of a plane at a distance from the convex on the unit sphere, the hemisphere of directions for each small angle of directions is defined as the plane cut off by the sphere. The complex of pattern with the surface changes. The fact that different surfaces reflect light differently means that the appearance of an object depends greatly on its attitude in space relative to the observer. Not only does the attitude vary, but the brightness also changes. The surface may appear dark when the light is incident at a right angle, and it may appear bright when the light is incident obliquely.
The solid angle subtended by the image of the object is seen from the center of the lens is just $\frac{J}{\theta \cos^2 \frac{\theta}{2}}$.

Similarly, the solid angle of the patch on the object as seen from the center of the lens is $\frac{J}{\theta \cos^2 \frac{\theta}{2}}$.

The ratio of the area of the object patch to that of the image patch is just $\frac{f}{\alpha \cos^2 \frac{\alpha}{2}}$.

Next, we need to determine how much of the light emitted by the sun is intercepted by the lens $\cos \theta$.

If these two solid angles are to be equal, we must have

$$\frac{\cos \alpha / 2}{\cos \theta / 2} \leq \frac{f}{\alpha}$$

where $\alpha$ and $\theta$ are the angles of the patch on the object and the image, respectively.

We next find the relationship between the radiance at a point on an object and the radiance at the corresponding point in the image.
10.4 Bidirectional Reflectance Distribution Function

The direction from which the light is incident, and the angle of incidence, are important in determining the amount of light reflected. The direction of reflection also depends on the surface properties and the angle of incidence. The amount of light reflected is thus a function of these parameters.

\[
\text{Reflectance} = \frac{\text{Intensity of reflected light}}{\text{Intensity of incident light}}
\]

When viewed from the light-emitting source, the light appears as a point source. The angle of incidence and the reflectance are thus important in determining the amount of light reflected.
10.6 Extended Light Sources

There is an interesting correlation on the form of the BRDF. If two or more light sources are present, then the BRDF can be described by a combination of their individual BRDFs. The BRDF of an extended light source can be approximated by the product of the BRDFs of the individual light sources. In the case of a single light source, the BRDF is given by:

\[
\frac{d\sigma}{d\Omega} = \sum_{i=1}^{n} \frac{d\sigma_i}{d\Omega_i}
\]

where \(d\sigma_i\) is the differential emission in the direction \(\Omega_i\) from the \(i\)-th light source, and \(n\) is the number of light sources. When combining multiple light sources, the BRDF is the product of the individual BRDFs:

\[
\frac{d\sigma}{d\Omega} = \prod_{i=1}^{n} \frac{d\sigma_i}{d\Omega_i}
\]

We will now study specific examples of BRDFs for several extended light sources.
The simple method cannot, of course, be used for surfaces with other reference properties.

\[ \mathbb{I} = \mathcal{A} \int_{\mathbb{V}} \phi \psi \frac{\partial}{\partial \mathbf{r}} \frac{\partial}{\partial \mathbf{r}} \]  

Note that since the RHF is constant for a Lambertian surface, we can write

\[ \phi = (\psi)^2 \psi \mathcal{A} \]  

ideal Lambertian surface.

Then the identity \( \psi \mathcal{A} = \phi \mathcal{A} \) holds, and we obtain

\[ \mathbb{I} = \mathcal{A} \int_{\mathbb{V}} \phi \mathcal{A} \frac{\partial}{\partial \mathbf{r}} \frac{\partial}{\partial \mathbf{r}} \]  

10.6 Surface Reflection Properties

An ideal Lambertian surface is one that appears equally bright from all directions.

The direction of the ray emitted toward the viewer. Since the test object is a function of two variables, \( \phi \) and \( \psi \), which specify the surface normal at each point, the integral over the entire surface becomes

\[ \mathcal{A} \int_{\mathbb{V}} \phi \psi \frac{\partial}{\partial \mathbf{r}} \frac{\partial}{\partial \mathbf{r}} \]  

and the total intensity of the surface is

\[ \mathbb{I} = \mathcal{A} \int_{\mathbb{V}} \phi \psi \frac{\partial}{\partial \mathbf{r}} \frac{\partial}{\partial \mathbf{r}} \]
10.6 Surface Orientation

10.7 Surface Brightness
surface orientation and direction of the surface normal.

A surface orientation can be parametrized by the first partial derivatives, \( f \) and \( g \), of the surface height, \( z \).

\[ \frac{\partial f}{\partial x} \times \frac{\partial g}{\partial y} = \mathbf{n} \]

The change in \( z \) can be shown using Taylor series expansion to be

\[ z + x \frac{\partial f}{\partial x} = z \]

**Figure 10.11:** Surface orientation can be parametrized by the first partial derivatives, \( f \) and \( g \), of the surface height, \( z \).
The Reflection Map

10.9 The Reflection Map

...The reference map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reference map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

...The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

...The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.

The reflection map is defined as the relationship between surface reference coordinates and the image plane. It encodes information about surface normal illumination and blurriness. It provides a parametric description of the surface's orientation at each point. The reflection map is used to render reflections in the scene. From now on, we shall assume that the viewer and the light sources are far from the objects being imaged.
Where these are orthogonal to the direction (d) \( \vec{v} + \vec{d} + \vec{c} = \vec{b} + \vec{d}^2 + \vec{d} + \vec{1} \)

Since \( \vec{v} = (b \cdot d) \vec{f} \)

The contours of constant brightness are parallel straight lines (fig. 10.1-a).

\[
\frac{\vec{b} + \vec{d} + \vec{c}}{\vec{b} + \vec{d}^2 + \vec{1}} = \frac{(b \cdot d)\vec{f}}{cos^2 \theta}
\]

The source, we find that the radiation is proportional to \( \cos^2 \theta \) since the cosine of the angle between the radius and the normal of the surface is zero. The cosine of the angle between the radius and the normal of the surface is zero, since when viewed obliquely, since the same power comes from a landscape.

![Reflection Map: Photometric Stereo](image)

**Figure 10.1-a.** The same power comes from a landscape.
The surface shape discussed in this and the next chapter.

The image formation equation is fundamental to the methods for recovery.

\[(f'(x)y = (f'x)F\]

We obtain

If we normalize by setting the constant of proportionality to one,

\[(f'(x)y = (f'x)F\]

If the surface gradient at the point is \(f'(x)\), then the projection there is proportional to the projection at the corresponding point in the image. The image intensity then is proportional to the projection at the corresponding point in the image. The image intensity then is proportional to the projection at the corresponding point in the image.

The correlation map captures the dependence of brightness on shape.

These importance properties of the surface and the distribution of light sources are also important.

The intensity pattern of the surface is determined by the shape of the object. The intensity pattern depends on light and shape of the object. The intensity pattern depends on the shape of the object. The intensity pattern depends on the shape of the object. The intensity pattern depends on the surface.

The image is an object, \(f'(x)\), is an example, consider a paraboloid. Inside the image of an object, \(f'(x)\).

In this chapter, we consider the source of illumination by a point source can have two peaks, one at the source location and a second at the image. The second peak comes from the illumination at the surface. The second peak is due to the contribution from the surface, the first peak is due to the light reflected from the surface, and the third peak is due to the light reflected from the surface. The intensity pattern is captured by the correlation map.
A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,

plane. A block diagram, in the shape of a set of prisms,
If these equations are linear and independent, there will be a unique solution:

\[ \mathbf{G} = (b' \cdot d) \mathbf{Y} \quad \text{and} \quad \mathbf{G} = (b' \cdot d) \mathbf{Y} \]

Image point (figure 10-20): Two images taken with different lighting will yield two equations for each surfacic orientation. To determine two unknowns, \( p \) and \( q \), we need two equations. Information to recover surface orientation locally, we must introduce additional constraints. For a local surface orientation, we can introduce additional constraints on the surface.

Assumed lighting conditions:

\[ \mathbf{b}' = \mathbf{b} \]

For a Lambertian surface, for example, \( \mathbf{b}' = \mathbf{b} \).

Surface orientation can usually be determined uniquely for some special cases.

The photometric stereo map is extremely useful in computer graphics where an object is depicted from a description of the shape of an object. But we imagine is created from a description of the shape of an object. There is a unique mapping from surface to map.

Reflection Map Photometric Stereo

Figure 10-19 shows two orthographic shaded views of the surface. The shading from west to east.

Figure 10-18: A block diagram made from a depth map of the surface of a mountainous region of the earth. (Digital terrain model kindly provided by North.)
In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent

conditions. In some cases this makes the equations linear. More important, other equations are linear when
than these rather than two different independent
10.4 Lookup Tables for Surface Orientation

The lookup tables for surface orientation can be stored in a lookup table based on gradients. The lookup table can be used to determine the orientation of the surface normal at a given point. The lookup table can be used in conjunction with the gradient and normal information to determine the orientation of the surface.

\[
[(g_x \times g_y) \cdot (f_x \times f_y) \cdot (f_z \times f_y)] \\
\frac{\hat{g}_x \times \hat{g}_y \cdot \hat{f}_x \times \hat{f}_y \cdot \hat{f}_z \times \hat{f}_y}{1} = \mathbf{u} \cdot \mathbf{d}
\]

Singularity: We show in exercise 10-10 that the Jacobian matrix is not full rank. This is because the normal is not a unique solution of the vector equation. We can combine these equations to find the closed-form solution to the photometric stereo equation.

\[
(u \cdot \hat{s}_d = \hat{s}_g) \\
(u \cdot \hat{s}_d = \hat{s}_g) \\
(u \cdot \hat{s}_d = \hat{s}_g)
\]

The gradient and the normal \( \mathbf{n} \) can be combined to find the closed-form solution to the photometric stereo equation.

\[
\frac{\hat{g}_x + \hat{g}_y + \hat{g}_z}{1} = \mathbf{u}
\]

where

\[
\text{for } i = 1, 2, 3, \quad \frac{\hat{g}_x + \hat{g}_y + \hat{g}_z}{1} = \hat{s}_g
\]

Then

\[
\text{for } i = 1, 2, 3, \quad \frac{\hat{g}_x + \hat{g}_y + \hat{g}_z}{1} = \hat{s}_g
\]

10.5 Recovering Albedo

Recall that the albedo is determined by the product of a reflection coefficient and the radiance of the light source. The reflection coefficient is a function of the angle between the surface normal and the direction of the light source. This relationship can be used to determine the albedo of a surface.

The reflection coefficient is a function of the angle between the surface normal and the direction of the light source. This relationship can be used to determine the albedo of a surface.

If a surface is not illuminated by a light source, then the albedo is 0. Otherwise, the albedo is determined by the product of the reflection coefficient and the radiance of the light source. The reflection coefficient is a function of the angle between the surface normal and the direction of the light source.

\[
\text{albedo} = \text{reflection coefficient} \times \text{radiance}
\]

The reflection coefficient is a function of the angle between the surface normal and the direction of the light source.

\[
\cos \theta = \frac{\mathbf{n} \cdot \mathbf{d}}{||\mathbf{n}|| \cdot ||\mathbf{d}||}
\]

where \( \mathbf{n} \) is the normal of the surface, \( \mathbf{d} \) is the direction of the light source, and \( \theta \) is the angle between the two vectors.

The albedo is then calculated as

\[
\text{albedo} = \frac{\mathbf{n} \cdot \mathbf{d}}{||\mathbf{n}||}
\]

This expression can be used to determine the albedo of a surface based on the angle between the surface normal and the direction of the light source.

10.6 Photometric Stereo

Photometric stereo is a technique for recovering the shape of a surface from the shading of a scene. The technique involves the measurement of the intensity of light reflected from a scene at different angles. The intensity measurements are then used to determine the surface normal at each point in the scene.

\[
I = \mathbf{n} \cdot \mathbf{L}
\]

where \( I \) is the intensity of light reflected from the surface, \( \mathbf{n} \) is the surface normal, and \( \mathbf{L} \) is the direction of the light source.

The surface normal is then determined by solving the following equation:

\[
\frac{\mathbf{n} \cdot \mathbf{L}}{||\mathbf{n}||} = I
\]

This equation can be solved for \( \mathbf{n} \) using standard linear algebra techniques.

Once the surface normal has been determined, the surface shape can be estimated using a variety of techniques. One common approach is to use a triangulation algorithm to approximate the surface shape from a set of points.

\[
\text{shape} = \frac{\mathbf{n} \cdot \mathbf{L}}{||\mathbf{n}||}
\]

where \( \mathbf{n} \) is the surface normal, \( \mathbf{L} \) is the direction of the light source, and \( \text{shape} \) is the estimated surface shape.

This technique can be used to recover the shape of a surface from a single image or a sequence of images. The shape can be used in a variety of applications, including 3D reconstruction, computer vision, and medical imaging.
10.5 References

After introducing the plotting of functions, and discussing the position of equations and their roots, we proceed to the further development of the methods of solving linear and quadratic equations. The method of finding roots of equations, and the graphical representation of functions, is developed in detail, with a focus on the graphical interpretation of equations in a coordinate system. The graphical representation helps in understanding the behavior of functions and in solving equations graphically.

We refer to the Appendix for more details on the plotting of functions and the graphical representation of equations. The Appendix also contains a discussion on the graphical interpretation of equations in a coordinate system, and it provides examples of graphical solutions for various types of equations.

10.6 Exercises

In this section, we provide a series of exercises to help you practice the concepts covered in this chapter. The exercises are designed to reinforce your understanding of the plotting of functions, the graphical representation of equations, and the graphical interpretation of equations in a coordinate system. You are encouraged to work through the exercises to develop your skills in these areas.

The answers to the exercises are provided in the Appendix for your reference. You are encouraged to check your solutions against the provided answers to ensure your understanding of the concepts covered in this chapter.

Further details on the plotting of functions, the graphical representation of equations, and the graphical interpretation of equations in a coordinate system can be found in the Appendix. The Appendix also contains additional resources for further study.

We hope that you find this chapter informative and engaging. We encourage you to explore the topics covered in this chapter further and to apply your knowledge to real-world problems.

References

For a detailed discussion on the plotting of functions and the graphical representation of equations, see the Appendix. The Appendix also contains additional resources for further study.

10.6 Exercises

The exercises provided in this section are designed to help you practice the concepts covered in this chapter. You are encouraged to work through the exercises to develop your skills in the plotting of functions, the graphical representation of equations, and the graphical interpretation of equations in a coordinate system.

The answers to the exercises are provided in the Appendix for your reference. You are encouraged to check your solutions against the provided answers to ensure your understanding of the concepts covered in this chapter.

Further details on the plotting of functions, the graphical representation of equations, and the graphical interpretation of equations in a coordinate system can be found in the Appendix. The Appendix also contains additional resources for further study.

We hope that you find this chapter informative and engaging. We encourage you to explore the topics covered in this chapter further and to apply your knowledge to real-world problems.

References

For a detailed discussion on the plotting of functions and the graphical representation of equations, see the Appendix. The Appendix also contains additional resources for further study.
In the plane, the plane is just the Euclidean space we have been using.

\[ \frac{z}{\sqrt{x^2 + y^2}} \]

10.6 The point \( \mathbf{r} \) on the Cartesian sphere maps to the point \( \mathbf{p} \) on the Cartesian plane where \( \mathbf{r} = \mathbf{p} \).

10.7 The geometric projection can be used to map the Cartesian sphere, i.e.

\[ \theta' \cos \phi' = \theta \cos \phi \]

\[ \theta' \sin \phi' = \theta \sin \phi \]

10.8 The projection of the sphere onto the plane is

\[ \frac{z}{\sqrt{x^2 + y^2}} = \frac{\theta}{\sqrt{\phi^2 + \phi^2}} \]

10.9 Show that

\[ \int_0^{\infty} \frac{z}{\sqrt{\phi^2 + \phi^2}} \, \frac{\theta}{\sqrt{\phi^2 + \phi^2}} \, \phi \, d\phi \, d\theta = \int_0^{\infty} \frac{z}{\sqrt{\phi^2 + \phi^2}} \, \phi \, d\phi \, d\theta \]

10.10 The contribution from the upper half of the hemisphere is

\[ \phi = \cos \theta \]

10.11 The amplitude of the radiant flux along the spherical coordinate is

\[ \lambda = \frac{\theta - \frac{\pi}{2}}{\lambda} \]

10.12 The radiant flux along the spherical coordinate is

\[ \beta = \cos \theta \]

10.13 Consider a hemispherical sky above a fixed location. Suppose that the sky has a constant radiant temperature of \( T \) and a constant luminance of \( L \).

10.14 Determine the radiant intensity at a specific location illuminated by a point light source. The point light source is located at a distance \( z \) from the point of interest.

\[ \frac{z}{\sqrt{x^2 + y^2}} = \frac{\cos \theta}{\sqrt{\phi^2 + \phi^2}} \]

10.15 Consider the radiant intensity at the position of the sky.

\[ \theta = \tan \frac{\pi}{4} \]

10.16 Exercises

---

**Figure 10.22:** A surface patch incident to the pointental will receive radiation.
Show that in the case of Lambertian reflectance, an extended light source can be replaced by an equivalent point source whose direction and position can be expressed by an equivalent source. How would you distinguish between the equivalent source and the extended source? Use the results in the equation for the equivalent source to determine the equivalent direction. Sketch the two limiting cases in which the equivalent source is a point source. Suppose the equivalent source is extended in its own right. What happens when part of the light is absorbed by the surface? Why is this not a valid approximation in this case?

Reference Map: Photometric Stereo

10.8 In the case of a Lambertian reflectance map, the illumination by a single point source and the direction of the light source are used. What are the most two surface orientations that correspond to a point on the surface? What are the most two surface orientations that correspond to a point on the surface? How do you determine the surface orientation? Suppose the equivalent source is extended in its own right. What happens when part of the light is absorbed by the surface? Why is this not a valid approximation in this case?


For the unit vectors \( \hat{a} \) and \( \hat{b} \),
\[
(\hat{a} \cdot \hat{b}) \hat{a} = 2 \hat{a} \\
(\hat{a} \cdot \hat{a}) \hat{b} = 2 \hat{b}
\]

The preposition here is to solve the three equations.

10.16 We saw in the case of a Lambertian surface and three light sources,
the essential issue covered in this chapter.

10.17 The question is to find the number of directional differences per unit area of the surface. This is the number of light sources that contribute to the illumination of the surface. We can find the number of light sources that contribute to the illumination of the surface.

A Lambertian surface illuminated by a point source has a reflectance.

\[
\int \int \int = \frac{2b + d + 2 + d + d + 1}{2b + d + d + 1} = \theta
\]

10.18 An ideal Lambertian surface lends to image formation.

10.19 The figure is to be drawn to scale. a) \( \int \int \int = \theta \)

Conclude that a point source is a Lambertian surface.

10.20 Suppose that a surface has a brightness of \( \theta \) or \( \gamma \).

A Lambertian surface illuminated by a point source has a reflectance.
Consider small variations in the brightness measurements. How do they affect the predicted color of the scene? The brightness measurements are used to determine the color of the scene, but variations in the measurements can affect the color predictions. Therefore, it is important to account for these variations when predicting the color of the scene.

For some constant \( c \), we have:

\[
(\frac{v}{\hat{v}})^2 = c
\]

This means that the ratio of the predicted brightness to the actual brightness is constant. If the brightness measurements are accurate, this ratio should be close to one. If the ratio is significantly different from one, then the brightness measurements are likely inaccurate.

Thus, we need to consider the relationship between the brightness measurements and the color of the scene. By analyzing the brightness measurements, we can predict the color of the scene with reasonable accuracy. However, variations in the measurements can affect the accuracy of the predictions. Therefore, it is important to account for these variations when predicting the color of the scene.
explained in the appendix.

How does one change if we assume that the abscissa is one? First, you

must realize that the indicated matrix inverse exists. Therefore, the part of the problem is

(9) What is the smallest number of measurements needed to guarantee that

\[
\begin{pmatrix}
\sigma_{x_0} & \sigma_{y_0} & \sigma_{z_0} \\
\sigma_{x_0} & \sigma_{y_0} & \sigma_{z_0} \\
\sigma_{x_0} & \sigma_{y_0} & \sigma_{z_0}
\end{pmatrix}
\]

and

\[
\begin{pmatrix}
\sigma_{x_0} & \sigma_{y_0} & \sigma_{z_0} \\
\sigma_{x_0} & \sigma_{y_0} & \sigma_{z_0} \\
\sigma_{x_0} & \sigma_{y_0} & \sigma_{z_0}
\end{pmatrix}^{-1} = \begin{pmatrix}
\sigma_{x_0} & \sigma_{y_0} & \sigma_{z_0} \\
\sigma_{x_0} & \sigma_{y_0} & \sigma_{z_0} \\
\sigma_{x_0} & \sigma_{y_0} & \sigma_{z_0}
\end{pmatrix}
\]

where \( \sigma \) is the diagonal product of the vectors \( a \) and \( b \).

\[
\sum_{i=1}^{n} \left( \sum_{j=1}^{m} y_i y_j \right) = y d
\]

(10) Show that the vector that minimizes the error sum is

where \( \theta_i \) is the mean of the measurements at that point.

\[
\sum_{i=1}^{n} (y_i - \theta \cdot y_i)^2
\]

normal \( \theta \) that minimizes different from one. At each point in the image, we wish to find the unit surface

the unit vector \( \theta \). This time we assume that the surface can have an abscissa

of consideration to the source is given by the surface under

high sources are used to obtain a number. Suppose that the surface under

to improve accuracy when using the photometric stereo method. Imagine that in

Refereences: Map Photometric Stereo