

Nov. 6th (Monday).

Note 1. Midterm Exam is Scheduled ON Next Monday.

Review Session in-class is scheduled ON Wednesday.

Today's Topics:

1° SSPI Init Code.

2° Hardware Design for LCD/CPU Interface Design.

Example: Line 210-246.

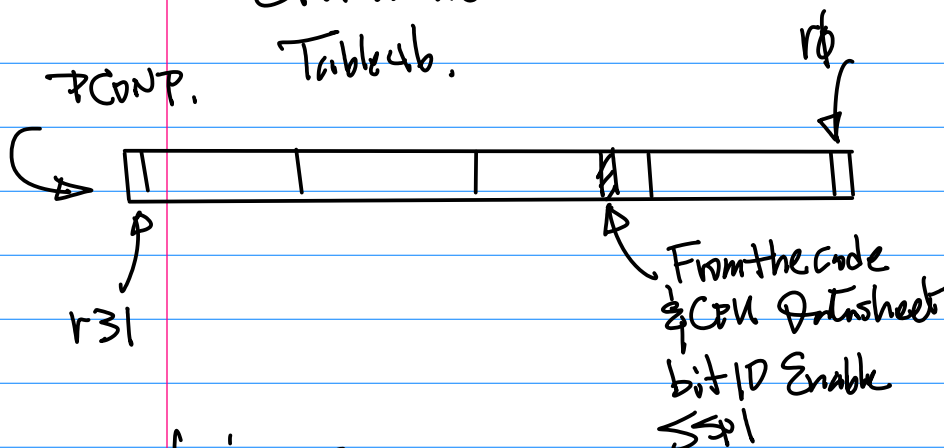
Line 224 Naming Convention

LPC_SC → PCOMP

Section 4.8.5. PP61

CPU Datasheet.

Table 4b.



Line 227.

LPC_SC → PCUKSEL

Line 229

Line 230

LPC_SC → PINSEL0.

TP.58, Table 42.

Section 4.7.3. TP57.

Note: Draw a 32 Bit SPR illustration.

Connect to CPU Datasheet (Tables for the SPR).

Memory Bank holding this SPR. Code Implementation.

Note: The Sequence to Init & Config SPRs for SSPI Interface. (SPI)

PCOMP → PCUKSEL → PINSEL0

Line 233/234 CS (Chip select: e.g. Select/Enable my LCD Display module)

Line 238

SSPI Init.

TP.431. Table 371

Use Case Leads to Design Requirements, for Example, 2D G.E. Design. Frame Rate, Resolution of the Display →

Carry out the Design By Using CPU Datasheet, and formula

$$f_{PWM} = \frac{PCLK}{CPDSUPR * (SCR + 1)}$$

Then, Coding.

Homework: Due Nov. 14th (Sunday).

1st Requirements:

a) Based on the Homework of Drawing A wire frame Cube in $x_w-y_w-z_w$, Add a point Light Source, such as

$$P_s(x_s, y_s, z_s) = (-5, 50, 250),$$

b) Use the vertices from the Top Surface of the cube to generate 4 Ray Equations, then Compute the intersection Points on x_w-y_w plane

Note: Computation is Carried out Before the Transformation Pipeline, e.g., in $x_w-y_w-z_w$ Coordinate.

c) Draw the shadow first Before Drawing the Cube.

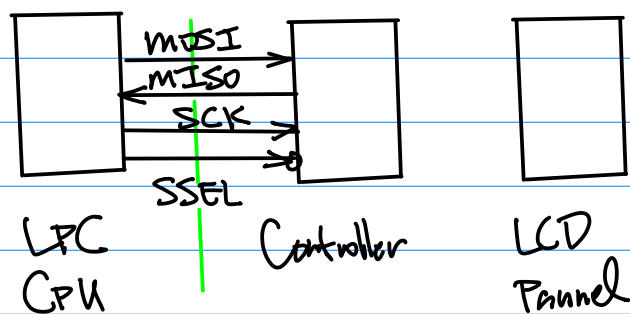
Note: Design/Select A proper dark color for the shadow.

Note: please work/Discuss this homework with your team. But coding has to Be individually, No code can be shared.

Note: Please Bring Your Board for

Show & Tell, Demo on Monday, Nov. 20 (Monday).

Consider Hardware Design for LCD Controller Interface.



LCD with Controller Build In.

Note: please provide Clear indication of the Signal Flow By Drawing Arrow on Each Signal Line.

Also, place a circle "0" for Active Low Signal.

Nov. 8 (Wed).

Note 1. Midterm Exam is Next Monday.

- please Bring your Prototype System;
- Bring Blank Papers for the exam hand Calculation;

Cmpe240
F2023

- use
- c) "printf" to print your First Name, Last Name and SID, while executing Program During the example.
- d) There are 3 Questions.

Question in the CPU Architecture, memory, SPRs. Memory Bank,

Question on the subject of Building A prototype System.

SCH, pin Connectors, functionality of the pins. and interface to LCD.

Question in the Area Design. Debugging, hand Calculation.

- e) Naming Convention of the Zip.

FirstName-LastName-SID-Cmpe240-mid.zip

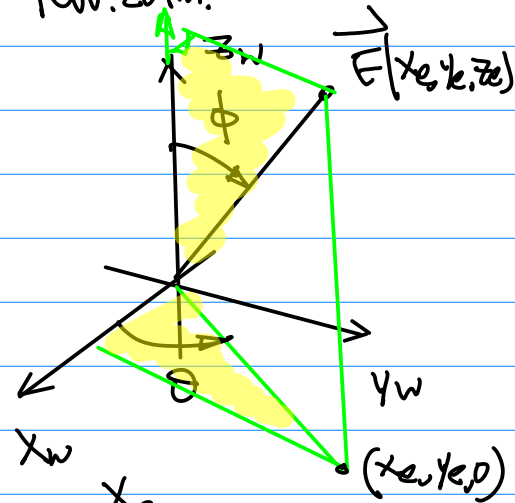
One pdf (integration of All pdf files)

- f) Resolution of the photos.
Not too high, Not too low
Resolution, 1 ~ 4 MB.

- g) Submission on CANVAS.
No Late Submission, No E-mail Submission

Homework 53/

Note: Shadow Computation
Due Nov 19 (Sun).
Please Bring your Board for Demo on Monday.
Nov. 20th.



$$\cos \theta = \frac{x_e}{\sqrt{x_e^2 + y_e^2}}$$

sin

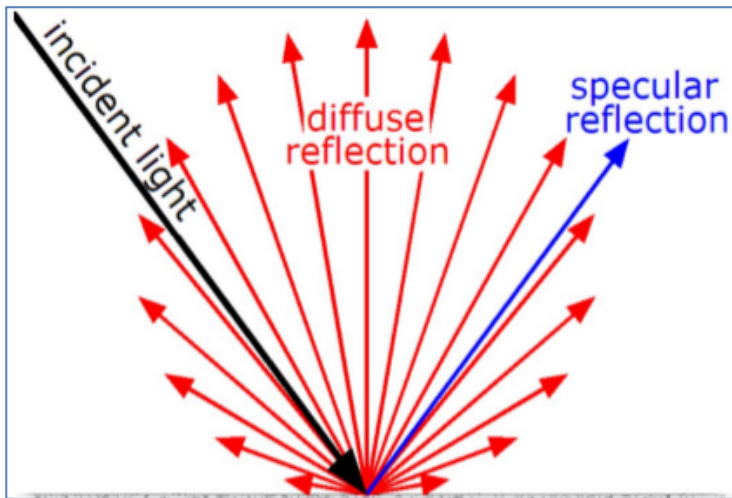
$$\cos \phi = \frac{z_e}{\rho} = \frac{z_e}{\sqrt{x_e^2 + y_e^2 + z_e^2}}$$

Nov.15 (Wed).

Ref: Pp.1. Definition/Concept of Diffuse Reflection.

2018S-23-lec7-DiffuseReflection-v6-2018-4-25.pdf

Diffuse Reflection



Two Key Characteristics:

1. The surface with reflectivity as $K_d = (k_r, k_g, k_b)$, e.g., diffuse coefficients;

2. The decay of incident light is inverse proportional to its distance from the source to the surface point. e.g., $1/(r^2)$, where r is being the distance from the light source to the surface.

Specular vs. diffuse reflection

https://en.wikipedia.org/wiki/Diffuse_reflection

Diffuse Reflection: the reflection of light uniformly in all different directions, the surface of this reflection exhibits Lambert reflection, e.g., equal luminance when viewed from all directions.

Harry Li, Ph.D.

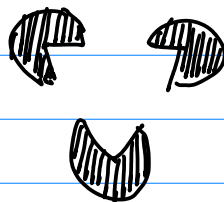
Ref2: on the class github.

2022F-101-notes-cmpe240-2022-11-30 (1).pdf

Example: Background On Diffuse Reflection.

Ref3:

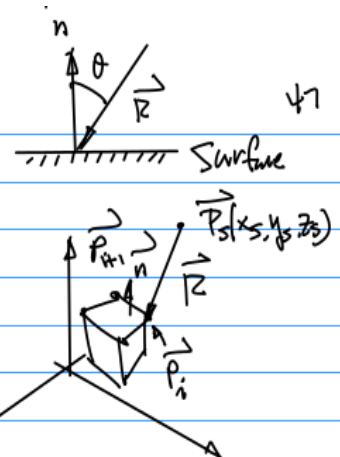
Pp54.



Brief Introduction, And 3 Lighting models.

CMPE240

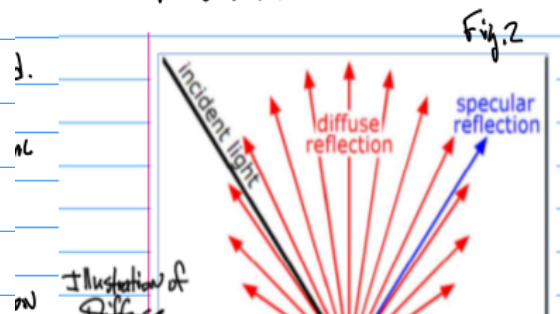
Nov.14, 22



Note:

1st Definition: PP.St. Reflection Uniformly in All different Directions.

Fig.1.



Three models. see Ref 3. pp. 54

$$I(x, y) = I_1(x, y) + I_2(x, y) + I_3(x, y)$$

Diffuse
Reflection

Specular
Reflection

Ambient
Light

Note: Specular

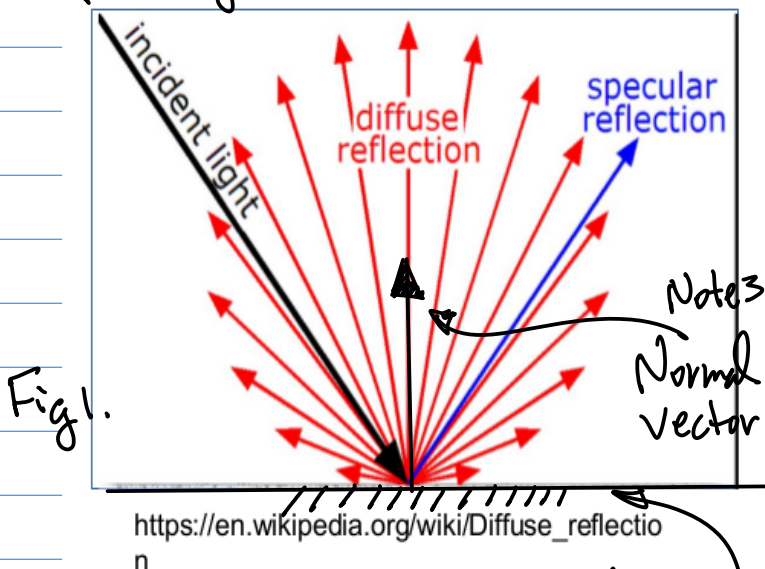
... (2)

Definition of Diffuse Reflection.

Ref. 1. Pp 1.

Reflection Uniformly reflects
the Incoming light in All
Different Direction.

Note 1. $P_s(x_s, y_s, z_s)$ Incident Light, White Color.
for example $r=g=b=255$ Diffuse Reflection



Note 3.
Normal
Vector.

Note 2:

Surface of Reflection

Color of A surface : physical
Characteristic.

Definition of Reflectivity to Describe

the Characteristics of A surface
Color.

Reflection of the color
leads to the perception
of the color.

Two Key Characteristics:

1. The surface with reflectivity as
 $K_d = (k_r, k_g, k_b)$, e.g., ... (1)
diffuse coefficients;

2. The decay of incident light is
inverse proportional to its
distance from the source to the
surface point. e.g., $1/(r^2)$, where
 r is the distance from the
light source to the surface.

Specular vs. diffuse reflection

where k_r : Reflectivity for red

k_g : green

k_b : blue

Normalized, so

$k_r \in [0, 1]$

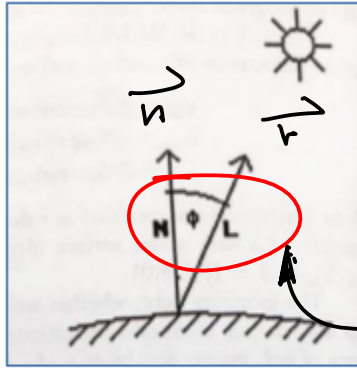
$k_g, k_b \in [0, 1]$... (2)

for Example for the Blue Chair,

$k_r = 0, k_g = 0, 0 < k_b < 1$

Consider the Normal \vec{n} and its
Angle formed by the incident light

pp.3. Ref. 1.

e, then
(x,y,z) canReference: Computer Graphics, C. K.
Pokorny, C. F. Gerald, pp. 514

$$\vec{n} \cdot \vec{r} = \|\vec{n}\| \|\vec{r}\| \cos \phi \quad \dots (3)$$

$$\cos \phi = \frac{\vec{n} \cdot \vec{r}}{\|\vec{n}\| \|\vec{r}\|}$$

$$\phi = \cos^{-1} \left(\frac{\vec{n} \cdot \vec{r}}{\|\vec{n}\| \|\vec{r}\|} \right)$$

Instead, use $\cos \phi$.

$$I_d(x, y) \sim K_d \cos \phi$$

$$= K_d \frac{\vec{n} \cdot \vec{r}}{\|\vec{n}\| \|\vec{r}\|}$$

pp.3. Ref. 1.

Note 1. Regarding Angle ϕ

$$I_r = K_{dr} \frac{\vec{n} \cdot \vec{r}}{\|\vec{n}\| \|\vec{r}\|} \frac{1}{\|\vec{r}\|_z} \quad \dots (1.1)$$

where
e

$$\|\vec{r}\|_z^2 = x_r^2 + y_r^2 + z_r^2$$

$$I_g = K_{dg} \frac{\vec{n} \cdot \vec{r}}{\|\vec{n}\| \|\vec{r}\|} \cdot \frac{1}{\|\vec{r}\|_z^2} \quad \dots (1.2)$$

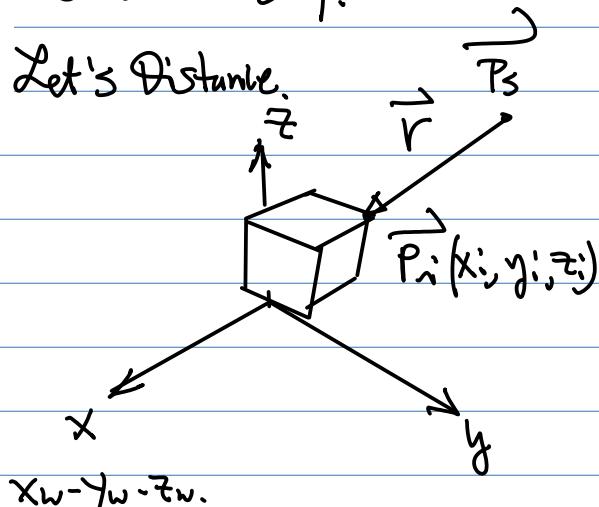
$$I_b = K_{db} \frac{\vec{n} \cdot \vec{r}}{\|\vec{n}\| \|\vec{r}\|} \cdot \frac{1}{\|\vec{r}\|_b^2} \quad \dots (1.3)$$

intermediate Result $\dots (4)$
in Eqn (4).

Nov. 20 (Monday)

Ref:

2021F-101b-notes-cmpe240-2021-12-1 (1).pdf

Example: Add Distance factor
into Eqn (4), e.g., the shorter
distance gives stronger
Color intensity.

Use Vector Dot Product.

 \vec{n} : Normal Vector. \vec{r} : Ray Equation (Reformulated).
To Point to \vec{P}_s , to get rid of
Negative Sign.) $x_w - y_w - z_w$

distance,

$$\|\vec{r}\| = \sqrt{(x_s - x_i)^2 + (y_s - y_i)^2 + (z_s - z_i)^2}$$

... (1)

$$I_{\text{diff}}(x, y, z) = k_d \frac{\vec{n} \cdot \vec{r}}{\|\vec{n}\| \|\vec{r}\|} \cdot \frac{1}{\|\vec{r}\|^2}$$

... (5)

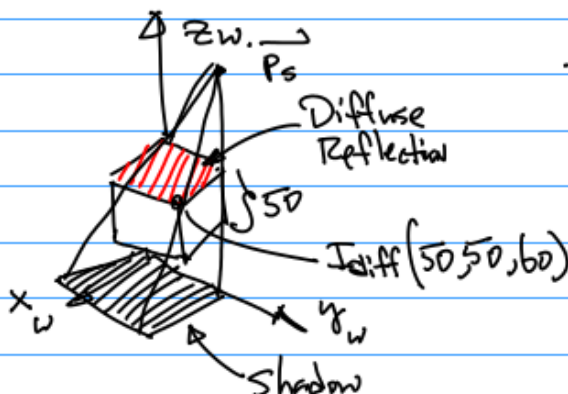
Note: from the ref. Hand Calculation.

Hence:

$$\begin{aligned} I_{\text{diff}} &= k_d \cdot \frac{1}{\|\vec{r}\|^2} \cdot \cos \alpha \\ &= k_d \cdot \frac{1}{\|\vec{r}\|^2} \cdot \frac{\vec{n} \cdot \vec{r}}{\|\vec{n}\| \|\vec{r}\|} \end{aligned}$$

... (4)

Example: Given Conditions



$$\text{Cmp240(I)} \quad (50, 50, 60) - (40, 60, 120) = (10, 10, -60) \quad 50$$

$$\vec{r} = \vec{P}_i + \lambda (\vec{P}_s - \vec{P}_i)$$

! for this calculation

$$= (50, 50, 60) + \lambda ((40, 60, 120) - (50, 50, 60))$$

$$= (50, 50, 60) + \lambda (-10, 10, 60)$$

$$\text{Let } \lambda = 1. \quad \vec{r}_{\lambda=1} = (50, 50, 60) + (-10, 10, 60)$$

$$= (40, 60, 120)$$

$$\vec{n} \cdot \vec{r} = (0, 0, 1) \cdot (40, 60, 120) = 0 \times 40 + 0 \times 60$$

$$+ 1 \times 120 = 120$$

$$\frac{\vec{n} \cdot \vec{r}}{\|\vec{n}\| \|\vec{r}\|} = \frac{120}{1 \cdot \sqrt{40^2 + 60^2 + 120^2}} = \frac{120}{\sqrt{40^2 + 60^2 + 120^2}}$$

therefore...

Note 1. Diffuse Reflection

Result is very Small Due to

$\frac{1}{\|\vec{r}\|^2}$, in the coding, add offset, constant to make it

Visible, such as $z_{\text{into}} \in [0, 255]$.
Sample code is on the github.

Keyword "diffusecpp"
20/8F-116 ~

Now, Consider Engineering Implementation.

Condition:

4 Vertices' color has been
Computed in $X_w - Y_w - Z_w$.

Now, Consider Computation After
Perspective Projection

$I_{diff}(x_{i+1}, y_{i+1}, z_{i+1})$

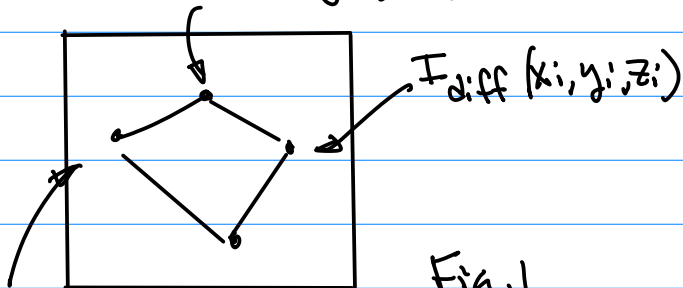


Fig.1

$I_{diff}(x_{i+2}, y_{i+2}, z_{i+2})$ ↓ Step 1. Colors @ all
Find Boundaries

$I_{diff}(x_{i+1}, y_{i+1}, z_{i+1})$

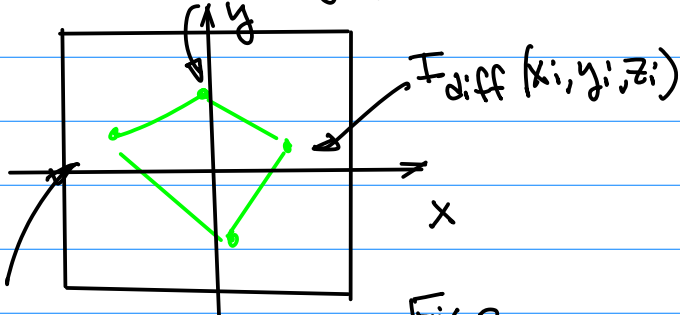


Fig.2

$I_{diff}(x_{i+2}, y_{i+2}, z_{i+2})$

↓ Step 2.
Find colors for all
the interior Points

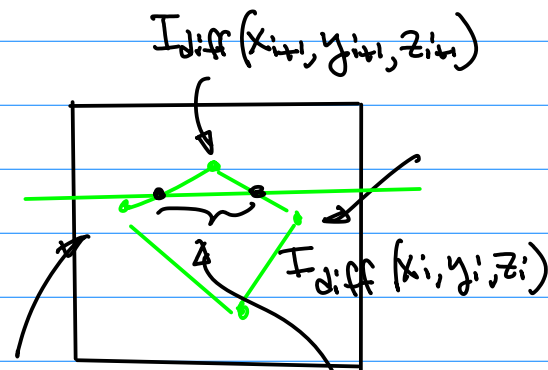


Fig.3

All Colors on this
Line (Arbitrary
Line)

Example: For Step 1.

Given 2 points of Diffuse
Reflection colour, Find all
colors on this Line.

I_{diff}

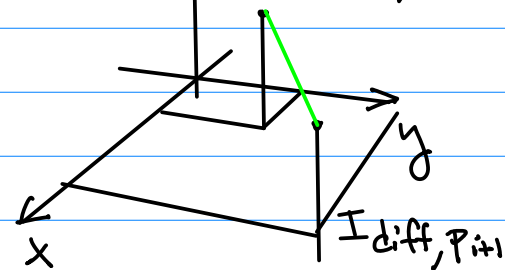
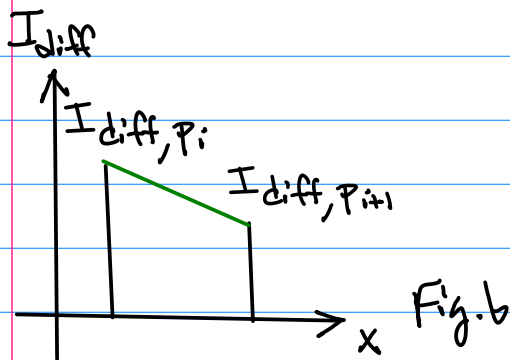
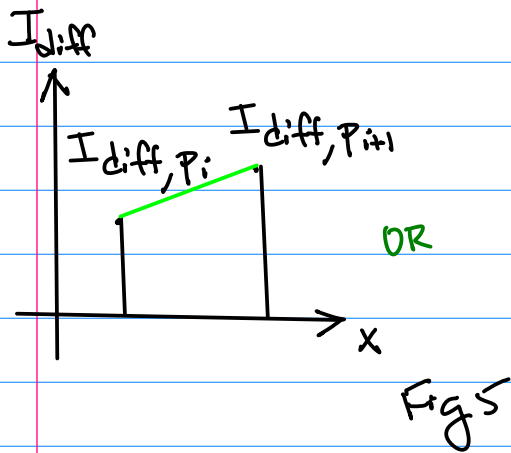


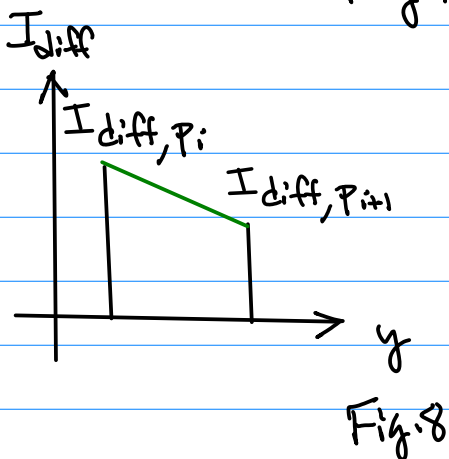
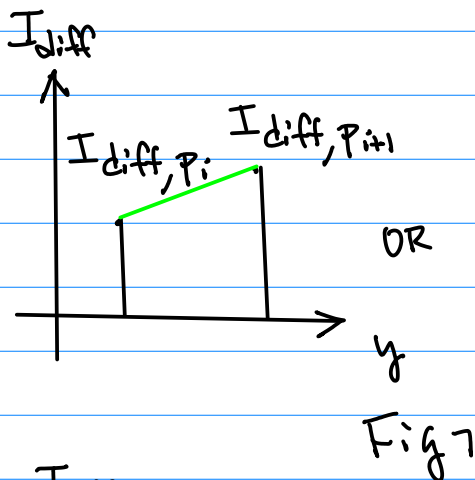
Fig.4

Fig.4

Projection to $x - I_{diff}$

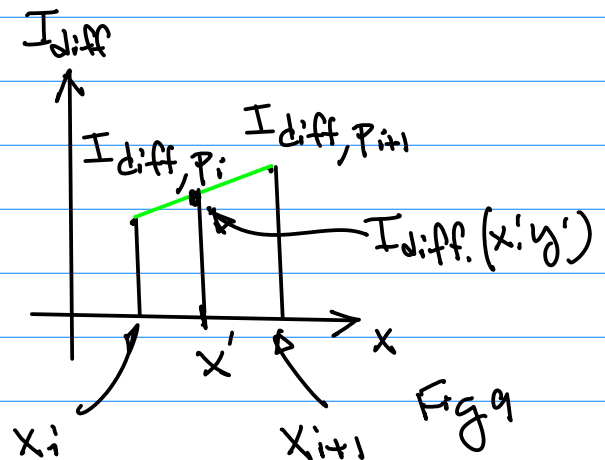


Similarly, Projection for y.

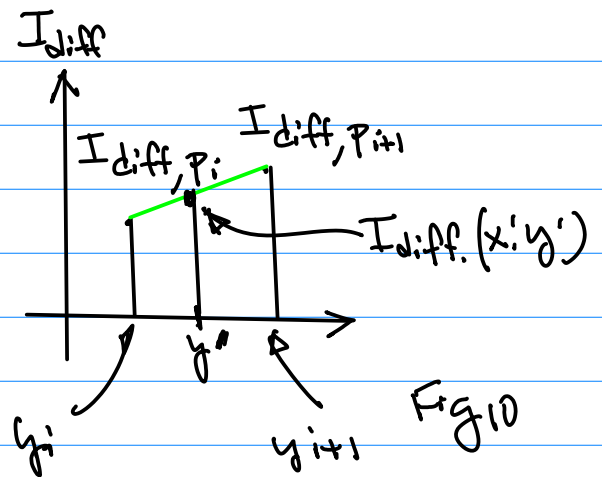


Use Linear Interpolation to find the Color of each and every point on this Line.

for example: for (x', y') find its color.



And for y.



To Combine them Final Dec. 13 (Wed)
12:15 - 2:30 PM.

$$\left(\begin{array}{c} \text{Diffuse} \\ \text{Reflection} \\ \text{@ Pt. } (x', y') \end{array} \right) = \left(\begin{array}{c} \text{Diffuse} \\ \text{Reflection} \\ \text{from } x \end{array} \right) + \left(\begin{array}{c} \text{Diffuse} \\ \text{Reflection} \\ \text{from } y \end{array} \right)$$

Z ... (b)

CMPE260

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60/

Projection Diffuse Reflection
Due Dec. 10 (Sun).