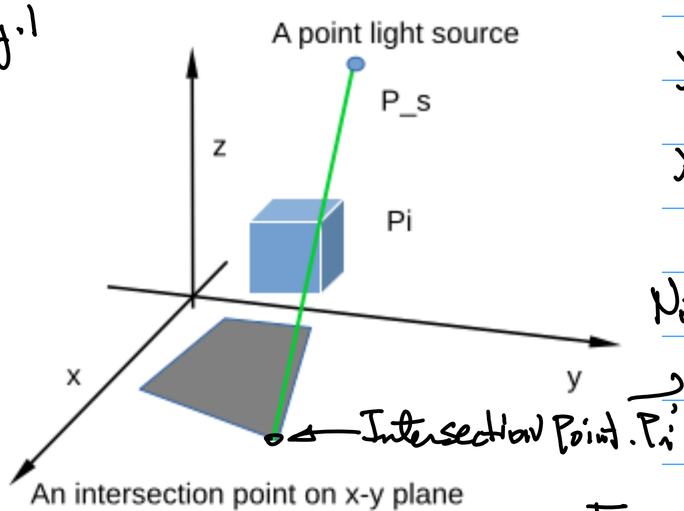
Nov. 15 (Monday).

Example: 3D Shadow Computation.

From Eqn (2) pp.50.

$$\vec{n}\cdot(\vec{v}-\vec{a})=0 \quad \cdots (2)$$

Fig. 1



Ray Equation: pp.46.

$$\vec{R}=\vec{P_i}+\lambda(\vec{P_s}-\vec{P_i}) \quad \cdots (3)$$

The Intersection Point on x_w-y_w plane, $\vec{P_i}'$ is a common pt shared by Ray Eqn (3) and plane eqn (2).

$$\begin{cases}\vec{R}=\vec{P_i}+\lambda(\vec{P_s}-\vec{P_i}) & \cdots (4\text{-}1)\\ \vec{n}\cdot(\vec{v}-\vec{a})=0 & \cdots (4\text{-}2)\end{cases}$$

From Eqn (4-2),

$$\vec{n}\cdot(\vec{v}-\vec{a})\Big|_{\vec{v}=\vec{R}}=0$$

$$\vec{n}\cdot(\vec{R}-\vec{a})\Big|_{\vec{R}=\vec{P_i}+\lambda(\vec{P_s}-\vec{P_i})}=0$$

$$\vec{n}\cdot(\vec{P_i}+\lambda(\vec{P_s}-\vec{P_i})-\vec{a})=0$$

$$\vec{n}\cdot\vec{P_i}+\lambda\vec{n}\cdot(\vec{P_s}-\vec{P_i})-\vec{n}\cdot\vec{a}=0$$

$$\lambda\vec{n}\cdot(\vec{P_s}-\vec{P_i})=\vec{n}\cdot\vec{a}-\vec{n}\cdot\vec{P_i}$$

$$\lambda=\frac{\vec{n}\cdot\vec{a}-\vec{n}\cdot\vec{P_i}}{\vec{n}\cdot(\vec{P_s}-\vec{P_i})} \quad \cdots (5)$$

Note: λ together with the Ray Equation (3), will give the intersection point.

Example: Given a single point light source $\vec{P_s}(-20,110,200)$, $\vec{P_i}(100,100,110)$. Find intersection Point to plot Shadow.

Sol

From Eqn (5), find λ.

Since

$$\vec{n}=(0,0,1),\ \vec{a}=(0,0,0)$$

$$\vec{P_i}=(100,100,110)$$

Hence,

$$\lambda=\frac{\vec{n}\cdot\vec{a}-\vec{n}\cdot\vec{P_i}}{\vec{n}\cdot(\vec{P_s}-\vec{P_i})}$$

$$=\frac{(n_x,n_y,n_z)(a_x,a_y,a_z)-(n_x,n_y,n_z)\cdot(x_i,y_i,z_i)}{(n_x,n_y,n_z)(x_s-x_i,y_s-y_i,z_s-z_i)}$$

CMPE240 (II)

$$= \frac{n_x \cdot a_x + n_y \cdot a_y + n_z \cdot a_z - (n_x x_i + n_y y_i + n_z z_i)}{n_x(x_s - x_i) + n_y(y_s - y_i) + n_z \cdot (z_s - z_i)}$$

Note: Define Letter(s) for my initial for Linear Decoration. Letter with Further Discussion.

$n_x = 0, n_y = 0, n_z = 1$.

Therefore, the above equation Becomes

$$= \frac{0+0+0 \quad -(0+0+1 \cdot z_i)}{0 + 0 + 1 \cdot (z_s - z_i)}$$

$$= -\frac{z_i}{z_s - z_i}$$ from the given Condition

```
typedef struct{
     float X[30], Y[30];
} letter;
```

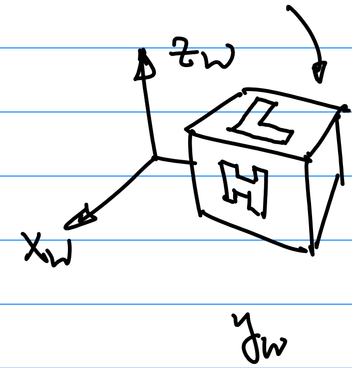
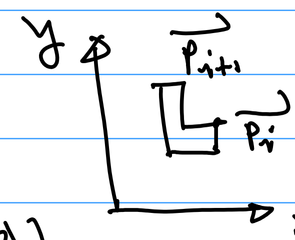


Fig. 2.

$z_i = 110, z_s = 200,$

$$\therefore \lambda = -\frac{110}{200-110} = -\frac{110}{90} = -11/9$$

Define 2D Patterns



2D Pattern to Decorate 3D plane.

Substitute λ into the Ray Equation (3)

$$\vec{R} = \vec{P_i} + \lambda(\vec{P_s} - \vec{P_i})$$

$$= (100,100,110) + \lambda((-20,110,200) - (100,100,110))$$

$$= (100,100,110) - \frac{11}{9}(-120,10,90)$$

$$= \left(100 + \frac{11}{9} \times 130, 100 - \frac{11}{9} \times 10, 110 - \frac{11}{9} \times 90\right)$$

$$= \left(100 + \frac{11 \times 130}{9}, 100 - \frac{11 \times 10}{9}, 110 - 110\right)$$

$$= \left(100 + \frac{11 \times 130}{9}, 100 - \frac{11 \times 10}{9}, \underline{\underline{0}}\right)$$

On $x_w - y_w$ plane, so z must Be 0!

C/C++ Implementation.

2018F-116-11diffuse20181114.cpp

2018F-117-12dda.cpp

```
//47 = normal vector, 46 = A, 45 = Ps, 7 = top left box vertex
world.X[45] = -200.0; world.Y[45] = 50.0; world.Z[45] = 200.0; // Ps (point source)
world.X[46] = 0; world.Y[46] = 0; world.Z[46] = 0; // arbitrary vector A on x-y plane
world.X[47] = 0; world.Y[47] = 0; world.Z[47] = 1; // normal vector for x-y plane
world.X[5] = 60.0;      world.Y[5] = 50.0;     world.Z[5] = 0.0; //p5 of box

world.X[6] = 60.0;      world.Y[6] = 50.0;     world.Z[6] = 100.0;//p6 of box
world.X[7] = 60.0;      world.Y[7] = -50.0;     world.Z[7] = 100.0;//p7 of box. Pi
```

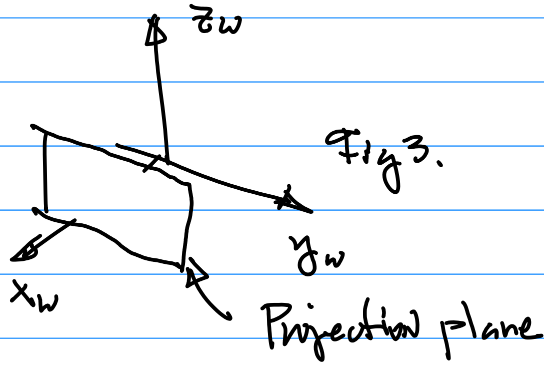


Fig 3.

② Point Light Source $\vec{P_s}(x_s, y_s, z_s)$

```
//47 = normal vector, 46 = A, 45 = Ps, 7 = top left box vertex
world.X[45] = -200.0; world.Y[45] = 50.0; world.Z[45] = 200.0; // Ps (point source)
world.X[46] = 0; world.Y[46] = 0; world.Z[46] = 0; // arbitrary vector A on x-y plane
world.X[47] = 0; world.Y[47] = 0; world.Z[47] = 1; // normal vector for x-y plane
```

① normal vector $\vec{n}$ $(0,0,1)$;

λ Computation is implemented Below,

```
//----------lambda for Intersection pt on xw-yw plane----------*
float temp = (world.X[47]*(world.X[46]-world.X[45]))
            +(world.Y[47]*(world.Y[46]-world.Y[45]))
            +(world.Z[47]*(world.Z[46]-world.Z[45]));
float lambda = temp / ((world.X[47]*(world.X[45]-world.X[7]))
                      +(world.Y[47]*(world.Y[45]-world.Y[7]))
                      +(world.Z[47]*(world.Z[45]-world.Z[7])));
float lambda_2 = temp / ((world.X[47]*(world.X[45]-world.X[6]))
                        +(world.Y[47]*(world.Y[45]-world.Y[6]))
                        +(world.Z[47]*(world.Z[45]-world.Z[6])));
```

$$\lambda = \frac{n_x \cdot a_x + n_y \cdot a_y + n_z \cdot a_z - (n_x x_i + n_y y_i + n_z z_i)}{n_x(x_s - x_i) + n_y(y_s - y_i) + n_z \cdot (z_s - z_i)} \quad \text{OR}$$

$$= \frac{n_x(a_x - x_i) + n_y(a_y - y_i) + n_z(a_z - z_i)}{n_x(x_s - x_i) + n_y(y_s - y_i) + n_z \cdot (z_s - z_i)}$$