①

image coord @ t = 0

$$p = f\frac{P}{Z} = \begin{bmatrix} \frac{fX}{Z} \\ \frac{fY}{Z} \\ f \end{bmatrix} = \begin{bmatrix} f3 \\ f6 \\ f \end{bmatrix} \Rightarrow f=1 \quad \begin{bmatrix} 3 \\ 6 \\ 1 \end{bmatrix}$$

$$V_x = \frac{T_z X - T_x f}{Z} \Rightarrow (x - x_0)\frac{T_z}{Z}$$

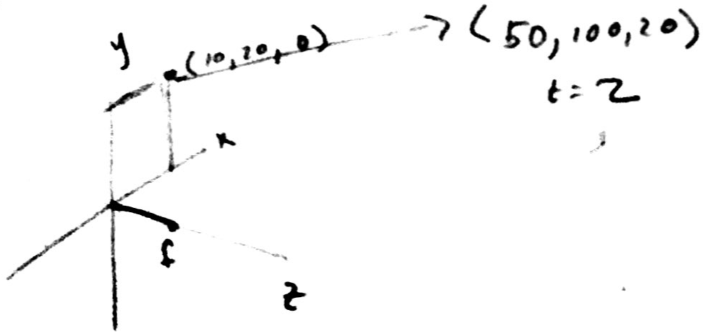
$$V_y = \frac{T_z y - T_y f}{Z} \Rightarrow (y - y_0)\frac{T_z}{Z}$$

$$P_0 = \begin{bmatrix} x_0 \\ y_0 \\ f \end{bmatrix} = \begin{bmatrix} f\frac{T_x}{T_z} \\ f\frac{T_y}{T_z} \\ f \end{bmatrix} = \begin{bmatrix} f\frac{5}{1} \\ f\frac{10}{1} \\ f \end{bmatrix} = \begin{bmatrix} 5f \\ 10f \\ f \end{bmatrix} = \begin{bmatrix} 5 \\ 10 \\ 1 \end{bmatrix}$$

time of collision : point passes through $Z = 0$.

$$\frac{Z}{T_z} \quad \frac{10}{1} = \boxed{10}$$

(2)

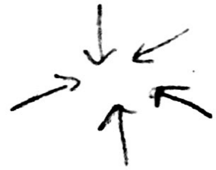


$$a = \begin{bmatrix} 20 \\ 40 \\ 10 \end{bmatrix}$$

$$\underset{t=2}{v} = \begin{bmatrix} 40 \\ 80 \\ 20 \end{bmatrix}$$

$$P_0 = \begin{bmatrix} f\,\frac{40}{20} \\ f\,\frac{80}{20} \\ f \end{bmatrix} = \begin{bmatrix} 2f \\ 4f \\ f \end{bmatrix} = \begin{bmatrix} 2 \\ 4 \\ 1 \end{bmatrix}$$

point of contraction.



(3) 40 people × 10 images = 400 images

400 images · 92 · 112 pixels = $\boxed{4,121,600}$ ← no compression.

$$\begin{array}{cc} & \text{400 images} \\ X = 10304 & \begin{bmatrix} x_1 & x_2 & \cdots & x_{400} \\ \vdots & \vdots & & \vdots \end{bmatrix} \end{array}$$

total = e + mean + coeff.

e: 10304 × 1

n = 400

= 4,121,600

$$\text{mean} = 10304 \begin{bmatrix} \bar{x}_1 \\ \vdots \end{bmatrix} = 10304$$

coeff = n images × n coeff/image

400^2

= 160,000

$\boxed{\text{all eigen vectors} = 4,291,904}$

40 vectors →

10304 × 40	=	412160	(eigen vectors)
10304 × 1	=	10304	(mean)
400 × 40	=	16000	(coeff)

$\boxed{438464 \quad \text{(40 vectors) universal}}$

individual

$$\begin{array}{cc} & 10 \\ 10304 & \begin{bmatrix} | & | & | \end{bmatrix} \end{array}$$

→ 10304 × 10	=	103040	(eigen vectors)
→ 10304 × 1	=	10304	(mean)
→ 10 × 10	=	100	(coeff)

113444 #/person

× 40 people

$\boxed{4,537,760 \quad \text{(keeping all vectors, keeping 10 vectors individual)}}$

10304 × 3 = 30912

10304 = 10304

10 × 3 = 30

41246 #/person

× 40 people

$\boxed{1649840 \text{ #'s for 3 eigen vectors}}$

(4)

a $\begin{bmatrix} 1 & 2 & 3 \end{bmatrix} \to 6/3 = \begin{bmatrix} 2 \\ 2 \end{bmatrix}$

$\begin{bmatrix} 1 & 2 & 3 \end{bmatrix} \to 6/3$

b) 2 vectors are orthogonal if they are perpendicular → dot product of vectors are 0

$$\begin{bmatrix} \sqrt{2}/2 \\ \sqrt{2}/2 \end{bmatrix} \cdot \begin{bmatrix} -\sqrt{2}/2 \\ \sqrt{2}/2 \end{bmatrix} = (\sqrt{2} \cdot \sqrt{2}/2) + (\sqrt{2}/2 \cdot \sqrt{2}/2) = 0$$

c) use $\begin{bmatrix} \sqrt{2}/2 \\ \sqrt{2}/2 \end{bmatrix}$ → non, zero eigen value

d)

$$\begin{bmatrix} 1 \\ 1 \end{bmatrix} \to \begin{bmatrix} 1 \\ 1 \end{bmatrix} - \begin{bmatrix} 2 \\ 2 \end{bmatrix} = \begin{bmatrix} -1 \\ -1 \end{bmatrix} \begin{bmatrix} \sqrt{2}/2 \\ \sqrt{2}/2 \end{bmatrix} = -\sqrt{2}$$

$$\begin{bmatrix} 2 \\ 2 \end{bmatrix} \to \begin{bmatrix} 2 \\ 2 \end{bmatrix} - \begin{bmatrix} 2 \\ 2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \begin{bmatrix} \sqrt{2}/2 \\ \sqrt{2}/2 \end{bmatrix} = 0$$

$$\begin{bmatrix} 3 \\ 3 \end{bmatrix} \to \begin{bmatrix} 1 \\ 1 \end{bmatrix} \begin{bmatrix} \sqrt{2} \\ \sqrt{2} \end{bmatrix} = \sqrt{2}$$

e) $\begin{bmatrix} 0 \\ 2 \end{bmatrix} \begin{bmatrix} \sqrt{2}/2 \\ \sqrt{2}/2 \end{bmatrix} = 0 + \sqrt{2} = \sqrt{2}$

f) closest match is $\begin{bmatrix} 3 \\ 3 \end{bmatrix}$