DSE 312

Computer Vision
Mid - Sem Exam

Shraddha Agarwal
19294

5. Given: Calibration matrix, M

We know that

$H = M_{3\times 3}$ $\quad$ $h = M_{3\times 1}$

Codes are applied and matrices K, R are ~~and t a~~ calculated using QR decomposition.

Intrinsic matrix, $K = \begin{bmatrix} 3.5939 & 1.8199 & -5.877 \\ 0 & 3.053 & -9.597 \\ 0 & 0 & 1 \end{bmatrix}$

Parameters $(f_x, f_y) = (3.5939, 3.053)$

$S = 1.8199$

$(u_0, v_0) = (-5.877, -9.597)$

translation t is also calculated as $t = K^{-1}h$

Extrinsic matrix $[R \; t] =$

$$\begin{bmatrix} 9.9548 & -9.4938 & -2.5580 & 1.9916 \\ 9.4939 & -9.9548 & -5.2034 & 2.8752 \\ 4.9484 & -3.2133 & 9.9999 & -1.8830 \end{bmatrix}$$

1. Level 12 image will be choosen.
Higher intesity results in high image quality.

2. S represents a subset of image's pixel for every pixel p in S, the set of pixels S which are connected to P is ~~reff~~ refered as connected components.
If S has one randomly component then S is called connected set.

13. This is salt and pepper noise and ~~it can be rem.~~ Median filter is the best suited filter for removing noise in this image.

8. If we smoothen the image repeatedly several times it will blur the image.

3. i) Isolation point detection
ii) Line detection
iii) Gaussian kernel filter used for smoothing
iv) Horizontal edge detection
v) Horizontal edge detection

4. ~~Horiz~~ Standard deviation parameter increases, the blurness in image increases and image becomes more smoothened as ST.D increased.

9. Suppose a part in x-y plane is translated by adding <h, K>
Let new-coordinate by (x', y')

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & h \\ 0 & 1 & k \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} \quad H$$

In Homogeneous plane

In Euclidian plane,

$$x' = x + k$$

$$y' = y + k$$

6. <u>Given</u> : $u_1 = (4, 2, 2)$ u_1 and u_2 are two lines

$u_2 = (6, 5, 1)$

Let $x = [x, y]^T$ be the point of intersection

Intersection of u_1 and u_2 in homogeneous coordinates is represented as $u_1 \cap u_2$

System of linear equations in projective geometry,

$$\begin{bmatrix} u_1 \cdot x \\ u_2 \cdot x \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Solving linear equations of the form $Ax = b$ using Cramer's rule

$$\begin{bmatrix} 4 & 2 \\ 6 & 5 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -2 \\ -1 \end{bmatrix}$$

$D_1 = \det(A_1) = 5(-2) - 2(-1) = -10 + 2 = -8$

$D_2 = \det(A_2) = 4(-1) - 6(-2) = -4 + 12 = 8$

$D_3 = \det(A) = 4(5) - 6(2) = 20 - 12 = 8$

$x = \frac{D_1}{D_3} = \frac{-8}{8} = -1$ $y = \frac{D_2}{D_3} = \frac{8}{8} = 1$

$x = \begin{bmatrix} -1 \\ 1 \\ 1 \end{bmatrix}$ is the point of intersection in homogeneous coordinates.

7. <u>Given:</u>

Projection matrix, M

$$= \begin{bmatrix} 512 & -800 & 0 & 800 \\ 512 & 0 & -800 & 1600 \\ 1 & 0 & 0 & 0 \end{bmatrix}$$

World coordinate = (4, 0, 0)

We know that,

In homogeneous coordinates,

world coordinate $= \begin{bmatrix} 4 \\ 0 \\ 0 \\ 1 \end{bmatrix}$

$$x = MX$$

where x denotes image plane coordinate

M denotes projection matrix

X denotes world coordinates

$$x = \begin{bmatrix} 512 & -800 & 0 & 800 \\ 512 & 0 & -800 & 1600 \\ 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} 4 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 2848 \\ 3648 \\ 4 \end{bmatrix} \quad = \begin{bmatrix} 712 \\ 912 \\ 1 \end{bmatrix}$$

Image coordinates = (712, 912)

10. b) Closing

11. b) Duals

12. b) Detection

Programming

1. LoG equations :-

1. Laplacian filter :-

$$\nabla^2 f = \frac{\partial^2 f}{\partial^2 x} + \frac{\partial^2 f}{\partial y^2}$$

$$\frac{\partial^2 f}{\partial x^2} = f(x+1, y) + f(x-1, y) - 2f(x, y)$$

$$\frac{\partial^2 f}{\partial y^2} = f(x, y+1) + f(x, y-1) - 2f(x, y)$$

$$\nabla^2 f(x, y) = f(x+1, y) + f(x-1, y) + f(x, y+1), f(x, y-1) - 4f(x, y)$$

LoG (Laplacian of Gaussian) operator :-

$$\nabla^2 G(x, y) = \frac{\partial^2 G(x, y)}{\partial x^2} + \frac{\partial^2 G(x, y)}{\partial y^2}$$

$$= \left(\frac{x^2}{\sigma^4} - \frac{1}{\sigma^2}\right) e^{-\left(\frac{x^2+y^2}{2\sigma^2}\right)} + \left(\frac{y^2}{\sigma^4} - \frac{1}{\sigma^2}\right) e^{-\left(\frac{x^2+y^2}{2\sigma^2}\right)}$$

$$= \left(\frac{x^2 + y^2 - 2\sigma^2}{\sigma^4}\right) e^{-\left(\frac{x^2+y^2}{2\sigma^2}\right)}$$