Model Matematika Transformasi Koordinat …

- Model Matematika

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} + \begin{bmatrix} v_X \\ v_Y \\ v_Z \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & -z & y & x \\ 0 & 1 & 0 & z & 0 & -x & y \\ 0 & 0 & 1 & -y & x & 0 & z \end{bmatrix} \begin{bmatrix} t_x \\ t_y \\ t_z \\ \varepsilon_x \\ \varepsilon_y \\ \varepsilon_z \\ ds \end{bmatrix} + \begin{bmatrix} x \\ y \\ z \end{bmatrix} + \begin{bmatrix} v_x \\ v_y \\ v_z \end{bmatrix}$$

Memperhatikan tingkat ketelitian koordinat titik sekutu pada sistem (*x,y,z*) & (X,Y,Z)

- Linearisasi Model Matematika & Perataan Kombinasi

$$\alpha = 1 + ds^o$$

$$\underbrace{\begin{bmatrix} \alpha & \varepsilon_z^o & -\varepsilon_y^o & -1 & 0 & 0 \\ -\varepsilon_z^o & \alpha & \varepsilon_z^o & 0 & -1 & 0 \\ \varepsilon_y^o & -\varepsilon_z^o & \alpha & 0 & 0 & -1 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} v_x \\ v_y \\ v_z \\ v_X \\ v_Y \\ v_Z \end{bmatrix}}_{v} + \underbrace{\begin{bmatrix} 1 & 0 & 0 & 0 & -z & y & x \\ 0 & 1 & 0 & z & 0 & -x & y \\ 0 & 0 & 1 & -y & x & 0 & z \end{bmatrix}}_{B} \underbrace{\begin{bmatrix} t_x \\ t_y \\ t_z \\ \varepsilon_x \\ \varepsilon_y \\ \varepsilon_z \\ ds \end{bmatrix}}_{x} = \underbrace{\begin{bmatrix} F_x^o \\ F_y^o \\ F_z^o \end{bmatrix}}_{F}$$

$$A \quad v \quad + \quad B \quad x \quad = F$$

Bentuk Matrik untuk Kasus 2 Titik Sekutu …

- Matrix A & B

$$A = \begin{vmatrix} \alpha_1 & \varepsilon^o_{z1} & -\varepsilon^o_{y1} & -1 & 0 & 0 & & & & & & \\ -\varepsilon^o_{z1} & \alpha_1 & \varepsilon^o_{z1} & 0 & -1 & 0 & & & 0 & & & \\ \varepsilon^o_{y1} & -\varepsilon^o_{z1} & \alpha_1 & 0 & 0 & -1 & & & & & & \\ & & & & & & \alpha_2 & \varepsilon^o_{z2} & -\varepsilon^o_{y2} & -1 & 0 & 0 \\ & & 0 & & & & -\varepsilon^o_{z2} & \alpha_1 & \varepsilon^o_{z1} & 0 & -1 & 0 \\ & & & & & & \varepsilon^o_{y2} & -\varepsilon^o_{z2} & \alpha_2 & 0 & 0 & -1 \end{vmatrix}$$

$$B = \begin{vmatrix} 1 & 0 & 0 & 0 & -z_1 & y_1 & x_1 \\ 0 & 1 & 0 & z_1 & 0 & -x_1 & y_1 \\ 0 & 0 & 1 & -y_1 & x_1 & 0 & z_1 \\ 1 & 0 & 0 & 0 & -z_2 & y_2 & x_2 \\ 0 & 1 & 0 & z_2 & 0 & -x_2 & y_2 \\ 0 & 0 & 1 & -y_2 & x_2 & 0 & z_2 \end{vmatrix}$$

Bentuk Matrik untuk Kasus 2 Titik Sekutu …

- Matrix v & Q

$$v^T = \begin{bmatrix} v_{x1} & v_{y1} & v_{z1} & v_{X1} & v_{Y1} & v_{Z1} & v_{x2} & v_{y2} & v_{z2} & v_{X2} & v_{Y2} & v_{Z2} \end{bmatrix}$$

$$Q = \begin{bmatrix} \underline{Q_1} & 0 \\ 0 & \underline{Q_2} \end{bmatrix}$$

$$Q_k = \begin{bmatrix} \sigma_{xk}^2 & & & & & \\ & \sigma_{yk}^2 & & & & \\ & & \sigma_{zk}^2 & & & \\ & & & \sigma_{Xk}^2 & & \\ & & & & \sigma_{Yk}^2 & \\ & & & & & \sigma_{Zk}^2 \end{bmatrix}$$

Solusi Perataan Kombinasi …

1. Matrix *x*

$$W_e = \left(AQA^T\right)^{-1}$$

$$N = \left(B^T W_e B\right)$$

$$x = N^{-1}\left(B^T W_e F\right)$$

2. Matrix *v*

$$v = QA^T W_e \left(F - Bx\right)$$

3. Variansi a posteriori

$$\bar{\sigma}^2 = \frac{v^T W v}{r}$$

$$W = Q^{-1}$$

r = degree of freedom

4. Ketelitian matrik *x*

$$\sum_{xx} = \bar{\sigma}^2 \left(B^T W_e B\right)^{-1}$$

5. Kofaktor residual

$$Q_{vv} = QA^T W_e \left(I - BN^{-1} B^T W_e\right) AQ$$

Tes Outlier Titik Sekutu …

1. Nilai kritis Tau

$$\tau_{\alpha/2} = \frac{\left(t_{\alpha/2,r}\right)\sqrt{r}}{\sqrt{r-1+\left(t_{\alpha/2,r}\right)^2}}$$

$t_{\alpha/2,dof} =$ t-student value

$\alpha =$ significant level (1 – confidence level)

2. Loop sebanyak *m* (isi matrik *v*)

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for i = 1, m
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$$\bar{v}(i) = \frac{v(i)}{Q_{vv}(i,i)}$$

if $\frac{|\bar{v}(i)|}{\bar{\sigma}} > \tau_{\alpha/2}$ then $l(i)$ is outlier

end