Previously we had the covariance of the observation Q_z and the covariance of the landmark, Σ_k. We computed H_{tk} and with those terms we computed the covariance of the expected measurement, Q_{tk}

$$Q_{tk} = H_{tk} \Sigma_k H_{tk}^T + Q_z$$

Now, we have only the covariance of the observation Q_z. We compute H_{tk}^{-1} and then:

$$\Sigma_k = H_{tk}^{-1} Q_z \left(H_{tk}^{-1}\right)^T$$

That's the only term we have in this situation.

Exercises of adding new landmarks

$z_t^{(1)} = \begin{bmatrix} \check{D}_t \\ \check{\Phi}_t \end{bmatrix} = \begin{bmatrix} 1000 \\ 0° \end{bmatrix} \xrightarrow{h^{-1}(\cdot)}$ Add a new landmark at $(1000, 0)$

$$\Sigma_1 = \begin{bmatrix} 200^2 & 0 \\ 0 & 261.8^2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 200^2 & 0 \\ 0 & 261.8^2 \end{bmatrix} \left(V_{\parallel}\, V_{\perp}\right)^T$$

($V_{\parallel}$, $V_{\perp}$, $\lambda_{\parallel}$, $\lambda_{\perp}$)

$\alpha_{\parallel} = \text{atan}\left(\frac{V_{\parallel y}}{V_{\parallel x}}\right) = \text{atan}\left(\frac{0}{1}\right) = 0° \rightarrow \lambda_{\parallel} = 200$

$\alpha_{\perp} = \text{atan}\left(\frac{V_{\perp y}}{V_{\perp x}}\right) = \text{atan}\left(\frac{1}{0}\right) = 90° \rightarrow \lambda_{\perp} = 261.8$

$z_t^{(2)} = \begin{bmatrix} \check{D}_t \\ \check{\Phi}_t \end{bmatrix} = \begin{bmatrix} 2000 \\ 0 \end{bmatrix} \xrightarrow{h^{-1}(\cdot)}$ Add a new landmark at $(2000, 0)$

$$\Sigma_2 = \begin{bmatrix} 200^2 & 0 \\ 0 & 523.6^2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 200^2 & 0 \\ 0 & 523.6^2 \end{bmatrix} \left(V_{\parallel}\, V_{\perp}\right)^T$$

($V_{\parallel}$, $V_{\perp}$, $\lambda_{\parallel}$, $\lambda_{\perp}$)

$\alpha_{\parallel} = \text{atan}\left(\frac{V_{\parallel y}}{V_{\parallel x}}\right) = \text{atan}\left(\frac{0}{1}\right) = 0° \rightarrow \lambda_{\parallel} = 200$

$\alpha_{\perp} = \text{atan}\left(\frac{V_{\perp y}}{V_{\perp x}}\right) = \text{atan}\left(\frac{1}{0}\right) = 90° \rightarrow \lambda_{\perp} = 523.6$

$z_t = \begin{bmatrix} \check{D}_t \\ \check{\Phi}_t \end{bmatrix} = \begin{bmatrix} 2000 \\ 45° \end{bmatrix} \xrightarrow{h^{-1}(\cdot)}$ Add a new landmark at $(1000\sqrt{2}, 1000\sqrt{2})$ $\quad 707.107 \quad 707.107$

$$\Sigma_3 = \begin{bmatrix} 54269.46 & -14269.46 \\ -14269.46 & 54269.46 \end{bmatrix} = \begin{bmatrix} 0.707 & 0.707 \\ 0.707 & -0.707 \end{bmatrix} \begin{bmatrix} (200)^2 & 0 \\ 0 & (261.8)^2 \end{bmatrix} \left(V_{\parallel}\, V_{\perp}\right)^T$$

($V_{\parallel}$, $V_{\perp}$)

$\alpha_{\parallel} = \text{atan}\left(\frac{0.707}{0.707}\right) = 45° \rightarrow \lambda_{\parallel} = 200$

$\alpha_{\perp} = \text{atan}\left(\frac{V_{\perp y}}{V_{\perp x}}\right) = \text{atan}\left(\frac{-0.707}{0.707}\right) = -45° \rightarrow \lambda_{\perp} = 261.8$