$$\mathbf{x}_k = \boldsymbol{\phi}_{k-1}(\mathbf{x}_{k-1}, \mathbf{u}_{k-1}) + \mathbf{w}_{k-1}, \quad \mathbf{w}_k \sim \mathcal{N}(0, \mathbf{Q}_k)\,, \tag{3.27}$$

$$\mathbf{z}_k = \mathbf{h}_k(\mathbf{x}_k) + \mathbf{v}_k, \quad \mathbf{v}_k \sim \mathcal{N}(0, \mathbf{R}_k)\,. \tag{3.28}$$

$$\boldsymbol{\phi}_k(\mathbf{x}_0 + d\mathbf{x}, \mathbf{u}) \approx \boldsymbol{\phi}_k(\mathbf{x}_0, \mathbf{u}) + d\mathbf{x}\, \left.\frac{\partial \boldsymbol{\phi}_k(\mathbf{x}, \mathbf{u})}{\partial \mathbf{x}}\right|_{\mathbf{x}=\mathbf{x}_0}\,, \tag{3.29}$$

$$\mathbf{h}_k(\mathbf{x}_0 + d\mathbf{x}) \approx \mathbf{h}_k(\mathbf{x}_0) + d\mathbf{x}\, \left.\frac{\partial \mathbf{h}_k(\mathbf{x})}{\partial \mathbf{x}}\right|_{\mathbf{x}=\mathbf{x}_0}\,, \tag{3.30}$$

$$\boldsymbol{\Phi}_{k-1}^{[1]} = \left.\frac{\partial \boldsymbol{\phi}_{k-1}(\mathbf{x}, \mathbf{u})}{\partial \mathbf{x}}\right|_{\mathbf{x}=\hat{\mathbf{x}}_{k-1}, \mathbf{u}=\mathbf{u}_{k-1}}\,, \tag{3.31}$$

$$\mathbf{H}_k^{[1]} = \left.\frac{\partial \mathbf{h}_k(\mathbf{x})}{\partial \mathbf{x}}\right|_{\mathbf{x}=\hat{\mathbf{x}}_k}\,. \tag{3.32}$$

$$\hat{\mathbf{x}}_k^- = \boldsymbol{\phi}_{k-1}(\mathbf{x}_{k-1}, \mathbf{u}_{k-1})\,, \tag{3.33}$$

$$\hat{\mathbf{z}}_k = \mathbf{h}_k(\hat{\mathbf{x}}_k^-)\,. \tag{3.34}$$

$$\hat{\mathbf{x}}_k = \hat{\mathbf{x}}_k^- + \mathbf{K}_k[\mathbf{z}_k - \hat{\mathbf{z}}_k]\,. \tag{3.35}$$

$$\mathbf{P}_k^- = \boldsymbol{\Phi}_{k-1}^{[1]} \mathbf{P}_{k-1} \boldsymbol{\Phi}_{k-1}^{[1]T} + \mathbf{Q}_{k-1}\,, \tag{3.36}$$

$$\mathbf{K}_k = \mathbf{P}_k^- \mathbf{H}_k^{[1]T} [\mathbf{H}_k^{[1]} \mathbf{P}_k^- \mathbf{H}_k^{[1]T} + \mathbf{R}_k]^{-1}\,, \tag{3.37}$$

$$\mathbf{P}_k = [\mathbf{I}_n - \mathbf{K}_k \mathbf{H}_k^{[1]}] \mathbf{P}_k^-\,. \tag{3.38}$$