Note

$$\hat{p}^{k+1} - \hat{p}^{k} = T_s \Lambda^{-1}\big(-(\hat{H}_{\mathcal{C}} - \hat{H}_{\mathcal{T}} \bar{H}_{\mathcal{T}}^{-1} \bar{H}_{\mathcal{C}}) q_{\mathcal{C}}(u^k) - \hat{H}_{\mathcal{T}} \bar{H}_{\mathcal{T}}^{-1} K \bar{d}_{\mathcal{K}}^{k} + \hat{H}_{\mathcal{T}} \bar{H}_{\mathcal{T}}^{-1} D v_{\mathcal{D}} \sigma^{k}\big)$$

$$f_{\mathcal{C}}(q_{\mathcal{C}}^{k}) - A_1(\hat{p}^{k} + \hat{h}) + A_2^T f_{\mathcal{T}}(A_2 q_{\mathcal{C}}^{k} + A_3 K \bar{d}_{\mathcal{K}}^{k} - A_3 D v_{\mathcal{D}} \sigma^{k}) = 0 \tag{1}$$

where

$$A_1 = \hat{H}_{\mathcal{C}}^T - \bar{H}_{\mathcal{C}}^T \bar{H}_{\mathcal{T}}^{-T} \hat{H}_{\mathcal{T}}^T,$$

$$A_2 = -\bar{H}_{\mathcal{T}}^{-1} \bar{H}_{\mathcal{C}},$$

$$A_3 = \bar{H}_{\mathcal{T}}^{-1}.$$

$$\bar{p}_{\mathcal{K}}^{k} = K^T \bar{H}_{\mathcal{T}}^{-T} f_{\mathcal{T}}(A_2 q_{\mathcal{C}}(u^k) + A_3 K \bar{d}_{\mathcal{K}}^{k} - A_3 D v_{\mathcal{D}} \sigma^{k}) - K^T \bar{H}_{\mathcal{T}}^{-T} \hat{H}_{\mathcal{T}}^T (\hat{p}^{k} + \hat{h}) - K^T \bar{h} \tag{2}$$

$$q_{\mathcal{C}}^{k} = q_{\mathcal{C}}\big((\hat{p}^{k} + \hat{h}), \bar{d}_{\mathcal{K}}^{k}, \sigma^{k}\big) = q_{\mathcal{C}}(u^k) \tag{3}$$