



$$\mathbf{P}(0) = \mathbf{P}_0 = \mathbf{P}_0^\top > 0, \mathbf{P}_0 = \rho \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \boldsymbol{\phi} = [u(k) \quad u(k-1) \quad y(k-1)]^\top,$$

$$\boldsymbol{\theta} = [\theta_1 \quad \theta_2 \quad \theta_3]^\top, \hat{\boldsymbol{\theta}} = [\hat{\theta}_1 \quad \hat{\theta}_2 \quad \hat{\theta}_3]^\top,$$

$$\hat{\alpha}_1(k) = \hat{\theta}_1(k), \hat{\alpha}_2(k) = \hat{\alpha}_3(k) \left[\frac{\hat{\theta}_2(k) + \hat{\theta}_1(k)\hat{\theta}_3(k)}{1 - \hat{\theta}_3(k)} + \hat{\theta}_1(k) \right], \hat{\alpha}_3(k) = -\frac{\ln(\hat{\theta}_{3*}(k))}{T_s},$$

$$\hat{\theta}_{3*}(k) = \begin{cases} \hat{\theta}_3(k) & \text{if } \hat{\theta}_3(k) > 0.01 \\ 0.01 & \text{if } \hat{\theta}_{3*}(k) \leq 0.01 \end{cases} \text{ and } T_S \text{ is sampling time.}$$