$$\boldsymbol{x}_i = \begin{pmatrix} X_{\mathrm{e}} \\ Y_{\mathrm{e}} \\ \theta_{\mathrm{e}} \end{pmatrix}^T \tag{1}$$

$$\ell_i = \sqrt{\left(X_{\mathrm{e}} - X_i + a_i\, C - b_i\, S\right)^2 + \left(Y_{\mathrm{e}} - Y_i + b_i\, C + a_i\, S\right)^2} \tag{2}$$

$$\dot{\ell}_i = \frac{\ell_i}{\boldsymbol{x}_{\mathrm{e}}} \dot{\boldsymbol{x}}_{\mathrm{e}} = \boldsymbol{J}_i \dot{\boldsymbol{x}}_{\mathrm{e}} \tag{3}$$

$$\boldsymbol{J}_i = \begin{pmatrix} \frac{2\, X_{\mathrm{e}} - 2\, X_i + 2\, a_i\, C - 2\, b_i\, S}{2\, \sqrt{(X_{\mathrm{e}} - X_i + a_i\, C - b_i\, S)^2 + (Y_{\mathrm{e}} - Y_i + b_i\, C + a_i\, S)^2}} \\ \frac{2\, Y_{\mathrm{e}} - 2\, Y_i + 2\, b_i\, C + 2\, a_i\, S}{2\, \sqrt{(X_{\mathrm{e}} - X_i + a_i\, C - b_i\, S)^2 + (Y_{\mathrm{e}} - Y_i + b_i\, C + a_i\, S)^2}} \\ -\frac{2\, (b_i\, C + a_i\, S)\, (X_{\mathrm{e}} - X_i + a_i\, C - b_i\, S) - 2\, (a_i\, C - b_i\, S)\, (Y_{\mathrm{e}} - Y_i + b_i\, C + a_i\, S)}{2\, \sqrt{(X_{\mathrm{e}} - X_i + a_i\, C - b_i\, S)^2 + (Y_{\mathrm{e}} - Y_i + b_i\, C + a_i\, S)^2}} \end{pmatrix}^T \tag{4}$$