$$oldsymbol{x}_{k+1} = oldsymbol{a}(oldsymbol{x}_k, oldsymbol{w}_k) = oldsymbol{q}_k \otimes oldsymbol{q}_{ riangle} + \left[\cos\left(rac{\|oldsymbol{w}\|}{2}
ight), oldsymbol{w}^T \sin\left(rac{\|oldsymbol{w}\|}{2}
ight)
ight]^T$$

$$A = \frac{\partial \boldsymbol{a}}{\partial \boldsymbol{x}} = \begin{bmatrix} q_{\triangle w} & -q_{\triangle x} & -q_{\triangle y} & -q_{\triangle z} \\ q_{\triangle x} & q_{\triangle w} & q_{\triangle z} & -q_{\triangle y} \\ q_{\triangle y} & -q_{\triangle z} & q_{\triangle w} & q_{\triangle x} \\ q_{\triangle z} & q_{\triangle y} & -q_{\triangle x} & q_{\triangle w} \end{bmatrix}$$

$$Q = \frac{\partial \boldsymbol{a}}{\partial \boldsymbol{w}} = \begin{bmatrix} \frac{-w_1 \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} & \frac{-w_2 \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} & \frac{-w_3 \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} \\ \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right) + \frac{w_2^2 \cos\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} & \frac{w_2 w_1 \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} & \frac{w_3 w_1 \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} \\ \frac{w_1 w_2 \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} & \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right) + \frac{w_2^2 \cos\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} & \frac{w_3 w_2 \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} \\ \frac{w_1 w_3 \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} & \frac{w_2 w_3 \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} & \sin\left(\frac{\|\boldsymbol{w}\|}{2}\right) + \frac{w_3^2 \cos\left(\frac{\|\boldsymbol{w}\|}{2}\right)}{2\|\boldsymbol{w}\|} \end{bmatrix}$$

$$oldsymbol{z}_k = oldsymbol{h}(oldsymbol{x}_k, oldsymbol{v}_k) = oldsymbol{q}_k^{-1} \otimes egin{bmatrix} 0 \ 0 \ 0 \ -g \end{bmatrix} \otimes oldsymbol{q}_k + oldsymbol{v}_k$$

$$H = \frac{\partial \mathbf{h}}{\partial \mathbf{v}} = 2g \begin{bmatrix} q_3 & -q_4 & q_1 & -q_2 \\ -q_2 & -q_1 & q_4 & -q_3 \\ q_1 & q_2 & q_3 & -q_4 \end{bmatrix}$$

$$R = \frac{\partial \boldsymbol{h}}{\partial \boldsymbol{v}} = \boldsymbol{I}$$