$$\vec{q}(t) = \begin{bmatrix} v_x(t) & (1) \\ v_y(t) & (2) \\ v_z(t) & (3) \\ x(t) & (4) \\ y(t) & (5) \\ z(t) & (6) \\ \omega_x(t) & (7) \\ \omega_y(t) & (8) \\ \omega_z(t) & (9) \\ \vec{\vec{R}}_1(t) & (10) \\ \vec{\vec{R}}_2(t) & (11) \\ \vec{\vec{R}}_3(t) & (12) \\ \vec{\vec{R}}_4(t) & (13) \\ m(t) & (14) \end{bmatrix}, \vec{q}(0) = \begin{bmatrix} v_x(0) \\ v_y(0) \\ v_z(0) \\ x(0) \\ y(0) \\ z(0) \\ \omega_x(0) \\ \omega_y(0) \\ \omega_z(0) \\ \vec{\vec{R}}_1(0) \\ \vec{\vec{R}}_2(0) \\ \vec{\vec{R}}_3(0) \\ \vec{\vec{R}}_4(0) \\ m(0) \end{bmatrix}, \vec{g}(t) = \begin{bmatrix} \frac{v_x(t)}{dt} \\ \frac{v_y(t)}{dt} \\ \frac{v_z(t)}{dt} \\ \frac{x(t)}{dt} \\ \frac{y(t)}{dt} \\ \frac{z(t)}{dt} \\ \frac{\omega_x(t)}{dt} \\ \frac{\omega_y(t)}{dt} \\ \frac{\omega_z(t)}{dt} \\ \frac{\vec{\vec{R}}_1(t)}{dt} \\ \frac{\vec{\vec{R}}_2(t)}{dt} \\ \frac{\vec{\vec{R}}_3(t)}{dt} \\ \frac{\vec{\vec{R}}_4(t)}{dt} \\ \frac{m(t)}{dt} \end{bmatrix} = \begin{bmatrix} a_x \\ a_y \\ a_x \\ v_x \\ v_y \\ v_z \\ \alpha_x \\ \alpha_y \\ \alpha_z \\ \frac{\vec{\vec{R}}(t)\vec{\omega}(t)}{2}_1 \\ \frac{\vec{\vec{R}}(t)\vec{\omega}(t)}{2}_2 \\ \frac{\vec{\vec{R}}(t)\vec{\omega}(t)}{2}_3 \\ \frac{\vec{\vec{R}}(t)\vec{\omega}(t)}{2}_4 \\ -\mu \end{bmatrix} = \begin{bmatrix} a_x \\ a_y \\ a_x \\ q_1 \\ q_2 \\ q_3 \\ \alpha_x \\ \alpha_y \\ \alpha_z \\ \frac{-q_{11}q_7 - q_{12}q_8 - q_{13}q_9}{2} \\ \frac{q_{10}q_7 + q_{12}q_9 - q_{13}q_8}{2} \\ \frac{q_{10}q_8 + q_{13}q_7 - q_{11}q_9}{2} \\ \frac{q_{10}q_9 + q_{11}q_8 - q_{12}q_7}{2} \\ -\mu \end{bmatrix} \tag{1}$$

Acceleration:

$$\begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix} = \begin{bmatrix} \frac{F_x}{m} \\ \frac{F_y}{m} \\ \frac{F_z}{m} \end{bmatrix} \tag{2}$$

Acceleration angulaire:

$$\begin{bmatrix} \alpha_x \\ \alpha_y \\ \alpha_z \end{bmatrix} = \begin{bmatrix} (\boldsymbol{I}^{-1}[\vec{\tau} - (\tilde{\boldsymbol{\omega}}\boldsymbol{I}\vec{\omega})])_x \\ (\boldsymbol{I}^{-1}[\vec{\tau} - (\tilde{\boldsymbol{\omega}}\boldsymbol{I}\vec{\omega})])_y \\ (\boldsymbol{I}^{-1}[\vec{\tau} - (\tilde{\boldsymbol{\omega}}\boldsymbol{I}\vec{\omega})])_z \end{bmatrix} \tag{3}$$