Useful Equations

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$$X = \frac{\cos\delta\sin(\alpha - \alpha_0)}{\cos\delta_0\cos\delta\cos(\alpha - \alpha_0) + \sin\delta\sin\delta_0}, \tag{1}$$

$$Y = -\frac{\sin\delta_0\cos\delta\cos(\alpha - \alpha_0) - \cos\delta_0\sin\delta}{\cos\delta_0\cos\delta\cos(\alpha - \alpha_0) + \sin\delta\sin\delta_0}, \tag{2}$$

$$x = f\left(\frac{X}{p}\right) + x_0, \tag{3}$$

$$x = \frac{f}{p}\left(X\cos\theta - Y\sin\theta\right) + x_0, \tag{4}$$

$$y = \frac{f}{p}\left(X\cos\theta - Y\sin\theta\right) + y_0. \tag{5}$$

$$az = \arctan\left(\frac{\vec{r'}_{2,1}}{\vec{r'}_{1,1}}\right),$$
$$alt = \arcsin\left(\vec{r'}_{3,1}\right). \tag{6}$$

$$\mathbf{x} = \mathbf{TX}, \tag{7}$$

$$\mathbf{T} = \begin{pmatrix} (f/p)a_{11} & (f/p)a_{12} & x_0 \\ (f/p)a_{21} & (f/p)a_{22} & y_0 \\ 0 & 0 & 1 \end{pmatrix}. \tag{8}$$

$$\mathbf{a} = \mathbf{Bc}, \tag{9}$$

$$\mathbf{a} = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_N \end{pmatrix}, \mathbf{B} = \begin{pmatrix} (f/p)X_1 & (f/p)Y_1 & 1 \\ (f/p)X_2 & (f/p)Y_2 & 1 \\ \vdots & \vdots & \vdots \\ (f/p)X_N & (f/p)Y_N & 1 \end{pmatrix}, and\ \mathbf{c} = \begin{pmatrix} a_{11} \\ a_{12} \\ x_0 \end{pmatrix} \tag{10}$$

$$\mathbf{X} = \mathbf{T}^{-1}\mathbf{x}. \tag{11}$$

$$\mathbf{r} = \mathbf{R} + \rho\mathbf{s}, \tag{12}$$

$$\rho = k^2\left(\frac{1}{R^3} - \frac{1}{r^3}\right)\frac{\dot{\mathbf{s}}\cdot(\mathbf{R}\times\mathbf{s})}{\dot{\mathbf{s}}\cdot(\ddot{\mathbf{s}}\times\mathbf{s})}, \tag{13}$$

$$r^2 = \rho^2 + R^2 + 2\rho\mathbf{R}\cdot\mathbf{s}, \tag{14}$$

$$s = \begin{pmatrix} \cos\alpha\cos\delta \\ \sin\alpha\cos\delta \\ \sin\delta \end{pmatrix}, \tag{15}$$

$$\dot{\mathbf{s}}_2 = \frac{\tau_3(\mathbf{s}_2 - \mathbf{s}_1)}{\tau_1(\tau_1 + \tau_3)} + \frac{\tau_1(\mathbf{s}_3 - \mathbf{s}_2)}{\tau_3(\tau_1 + \tau_3)},$$

$$\ddot{\mathbf{s}}_2 = \frac{2(\mathbf{s}_3 - \mathbf{s}_2)}{\tau_3(\tau_1 + \tau_3)} - \frac{2(\mathbf{s}_2 - \mathbf{s}_1)}{\tau_1(\tau_1 + \tau_3)}. \tag{16}$$

$$\text{T} = \begin{pmatrix} 0.9685 & 0.0235 & 507.6056 \\ -0.0023 & 1.0123 & 517.7182 \\ 0 & 0 & 1 \end{pmatrix} \text{ for day 17,}$$

$$\text{and T} = \begin{pmatrix} 0.9928 & 0.0394 & 504.6182 \\ 0.0193 & 0.9959 & 491.0023 \\ 0 & 0 & 1 \end{pmatrix} \text{ for day 21.} \tag{17}$$