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Homework #

Control

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這是一個模板供使用。

I'm writing to demonstrate use of automatically-generated footnote markers[1] and footnotes which use a marker value provided to the command [42].

Now, I will use another automatically-generated footnote marker [2].

1 Equation Example

In this paper, the 3–2–1 intrinsic convention is considered. The direction cosine matrix (DCM), ${}^{\mathcal{G}}\mathbf{C}^{\mathcal{B}}(\phi,\theta,\psi)$, is constructed in terms of the Euler angles as follows:

$$
{}^{\mathcal{G}}\mathbf{C}^{\mathcal{B}}(\phi,\theta,\psi) = \mathbf{R}_z(\psi)\mathbf{R}_y(\theta)\mathbf{R}_x(\phi) \tag{1}
$$

where

$$
\begin{aligned}
\mathbf{R}_x(\phi) &= \begin{bmatrix} 1 & 0 & 0 \\ 0 & c_\phi & -s_\phi \\ 0 & s_\phi & c_\phi \end{bmatrix}, \quad \mathbf{R}_y(\theta) = \begin{bmatrix} c_\theta & 0 & s_\theta \\ 0 & 1 & 0 \\ -s_\theta & 0 & c_\theta \end{bmatrix}, \\
\mathbf{R}_z(\psi) &= \begin{bmatrix} c_\psi & -s_\psi & 0 \\ s_\psi & c_\psi & 0 \\ 0 & 0 & 1 \end{bmatrix}
\end{aligned} \tag{2}
$$

are the rotation matrices and the notations $s_{(\cdot)}$ and $c_{(\cdot)}$ represent $\sin(\cdot)$ and $\cos(\cdot)$, respectively.

$$
\begin{aligned}
\dot{\mathbf{e}}_{1,\Theta} &= \mathbf{e}_{2,\Theta} \\
\dot{\mathbf{e}}_{2,\Theta} &= -\mathbf{T}^{-1}\mathbf{J}^{-1}\mathbf{J}_0\mathbf{T}\Big(\mathbf{K}_{p,\Theta}\mathbf{e}_{1,\Theta} + \mathbf{K}_{i,\Theta}\int_0^t \mathbf{e}_{1,\Theta}\, d\tau \\
&\quad + \mathbf{K}_{d,\Theta}\mathbf{e}_{2,\Theta}\Big) + [\mathbf{JT}]^{-1}\mathbf{d}_\Theta \\
&\quad + \left([\mathbf{JT}]^{-1}\mathbf{J}_0\mathbf{T} - \mathbf{I}_3\right)\ddot{\mathbf{x}}_{1d,\Theta} \\
&\quad - [\mathbf{JT}]^{-1}\left([\mathbf{T}\mathbf{x}_{2,\Theta}]^\times \Delta\mathbf{J}\mathbf{T}\mathbf{x}_{2,\Theta} - \Delta\mathbf{J}\dot{\mathbf{T}}\mathbf{x}_{2,\Theta}\right)
\end{aligned} \tag{3}
$$

2 Figure Example

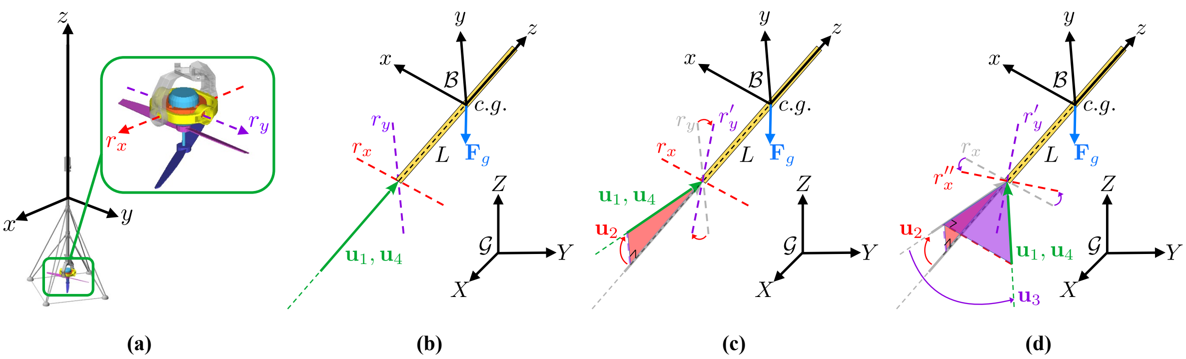

Figure. 1. Illustration of the rocket-type UAV force analysis.

[1] Automatically generated footnote markers work fine!

[42] ...is that the answer to everything?

[2] Now, footnote markers are 1, 42, but then back to 2? That will be confusing if the automatically-generated number also reaches 42!

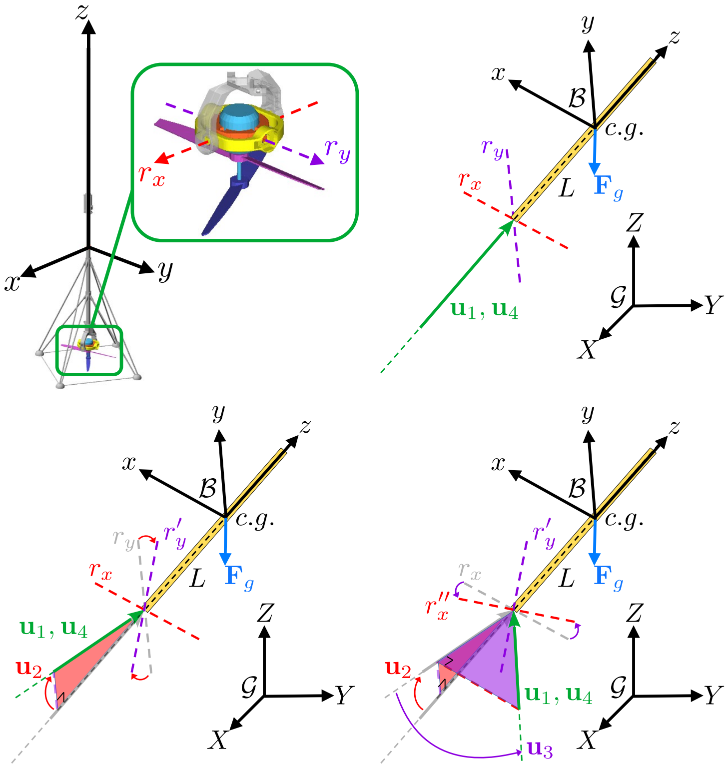

Figure. 2. Illustration of the rocket-type UAV force analysis.

3 Table Example

Table. 1. Simulated system parameters

m (kg)	g (m/s^2)	$\mathbf{J}$ (kg-m^2)	L (m)	C_d
0.65	9.8	$\begin{bmatrix} 0.1287 & 0 & 0 \\ 0 & 0.1287 & 0 \\ 0 & 0 & 0.052 \end{bmatrix}$	0.45	0.05

Table. 2. Levenberg-Marquardt Method pseudo code.

Algorithm 1 Levenberg-Marquardt Method

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given an initial value $\mathbf{u}^{(0)}$, $\lambda^{(0)} = 1000$, $\epsilon = 10^{-5}$.

repeat

1. Determine a Jacobian matrix $\mathbf{J}_{\mathbf{r}}^{(k)}$.
2. Update the damping parameter $\lambda^{(k)}$.
3. Update the LM step.
   $\mathbf{d}^{(k)} = -\left(\mathbf{J}_{\mathbf{r}}^{(k)T}\mathbf{J}_{\mathbf{r}}^{(k)} + \lambda^{(k)}\mathbf{I}_4\right)^{-1}\mathbf{J}_{\mathbf{r}}^{(k)T}\mathbf{r}(\mathbf{u}^{(k)})$.
4. Update the control variables.
   $\mathbf{u}^{(k+1)} = \mathbf{u}^{(k)} + \mathbf{d}^{(k)}$.
   $k \leftarrow k + 1$.
5. Compute the residual error vector to evaluate the stopping condition.
   $\mathbf{r}(\mathbf{u}^{(k+1)}) = [r_1, r_2, r_3, r_4]^T$

until $\|\mathbf{r}\| < \epsilon$ is satisfied, $\mathbf{u}^* = \mathbf{u}^{(k+1)}$.
