Book Corrections for
Fundamentals of Spacecraft Attitude Determination and Control

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This document provides corrections for the book: Markley, F.L., and Crassidis, J.L., *Fundamentals of Spacecraft Attitude Determination and Control*, Springer, New York, NY, 2014. Any other corrections are welcome via email to the authors.

Chapter 1

- On page 2 there should be a closed parenthesis after "1630" in Table 1.1.

Chapter 2

- On the sixth line of page 17 "conceptionally" should be "conceptually."
- On page 23, the sentence below Eq. (2.28) should read "In particular, if we have a scalar $f(\mathbf{x})$ in place of the vector function $\mathbf{y}(\mathbf{x})$, this reduces to the $1\times n$ row vector..." Also, the next sentence should read "The transpose of this, an $n \times 1$ column vector..."

Chapter 3

- In the first paragraph of page 67 the translational momentum should be defined as $\mathbf{p} \equiv m\mathbf{v}$ not $\mathbf{p} \equiv m\dot{\mathbf{v}}$.
- In the second paragraph on page 89 (fourth line), the word "away" should read "a way."
- The inertia matrix in Exercise 3.6 on page 119 does not satisfy the triangle inequality. We recommend using the following inertia matrix:

$$J_B^c = \begin{bmatrix} 100 & 0 & 0 \\ 0 & 75 & 0 \\ 0 & 0 & 50 \end{bmatrix} \text{ kg-m}^2$$

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Chapter 4

- On page 129, above Eq. (4.9) “finding N stars” should be changed to “finding exactly N stars.” Also, below Eq. (4.9) and in the next paragraph “finding 4 stars” should be changed to “finding 4 or more stars” (3 places). Finally, below Eq. (4.9) and in the next paragraph “finding 5 stars” should be changed to “finding 5 or more stars” (3 places).

- On page 159 the label “newpoly.eps” should be removed from Figure 4.10.

- On page 176 the subscript “min” in Eq. (4.127) should be text, not italic.

Chapter 5

- On page 200 the reference to Eq. (5.3) in the second line of the second (new) paragraph should be to Eq. (5.6).

- The matrix A^{true} in Problem 5.3 on page 225 should read

$$A^{\text{true}} = \begin{bmatrix} 0.352 & 0.864 & 0.360 \\ -0.864 & 0.152 & 0.480 \\ 0.360 & -0.480 & 0.800 \end{bmatrix}$$

  That is, the (2,3) element is changed from 0.460 to 0.480 to ensure that A is orthogonal.

Chapter 6

- On page 243 in the last sentence of the paragraph below Eq. (6.25), $\boldsymbol{\delta\vartheta}_k^-$ and $\Delta\boldsymbol{\xi}^-$ should be $\boldsymbol{\delta}\hat{\boldsymbol{\vartheta}}$ and $\Delta\hat{\boldsymbol{\xi}}$.

- An asterisk is used in Eqs. (6.27) and (6.28) for the unnormalized reset quaternion. This notation also appears in Tables 6.1 and 6.3. The asterisk in these specific equations and tables does not denote the conjugate quaternion, which is used elsewhere throughout the book.

- In Table 6.1 on page 250, $\hat{\mathbf{q}}_k^+ = \mathbf{q}^*/\|\mathbf{q}^*\|$ should be replaced with $\hat{\mathbf{q}}_k^+ = \hat{\mathbf{q}}^*/\|\hat{\mathbf{q}}^*\|$. The same change needs to be made in Table 6.3 on page 257.

- The simulation for Example 6.2 has been changed. The boresight of the star tracker sensor is along the body z-axis. It is assumed that the Earth-pointing spacecraft is in an equatorial 350 km circular orbit, which is equivalent to a 91.5 minute orbital period. The spacecraft’s z-axis is pointed in the nadir direction, the y-axis is pointed in the negative orbit momentum’s vector, and the x-axis is pointed in the orbit velocity direction. The true angular velocity is given by $\boldsymbol{\omega}(t) = [0 \ \ -1.11445 \times 10^{-3} \ \ 0]^T$ rad/sec. First rotate +90 degrees about x-body axis. Then rotate 180 degrees about the new x-body axis, which places the boresight in the anti-nadir direction (i.e. the radial direction). The initial quaternion is then given by $q_0 = \frac{\sqrt{2}}{2}[0 \ \ 1 \ \ 1 \ \ 0]^T$.

- On page 264, just above Eq. (6.102a) the estimate should be defined as $E\{\mathbf{x}|\theta^{\text{out}}\}$. Thus, the sentence should read "Because η_u, η_v, and v_e have zero mean, the conditional expectation $\hat{\mathbf{x}} \equiv E\{\mathbf{x}|\theta^{\text{out}}\}$ and the state error vector $\Delta\mathbf{x} \equiv \mathbf{x} - \hat{\mathbf{x}}$ obey"
- On page 265 three lines from the bottom "Equation (6.107) are" should be "Equations (6.107) are."
- On page 284, the word "convergence" in Ref. 34 is misspelled.

Chapter 7

- On page 300 $\boldsymbol{\omega}_c$ should be given by

$$\boldsymbol{\omega}_c = \begin{bmatrix} \dot{\phi}_c \sin\theta_c \sin\psi_c \\ \dot{\phi}_c \sin\theta_c \cos\psi_c \\ \dot{\psi}_c + \dot{\phi}_c \cos\theta_c \end{bmatrix} \frac{\text{rad}}{\text{sec}}$$

- On page 302 "Substituting Eqs. (7.1b) and (7.3.1) into Eq. (7.33), and after..." should read "Substituting Eqs. (7.1b) and (7.32) into Eq. (7.33), and after..."
- On page 342 the last page of Ref. [30] is 2566 not 2565.
- On page 328 the fourth line of the last paragraph of Section 7.7.3.2 should read "the rotation of the z-axis..."

Appendix A

- On page 346 the sentence above Eq. (A.6) should read "...then from Eq. (A.3b) we have."
- The third sentence on page 358 should read "Equation (A.50a) can be used to prove..."
- The last sentence on page 358 should read "Equation (A.50d) can be used to prove..."

Appendix C

- On page 390, nine lines under the first paragraph of Section C.3.4 "SRP only contributes as times..." should be replaced with "SRP only contributes at times..."
- On page 397 two lines under Eq. (C.129), it should say "greater than 90°," not 95.68°.

Appendix D

- On page 412, the ΔT_c term in Eq. (D.18) should read

$$\Delta T_c = A + Bh_p + Ch_p^2 + Dh_p^3$$

- Also, the B term in Eq. (D.20) should read

$$B = B_{13}y + B_{14}yT + B_{15}yT^2 + B_{16}yT^3 + B_{17}yT^4 + B_{18}yT^5$$

Appendix E

- On the first line of page 459 “Nonlinear Least squares implies that an fairly...” should be replaced with “Nonlinear Least squares implies that a fairly...”
- Equation (E.113) should read

$$\hat{\mathbf{p}} = \frac{\left(1 - \|\mathbf{p}_c\|^2\right)\Delta\mathbf{x} + \left(1 - \|\Delta\mathbf{x}\|^2\right)\mathbf{p}_c - 2\,\Delta\mathbf{x}\times\mathbf{p}_c}{1 + \|\mathbf{p}_c\|^2\|\Delta\mathbf{x}\|^2 - 2\,\Delta\mathbf{x}\cdot\mathbf{p}_c}$$

- On line two of page 465 “This the preferred form...” should be replaced with “This is the preferred form...”
- Equation (E.69) should read

$$s = \left(\frac{d}{dt} + \lambda\right)^{n-1} \Delta x$$

  Also, the sliding surface for $n = 3$ should be $s = \Delta\ddot{x} + 2\,\lambda\,\Delta\dot{x} + \lambda^2\Delta x$. Note that Eq. (E.69) is a notational simplification for the weighted sum average used to generate s, which is discussed in [25].

- On page 446 the wording and subsequent equations should be changed as follows.

  As an example consider the following second-order system:

$$\ddot{x} = f(x,\,\dot{x}) + u$$

  where an assumed model $\bar{f}(x,\,\dot{x})$ will be used to develop the control law. Taking the derivative of s in Eq. (E.65) and substituting $\ddot{x} = f(x,\,\dot{x}) + u$ gives

$$\begin{aligned}\dot{s} &= \ddot{x} - \ddot{x}_c + \lambda\,\Delta\dot{x}\\ &= f(x,\,\dot{x}) + u - \ddot{x}_c + \lambda\,\Delta\dot{x}\end{aligned}$$

  Using the condition $\dot{s} = 0$ from Eq. (E.67) with the assumed model $\bar{f}(x,\,\dot{x})$ leads to the following control law:

$$u_e = -\bar{f}(x,\,\dot{x}) + \ddot{x}_c - \lambda\,\Delta\dot{x}$$

- In Example E.3 on page 448, $\dot{x}_2$ should be

$$\dot{x}_2 = -(k_1/m)x_1 - (k_2/m)x_1^3 - (c/m)x_2|x_2| + u/m$$