

Errata: Robot Modeling and Control

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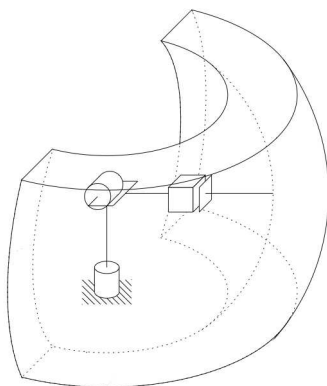
November 19, 2013

Compiled by Katherine J. Kuchenbecker and others affiliated with MEAM 520 at the University of Pennsylvania, expanding on the errata from Seth Hutchinson.

Chapter 1

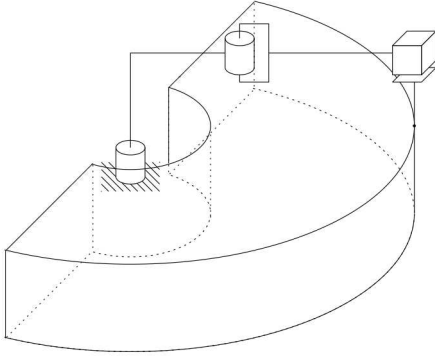
Page 4 Near the bottom of the page, change “if the joint is the interconnection of links i and $i + 1$ ” to “if the joint is the interconnection of links i and $i - 1$ ”.

Page 18 In Figure 1.17(a) the workspace for the spherical robot is drawn too low. The spherical surface should be centered on the intersection between the two revolute joints, as shown in the image below, which was taken from an early draft of the book:



Page
18

In Figure 1.17(b) the workspace for the SCARA robot is too far away from the base. The tip of the robot should be at the far arc of the workspace. The two end arcs should also be tangent to the outer arc and should have a radius equal to the length of the robot's forearm. Generally this is a poor illustration of the workspace of a SCARA robot. Here is a version that has the workspace in the right location, but it erroneously shows straight instead of curved edges:



Page 29

In the caption for Figure 1.25, change Problem 1-15 to Problem 1-13.

Chapter 2

Page 43

The vectors x_1, x_2, x_3 should be x_1^0, x_2^0, x_3^0 , respectively.

Page 49

In the paragraph immediately before Example 2.5, change “We first rotate the frame $o_2x_2y_2z_2$ ” to “We first rotate the frame $o_1x_1y_1z_1$.”

Page 50

In Equation (2.18) the (1,2) element of the matrix $R_{z,\theta}$ should be $-s_\theta$.

Page 62

In Equation (2.67) the (3,2) element of the matrix H_1^0 should be s_z .

Page 70

Question 2-38 should say “Show that $H_2^0 = H_1^0 H_2^1$.”

Page 71

Question 2-39 should say “with frame $o_2x_2y_2z_2$ established at the center of the cube's bottom surface as shown.”

Chapter 3

Page 79

Equation (3.13) should begin $R_1^0 = R_{z,\theta} R_{x,\alpha}$ instead of having both rotations be around x . The provided elements of the matrix are correct, though.

Page 82

In the fourth line from the top, “If z_{i-l} and z_i are not coplanar ...” the first subscript should be “If z_{i-1} ...”

Page 82

In section (iii), “The most natural choice...” should be “The only choice...” Delete the sentence “However, any convenient point along the axis z_i suffices.”

Page 86

In the first line, “...could just as well be placed at joint 2” should read “...could just as well be placed at joint 1.”

Page 87	In Figure 3.8, joint 5 is shown at $\theta_5 = -90^\circ$. The end part of the wrist should be straight up to match the given DH parameters. The wrist is drawn correctly later in the chapter.
Page 87	The (3,2) element of A_5 should be +1.
Page 90	In Figure 3.10, the origin of frame 6 should be at the end of the gripper, not at the center of the spherical wrist. This placement follows the guidelines for choosing the end-effector frame. If you leave the sixth frame where it is, d_6 should be equal to zero in Table 3.4.
Page 91	In the expressions for r_{11} , the term $-d_2$ should be $-s_1$.
Page 92	In Figure 3.11, Frame $x_0y_0z_0$ should be drawn at the shoulder joint of the robot arm, moved up along z_0 to match the given DH parameters in Table 3.5. Alternatively, you can add d_1 as a constant parameter in the first step of the DH transformations and adjust the matrices A_1, T_4^0 .
Page 99	In Figure 3.14, θ_1 should be θ_1 .
Page 109	In Equation (3.70), T_4^1 should be T_4^0 .
Page 109	In Equation (3.75), $\sqrt{1 - c_2^2}$ should be $\sqrt{1 - c_2^2}$.
Page 109	Equation (3.78) should read $d_3 = -o_z - d_4$.

Chapter 4

Page 130	In Equation (4.46), the summation $\sum_{i=1}^n$ should be $\sum_{i=1}^n$.
Page 132	The first line should say “the translational velocity is \dot{d}_i ” instead of “the magnitude of the translation is \dot{d}_i .”
Page 135	In the second sentence, the reference to Equation (4.62) should be Equation (4.63).
Page 140	In the sentence before Equation (4.85), $R = R_{z,\psi}R_{y,\theta}R_{z,\phi}$ should be $R = R_{z,\phi}R_{y,\theta}R_{z,\psi}$.
Page 143	In the second line after Equation (4.90), “that the all possible” should be “that all possible”.
Page 144	In the middle of the first paragraph, θ_4 should be θ_5 .
Page 144	In the middle of the first paragraph, “the are unavoidable” should be “they are unavoidable”.
Page 144	In Equation (4.99) the sign of the determinant should be switched.
Page 153	In Equation (4.121), $\xi^T(JJ^T)^1\xi^T$ should be $\xi^T(JJ^T)^{-1}\xi$.
Page 154	After Equation (4.124), $\lambda_1 \geq \lambda_2 \dots \leq \lambda_m$ should be $\lambda_1 \geq \lambda_2 \dots \geq \lambda_m$.
Page 158	In problem 4-7, $\phi = \frac{\phi}{2}$ should be $\phi = \frac{\pi}{2}$.

- Page 159 In problem 4-10, the word “acts” should be “facts”.
- Page 159 In problem 4-13, $R = R_{z,\psi}R_{y,\theta}R_{z,\phi}$ should be $R = R_{z,\phi}R_{y,\theta}R_{z,\psi}$.

Chapter 5

- Page 170 In Equation (5.2), ζ should be ζ_i .
- Page 175 After Equation (5.8), “inlcudes” should be “includes”.
- Page 177 In the first equation, the term $(a_x \sin \theta a_y \cos \theta)$ should be $(a_x \sin \theta + a_y \cos \theta)$.
- Page 178 In Example 5.7, the word “repuslive” should be “repulsive”.
- Page 187 In the next-to-last paragraph, “near by” should be “nearby”.
- Page 193 The first line of text should say “The constraints $q(0) = q_0$ and $\dot{q}(0) = 0$ imply that”.
- Page 197 In Equation (5.28), $q(t_0)$ should be $q(t)$.
- Page 198 Example 5.11 should be called “Quintic Spline Trajectory with Blending Constraints”.

Chapter 7

- Page 242 In Figure 7.2, the motor inertia should be labeled J_m and the link inertia should be labeled J_ℓ .
- Page 255 In Equation (7.53), add the term $\frac{1}{2}$ before the last summation sign.
- Page 257 In Equation (7.64), change $\frac{\partial d_{kj}}{\partial q_j}$ to $\frac{\partial d_{kj}}{\partial q_i}$.
- Page 261 In the first line, $I_i \omega_i^2$ should be $\frac{1}{2} I_i \omega_i^2$.
- Page 262 In the matrix in Equation (7.90), the (1,1) term should be $-\ell_1 \sin p_1$.
- Page 265 The first vector in Equation (7.99) should be $\begin{bmatrix} \ell_2 \cos q_2 \\ \ell_2 \sin q_2 \end{bmatrix}$.
- Page 266 In Equation (7.102), $\omega_3 = q_1 k$ should be $\omega_3 = \dot{q}_1 k$.
- Page 276 In Figure 7.12, the term $-R_i^{i+1} \tau_i$ should be $-R_{i+1}^i \tau_{i+1}$ and the term $-R_i^{i+1} f_{i+1}$ should be $-R_{i+1}^i f_{i+1}$.
- Page 277 In Equations (7.145) and (7.147), the term α_i should be $I \dot{\omega}_i$.
- Page 277 In the fourth line in the paragraph after Equation (7.147), “joint s” should be “joints”.
- Page 278 In Equation (7.153), R_{i-1}^i should be R_i^{i-1} .
- Page 278 Equation (7.155) should be $a_{c,i}^{(0)} = a_{e,i-1}^{(0)} + \dot{\omega}_i^{(0)} \times r_{i,ci}^{(0)} + \omega_i^{(0)} \times (\omega_i^{(0)} \times r_{i,ci}^{(0)})$

- Page 279 In the second-to-last paragraph the reference to Figure 7.9 should be to Figure 7.8.
- Page 279 In Equation (7.162), $\omega_2 = (q_1 + q_2)k$ should be $\omega_2 = (\dot{q}_1 + \dot{q}_2)k$
- Page 280 In Equations (7.163) and (7.164) the terms $(\ell_1 - \ell_{c1})$ and $(\ell_2 - \ell_{c2})$ should be $-(\ell_1 - \ell_{c1})$ and $-(\ell_2 - \ell_{c2})$, respectively.
- Page 280 In Equation (7.166) the term $\sin q_1$ should be $-\sin q_1$.
- Page 280 In Equation (7.168), the term $\alpha_{c,2}$ should be $a_{c,2}$ and R_1^2 should be R_2^1 .
- Page 281 In Equation (7.169), R_1^2 should be R_2^1 and $\sin \dot{q}_2$ should be $\sin q_2$.
- Page 281 The vector in Equation (7.171) should have a third element equal to 0.
- Page 282 All occurrences of R_1^2 should be changed to R_2^1 .
- Page 300 After Equation (8.45) the term $\tilde{(\cdot)} = (\cdot) - (\hat{\cdot})$ should be changed to $\tilde{(\cdot)} = (\hat{\cdot}) - (\cdot)$.

Chapter 9

- Page 330 In Equation (9.21), $K_d \tilde{+} F$ should be $K_d \tilde{x} + F$.
- Page 332 In Equation (9.27), $\frac{1}{m_c}$ should be $\frac{1}{M_c}$.
- Page 333 In Equation (9.33), $(\dot{x}^d - x)$ should be $(\dot{x} - \dot{x}^d)$.

Chapter 10

- Page 341 In Definition 10.1, change $f : M \rightarrow T_x M$ to $f : M \rightarrow TM$ and change

$$f(x) = \begin{bmatrix} f_1(x) \\ \vdots \\ f_m(x) \end{bmatrix} \quad \text{to} \quad f(x) = \begin{bmatrix} f_1(x) \\ \vdots \\ f_m(x) \end{bmatrix} \in T_x M \text{ for all } x \in M$$

- Page 341 In Definition 10.2 change $T_x^* M$ to $T^* M$.
- Page 343 In Example 10.2, the third element of the vector $f(x)$ should be changed to $x_1 + x_3^2$.
- Page 352 Equation (10.49) should be $L_{ad_f^k}(g)T_1 = 0 \quad k = 0, 1, \dots, n-2$.
- Page 352 Equation (10.50) should be $L_{ad_f^{n-1}}(g)T_1 \neq 0$.
- Page 353 In Equation (10.56), L should be changed to ℓ .
- Page 354 In Equation (10.57), L should be changed to ℓ .

- Page 354 In Equation (10.62), the left side of the last two terms should be changed to $L_{ad_f^2}(g)T_1$ and $L_{ad_f^3}(g)T_1$, respectively.
- Pages 355-6 All occurrences of MgL should be changed to $Mg\ell$.
- Page 359 In Equation (10.83), change \dot{x}_1 and \dot{x}_3 to x_1 and x_3 , respectively.
- Page 359 In Equation (10.86), change $T_1(x_1)$ to $T_1(x)$ in the first equation.
- Page 362 Remove the semicolon in Equation (10.100).
- Page 367 After Equation (10.113), change g_2 *it follows* to g_2 . *It follows*.
- Page 368 In the third sentence of Definition 10.11, change $\bar{\Delta}$ *is an involutive distribution such that* to $\bar{\Delta}$ *is an involutive distribution containing Δ such that*.
- Page 375 In Problem 10-21, change rank 3 to rank 2.

Chapter 11

- Page 387 In the second paragraph, change "Likewise, if half or the pixels" to "Likewise, if half of the pixels".

Chapter 12

- Page 426 In the first row vector in Equation (12.21), change the first term L_{v_z} to L_{v_x} .

Appendix A

- Page 436 In the Law of Cosines, change cb^2 to b^2 to give $c^2 = a^2 + b^2 - 2ab \cos \theta$.

Appendix D

- Page 452 In Equation (D.7), change $x_i x_i$ to $x_i x_j$.