Feedback Control of Dynamic Bipedal Robot Locomotion
Eric R. Westervelt, Jessy W. Grizzle,
Christine Chevallereau, Jun Ho Choi, and Benjamin Morris

Errata

Known errors and correction as of January 28, 2014.

- Page 58 (Submitted by Kaveh Akbari Hamed): Equation (3.31) should be the following.

$$\mathcal{S} := \{(q_{\rm s}, \dot{q}_{\rm s}) \in T\mathcal{Q}_{\rm s} \mid p_2^{\rm v}(q_{\rm s}) = 0,\ p_2^{\rm h}(q_{\rm s}) > 0\}.$$

- Page 63 (Submitted by Kaveh Akbari Hamed): Equation (3.57) should be the following.

$$\tilde{\Sigma} : \begin{cases} \dot{\tilde{x}} = \tilde{f}_{\rm s}(\tilde{x}) + \tilde{g}_{\rm s}(\tilde{x}) v & \tilde{x}^- \notin \mathcal{S} \\ \tilde{x}^+ = \tilde{\Delta}(\tilde{x}^-) & \tilde{x}^- \in \mathcal{S}, \end{cases}$$

- Page 67 (Submitted by Hae Won Park): Equation (3.67) should be the following.

$$\begin{aligned} (C_{\rm s}(q,\dot{q}))_{1,2} &= -\frac{1}{2} m r^2 \sin(\theta_1 - \theta_2)\dot{\theta}_2 \\ (C_{\rm s}(q,\dot{q}))_{1,3} &= M_T r \ell \sin(\theta_1 - \theta_3)\dot{\theta}_3 \\ (C_{\rm s}(q,\dot{q}))_{2,1} &= \frac{1}{2} m r^2 \sin(\theta_1 - \theta_2)\dot{\theta}_1 \\ (C_{\rm s}(q,\dot{q}))_{3,1} &= -M_T r \ell \sin(\theta_1 - \theta_3)\dot{\theta}_1 \end{aligned}$$

- Page 93 (Submitted by Kaveh Akbari Hamed): In item (e), "$\varphi^+(t) := \lim_{\tau \nearrow t} \varphi(\tau)$" should be "$\varphi^-(t) := \lim_{\tau \nearrow t} \varphi(\tau)$".
- Page 95 (Submitted by Kaveh Akbari Hamed): On the first line, "$\mathcal{X}_2$" should be "$\mathcal{X}_1$".
- Page 107 (Submitted by Kaveh Akbari Hamed): The following hypothesis should be added to list of hypotheses for Proposition 4.3:

  5. $\mathcal{Z}_{(\alpha\to\beta)}$ is forward invariant and continuously finite-time attractive under $f_{(\alpha\to\beta)}$.
- Page 147 (Submitted by Kaveh Akbari Hamed): In Table 6.1, "0.813" should be "0.662".
- Pages 153,154: NEC2, NEC4, and NEC5 should be NIC4, NIC5, and NIC6, respectively.
- Page 158 (Submitted by Thomas Schauss): Equation (6.67) should be the following.

$$\left[L_{\tilde{g}} L_{\tilde{f}} h(\tilde{q})\right]^{-1} = \mathrm{I}_{(N-1)\times(N-1)} - \frac{1}{\det(L_{\tilde{g}} L_{\tilde{f}} h)(\tilde{q})} \frac{\partial h_d(\theta)}{\partial \theta} \tilde{J}^{\rm norm}(q_{\rm b}).$$

- Page 158 (Submitted by Thomas Schauss): Equation (6.68) should be the following.

$$\Big[L_{\tilde{g}} L_{\tilde{f}} h(\tilde{q})\Big]^{-1} = \mathrm{I}_{(N-1)\times(N-1)} - \left(\frac{1}{\tilde{d}_{N,N}(q_{\mathrm{b}}) + [\ \tilde{d}_{N,1}(q_{\mathrm{b}}), \cdots, \tilde{d}_{N,(N-1)}(q_{\mathrm{b}})\ ]\frac{\partial h_d(\theta)}{\partial \theta}}\right) \left(\frac{\partial h_d(\theta)}{\partial \theta}\ [\ \tilde{d}_{N,1}(q_{\mathrm{b}}), \cdots, \tilde{d}_{N,(N-1)}(q_{\mathrm{b}})\ ]\right).$$

- Page 195 (Submitted by Amine Kamel): Equation (7.9) should be the following.

$$\begin{bmatrix} \alpha_0 \\ \theta_\alpha^+ \end{bmatrix} = HRH^{-1} \begin{bmatrix} \alpha_M \\ \theta_\alpha^- \end{bmatrix}$$

- Page 242: "10.1 W" should be "40.4 W"
- Page 245: "8.9 W" should be "35.6 W"
- Page 271 (Submitted by Ulrich Romer): Equation (9.51) should be the following.

$$\dot{q}^{\mathrm{f}-} = A^{-1}\left(A + m_{\mathrm{tot}} \frac{\partial \mathbf{f}_2}{\partial q}' \frac{\partial \mathbf{f}_2}{\partial q}\right) R^{-1} \dot{q}_0^{\mathrm{s}+} \delta(\sigma_1^{\mathrm{s}-}) - m_{\mathrm{tot}} A^{-1} \frac{\partial \mathbf{f}_2'}{\partial q} \begin{bmatrix} \dot{\mathbf{x}}_{\mathrm{cm}}^{f-} \\ \dot{\mathbf{y}}_{\mathrm{cm}}^{f-} \end{bmatrix}.$$

  (In the book, there is a + sign in front of $m_{\mathrm{tot}} A^{-1}$)
- Page 398 (Submitted by Kaveh Akbari Hamed): Equation (B.83) should be the following.

$$\tilde{f}^*(\eta, z) = \begin{bmatrix} \tilde{f}_1^*(\eta_1) \\ \vdots \\ \tilde{f}_m^*(\eta_m) \\ \tilde{f}_{r+1}(\eta, z) \\ \vdots \\ \tilde{f}_n(\eta, z) \end{bmatrix}$$

- Page 398 (Submitted by Kaveh Akbari Hamed): Equation (B.85) should be the following.

$$\tilde{f}^*\Big|_{\mathcal{Z}}(z) = \begin{bmatrix} \tilde{f}_{r+1}(0, z) \\ \vdots \\ \tilde{f}_n(0, z) \end{bmatrix}$$

- Page 431 (Submitted by Hae Won Park): Equation (B.204) should be the following.

$$\bar{D}(\bar{q}) = \left(\frac{\partial F(q)}{\partial q}'\right)^{-1} D(q) \left(\frac{\partial F(q)}{\partial q}\right)^{-1}\Bigg|_{q=F^{-1}(\bar{q})}$$

- Page 432 (Submitted by Noah Cowan): Equation (B.211) should be the following.

$$\Gamma = \begin{bmatrix} -\left(\frac{\partial \lambda(q_1)}{\partial q_1}\right)' \\ \mathrm{I} \end{bmatrix} u^*(q, \dot{q}),$$

- Page 432 (Submitted by Noah Cowan): Equation (B.212) should be the following.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} x_2 \\ D^{-1}(x_1)\left(-C(x_1,x_2)x_2 - G(x_1) + \begin{bmatrix} -\left(\frac{\partial\lambda(q_1)}{\partial q_1}\right)' \\ \mathrm{I} \end{bmatrix} u^*(x_1,x_2)\right) \end{bmatrix}.$$

- Page 432 (Submitted by Kaveh Akbari Hamed): Equation (B.214) should be the following.

$$D(q_1,q_2) = \begin{bmatrix} D_{11}(q_1,q_2) & D_{12}(q_1,q_2) \\ D_{12}'(q_1,q_2) & D_{22}(q_1,q_2) \end{bmatrix}$$

- Page 432 (Submitted by Noah Cowan): Equation (B.216) should be the following.

$$\Gamma \cdot \dot{q} = \left(\begin{bmatrix} -\left(\frac{\partial\lambda(q_1)}{\partial q_1}\right)' \\ \mathrm{I} \end{bmatrix} u^*\right)' \dot{q} = (u^*)' \frac{d}{dt}\left(q_2 - \lambda(q_1)\right),$$

- Page 438 (Submitted by Oscar E. Ramos Ponce): Equation (B.234b) should be the following.

$$(G_{\mathrm{s}}(q_1,q_2))_2 = \left(m_1 g_0 L_2 + m_2 g_0 \ell^{\mathrm{h}}_{\mathrm{cm},2}\right)\cos(q_2) + m_1 g_0 \ell^{\mathrm{h}}_{\mathrm{cm},1}\cos(q_1+q_2),$$

- Page 441 (Submitted by Kaveh Akbari Hamed): On the second line of Section C.1.4, "$T_I(x) < \infty$" should be "$T_I(\Delta(x)) < \infty$".

- Page 445 (Submitted by Kaveh Akbari Hamed): Equation (C.25) should be the following.

$$\mathcal{D}T_I^{\epsilon}(\hat{\Delta}(z^*_{2:k},\eta^*)) = -(L_{f^{\epsilon}}H(x^*))^{-1}\frac{\partial H}{\partial x}(x^*)\Phi^{\epsilon}(t^*,\hat{\Delta}(z^*_{2:k},\eta^*)).$$