Equations for "Stride Period Adaptation of a Biomimetic Running Hexapod"

Jorge G. Cham Jonathan K. Karpick Mark R. Cutkosky

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This document contains LaTEX versions of the equations for the paper, "Stride Period Adaptation for a Biomimetic Running Hexapod", to be published in the International Journal of Robotics Research.

1 Main Body Equations

$$GRF = ky + b\dot{y} - f(t) \tag{1}$$

$$m\ddot{y} = -ky - b\dot{y} - g + f(t) \tag{2}$$

$$\int_{t_{off}}^{(t_{off}+t_{on})} f(t) \cdot \dot{y}(t)dt = WorkInput \tag{3}$$

$$\tau_{n+1} = \tau_n - K_p(t_d - t_L - t_v) \tag{4}$$

$$K_p < 2/s \tag{5}$$

2 Appendix A Equations

$$\dot{X} = AX + B \tag{1}$$

$$A = \left[\begin{array}{cc} 0 & 1 \\ -w^2 & -2\zeta w \end{array} \right] \quad B = \left[\begin{array}{c} 0 \\ f(t) - 1 \end{array} \right] \Bigg\} (x \leq 0) \tag{2}$$

$$A = \left[\begin{array}{cc} 0 & 1 \\ 0 & 0 \end{array} \right] \quad B = \left[\begin{array}{c} 0 \\ -1 \end{array} \right] \Bigg\} (x > 0) \tag{3}$$

$$f(t) = \left\{ \begin{array}{ll} T_n & \text{if } t_{off} < t \leq t_{off} + t_{on} \\ 0 & \text{otherwise} \end{array} \right. \tag{4}$$

$$\begin{array}{ll} AIR & X(t) = \left[\begin{array}{cc} 1 & t \\ 0 & 1 \end{array} \right] X_0 - \left[\begin{array}{c} t^2/2 \\ t \end{array} \right] \\ ON & X(t) = e^{At}(X_0 - X_{eon}) + X_{eon} \\ OFF & X(t) = e^{At}(X_0 - X_{eoff}) + X_{eoff} \end{array} \tag{5}$$

$$X_{eon} = \left[\begin{array}{c} \frac{T_n - 1}{w^2} \\ 0 \end{array} \right] \quad X_{eoff} = \left[\begin{array}{c} -\frac{1}{w^2} \\ 0 \end{array} \right] \tag{6}$$

$$X_{n+1} = F(X_n) = X_{eoff} - e^{A(\tau - 2t_a - t_{on})}(X_{eon} + X_{eoff}) - e^{A(\tau - 2t_a)}(X_n - X_{eon}) \tag{7}$$

$$X_{takeoff} = e^{A(t_{on} + t_{off})}(X_{touchdown} - X_{eoff}) + e^{At_{on}}(X_{eoff} - X_{eon}) + X_{eon} = -X_{touchdown} \tag{8}$$

$$X_{takeoff} + e^{A(t_{on} + t_{off})}(X_{takeoff} + X_{eoff}) + e^{At_{on}}(X_{eon} - X_{eoff}) - X_{eon} = \left[\begin{array}{c} 0 \\ 0 \end{array} \right] \tag{9}$$

$$X^* = F(X^*) \tag{10}$$

3 Appendix B Equations

$$T_{n+1} = T_n - K(d - t) \tag{1}$$

$$d(T) = \begin{cases} b & \text{if } T < T_c \\ s(T - T_c) + b & \text{if } T \geq T_c \end{cases} \tag{2}$$

$$K < 2/s \tag{3}$$

$$T_{n+1} = T_n - K(s(T_n - T_c) + b - t) \tag{4}$$

$$T_{n+1} = (1 - Ks)T_n + K(t - b - sT_c) \tag{5}$$

$$|1 - Ks| < 1 \tag{6}$$

$$K \cdot s < 2 \tag{7}$$

$$T_{n+1} = T_n - K(b - t) \tag{8}$$

$$T_{LC1} = (t - b)/(2s) + T_c \tag{9}$$

$$T_{LC2} = T_{LC1} - K(t - b) \tag{10}$$

$$T_{min} = T_c + K(t - b) \tag{11}$$

$$T_{max} = T_c + K(t - b)(2 - Ks) \tag{12}$$