Model parameters

Symbol	Description	Value
$\mathbf{x}_b = [x_b, y_b, z_b]^T$	Coordinates of the ball	–
$\dot{\mathbf{x}}_b = [\dot{x}_b, \dot{y}_b, \dot{z}_b]^T$	Velocity of the ball	–
$\mathbf{x}_c = [x_c, y_c]^T$	Coordinates of the catcher	–
$\dot{\mathbf{x}}_c = [\dot{x}_c, \dot{y}_c]^T$	Velocity of the catcher	–
$\{\phi, \psi\}$	Spherical angles defining gaze	–
$\mathbf{x} = [\mathbf{x}_b, \dot{\mathbf{x}}_b \mathbf{x}_c, \dot{\mathbf{x}}_c, \phi, \psi]^T$	State of the system	–
$\mathbf{z} = [\mathbf{x}_b, \mathbf{x}_c, \phi, \psi]^T$	Observations	–
$\mathbf{u} = [F, \dot{\phi}, \dot{\psi}, \theta]^T$	Controls	$-2\pi \leq \dot{\phi}, \dot{\psi} \leq 2\pi,\ |\theta| < \pi$
$\{F_1, F_2\}$	Force parameters	$\{7.5, 2.5\}$
λ	Damping	$^5/_6$
$\mathbf{Q}$	System covariance	$\mathrm{diag}\,\{\sigma_b^2 \mathbf{1}_6, \sigma_c^2 \mathbf{1}_6\}, \sigma_b^2 = 10^{-3}, \sigma_c^2 = 10^{-5}$
$\boldsymbol{\Sigma}_0$	Initial covariance	$^1/_4 \cdot \mathrm{diag}\,\{^1/_5, ^1/_5, 0.0, ^1/_2, ^1/_2, 0.0, 10^{-2}\mathbf{1}_6\}$
$\{\sigma_{min}, \sigma_{\max}\}$	Observation noise parameters	$\{10^{-2}, 1.0\}$
$\mathbf{R}$	Observation covariance	$\mathrm{diag}\,\{\sigma_o^2 \mathbf{1}_3, \mathbf{0}_4\}$
$\varepsilon_{\mathrm{threshold}}$	Successful catch distance	0.5
τ	Discretization step	0.1
N	Planning horizon length	$N \leq 30$
$\{w_0, w_1, w_2, \mathrm{M}\}$	Cost function weights	$\{10^3, 10^3, 10^2, \mathrm{diag}\,\{10, 1, 1, 0.1\}\}$