Viability and Global Stability of a Task-Regulated Compass Walker

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Overview

Fall risk $\Leftrightarrow$ dynamic stability of walking.

Hierarchical schema for biological movement:

Control to remain viable (avoid failure).

Regulation to achieve task-level goals.

Humans exploit task-level redundancies [1, 2]; perhaps to minimize their fall risk?

We study the effect of regulation strategies on global stability of the simplest dynamic walker in its viable region.

Powered compass walker [3]

Hybrid Poincaré map: $x_{k+1} = F(x_k; P_k)$.

Step speed: $V_k = L_k/T_k$

Absolute position: $d_k^- = d_k^+ + L_k - \bar{v}T_k$

Task-level regulation: $\mathcal{O} \in \{V, d^-\}$

$P_k^{\text{opt}} := \arg\min_{0 \leq P \leq P_{\text{max}}} \left[ \mathcal{O}_{k+1}(x_k; P) - \mathcal{O}^* \right]^2$

Open-loop: $P_k = P^*$; Regulated: $P_k = P_k^{\text{opt}}$.

References


Acknowledgments: NIH grant #R01-AG049735