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A Panic-Dependent Collision Avoidance Framework for Heterogeneous Pedestrian Dynamics

Communication Info

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Abstract

We present ASOCA, an extension to the Optimal Reciprocal Collision Avoidance (ORCA) framework for pedestrian dynamics [1]. We replace the fixed temporal horizons with an agent-dependent spatial horizons d_i^h , which represents the maximal collision-free planning distance along each agent's trajectory [2]. Asymmetric responsibility sharing is introduced, which distribute the collision avoidance effort according to differential panic intensities without preserving reciprocity. Panic intensity is coupled to avoidance behavior through a continuous dynamical system, incorporating emotional heterogeneity into navigation decision [3]. The ASOCA framework unifies anticipatory avoidance contact dynamics via conditional constraints: ASOCA half-plane for separated agents ($d_{ij} > 0$) and impulse-based non-penetration constraints for physical contact ($d_{ij} \leq 0$) [4]. Convexity of the resulting constraint set ensures efficient quadratic programming solutions. Numerical simulations validate the framework's capacity to reproduce bottleneck formation, panic propagation, and heterogeneous evacuation dynamics in dense crowds [5].

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