

## Abstract

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# Exploring Ragdoll Physics in Crowd Disaster Simulation

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## Abstract

**Objective:** This study explores the feasibility of applying ragdoll physics, a procedural animation, and related game-engine technologies to create real-time simulations for investigating crowd disasters.

**Methods:** We harnessed the power of the Unity Game Engine to develop real-time simulation for the dynamics of a crowd disaster with rendering of scene objects and user interface (UI) elements. Humanoid agents with trigger colliders were linked to color schemes representing impact forces sustained with lethal thresholds ranging from 500 to 550 pounds force for males and 450 to 500 pounds force for females. The simulation enables users to manipulate parameters such as population, crowd density, directional movement and forces applied.

**Results:** Our simulation showcases an animated real-time depiction of a crowd disaster and enables visualization of casualties, both injured and dead, based upon a quantitative evaluation of the forces sustained.

**Conclusions:** Utilization of the Unity Game Engine for the development of visually-engaging real-time crowd disaster simulation has promising outcomes. This novel approach for modeling and analysis of crowd dynamics may provide valuable insights with applications in mass gatherings, crowd management, safety, and preparedness.

**Supplementary material.** The supplementary material for this article can be found at <http://doi.org/10.1017/dmp.2024.244>.