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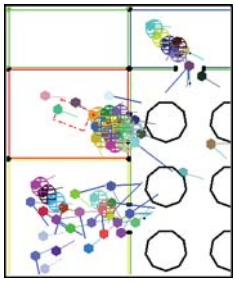
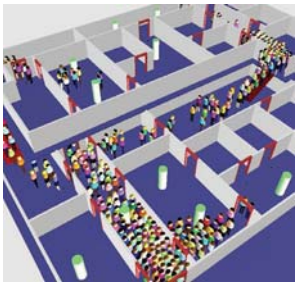
D. Metaxas and J. Popovic (Editors)

Controlling Individual Agents in High-Density Crowd Simulation





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Abstract

Simulating the motion of realistic, large, dense crowds of autonomous agents is still a challenge for the computer graphics community. Typical approaches either resemble particle simulations (where agents lack orientation controls) or are conservative in the range of human motion possible (agents lack psychological state and aren't allowed to 'push' each other). Our HiDAC system (for High-Density Autonomous Crowds) focuses on the problem of simulating the local motion and global wayfinding behaviors of crowds moving in a natural manner within dynamically changing virtual environments. By applying a combination of psychological and geometrical rules with a social and physical forces model, HiDAC exhibits a wide variety of emergent behaviors from agent line formation to pushing behavior and its consequences; relative to the current situation, personalities of the individuals and perceived social density.

CR Categories: I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Animation; I.6.8 [Simulation and Modeling]: Types of Simulation—Animation

1 Introduction

Animating motion for large crowds has been an important goal in the computer graphics, movie and video games communities. There has been a considerable effort on locomotion, path planning, navigation in large virtual environments, and realistic behavior simulation using cognitive models.

We classify crowd agent motions by three main approaches: *social forces* models, *rule based* models and *cellular automata* models. Although much effort has gone into improving the behavioral realism of each of these approaches, none of the current models can realistically animate *high-density* crowds. Social forces models tend to create simulations that look more like particle animation than human movement. Cellular automata models limit agent spatial movements and tend to expose the underlying checkerboard of cells when crowd density is high. Finally, rule based models either don't consider collision detection and repulsion at all or adopt very conservative approaches through the use of waiting rules, which work fine for low densities in everyday life simulation, but lack realism for high-density or panic situations.

Figure 1 shows a taxonomy for crowd simulation and compares our model (HiDAC: High-Density Autonomous Crowds) with the main models in the literature along the dimensions of animation realism and crowd density.

HiDAC addresses the problem of simulating high-density crowds of autonomous agents moving in a natural manner in dynamically changing virtual environments. Our solution to the problem of realistically simulating local motion under different situations and agent personalities uses psychological, physiological and geometrical rules combined with physical forces. Since applying the same

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