Short Communication

International Journal of
Innovative Research in Computer and Communication Engineering

2020
Vol.5 No.4.4

Computer Graphics 2016: Crowd Simulation: Overview and Applications

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Crowd simulations are often classified into two different broader areas. the primary one focuses on a realism of behavioral aspects, this is often usually done using simple 2D visualizations like evacuation simulators, sociological crowd models, or crowd dynamic models. during this area, simulated behaviors are generally represented from a really narrow, controlled range (for example, people just trying to exit a building or people forming ring-like crowd structures) with efforts to quantitatively validate correspondence of results to real-world observations of particular situations. within the second area, the most goal is high-quality visualization (for example movie production and computer games), but usually the realism of the behavior model isn't the priority. what's important may be a convincing visual result, which is achieved partly by behavior models, partly by human intervention within the production process. A virtual crowd should both look good and be animated during a believable manner. Simulating dense crowds that are composed of many thousands of virtual humans is impossible without the help of Level of Detail (LOD) techniques. the need in interactive systems for real-time frame rates means a limited number of polygons are often displayed by the graphics engine in each frame of a simulation. Therefore, meshes with a high polygon count often need to be simplified so as to realize acceptable display rates. Crowd simulation has gained attention recently within the movie and computer game industry; still, there are broader applications during which crowd simulation is associated. Agoraphobia treatment, virtual heritage, urban planning, traffic simulation could also be some applications of this research, and governments and personal industries like computer game or movie companies can enjoy it.

Crowds are complex systems containing collections of individuals, like human groups, animal herds, insect swarms, and vehicle flows, within the same physical environment. Their exhibited collective behaviors are often different from people who they might act when they are alone. Crowds are ubiquitous phenomena with interesting and uncanny spatial, physical, biological, social, and cultural patterns in nature. Crowd simulation in special effects dates back to the 1980s. In recent years, it's attracted significant attention from many research fields, not limited to computer animation and simulation, thanks to its broad applications during a variety of fields including military simulation, architectural design, safety science, entertainment, physics, psychology, training systems, robotics, sociology, town planning, traffic engineering, insect swarm simulation, and culture computing. Although there are numerous research progress and demonstrated applications in crowd simulation, it's still a rapidly growing area. Indeed, to date, many crowd simulation research challenges still remain widely open thanks to highly complex behaviors driven by individuals counting on various physiological, psychological, and social factors. To manage the scope of this text, we don't attempt to completely survey crowd simulation techniques that have been proposed during the past several decades. We refer interested readers to recent comprehensive surveys for more details. Instead, during this article, after briefly reviewing mainstream crowd simulation methodologies, we'll switch its focus to our recent research advances during this research field. The remainder of this text is organized as follows. We first provides a high-level overview on existing crowd simulation methodologies. Then, we present our recent research advances on crowd evacuation, pedestrian crowds, crowd formation, traffic simulation, and swarm simulation. Finally, we offer our remarks on open research challenges during this field and mean potential research directions.

Although researchers have extensively studied crowd simulation (algorithms, models, and applications) to date, it's still a comparatively young research area. Many open research problems are still considerably in flux due to the complexity, variety, and dynamics of real-world crowd behaviors. To date, most of existing crowd simulation methods are essentially application specific. Indeed, the design of a general, robust, and practical crowd simulation framework which will handle an outsized sort of applications remains considered as a grand challenge in crowd simulation field. Moreover, many research problems are still widely open and wish to be further investigated to advance the applications and practices of crowd simulation. because the final remark, we offer our own viewpoints on these remaining research challenges that are either inadequately studied or largely ignored within the current literature.

This work is partly presented at 3rd International Conference and Expo on Computer Graphics & Animation on November 07-09, 2016 Las Vegas, USA