Game research for training and entertainment

Believable virtual characters

The GATE project is developing visions on research that is necessary to maintain a leading role of the Netherlands in game research for training and education. One of the research directions with high impact is into believable virtual characters. Animated virtual characters increasingly populate interactive graphical applications, such as computer games, training and tutoring systems, online virtual worlds and simulations. In order to appear believable, these characters must move, interact, and behave in a realistic and natural way. To this end we must bridge the 'uncanny valley'. Such virtual characters will play a crucial role as virtual assistants, coaches, teachers, companions, and opponents in serious games and other virtual worlds.

Current animation techniques offer trade-offs between control, naturalness and calculation time. However, physical realism alone is not enough for naturalness and physical simulation offers poor precision in both timing and limb placement. Animation of collections of characters, crowd simulation, asks for such aspects as path planning, collision avoidance, and social behavior. However, having virtual characters that behave in a natural manner are, by themselves, not sufficient to develop effective training. In order to achieve believable virtual characters that support learning by the trainee, additional functions need to be developed, such as cognitive capabilities.

Challenges

A big challenge in the animation domain is finding an integrated way of generating natural motions and behavior that interact with the environment and provide detailed control. Hybrid systems that combine and concatenate motion generated by different paradigms can enhance both naturalness and control, and could provide a starting point for such integration. Incorporating the above techniques into a single framework has proven to be difficult because not all techniques are compatible. In order to realize this, we need to integrate and incorporate knowledge from various disciplines such as psychology, sociology, education, AI, game theory, animation, and computer vision. For example, models of emotions regarding triggers, experience, regulation / coping as well as personality must be incorporated in order to create virtual characters with enhanced cognitive attitudes, such that in concrete situations the character (re)acts adequately on stimuli from the environment (and the trainee!).

Impact

Developments in all these directions will lead to new possibilities. For example, they will enable a simulation system that can efficiently simulate intelligent heterogeneous social massive crowds in huge dynamic environments to evaluate evacuation procedures, to obtain insight into potential safety hazards, and to create nice game-play. It will lead to *Design for safety*, where we can evaluate different designs of public spaces, buildings, and event grounds to maximize safety. Also, professionals can be trained to deal with incidents such as car accidents, riots, explosions, fires, earth quakes, and floods. Consequently, we may prevent future stampede disasters such as those at the Love Parade event in Duisburg and Phnom Penh water festival in 2010, and the Heizel Stadium in 1985. Clearly, such studies will benefit the growing gaming industry, the government and its citizens.

Currently, there is much interest in simulation research in the industry because companies need realistic virtual environments for their training applications and games. For instance, VSTEP focuses on creating training facilities to improve public safety, InControl makes pedestrian simulation tools (e.g. to find out where the bottlenecks in the environments are), and GreenDino makes car simulators and carries out traffic simulation/interaction.

Another example of such a future application is to train communication skills in e.g. health care. Virtual characters endowed with emotional faculties enable practicing 'soft' skills such as handling an emotional situation appropriately, recognizing emotions in another person, and choosing one's own emotions (and actions) carefully and consciously to reach a particular aim.

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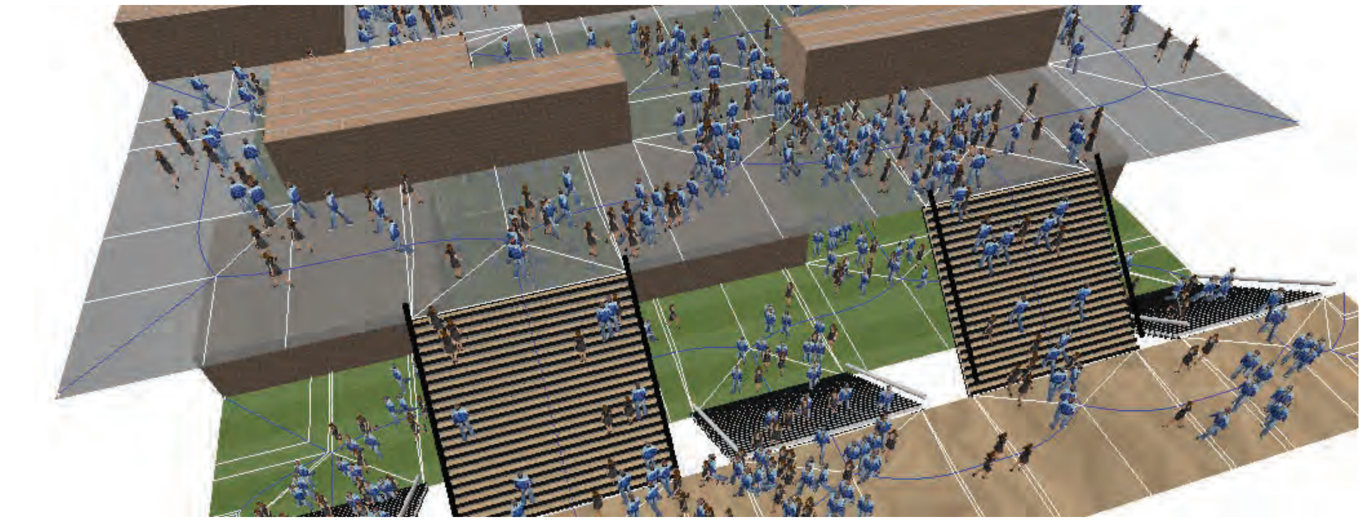
Foresight studies

The GATE project and the STT Netherlands Study Centre for Technology Trends in a joint initiative have organized a series of Expert Meetings, as part of the STT foresight study on the future of serious gaming.

The foresight is explored on the basis of four forms of games: simulation games, evidence-based gaming, serious sandbox games, and life as game. A central theme in these explorations is the transfer of gaming. For more information about the foresight study, see http://seriousgames.tv

Crowd Movement in Games and Simulations

Realistic Crowd Movement: We are moving with you, sire! For Sparta!



Realistic crowd movements are crucial for games and simulations. Games may have thousands of Spartans charging through an environment while simulations can teach people how to drive safely.

Old-School Path Planning

Early real-time strategy (RTS) games were plagued with path planning issues. When squadrons of warriors were ordered to march through a narrow chasm, the Spartans at the rear of the army would frequently wander off in small groups in search of another route. These small groups were quickly annihilated by the enemy.
One path planning approach is to manually annotate the traversable paths in an environment. This process is tedious, and it has led a few gamers to exclaim, “Why can’t I go that way?!” when an avatar stubbornly refuses to follow a visible route that was missed by a designer.

Automatic Path Planning

Modern games are beginning to use algorithms to automatically partition an environment into a collection of two-dimensional walkable regions. The resulting `navigation mesh’ can be constructed using grid-based sampling approaches, but grids are frequently either too dense or too sparse.
Triangulation approaches have also been used to describe the walkable regions in an environment, but triangulations do not typically encode the nearest stationary obstacle to a character. This makes it more difficult for a character to avoid obstacles.
We have shown that a structure called the `medial axis’ can be used to automatically partition an environment into a collection of two-dimensional walkable regions such that each point in the environment encodes the nearest stationary obstacle. This structure can produce real-time paths for tens of thousands of characters.

Multi-Layered Environments

Modern environments can have multi-storey buildings, stairs, and elevators. These environments cannot be entirely represented in 2D. However, we have recently shown how to efficiently stitch together the medial axis at connection points on stairs and elevators. This permits lightning-fast path planning in city-like environments.

Avoiding that Traffic Jam

If shortest paths are used to guide a crowd of characters, then nearly all of the characters will frequently choose the same route to reach their destinations. This leads to traffic jams in overutilized routes. It can also cause some routes to not be utilized at all. We have shown how to periodically replan routes based on the current crowd density information. This helps spread a crowd among the available routes.

Weighted Regions

Environments for driving simulators typically contain a variety of characters. Car characters should mostly travel on the roads. Pedestrian characters should mostly travel on the sidewalks. However, pedestrians should be able to cross roads, and cars should be able to park on the sidewalks when necessary. Our recent research takes these preferences into account, and the approach is being implemented in a commercial driving simulator for the company GreenDino (http://www.greendino.nl).

The work on path planning in games and simulations is done within the “Virtual Characters” theme of the Gate project. The persons involved are Roland Geraerts and Atlas Cook (Postdoc). **Roland Geraerts** is an Assistant Professor at the Games and Virtual Worlds group in the Department of Information and Computing Sciences at Utrecht University in the Netherlands. There, he obtained his PhD on sampling-based motion planning techniques. In addition, he studied quality aspects of paths and roadmaps.

His current research focuses on path planning and crowd simulation in games and virtual environments. Furthermore, he teaches several courses related to games and crowd simulation.
Roland has organized the Creative Game Challenge and is one of the co-founders of the annual Motion in Games conference. More information can be found on his webpage: http://www.staff.science.uu.nl/~gerae101/