Realistic Responses to Virtual Crowds

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ABSTRACT
Virtual Environments have been widely employed for the study, training and treatment of many human factors. People can be exposed to a small virtual audience to study and treat social phobias in people that suffers from fear of public speaking. Virtual environments have been proven to enhance the training experience in unanimated worlds, such as airplane simulators, or virtual worlds with a few avatars that interact with the real person in a bar. As crowd simulators improve the quality of the animating navigation and locomotion for large number of agents, a new area of study appears. Questions such as: how does people behave in a crowd given different environmental conditions, could now be investigated.

In previous work experiments have been carried out where participants interacted with the crowd members in an immersive virtual environment for the purpose of studying presence in virtual crowds, with the goal of establishing the basis for a future validation method and the study of human behavior under the influence of the crowd movement and decision making. In this poster we would like to explore the possibilities of this exciting area of research.

Keywords
Presence, crowd simulation, egocentric features.

1. PRESENCE IN CROWD SIMULATION
Large animated groups of autonomous agents are being widely used for computer graphics applications, video games, training, and education. An important practical problem in this research lies in how to validate the models. In previous work [3] presence in virtual environments was presented as a validation tool, and a framework to study human decision-making.

Controlled experiments are therefore needed where human behaviours in response to different crowd models can be tested. These experiments are usually either difficult to replicate in real life, or simply impossible to run in the first place (i.e., fire evacuation). Experiments in virtual environments (VEs) could be invaluable for gathering the behavioural information necessary to on the one hand improve current crowd simulation models experimentally validating them, and on the other hand use the simulated environment for training and treatment purposes.

In order to gather accurate information, it is essential to achieve *place illusion (PI)* so that a subject immersed in the virtual environment will have the illusion of being in the place depicted by the VE, and also *plausibility* (PSI), that is the illusion that what is taking place is experienced as real – even though the participants know that it is only virtual. When both PI and PSI occur participants will tend to respond realistically to virtual situations and events. We call this 'response-as-if-real' (RAIR). as close as possible to real life [4][6].

There are many examples that provide evidence that this RAIR occurs – Bideau et al show that in the context of a virtual handball simulation that there are conditions under which players will exhibit the same types of movements as they would in reality [2]. In [7] it is shown that in a virtual reproduction of the Stanley Milgram obedience experiments that people responded with anxiety when required to give electric shocks to a virtual character.

Figure 1. Example of a Virtual Crowd.

The main features that we can extract from most crowd simulation models, which we believe are significant factors influencing PSI are:

- Shaking: vibrations in the agents when walking.
- Discrete/Continuous movement: whether space and time are discretize or not when moving in the environment.
- Overlapping: Intersections between agents' bodies.
- Communication: Agents exchanging information.
- Pushing: Having physical contact between the agents.

Realistic response to virtual stimuli and events is, of course, not guaranteed and can easily break. For example,

- Whiteouts during a VE experiment produce disruptions to the experience [8]. A similar effect happens when walking through a virtual agent or object therefore it is essential not to have *overlapping*.
- Being able to physically manipulate objects [5]. Therefore to enhance the chance for RAIR a participant must be able to manipulate virtual agents/object by for example *pushing* others
- Discontinuous movement or jerkiness destroys PI. Jerkiness comes from low frame rate [1]. Models that suffer from continuous *shakiness* or moving in large discrete steps would reduce both PI and PSI.

With the knowledge that people tend to act in a VE as if they are in a real-world situation, we believe that a good crowd simulation model should enhance the probability of RAIR. Once this is achieved, we can confidently run simulations to study human behavior and use the resulting data both to validate and improve current models.

3. EXPERIMENTAL EVIDENCE

In a pilot experiment published in [3] some interesting results were shown regarding the interaction between human and a virtual crowd.

A virtual scenario simulating a cocktail party allowed a participant to be immersed in the virtual crowd through a head mounted display. The virtual humans walked around "mingling" with others through non-verbal communication.

Figure 2 shows a participant during the experiment wearing the head mounted display and a large screen showing what the participant is observing. By videotaping the subject's behavioral response together with the scene we can simultaneously study the response of the person to the behavior of the virtual crowd.

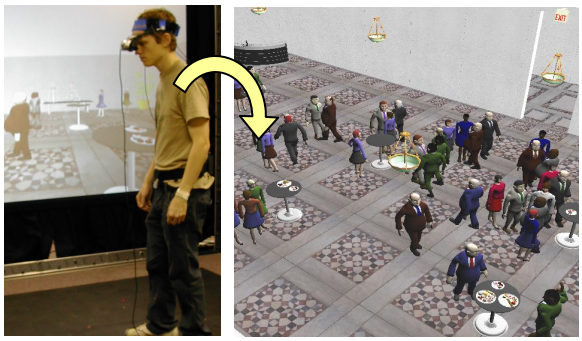

Figure 2. Participant during the experiment. [3]

The experiment showed that some people do think about the interaction with virtual agents in a similar way as when they interact with real people. Some of the participants' comments include:

- *"The sense of crowd movement was most compelling during the evacuation."*
- *"I felt bad whenever I bumped into someone."*
- *"The second time, everyone immediately started leaving and it made me really want to leave as well."*

Their behavioral response observed through videos also shown the level of presence experienced. We observed people moving backwards after bumping into a virtual agent, stepping sideways to avoid a virtual agent walking into them, and turning their head to watch an agent walk around them. One of the participants even waved back in response to a virtual agent's wave.

We are currently planning a series of studies that displays sophisticated crowd simulations models in interactive situations within immersive virtual environments.

6. CONCLUSIONS

Virtual reality experiments with virtual crowds are necessary to study human behavior under panic or stressful situations that cannot be evaluated in the real world (i.e., building evacuation due to fire). In order to carry out those experiments it is necessary to use a crowd simulation model in which a real person is seamlessly immersed and experiences strong place illusion when interacting with such a crowd that behaves in a plausible way. Not only would the participant feel that they are there, but that the events caused by the behaviour of the crowd were really happening, and therefore happening to the participant him or herself.

With a participant immersed in a VE crowd, we expect to observe the same type of behavior as in real life. Therefore we would be able to run experimental scenarios in order to study human behavior and decision-making in stressful situations. Immersive virtual environments have successfully been applied to cure some phobias, such as fear of public speaking, heights, flying, etc. Likewise we could use a VE for two new purposes: studying human behavior to improve current crowd simulation models and employing this VE for building design simulations.

7. ACKNOWLEDGEMENTS

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