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Visualization of Fires in VR

The interaction between fire smoke and light sources is a critical part when visibility is estimated and a factor that is in principle always simplified because of its complexity and requirements on computer hardware. However, computer hardware has progressed tremendously over the past decade and it is now possible to do this in real time on modern graphics cards through so-called volume rendering (similar technology used in visualizing magnetic x-ray). By also allowing interaction between the fire simulation and evacuating people in the virtual reality, one gives access to a completely new tool in order to understand people's behavior in a fire.

Objectives

The project aimed to create tools for visualization of fire and fire gases, as well as interaction between light sources and fire gases in 3D environments that could then be applied in an interactive virtual reality for use in several different areas. The aim was to offer interaction between the fire simulation and evacuating people in order to provide access to a completely new tool in order to understand people's behavior in a fire process.

Methods and Content of the project

The project included the following sub-projects:

- *Obtain knowledge of advanced phenomena useful in visibility calculations and visualization of interaction between particles (fire gases) and light and implementation of this in a 3D software.*
- *Develop tools to be able to simulate dynamic fire scenarios with user interaction in real time.*
- *Make a pilot study in smaller format to be able to improve the developed tools. This was done in the form of implementation of the model in experimental studies.*
- *Create a platform for future research that includes fire development, evacuation, emergency response and virtual reality in a symbiosis.*

The main methods used were literature study and the use of a game engine to develop the model.

Results

A novel implementation of visualization of smoke and fire in virtual reality has been demonstrated, as well as an implementation of a two-zone fire model in a game engine which allows for interactivity between the user and fire scenario. The resulting visibility is in agreement with previous simplified calculations, but also demonstrates that the visibility is complex and is dependent on several factors such as proximity to light sources, ambient light, contrast against walls.

The implemented algorithm is flexible in terms of visual quality and thereby computational cost, making it suitable for several different applications with different visual requirements.

The implemented two-zone model is basic but provides the user of interactivity that has previously not been possible. This opens up the possibility for using virtual reality in a range of applications, most obvious different kinds of training in smoke laden environments.

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