Real time visualization with an evacuation simulation by using OpenGL fusion technique

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Abstract

We have been trying to show our disaster simulation outputs to people in an immersive virtual reality (VR) environment. Because we believe that the cooperation of residents is important for reducing the damage of the disaster. The tsunami runup is simulated with considering the buildings based on nonlinear dispersive wave theory by stabilized FEM. The result is visualized by using a visualization software: AVS/Express. The behavior of evacuees is simulated and visualized by using multi-agent simulator: NetLogo. The both 3D visualization are shown together in the VR environment by using OpenGL fusion technique. So far we have showed the animation after completing all simulations, but we have developed a prototype system that could show the animation while executing the evacuation simulation. In this paper, we introduce the architecture and show the visualization example by the system.

Keywords – Tsunami runup, Virtual reality, OpenGL fusion

1 Introduction

Now, massively parallel finite element computation enables to solve large scale and complex disaster simulation. With the ability, we have conducted evacuation simulation in conjunction with analysis of tsunami runup [1]. In order to utilize the results, we have been trying to show them in an immersive virtual reality environment [2]. It is expected that the pseudo experiences enhances the residents’ disaster prevention awareness. So far our system could perform as post processing after completing all simulation, but we have improved it to perform as a simulator. The new system visualizes the tsunami runup simulation result with an active evacuation simulator. Here, we describe the system architecture and show the example of the work,

2 Evacuation simulation

The figure 1 shows the outline of the evacuation simulation.

The evacuation simulator needs two prerequisites. The first is information on road. That is a graph data that is consisted of node and segment. The second is information of tsunami runup. That includes the fluid dynamics information such as the water depth and the 3D velocity vector at the node points and the building information that is a flag data if the building is collapsed or not. Parameters for the evacuation simulation are the initial point of evacuees and the rules of agent simulation as follows.

(1) The course choice of evacuees
(2) The walking ability and the height (elderly or not)
(3) The walking ability reduction ratio by water depth
(4) The walking speed according corresponding to congestion
(5) The route of the warning announcing cars and the warning outreach

The evacuation simulator analyzes the behaviour of each evacuee from the above input and parameters and outputs the time series positions of them. This is a kind of multi-agents simulator developed on NetLogo (ver.5.0.2).

3 Visualization

Our system visualizes many components as follows.

(1) The 3D topography data (from GIS software)
(2) The buildings (From CFD simulation)
(3) The water surface (From CFD simulation)
(4) The evacuees (From evacuation simulation)
(5) The warning announcing cars(From evacuation simulation)

The 3D topography data is come from GIS software, which is static information. The (2) and (3) are come from CFD simulation. From (1) to (3) data are visualized with a visualization system: AVS/Express. The (4) and (5) are come from NetLogo and visualized with NetLogo itself.

So far, we have been visualized all data after completing all simulation. Now, we have enhanced it to visualize them with the working evacuation simulation. The detail is written in the next section.

4 Synchronization of two visualization systems

Generally it is difficult to merge two or more 3D computer graphics into a scene, but it is possible to use OpenGL fusion technique [3]. OpenGL commands generated by OpenGL API can be captured by using GL DLL replacement technique. Chromium [4] system makes the copies from the captured information and sends them to some displays. Adjusting the camera matrix of each copy, it can display any OpenGL graphics onto tiled-displays (Fig.2).
OpenGL fusion technique is the derived one. It captures OpenGL commands from multi programs and sends them to a display. As the result, multi 3D graphics are shown in not only a display but also tiled-displays. (Fig.3)

We had merged both NetLogo and AVS/Express visualization by this way. In addition, we have made a synchronization mechanism on the system and enabled the visualization with working evacuation simulator (Fig.5).

In this case, the visualization is shown in not tiled-displays but an immersive VR system. The Synchronization is performed via a file system. The time management is controlled by the evacuation simulator. It output the time information in a file periodically. A small program keeps watching the file. It notifies the time update to AVS/Express when the time stamp of the file is updated. Some delay is inevitable in this way. However, it is enough for this visualization. We take an easier implementation.

5 Conclusion

We have developed a new system which visualizes CFD information with the working evacuation simulator. It allows us to enable a kind of real time simulation in an immersive environment. We expect that the system helps residence to understand the output of disaster simulation.

References


