Scientific Computing with OpenSim

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September 10, 2008

Abstract

This paper summarises ideas and suggestions on how to use OpenSim and virtual reality technology in scientific computing.

1 Introduction

OpenSim is an open source virtual world server, currently an accurate implementation of the Second Life server from Linden Labs, which allows people to build content and interact with each other in virtual worlds. Until now, most people have used OpenSim for building social networks, but it can be used in other contexts. A recent example is a N-body physics simulation that is used in a virtual world aimed at scholars in astro physics [1]. Traffic simulations [2] as well as emergency response training simulations [3] are also under development. Another promising fields is scientific computing, and in this paper we discuss how OpenSim may be applied in fusion reactor research.

There has long been an interest in virtual reality to display and manipulate simulations. However, OpenSim has unique properties compared to traditional virtual reality systems which enables new kinds of applications. The main difference is that OpenSim allows collaboration, in that many avatars share the same space, and are able to talk to each other (either by voice chat or messaging), look at objects and videos together, and move around using realistic physics to disallow people from occupying the same space. The contents of the world can either be created directly by the avatars while running the application, or by importing existing models from other 3D design software. The objects in the world can be controlled by scripts, and various visual effects, such as various particle system algorithms, can be used to display physical phenomena.

2 Connecting OpenSim to External Simulators

Scientific computing applications generally require a lot of computing power, and a typical simulation will be too heavy to run on the OpenSim servers. The general solution is to run the heavy physics simulation on an external physics server, and to represent the calculation with in-world objects whose attributes are calculated using values from the physics simulation. The state of the OpenSim and external physics servers must be synchronised, which could be done either by extending the scripting languages to read and write data from the external server, or by defining a mapping between in-world variables and variables in the external physics server. The latter method is more flexible, and 3Di have already implemented similar functionality that could be extended to cover more general cases.

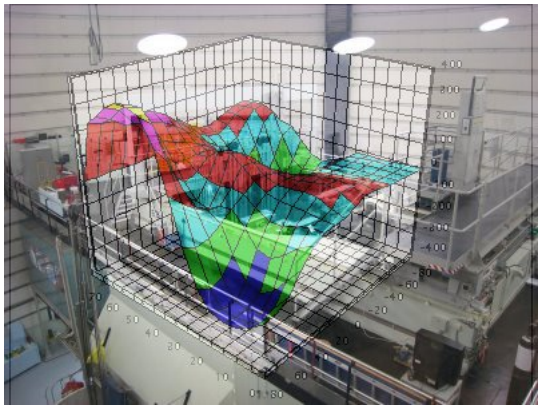

Figure 1: Concept image showing a transparent surface graph on top of a 3D scene. The real implementation will have higher visual quality.

3 Ideas: Data Display

This sections contains ideas for using the 3D capablities of OpenSim and its viewer to display simulated data. Some of the ideas require a custom-made viewer.

Most users of OpenSim use the Second Life viewer to display the 3D world, interact with objects in the world, and creating new contents using the built-in editor. However, the Second Life viewer has limitations, and there are several projects going on to provide replacements that could add new capabilities to the display, some of which 3Di is actively involved in.

3.1 HUD display and control

The viewer has support to Head-up displays (HUD) that can be used to display data, such as trend curves, graphs, data tables, or even animations and videos. The display can also contain control elements, such as buttons and sliders, that can activate scripts that control the simulation.

One HUD use case is to access data which is normally hidden. For example, imagine that we have a room showing the nuclear reactor hall. By clicking on a pipe or a valve, we can pass the simulator parameters for this object and appropriate control elements. A valve could show its current position (e.g. 37% open) and buttons to open, close and stop the valve motor. A pipe could show a trend curve that displays pressure, temperature, and vapor levels. Various buttons can be used to change the time range, or displayed variables.

3.2 Data Overlay

With a more advanced viewer we could enhance the rendered 3D image with other information. We could for instance add a transparent surface graph showing things like temperature or radiation directly on top of the 3D image, and move the graph together with the picture (see Figure 1). We can also add effects, such as an arrow showing the flow of steam, water, or even people's movements on top of the image.

3.3 Interaction and Cut-out Views

We can look inside objects or change the display format by clicking on them. Possible application would be to click on a pipe to display flow (with a particle system, or a more abstract representation using arrows or colors). We can get closer or even inside the object, and use a HUD or repeated clicks to change the display. Once we are done we can then return to the normal display.

3.4 3D Browsing

Since each avatar only sees his or her immediate neighbourhood we may need a way to move about in a larger 3D space, as well as keeping track of other avatars participating. The

Second Life viewer has a map mode that either shows a global overview of all areas or a outline of the current area the avatar is standing in, but the global information is quite limited. 3Di has developed ways of recording and displaying data from fixed cameras that could be used to create a HUD display of several views of the environment. This can be displayed accordingly, allowing the user to interact with the current surroundings while still seeing what is happening further away. A natural extension would be to allow the user to teleport between different areas of the environment by simply clicking on the area in the HUD that shows the area he/she wants to visit.

3.5 Mixing Display Systems

The viewer can be designed to mix traditional data displays and OpenSim content by using multiple monitors or frames, or switching between different modes.

3.6 Embedding External Displays

Video streams and external pictures can easily be added to the 3D world. In addition to this, some viewers allow VNC links which means that an external applications or desktops display can be rendered on a surface in the 3D world. This can be used to let the avatar interact with external software, or share information by sharing their desktop contents with other avatars.

4 Ideas: Collaborative Tasks

The avatars in OpenSim are seldom alone, which makes is possible to study how humans interact with other people, and with the simulated world. The other avatars can either be controlled by real users, or implemented by code (bots).

4.1 Plant Operation

Complicated technology is seldom controlled by a single individual, and OpenSim makes it easy to make an environment where several people can meet and cooperate to carry out tasks. An application in the nuclear industry could be to model a control room, in which typically 4-5 operators with different specialities together monitor and control the plant. Since the model can be very close to reality, operators can easily work in the simulation as they would in a real plant without special training. However, the physics model may differ and the setup can be used in research and training when considering new or modified hardware in a plant.

4.2 Man-machine Studies

Furthermore, the virtual space where people can co-operate to carry out tasks can be used for man-machine studies, where the researcher can test new control equipment, data displays, and alarms systems to see how well people respond to various situations. It is also easy to make larger modifications, such as trying out room layouts or special operating conditions.

4.3 Crowd Control

Another application area is crowd control, e.g. monitoring how people move around during normal operations or in emergencies. Are there bottlenecks, are people able to access areas of interest in time? 3Di has implemented solutions where such data can be stored in log files and later analysed in programs that can summarise information over various categories, such as a given time period, only in a given area, and so on; as well as show the actions of single individuals (see Figure 2).

5 Summary

OpenSim has unique strengths compared to traditional virtual reality and data display systems, and the previous sections briefly described ideas on how OpenSim may be used in Scientific Computing, especially in nuclear research. This list is incomplete and we welcome more suggestions.

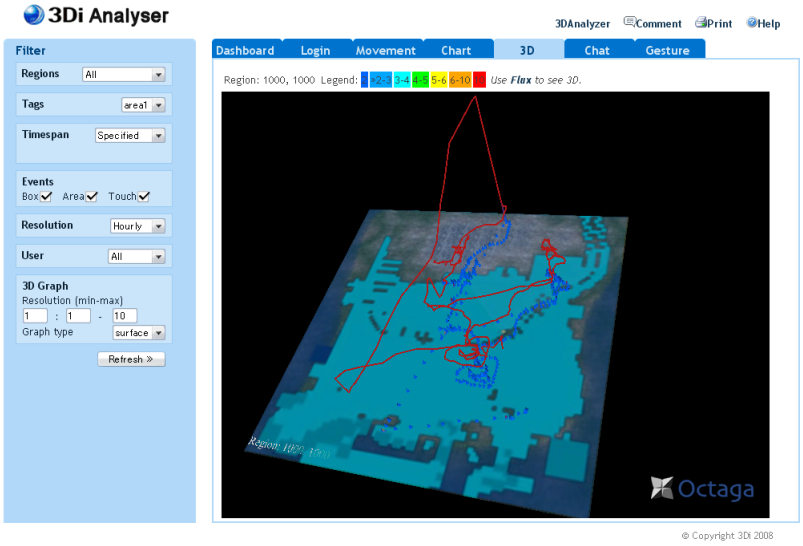

Figure 2: Data analysing tool, showing recorded avatar movements in 3D space. The view is animated and can be rotated freely.

References

[1] OpenSim Astrophysics Simulation
http://code.google.com/p/micasim/

[2] OpenSim Traffic Simulation
https://lists.berlios.de/pipermail/opensim-dev/2008-September/002851.html

[3] OpenSim Emergency Response Application
https://lists.berlios.de/pipermail/opensim-dev/2008-September/002869.html