DATA-STREAM DRIVEN DISTRIBUTED VIRTUAL ENVIRONMENTS: AIR QUALITY MANAGEMENT DISTRICT VISUALIZATION

Kostas Terzidis and David Campbell
UCLA - School of Arts and Architecture
Los Angeles CA USA

ABSTRACT

The physical space we experience and live in on a daily basis is controlled by the physical laws of nature, which are identified through science. For the most part, scientific data visualization has been used to present a clear and faithful representation of aspects of our physical world which are impossible to perceive. With the explosion of the Internet and recent programming technologies comes an emerging number of web sites that publish scientific, economic, physical and other types of data which describe our physical world and are updated in real-time. This project attempts to takes advantage of this data and cause a visual response inside virtual environments in reaction to current physical conditions in the world.

INTRODUCTION

Scientific visualization and animation of complex data such as thunderstorm modeling, planetary magnetospheres or chemical reactions are examples of how the computer has allowed us to see and experience the previously unimaginable[1] and [4]-[8]. Scientific and data visualization are for the most part reserved for high performance computers such as supercomputers that have the ability to process large amounts of data and to generate high-resolution results of typically large problems. Interpreting these large amounts of data requires sophisticated software and visualization systems that have the ability to reduce the data to visual representations.

The majority of scientific visualization applications use data stored locally on the computer. Although the data many times has originated elsewhere, the processing of the data takes place within a confined environment, accessible only to the local equipment. The general approach for this project has been to use third party, publicly available data across the Internet, leaving the collecting and publication of the source data to others. The data used is limited to one source, the current smog conditions in the southern California area. AQMD (Air Quality Management District) has current levels of Ozone, Nitrogen Dioxide, Carbon Monoxide and Particulate Matter posted on their web site (http://www.aqmd.gov) however they have no graphic representation of these values. The data being retrieved from AQMD is essentially being collected, processed and reused for visualization purposes. No prior arrangements have been made, the data is simply retrieved off of AQMD's web site. The project has been limited to using standard desktop computer equipment and very inexpensive or free software. To this end, two network-centric technologies are employed: VRML (Virtual Reality Modeling Language) and Java.

CURRENT SCENARIO

The migration towards a more visually oriented world, with the ever-expanding interest in multimedia, television, fractal and math art, holography, hyper-advertisement and cinematic displays of all kinds, has brought with it an increased appreciation to the visual representation of our physical world. In addition, we are overwhelmed by the daily vast amounts of data accumulating at an ever-increasing speed. Although this flow may add depth to our knowledge, the extraction of the information needed becomes more and more critical.

The concepts and techniques of scientific visualization that rely on the human ability of cognition offer a powerful set of tools to understand the collected data and discover hidden phenomena buried in the data[2]. The recent growth of the World Wide Web has given the scientific community the opportunity to broadcast their work to a massive audience. This has caused a large increase in the number of sites that publish real time data describing in some way or another, the physical state of the planet, from weather conditions to traffic to stock quotes.

One of the key aspects that set this project apart form other visualization and real-time data sites is that there is no back-end software involved, that is, all the software designed for the project runs on the user's machine, downloaded at run time and executed in memory. The back-end is referred as such because the main software normally resides on a server, away from the user's machine, accessible only through network protocols. Normally back-end solutions take care of receiving communications and instructions from the client and the software processes the communication, usually a request to access the

database and retrieve information, then the information is packaged and sent to the requesting client in graphic or text form. In most cases the database resides on the same server machine and is updated periodically, from every second to several hours. Updating the database is usually achieved using separate software which handles the connection from the source, such a group of thermometers, video cameras, meteorological sensing devices or other devices located in the field.

This project takes advantage of the back-end solution provided by a third party source and collects information directly off the web page intended to be the final destination of the data. One note of caution, there are some real-time data web sites which specifically alert the viewer that the information is not allowed to be republished. For the most part these tend to be sites that provide real time stock quotes and other financial data. It is beyond the scope of this project to address all the legal implications of gathering and republishing information intended to be residing in it's final location. Most likely, permission to use the data would have to be granted prior to commercializing a product such as the program produced in this project. It is an interesting legal topic however and surely exhaustive research could be performed about the World Wide Web's effect on copyright laws.

THE PROJECT

The fundamental objective was to achieve a connection in some way from the real world to a cyber-world and produce a visual response to that connection. The project is essentially divided into two solutions, one more abstract and artistically driven, the other more scientific and representational. Although they are quite opposite in their underlying concept, they share the same objective in expressing behavior that relates to a real life condition and the search for a hidden pattern within a world of data. They both follow the belief that visualization can be both a science and an art. Visualizations of natural phenomena and mathematical functions are quite visually compelling and many artists such as Klee and Mondrian experimented with the concept of hidden elements in nature and transformed them into essential aesthetic statements. Contemporary artists like Bill Viola have expressed interest in the physics of perception with exhibits that ultra-magnify natural conditions that we would normally never perceive[3]. If we consider vision to be our most highly developed method of understanding the environment, the process of visualization represents not only a scientific tool allowing synthesis, validation, comprehension of abstract concepts and the manipulation of inaccessible or invisible objects, but also a means of communication, of discovery and of creativity, which bring science and art closer together.

The work for this project is divided into three components, they have been given different names, Vapors, Data Builder and Data Viz:

Vapors

This was the first program developed and takes on an abstract approach to real time data visualization. It connects to AQMD's web site and gathers the current levels of the main air pollutants (Ozone, Nitrogen Dioxide, Carbon Monoxide and Particulate Matter) in the central Los Angeles area and uses these values to effect a VRML world. The world reacts differently depending on the current smog conditions. The world's native coordinates are derived from a simple model of a human esophagus. The model is used as a basis for creating further forms through algorithms affected by the air pollutant values. If the current smog levels are low the world will tend to build itself to closer resemble the native model of the human esophagus, if the current values are high the model will build itself more decomposed.

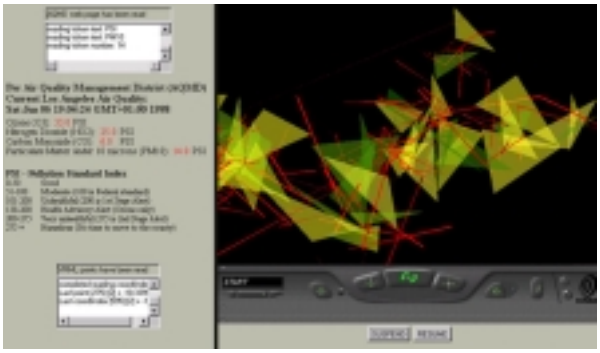

Figure 1. Vapors

Data Builder

This program checks the Ozone levels off of 29 different AQMD web pages (29 different monitored areas) and appends a file with the data. It is presently running on a dedicated computer that has been dialing the Internet, running the program, and hanging up every 4 hours for 24 hours a day since May 11, 1998. The database created is used by Data Viz. The intent is to gather smog data for a full year for the purposes of future work on elapsed time visualization.

Figure 2. Data Builder

Data Viz

Considered to be an ongoing project, this program uses the smog data gathered from Data Builder and uses it for a more representational approach to elapsed time visualization. It shows a map of southern California and a series of boxes interconnected with a web of lines directly above the map. The z position for the boxes and the points connecting the lines change depending on the smog values. The higher the smog, the higher the box. It animates the 4 hour smog reading intervals initially every second. The speed of the animation is adjustable.

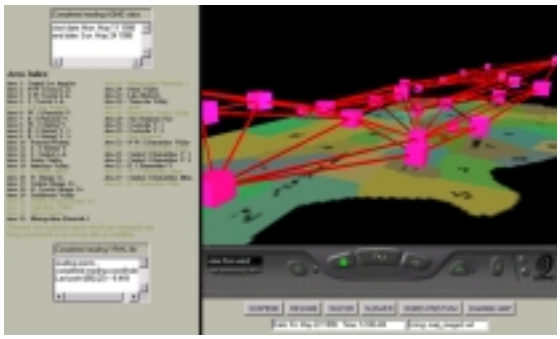

Figure 3. DataViz

CONCLUSION

Evaluation

The experimentation performed for this project uses some of the newest technologies and would not be possible if not for the enormous recent progress made in the field of computer science in both hardware and software. Once again it must be emphasized that the rapid, nearly exploding growth of the World Wide Web community has already demonstrated how powerful this new communication concept is. Although Vrml is still in it's infancy and it has been slow to find it's way into the mass market, it is becoming an increasingly important tool in the area of 3D visualization. Many Vrml improvements are expected to occur which will improve performance and the general acceptance by the common web surfer. The most significant will be the wide spread implementation and turn-key solutions to Vrml Browsers. This will undoubtedly increase the popularity of VRML since most people don't know how or don't want to spend the time downloading the latest VRML plug-in. This will change VRML from mostly being popular only with enthusiasts to a common Internet language like HTML. Another desperately needed improvement is speed. The majority of Internet access is by telephone modems which is not the most effective way to transmit large files. This will quickly be changing as more and more types of alternative access is available, including cable modems, faster telephone line technologies, and satellite dish transmission. In addition a VRML binary format is underway which will further speed up transmission times.

An inordinate amount of time and energy was spent resolving the numerous bugs in relation to the EAI, Java, Netscape and Cosmo Player compatibility. Although many of these have recently been resolved with the newer releases of Netscape 4.04 and Cosmo Player 2.0, the fact remains that there are still several unsupported methods or features which can make development a hair pulling experience. This is of

course indicative of the still immature technology and is expected to stabilize.

FUTURE WORK

Now that the programming aspects of the fundamental idea have been generally resolved the next steps will attempt to resolve the Netscape security issues so that the user does not have to perform changes to Netscape. For this to occur a digital certificate will need to be obtained as well as a web server that will support Secure Socket Layer technology.

A few projects for future consideration:

- Virtual Environment such as a chat space in which environmental conditions are connected to real world conditions. Example, if it is cloudy in the real world the virtual world would be cloudy as well. Of course, some other form of reaction could be possible that would be opposite or have an indirect relationship to the real world conditions.
- Game environments which use physical world conditions to change aspects of the game itself. Example, game reacts in some way depending on real world data, such as current scores in a football game.
- Visualization project that uses current freeway speed data and maps transformations to objects in reaction to the data.
- Real time bar graphs and other types of financial visualization

REFERENCES

[1] Stafford Barbara, *Good Looking, Essays on the Virtue of Images*, MIT Press, 1996

[2]. Popper Frank, *Visualization, Cultural Mediation and Dual Creativity*, MIT Press, 1997

[3]. Ross David and Peter Sellaars (curators), Bill Viola (exhibit catalog and commentaries), 1998

[4]. Web Museum, http://www.oir.ucf.edu

[5]. H. Vollahardt and J. Brickmann, *3D Molecular Graphics on the World Wide Web* ZDPress, 1997

[6] Ridley B.K., *Time Space and Things*, Wiley, 1995

[7] Briggs John and F. David Peat, *Turbulent Mirror*, 1989

[8]. Wierse Andreas, *Issues in the Integration of Data Mining and Data*, IEEE Computer, v.1, 1997