Scientific Visualization Production for the Media

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Introduction

SVS visualization productions are used in NASA's outreach efforts to help keep the public informed about important NASA science results. These products consist primarily of broadcast quality video packages and web based packages [ref: http://svs.gsfc.nasa.gov]. These video packages are distributed by NASA Public Affairs and are the primary means for getting our visualization products exposed to the public. Accompanying web packages contain detailed visualization meta-data, movie files, and high-resolution imagery for use by the print media.

Typical video news releases may get between 1 million and 30 million national and local television viewers exposed to our visualizations. The visualizations appear on local and national evening news broadcasts, feature television shows (e.g., NOVA), and other video venues. Many of these stories are also reported on by the print media such as newspapers, magazines, and books – often using SVS imagery in support of the stories. Through these and other venues, NASA estimates that well over one billion viewers have been exposed to SVS visualizations.

The SVS staff is made up of a diverse team of approximately ten people including computer programmer/visualization specialists, artists, an astronomer, a physicist, and a video editor. The SVS strives to maintain staff members competent in computer programming (required for reading/processing data), the physical sciences (to understand the science stories), and art (to produce appealing visualizations). This combination of skills is difficult to find.

The technology used to produce SVS visualizations is usually a combination of several commercial products along with in-house custom code. We tend to use Research Systems, Inc. (RSI) Interactive Data Language (IDL) to read and process science data sets. Custom IDL code converts science data into formats that our 3D animation software can read such as texture map sequences and 3d geometry. We then typically use Alias|Wavefront's Maya and Pixar's Renderman or Newtek's Lightwave to design and render our visualizations. The 3d animation and rendering software that we use is the same software used by movie and television studios.

The 3d animation software (Maya and Lightwave) provides us with precise control over cameras, lighting, animation, dynamics, etc. Renderman is a robust renderer that we use to provide programmatic control over the rendering process using custom written shaders. We have developed a library of powerful shaders that we reuse in many of our visualizations.

A Case Study

A very popular, recent series of visualizations called the 'Great Zooms' is now described to illustrate how the SVS integrates various technologies. These visualizations start with a global, cloud free view of the Earth and zoom down through several resolutions of data to finally rest at a 1-meter resolution view of a particular location [ref: http://svs.gsfc.nasa.gov/stories/zooms]. These visualizations are seamless between datasets and are usually cloudless. We have created zooms into numerous cities including New York, Chicago, Los Angeles, Washington, San Francisco, Atlanta, Salt Lake City and Orlando which have been shown in such broadcasts as the 2002 Olympics and the Super Bowl XXXVI.

In order to generate a large number of these zooms, we developed a production pipeline that allowed us to efficiently distribute the work involved. The pipeline consists of *Data Acquisition*, *Georegistration*, *Rendering*, and *Color Matching* phases.

Data Acquisition involved the identification and collection of datasets at the various resolutions covering the particular areas. We usually worked with 1-meter IKONOS data, 15/30-meter Landsat7 data, and 250meter/4-kilometer Terra/MODIS data. We usually started by choosing the best 1-meter IKONOS data, and then choosing the other data sets based on the same time of season. We had problems with clouds, water, and snow between various datasets, sometimes limiting the locations that we chose. We also required that our zoom targets be somewhat centered in the images causing us to often composite several images at the same resolution together.

Georegistration of the data was necessary to ensure that each layer was represented in the exact same map projection. This phase also involved pan-chromatic sharpening of the images using principal component analysis [P. S. Chavez, S. C. Sides, and J. A. Anderson] where appropriate. We used ERDAS Imagine software to pan-sharpen and register most of our datasets.

Color Matching was the most time consuming portion of the pipeline. We found that without extremely close color matching by hand, the human eye could pick up boundaries. Therefore, this phase involved a person using Adobe Photoshop carefully matching colors between datasets. Numerous adjustment layers where used for each image such as Color Balance, Hue/Saturation, Levels, Curves, and Brightness/Contrast. This phase was very iterative – changes where made, then render tests were performed to see where problems existed and the phase was repeated.

Rendering and animation was accomplished using Maya and Renderman. Maya was used to set up the scene with geometry, cameras, and lights. The camera was controlled analytically to produce the desired exponential motion. A custom Renderman shader called the ‘registration shader’ [G. W. Shirah, H. G. Mitchell] was used to precisely place each dataset on the sphere and blend between them. Renderman allowed us to deal with multiple extremely large textures very efficiently.

Each phase of the pipeline is, for the most part, independent allowing multiple people to work asynchronously. The pipeline has enabled the SVS to produce over 30 zoom visualizations. These visualizations have played a major role in helping NASA spread it’s remote sensing outreach messages.

Future Trends

In the past, our delivery mechanism has been broadcast quality NTSC betacam-SP videotape. Recently we have begun delivering only digital frames. These frames are still usually NTSC resolution, but we are now starting to produce a significant number of High Definition Television (HDTV) frames for delivery as well. In the near future, all of our products will be digitally available all of the time via the Internet. We will likely start producing only HDTV resolution frames in the near future.

The field of scientific visualization is a subset of computer graphics. Computer graphics technology is constantly evolving as demonstrated by continual advances in the state of the art in motion pictures and television. Since our primary audience, the general public, is constantly exposed to television and movies, their expectations are continually increasing. New and more complex visualizations become possible each year as more capabilities are realized such as complex particle dynamics, fluid flow simulations, and volumetric rendering techniques.

In the future (and even now) computer graphics imagery will be indistinguishable from reality (when desired). Increased computer processing power allows for more iterations of more complex visualizations – facilitating the production of visualizations that convey the science stories even better.

References

P. S. Chavez, S. C. Sides, and J. A. Anderson, Comparison of three different methods to merge multiresolution and multispectral data: Landsat TM and Spot panchromatic, *Photogrammetric Eng*. *Remote Sensing*, 57(3), pp. 295-303, 1991]

G. W. Shirah, H. G. Mitchell, NASA's Great Zooms: A Case Study, IEEE Visualization 2002 Proceedings, pp 541-544]