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49

Welcome to Issue 49

1998

Features

	Page
AISRP - Automated Identification of Morphological Signatures in Global Auroral Images	1
AISRP - NCSA's Project 30: Accessing Space Science Data	5
MPF Technology Aids in Search for Sunken Whaling Fleet	7
WebWinds - A Platform Independent Distributed and Extensible Visual System	8
Computer Interface Facilitates Communication for the Deaf-Blind Community	9
First Web Simulcast with NPR Radio Program	11

Outreach

Report on Visiting Student Enrichment Program 1998	13

Spinoff

Technology Provides Early Emergency Warnings to Motorists	14
ARC Partners to Implement Virtual Hospital	15

The NASA Science Information Systems Newsletter (SISN) is prepared for the Office of Space Science (OSS), Science Information Systems (SIS) Program through an agreement with the Jet Propulsion Laboratory. The newsletter, which has been an ongoing task for over ten years, is a forum for the space science and applications research community to report research and development activities, outreach activities, and technology transference. SISN offers a venue for articles that are not likely to appear elsewhere and provides the opportunity for information exchange within the science community, as well as a platform for accomplishments by that community. Related articles from other programs and agencies are also published.

Questions or comments regarding this newsletter task may be emailed to Sandi Beck at <sandi.beck@jpl.nasa.gov>.

Credits: Design and format by Editor, Sandi Beck. Graphics design, animation, and rollovers by Scott Brenneisen, XTREME GRAFX. Also, thanks over the years to Calvin Yee, formerly of Telos Information Systems, Doug Steinwand, formerly of JPL, and the JPL documentation staff.

The Applied Information Systems Research Program (AISRP) maintains an awareness of emerging technologies applicable to space science disciplines, supports applied research in computer and information systems science and technology to enhance NASA Office of Space Science (OSS) programs, stimulates application development where warranted, and provides for the systems analysis and engineering required to transfer new technology into evolving OSS space science programs through NASA Research Announcements.

Automated Identification of Morphological Signatures in Global Auroral Images

P. G. Richards, H. Ranganath, and G. A. Germany, University of Alabama in Huntsville

The purpose of this research is to develop software to extract useful scientific information from a large data base of auroral images taken from space. Initial development of this software is based on images from space that have been obtained by the Ultraviolet Imager (UVI) [Torr et al., 1995] on the Polar satellite but the software will also be applicable to data from past, current, and future imaging programs. UVI is one of three global auroral imagers on the POLAR satellite [Harten and Clark,1995], which was launched in late February 1996 as part of the NASA Global Geospace Sciences (GGS) mission [Acuna et al., 1995]. GGS is a part of the International Solar Terrestrial Physics (ISTP) program. UVI has been operational since mid-March 1996 and has returned over 1.5 million images to date.

What is the aurora?

The aurora is a dazzling light display that occurs in the upper atmosphere above about 100 km altitude in the arctic regions of the Earth. It is caused when charged particles from the Sun strike the region dominated by the magnetic field of the Earth (magnetosphere). Some of the energy is transferred to charged particles in the magnetosphere which race along the magnetic field and crash into the atmosphere. These collisions cause the atmospheric gases to emit the red, green, and blue light that forms the spectacular auroral displays that are visible from Earth.

The Aurora over artic regions

The auroral oval is a ring several degrees wide encircling the magnetic poles where the probability of observing auroral activity is high. Information about the location and size of the aurora is critically important for determining the rate of energy deposition into the upper atmosphere by electron precipitation into the atmosphere and is a key input to global circulation models, which are needed to improve the prediction of ionospheric storm effects, which can severely disrupt satellite orbits, electricity grids, and radio communication. The location of auroral boundaries also plays a key role in understanding the morphology of the aurora and its relationship to magnetospheric boundaries.

Sample image identifications

The extraction of the auroral oval from auroral images is a challenging task because the aurora is a dynamic object which may grow, thicken, thin, fade, or brighten in the time between images. It may also be partially obscured by the field of view of the instrument and the bright emissions from

the sunlit part of the Earth. This dynamism is evident in the UVI movie, which shows a spectacular example of a major auroral event that occurred on January 10, 1997, four days after the Sun spat out a cloud of charged particles. As the magnetic cloud reached the Earth's magnetosphere, UVI observed a strong response in the form of increased auroral emissions. The peak of the aurora occurred at 1100 UT on January10, with activity reaching as far down as 55 degrees latitude from both poles. Results of applying the algorithm to the first few hours of the January 10, 1997 UVI images is shown in the pulse coupled neural network (PCNN) movie. Comparison of the two movies shows how the software automatically finds the regions of auroral activity.

Analysis approach

The approach to determining the auroral boundaries is to use a segmentation algorithm based on a PCNN initially to identify the pixels that belong to the aurora. If a digital image is input to a PCNN, the network groups image pixels based on spatial proximity and brightness similarity. During grouping, the network bridges small spatial gaps and minor local intensity variations.

In a paper that was recently submitted for publication [Germany et al., 1997], the PCNN masks have been used to determine the poleward and equatorward boundaries of the auroral using one hour bins in magnetic local time for each available image between 0100 and 0430 UT. The image masks allowed a detailed study of the substorm growth phase from 0230 to 0338 UT which is clearly seen in both the equatorward and poleward boundaries in the 2400 MLT sector. The equatorward boundary advances from 68 to 60 degrees magnetic latitude during the growth period. The poleward boundary moves from 77 to 65 degrees at the same time. The growth phase is also seen in the 0300 and 2100 MLT sectors of both boundaries. The substorm onset is seen in the northward expansion of the poleward boundary as seen in the 2100, 2400, and 0300 MLT data. The dusk/dawn boundaries at 0600 and 1800 MLT show little response to either the substorm growth phase or the initial substorm onset. The period of time between 0200 and 0300 UT is dominated by the transpolar arcs as seen in Figure 1, which shows images and derived image masks for three periods during the january 10, 1997 magnetic storm. The UVI images are unprocessed except that the images have been scaled to enhance the dim oval forms for the human eye. This is for presentation only. No scaling was done for use with the Pulse Coupled Neuron (PCN) algorithm. In each image, local midnight is to the bottom, noon to the top, and dawn to the right.

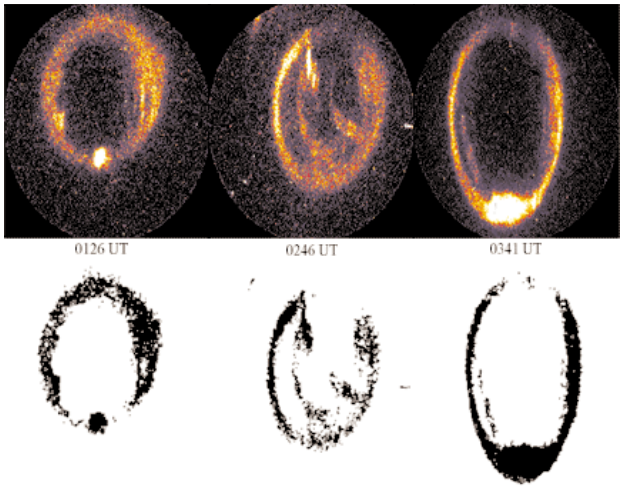

Figure 1. Images and derived image mask for three periods

Pulse Coupled Neural Network

The PCN model is a modified version of the cortical neuron model of Eckhorn et al. [1990] which has been developed by Ranganath and Kuntimad [1994] for image processing applications. A PCNN is a single layered, 2D, laterally connected network of pulse coupled neurons. There exists a one-to-one correspondence between the image pixels and network neurons. That means each pixel is associated with a unique neuron and vice versa.

If a digital image is applied as input to a PCNN, the network groups image pixels based on spatial proximity and brightness similarity Kuntimad [1995]. During grouping, the network bridges small spatial gaps and minor local intensity variations. This is a very desirable property for image processing applications. We have employed PCNNs for image smoothing, segmentation, and even feature extraction. The PCNN based iterative technique smoothes images without blurring, eroding, or dilating edges.

A PCNN based segmentation method, under certain conditions, guarantees perfect segmentation of the input image even when the intensity ranges of adjacent regions overlap. Perfect segmentation conditions are derived in Kuntimad [1995]. The inclusion of an inhibition receptive field in the neuron model significantly improves the segmentation capabilities of the PCNN by compressing the intensity ranges of the individual regions in the image and by reducing the extent of overlap of the intensity ranges of adjacent regions. Simulation results have indicated that, for two region images, the PCNN yields better segmentation results than intensity thresholding, region growing, split and merge, relaxation and boundary detection methods.

There exists a one-to-one correspondence between the image pixels and network neurons. That means each pixel is associated with a unique neuron and vice versa. For example the network neuron Nij is associated with the image pixel Pij. Each PCN consists of an external feeding input, linking receptive field, threshold signal generator, and a spike generator as shown in Figure 2, the PCNN chart.

The external input to Nij is Xij, the intensity of the pixel Pij. Therefore, the feeding input Fij(t) is equal to Xij. All linking leaky integrators are identical. Vl and tl are the amplification factor and decay time constant of a linking leaky integrator in the network. Each neuron receives linking inputs from its neighbors that are within a distance of r units from it. The distance between the neurons Nij and Npq is defined as the Euclidean distance between the corresponding pixels Pij and Ppq. The weighting factor for a linking input from a neuron that is at a distance of d units is 1/d2. The net input to Nij, denoted by Lij, is the sum of linking inputs from neurons that are within the linking receptive field of Nij. The internal activity Uij(t) of Nij which is analogous to membrane potential in biological neurons is computed by the equation Uij(t)=Fij(t)(1+ Lij(t))(1) where is a positive constant referred to as the linking coefficient. The threshold signal generators of all neurons in the PCNN are identical to one another. When the value of Uij(t) exceeds the value of the exponentially decaying threshold signal qij(t), Yij (output of Nij) pulses and sends linking input to its neighbors. Some neighbors of Nij with feeding inputs similar to that of Nij may pulse with Nij because of this linking input. If this happens, we say that Nij has captured its neighbors. At the beginning of each pulsing cycle the threshold signals of all neurons is initialized to qmax (greater than maximum possible value of feeding input) and then allowed to decay exponentially. Therefore, neurons with the highest feeding input pulse first naturally. These naturally pulsing neurons may capture other neurons in their neighborhood. This process of natural and secondary pulsing continues until all neurons pulse. This completes a pulsing cycle. Each neuron can pulse only once during each pulsing cycle.

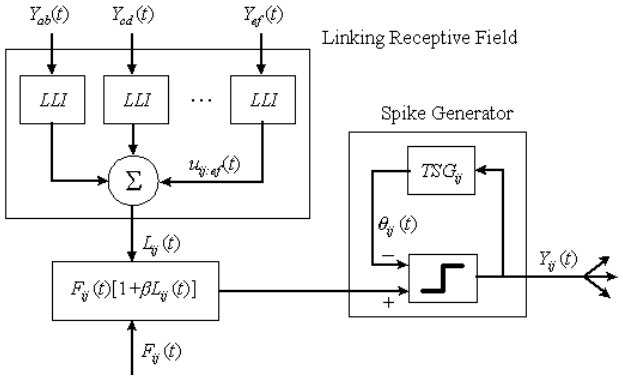

Figure 2. Auroral oval extraction

The aurora oval extraction system consists of four major modules: (i) smoothing, (ii) segmentation, (iii) control, and (iv) knowledge base.

Step 1: The input image is smoothed to reduce the effects of random noise.

Smoothing of the auroral images is necessary to reduce the effects of random noise. Three image smoothing methods, neighborhood averaging, median filtering, and PCNN based smoothing methods are being compared. The first two are well known methods that are widely used for image smoothing. The PCNN based method is a fairly new technique and is described below.

The PCNN based image smoothing technique developed by Kuntimad [1995] is used. In general, the intensity of a noisy pixel is expected to be significantly different from the intensities of the surrounding pixels. Therefore, neurons corresponding to most of the noisy pixels do not pulse with their neighbors. In other words, neurons corresponding to noisy pixels neither capture neighboring neurons nor are captured by them. Image smoothing can be accomplished by adjusting the intensity of each pixel so that the corresponding neuron either captures its neighbors or is captured by them. The intensity of each neuron is adjusted when it pulses and the adjustment procedure is described below:

- When a neuron Nij pulses, if a majority of the neurons linked to it have not yet pulsed during the current pulsing cycle, the intensity Xij is adjusted down by subtracting C, where C a predetermined constant.
- When Nij pulses and a majority of the neurons linked to it have already pulsed during the current pulsing cycle, the intensity Xij is adjusted up by adding C.
- If there is no clear majority then the intensity Xij is not altered.
- At the end of each pulsing cycle, thePCNN is reset, the modified image is applied to the PCNN and the smoothing process is repeated.

Early simulation results indicate that, while the neighborhood averaging method is computationally efficient, it has the undesirable property of blurring fine features of the aurora oval. Significant blurring of the auroral boundary usually leads to liberal extraction.

Because the auroral oval has a variable intensity and a discontinuous boundary, median filtering omits many boundary pixels; leading to a conservative extraction. The PCNN is capable of retaining fine features while smoothing the image, but being iterative in nature, it is too slow for a software implementation.

Step 2: The image is segmented by a PCNN in one or more stages using the knowledge based approach.

Aurora images differ from one another in size, shape, brightness, and contrast. The oval is completely visible in some images and partially visible in others and the background may be uniform or non-uniform. The segmentation process has to deal with the Earth's limb and stars that may appear in the image. No single method can be expected to accurately segment all types of images. Therefore, the the decision was made to develop an adaptive knowledge based segmentation approach which is driven by attributes that characterize the oval and background. During the first year, techniques for analysis of two distinct classes of aurora have been developed.

First, simple images which are characterized by a complete oval and fairly uniform background are segmented by the PCNN in one step. You obtain a liberal to conservative extraction of the aurora by controlling the level of segmentation. Second, a multistage segmentation approach is being

developed for images in which the background intensity is not uniform due to solar illumination or the presence of stars in the field of view. The approach is briefly described below.

The control module identifies a small subimage for segmentation with the aid of information stored in a knowledge base. The selected subimage is applied as input to the segmentation PCNN causing the network neurons to pulse based on their feeding and linking inputs. Note that the feeding input to a neuron is the intensity of its corresponding image pixel. Due to the capture phenomenon the neurons associated with each group of spatially connected pixels with similar intensities tend to pulse together. Thus, each contiguous set of synchronously pulsing neurons identifies a segment of the image. The value of the linking coefficient has a significant effect on the segmentation process. If the value of is low, the pixels that belong to a single region are partitioned by the PCNN into several segments. This is known as over-segmentation. On the other hand, if the value of is high, the PCNN groups pixels that belong to two or more regions to form a single segment. This is known as under-segmentation. It may be possible to find the optimal value of based on the intensity probability density function of the image and the geometry of objects present in the image. Another approach is to segment the subimage using different values of and pick the best result.

After locating a segment of the auroral oval, the control module will select the next subimage for segmentation. The size and location of the subimage will be determined based on prior knowledge and parts of the aurora oval that have already been identified. This process of finding the auroral oval piece by piece continues until a skeleton of the oval is found.

Conclusions

The final product will be able to automatically recognize standard auroral morphological signatures such as location of equatorward and poleward boundaries, total area of the auroral display, and total integrated intensity in selected areas of the auroral oval as well as identification of features such as arcs, theta aurora, and substorm onset. Each of these morphological displays is a signature of processes occurring throughout the Earth's magnetosphere, thermosphere, and ionosphere (above 100 km altitude) and are critical to understanding its interaction with the solar wind.

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The Applied Information Systems Research Program (AISRP) maintains an awareness of emerging technologies applicable to space science disciplines, supports applied research in computer and information systems science and technology to enhance NASA Office of Space Science (OSS) programs, stimulates application development where warranted, and provides for the systems analysis and engineering required to transfer new technology into evolving OSS space science programs through NASA Research Announcements.

NCSA's Project 30: Accessing Space Science Data

Robert E. McGrath and Joe Futrelle, NCSA, and Raymond L. Plante, Department of Astronomy/NCSA

Project 30 is a collaboration of the Radio Astronomy Imaging Group and the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana Champaign. The main goals of the project are the application of new Web and Internet technologies to improve access to astronomy and space science data, and to bring scientific data into the Digital Library of the future.[1] One key problem is locating and evaluating complex scientific data sets that may reside at many repositories on the global Internet. Standard Web browsers and servers are not well suited to deal with scientific data because the objects are large, complex, and diverse. Such objects include text abstracts and articles, rendered imagery, observational data, and simulations.[2,3]

The Astronomy Digital Image Library (ADIL) serves radio astronomy and related scientific data and imagery to scientists, students, and the public. The ADIL provides cross links to related data and information resources. For instance, each dataset stored in the ADIL has the URL of the published abstract in the Astrophysics Data System (ADS) that described the data. Using the ADIL, scientists can quickly locate data and publications most relevant to their inquiry.

Since it's inception, the ADIL has served as a technology testbed, bringing NCSA's computer and information technologists together with working scientists. Today, our team is working closely with the data centers of NASA's Space Science Data Services (SSDS) and other information providers, tying together the many information sources of interest to astronomy and space science.

New technology

Current work has centered on three important new technologies:

- Java-based browsing of scientific data and imagery
- an interactive VRML server to visualize multi-dimensional data
- interoperable search across databases, using the ISO Z39.50 standard for information retrieval

Java classes for a "first look" at scientific data

NCSA's Horizon Image Browser is a collection of generic Java classes, customizable for specific applications. The applets provide simple, general solutions to accessing scientific images, handling metadata, world coordinates, object names, and other important functions. This software is freely available for scientists and educators who wish to create their own data browser.

A VRML server for 3D visualization of radio astronomy data

The team has created a powerful 3D visualization system for the data in the ADIL, which is available to users through a standard Web interface. You select radio astronomy data from the ADIL and specify parameters of the visualization. The visualization is created by compute servers at NCSA and the output is stored as standard VRML. The VRML can be downloaded and interactively navigated with standard Web plug-ins, and you can revise the parameters to control the visualization. The resulting VRML can be stored in the ADIL and disseminated as an additional form of imagery.

Enabling cross discipline research: interoperable searching

There are many independent sources of scientific information and data on the Internet, provided by large and small institutions, individual projects, and even individual scientists. Many data services provide the ability to search for data items relevant to particular scientific questions. In order to locate all the information available relevant to a scientific question, a scientist or student might have to search tens or even hundreds of data services. Not only does the user have to repeat the query and collect the responses, each service has a unique interface, and returns information in it's own unique format.

The ISO Z39.50 standard

The team is exploring the use of Z39.50, the ISO information retrieval standard. Z39.50 is an established standard, with hundreds of information services already using it, and many commercial products are available. The same infrastructure is being used for many kinds of information services, such as medical and technical literature, geospatial imagery, as well as space science data. Using Z39.50 enables any compliant client or server to interoperate. This will open the door for searching multiple data sources with a single query. Since most libraries and text services already use Z39.50, it will be possible to locate both scientific data and published literature, with a single search.

The team has designed an architecture for cross database search, and are implementing the key pieces required.[4] The software is freely available so that any data provides, small or large, may participate. There are three components, currently under construction:

- a free, drop in Z39.50 server (pizazzd) that can be added to any on-line data service without changing the existing facilities
- a gateway (gazebo) that is configured to search a set of data services (using Z39.50), and return the combined results
- a Java toolkit that provides classes to interface with the gazebo server. The Java classes provide windows to construct queries, report on the progress of searches, list results, and display standard types of records.

The latest version of this software is available from our Web pages.

Interoperable search - the importance of profiles

Z39.50 is like the Web in that it is a communication protocol that transports but does not define what queries and results should be. For cross database search to be possible, communities must define profiles define standard queries and responses relevant to specific problem domains. Profiles serve as common denominators, so that cooperating data services can answer commonly used queries in standard ways, and return results in standard formats.

The team is currently working with astronomers and space scientists, led by the SSDS Technical Working Group (TWG), to define a set of profiles for different kinds of space science data. A draft profile for searching observational data, submitted for consideration by the SSDS TWG, has been published. [5] Similar profiles are being developed for planetary, solar, and space physics data.

Future work

As this project continues, the team will work with scientists, educators, and data providers to complete and refine profiles for astronomy and space science data. In the research system, the team will demonstrate an implementation of these profiles using its Emerge technology, based on Z39.50. In this demonstration, the team will deploy its software at several sites, to provide advanced, more intelligent searching.

A key area of future work will move from standardizing queries into the more difficult problem of standardizing the format of responses. Implementing standard, structured records will make it possible for gateways and clients to intelligently process the results of search, paving the way for many advanced services, such as search agents, automatic query refinement, and the cross-correlation of information from different sources

Acknowledgements and References

Project 30 is funded by the NASA Office of Space Science's Applied Information Science Research Project (AISRP) . A portion of this work was originally funded by Project Horizon, a NASA CAN NCSA is supported by the National Science Foundation, the State of Illinois, and private and public partnerships.

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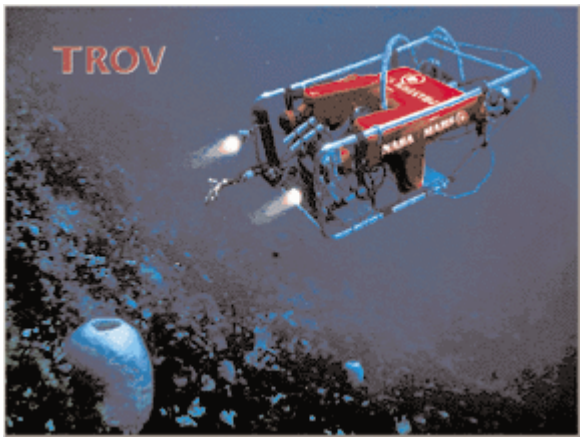
MPF Technology Aids in Search for Sunken Whaling Fleet

Using technology originally developed for the Mars Pathfinder (MPF), NASA scientists began a search in August of this year for a whaling fleet lost in 1871 beneath the frigid waters of the Arctic Ocean. Scientists from Ames Research Center (ARC), are using an underwater telepresence remotely operated vehicle (TROV) equipped with a pair of stereo video cameras to record underwater footage in 3D. Computer software developed for Pathfinder by the Intelligent Mechanisms Group (IMG) at ARC is being used to produce a virtual reality computer simulation of the underwater environment. Scientists believe these marine maps can be used for astrobiology hydrothermal vent research and for marine biology and archaeology research.



Credit: Example of a TROV, developed by ARC's IMG. Photograph courtesy of the IMG Website.

The expedition

Scientists will deploy the TROV from aboard the US Coast Guard cutter, Polar Star, one of the world's most powerful non-nuclear icebreakers, which will depart from Seattle and travel north along the Canadian and Alaskan coasts to Point Barrow. During its journey, the Polar Star will pass through the waters near Icy Cape, where the New Bedford whaling fleet sank in September of 1871 after becoming trapped in the ice and abandoned.

Credit: US Coast Guard cutter, Polar Star. Image courtesy of the Quest/Artic homepage.

Jeff Ota, an ARC research engineer and the project leader, explained that the goal was to locate the sunken fleet, reportedly situated between 27 and 52 feet of water, and deploy the TROV to take images of at least a few of the ships. According to Ota, TROV's stereo cameras along with the software developed by the IMG promise to attain a new level of 3D accuracy, detail, and realism that has not been achieved to date in the underwater realm.

During the July 29-August 30 Arctic expedition, NASA scientists worked with the National Oceanic and Atmospheric Administration (NOAA) West Coast and Polar Regions Undersea Research Center, Santa Clara University, and the US Coast Guard to try to locate the sunken whaling fleet. They also searched for the remains of a mastodon or mammoth, extinct mammals resembling giant elephants.

Student participants

The ARC Learning Technologies Project, led by Mark Leon, and the "Jeremy Project," named after Jeremy Bates, Santa Clara University's student principal investigator, participated in the expedition. NASA's latest technological advances such as robotic underwater rovers, stereo imagery, and computer software, were used by these projects to make the marine environment more accessible. Project students plan to disseminate information from the expedition to schools throughout the nation during "Live from the Arctic" Internet web chats in an effort to stimulate interest in marine research.

"It is our hope that NASA's technology will make underwater research more efficient and more accurate and give us a better picture of how we have historically related to the

sea," Bates said. "We want to make it easier for scientists to map marine archeological sites more accurately and efficiently."

In addition to Bates, Jeremy project participants included California students from Santa Clara University, Santa Clara; Case Western University; Aptos High School, Aptos; Broadway High School, San Jose; and Seth Carter, a Raytheon Corporation contractor from ARC. During the expedition, project team members stopped at towns and villages along the Alaskan coast to discuss environmental concerns with residents in Kodiak, Nome, Chuckchi, and Point Barrow.

"More than anything else, it is our hope that this cooperative project will be used as a stepping stone for scientists in the future in order to learn about mankind's past and continuing relationship with the sea," Ota said.

Excerpted from NASA press release 98-42, written by Michael Mewhinney, ARC, July 23, 1998.

Learn more about the Arctic Exploration - including the Jeremy Project, and ARC's Intelligent Mechanisms Group - at <http://quest.arc.nasa.gov/arctic/> and the Learning Technologies Project <http://learn.ivv.nasa.gov/>. ■

WebWinds - A Platform Independent Distributed and Extensible Visual System

Lee Elson, Earth and Space Sciences Division, Jet Propulsion Laboratory

Visualization has always been a part of many scientific analysis activities. Exploring today's large and complex data sets often requires the detection of trends, correlations, and anomalies. Previously the Earth and Space science Division at Jet Propulsion Laboratory developed a package called LinkWinds, which is a highly interactive, multidisciplinary, client-based, visual data analysis tool. LinkWinds' functions and services include 2-D and 3-D graphical displays of data, hard copy of graphical displays and numerical information, interactive color manipulation, animation creation and display, data subsetting at both input and output, a journal and macro capability, context-sensitive help, and network support for collaborative data analysis. Using this package, it is easy to detect interesting trends in long-term data sets.

Researchers today must be able to do more than use a client tool with a downloaded data set. The emergence of the World Wide Web has made it possible and necesssary to distribute data as well. This is best done through client-sever arrangements that accommodate different computer platforms and deliver data dynamically so the client can expeditiously obtain just the information that is needed. Although current Web browsers run on most platforms, they lack the necesssary dynamic capabilities for efficient research. To address this issue the group is developing a Java-based tool called WebWinds, which is based on the LinkWinds paradigm.

Program objectives

The program objectives for developing WebWinds are to develop a data analysis environment that:

- inherits LinkWinds functionality, making it intuitive and easy to learn
- is platform independent so that it functions efficiently in today's heterogeneous environment
- is modular, allowing flexibility in tool construction and application and thereby lowering costs
- is a system that can be distributed over the net
- is user extensible, with interface standards that facilitate enhancements
- is scalable to client capability to accommodate a broad range of hardware and software
- addresses needs of data providers as well as consumers
- is secure so that access can be restricted at several levels

Implementation features

The freely distributed WebWinds development kit provides UNIX, Mac, Windows 95/NT protability; JAVA database connectivity API; remote method invocation, servelet and server APIs; and JAVA Beans APIs. Currently, the inital design is complete, with performance, upon testing, better than expected. WebWinds features platform independence (Mac, PC, UNIX), secure distributed processing, user extensibility, standardized interfaces, and will have an advanced data manipulation capability suitable for data servers. These features will help conserve network bandwidth and provide an analysis environment that can be tailored to match a platform's capabilities.

Future development

You can expect to see additional features in the next few months. Some of them are:

- 3-D displays of data including globes and planes with vertical relief and shading
- output capability in FITS, HDF, ASCII and binary formats
- a powerful scripting language which will allow macros to be used to re-run sessions and collaborate over the Internet
- the ability to read tabular-type ASCII data
- the ability to display data that is not on a uniform grid
- concatenation of data files

Learn more about LinkWinds by emailing the development team at <webwinds@twinky.jpl.nasa.gov>. ■

Computer Interface Facilitates Communication for the Deaf-Blind Community

Beth Gaston, Public Information Officer, National Science Foundation

According to recent surveys by the Helen Keller National Center, nearly 60,000 individuals in the US are deaf-blind, a condition in which a combination of visual and hearing impairments cause a severe communication and/or developmental gap. Individuals with this condition may suffer feelings of isolation, a lack of independence, difficulty in obtaining education, and inadequate employment opportunities. The underlying foundation of all of these problems is the barrier to communication. A common approach to overcoming this barrier is the use of a human sign lanquage interpreter. However, currently the National Science Foundation (NSF) is funding the development of computer-based technology to facilitate communication for the deaf-blind. Developers include the Applied Science and Engineering Laboratories at the duPont Hospital for Children and the University of Delaware.

Alternative communication

Krista Caudill, who has been deaf and blind since she was a child, uses the Internet extensively to stay in touch with many people around the world. However, she must rely on a human interpreter for face-to-face interactions with people who do not know sign language. Because trained interpreters are costly and must be scheduled in advance, spontaneous one-to-one conversations are difficult.

Krista with her sign lanquage interpreter. Credit: photo courtesy of the Speech to Braille website.

Caudill has been eager to pursue a meaningful college education, but both formal education and personal interactions are frequently stymied by her complete dependence upon a sign language interpreter to communicate. As an undergraduate researcher at the University of Delaware, she is helping to design a portable computer that will "speak" as she types and will translate other people's speech into Braille. The project, funded by the NSF, is called Speech to Braille. This computer-based system will begin to free Caudill and others like her from total dependence on sign-language interpreters in order to communicate.

Conceptualizing the design

Speech to Braille was inspired by Caudill's participation in an undergraduate student design course taught by Richard Foulds of A.I. duPont Hospital for Children. Using a technique known as scenario-based design, Caudill and a colleague, Beth Finn, developed a conceptual design that was selected as a winner in the student design competition of the

Rehabilitation Engineering Society. The project was then funded with a grant from NSF.

During the project's two-year study period, student researchers are constructing a working prototype by brainstorming and writing trial scenarios describing the technology and the interactions of users, who include both the deaf-blind individual and the those with whom he/she communicates. The scenario is "acted out," assessed, modified, and iterated until a truly user-responsive scenario is achieved. The goal is to create a system that is useful a wide range of individuals.

The following is a scenario, incorporating the flow of movement and actions comfortable to users, respecting personal space and normal conventions of social interaction, and accommodating the limitations of commercial computer technologies, that was developed by the researchers:

The deaf-blind user is working in an office with a computer. A co-worker enters the room, triggering a device that sends a signal to the user, announcing the co-worker's presence. The user's choice of responses includes: acknowledging the co-worker, ignoring the co-worker, or indicating that the co-worker should come back at a more convenient time.

Once acknowledged, the co-worker lifts the handset, says, "Hello," and several processes begin simultaneously. In the background, without interrupting currently open applications, the computer chooses the appropriate voice file for the co-worker. Additionally, a second signal indicates that the co-worker wishes to speak to the user.

Once the user is ready to converse, a pre-defined key combination accesses the communication software. The communication window is a split screen with the co-worker's remarks occupying one half and the user's comments in the other. The Braille terminal displays the co-worker's name based on the selected voice file and conversation can then commence. As the user types comments into the window, the speech synthesizer converts the text to spoken language. As the co-worker speaks into the handset, speech recognition software translates the spoken words into text, which is output to both the monitor and the Braille terminal. Once the conversation is finished, the co-worker leaves, and the user returns to work.

Krista and Beth have a "conversation" on the project workstation. Credit: photo courtesy of the Speech to Braille website.

Developing the prototype

In the laboratory prototype, developed on a PC, the system integrates several hardware and software components to translate speech to Braille and keyboard input to synthesized speech, including a multi-tasking operating system that is fully compatible with preferred software packages; software that translates the output onto an Braille terminal; commercially available software that allows complete voice control of the system for integrated and sophisticated voice recognition; a high-quality microphone placed in a wall mounted telephone unit; a text-to-speech synthesizer; and object oriented programming lanquage.

Based on the feedback from a test group of deaf-blind users, the project team is confident that a market exists for such a system. Even with th limitation of the dictate system to speak isolated words, the team determined that the speed of conversation was still close to 50% of spoken conversations (100-150 wpm) and equivalent to interpreted conversation. The speech synthesizer is limited only by the typist's speed. Many enhancements are planned for future models.

The project workstation. Credit: photo courtesy of the Speech to Braille website.

"Computers have such potential to open doors to better communication for people with disabilities-and for all people," said Gary Strong, NSF program manager for human-computer interaction. "By understanding how computers can mediate communication, we can not only help Krista and the deaf-blind community, but potentially everyone."

Translating information formats

in addition to designing the prototype that Caudill will evaluate extensively in the real-world setting of her campus, researchers will study the impact on communication between individuals when a computer translates the information from one format to another, such as from the spoken word to Braille. During such translation, errors are inevitable.

To this end, the project will address many questions:

- How many mistakes are acceptable before communication breaks down?
- What happens when Caudill is talking to someone who has never used such a system?
- How will the users adapt to using a computer to facilitate human-human communication?

- Can the system be adapted to include other users, such as people who are deaf-blind, people with other disabilities and perhaps people who have no disabilities?

Caudill is pleased to be part of the project. “This system will help me tremendously,” she said. “I will be able to communicate with other people who don’t know sign language. I would be able to have conversations with a group of people, such as a study group, or carry the laptop and use the system in public. It will also help other people who are like me.” ■

Krista using the project workstation. Credit: photo courtesy of the Speech to Braille website.

Hubble Space Telescope Space Science -

First Web Simulcast with NPR Radio Program

Carol Christian, Bonnie Eisenhamer, Stratis Kakadelis and Jonathan Eisenhamer, Office of Public Outreach, Space Telescope Science Institute

Merging National Public Radio (NPR) broadcast talk radio programming with Web resources, the Office of Public Outreach (OPO) at Space Telescope Science Institute (STScI) collaborated with the Baltimore station, WJHU, and the Marc Steiner Show to simulcast live audio and multimedia to a worldwide Internet audience. OPO is responsible for all news, education, and outreach showcasing the science research and technological advances associated with NASA’s Hubble Space Telescope (HST) Program. STScI is managed by the Association of Universities for Research in Astronomy (AURA) on contract to NASA to operate the HST observatory. OPO provides public dissemination of informative and educational materials through networks of media, educators, science museums, planetaria, libraries, professional organizations, and community groups in addition to NASA’s established distribution networks.

OPO’s Emerging Technologies Experiments Program is an intitiative to test and evaluate new methods for delivering scientific and technical content through appropriate technology in the context of formalized curricula and distributed informal learning environments. The technology experiments are complemented by robust programs that provide affordable curriculum support materials tightly coupled to existing curricula and national science, mathematics, and technology standards keyed to educator needs.The previous experiments in the series include the “Passport to Knowledge” Live from Hubble project and the first international webcast on space science, Looking Beyond Boundaries, which took place during the HST second servicing mission in February 1997. The experiments are subjected to the same evaluation procedures as all other OPO programs in order to access both methodology, design, pedagogical approach, useablity, and accessibility.

Talk radio - a new venue

OPO provides regular media support to newspaper writers, TV and radio journalists, and science writers through interviews and a large suite of online Web materials such as images, textual information, video, audio, graphics, animation, and interactive tools. The Baltimore radio program, The Marc Steiner Show, is produced at the NPR station, WJHU. The show is renowned for its dynamic nature in which the host, Marc Steiner, guides his eclectic mix of guests through threaded discussions on a variety of topics addressing science, politics, social issues, and theology. The show format accommodates call in listener contribution and discussion with the guests, facilitated by Steiner.

The simulcast, dubbed Tour of the Cosmos with Marc Steiner, was created through a collaboration intiated by Steiner and Carol Christian, Head of OPO at STScI. The context of the program was to be a variety of scientific research topics related to recent NASA press releases on HST science.

Marc Steiner's guests included Carol Christian and Mario Livio, scientists from STScI, and Jim O'Leary, the director of the Davis Planetarium. The concept of the show was to support the radio program through a rich Web site populated with the imagery and other visually inspiring and educational materials.

The Web pages supporting the program were created prior to the simulcast and showcased a variety of images, graphics, and other multimedia related to a core suite of space science topics to be discussed during the program. The event took place on July 7, 1998, at 1PM EDT. During the radio show, the audio was broadcast live on the internet, and listeners could browse the web site, viewing the stunning HST images and explanitory materials that supported the discussion being heard. Call-in listeners and email questions were fielded by the guests, while the discussion was steered skilfully by Steiner.

The mix of Steiner as the "listener surrogate", asking thought provoking questions, with O'Leary serving as the adept science broker and interpreter, worked well as the scientists discussed topics such as the fate of our sun, the creation of black holes in galaxies, the size of the universe, and a timely rant on the possibilties of scenarios such as those depicted in the movie Armaggeddon.

A variety of questions was submitted from a diverse group of listeners. Email questions ranged from a 13 year old student asking "If there was a sensor very far from earth that analzyed light reflected from earth a very long time ago, [would it be] possible to see the past?" to a queston from a staff person at a US Network affiliate asking "what is the difference between a gas planet and a brown dwarf star?" A middle school teacher queried: "What do the different colors in the Planetary Nebula pictures taken by HST mean?"

The occupations of the listeners varied also. Fourteen of those surveyed were teachers and/or students while 84% came from occupations that ranged from retired professionals, laborors, planetarium directors in other states, to an internet service provider. The web audience statistics indicated that 9% of the web hits on the site were, and still are, from outside the country.

The post-production and evaluation

A multi-media slide show was added to the site after the radio program was aired. Users can listen to the rebroadcast, viewing a variety of images in context as the discussion is heard to proceed. Users can move randomly through the rebroadcast, and also delve deeper into the science and technical content through the website.

Listeners and subsequent web users responded enthusiastically:

- "I was incredibly impressed by the amount of work done to synchronize the images with the audio interview, along with the links."
- "Great Job!"
- "I really liked the format. The RealAudio program and the web pages change together from topic to topic. Very impressive and a great use of the technology."
- "I was very impressed with the organization of the information and was inspired by the content"

Users strongly preferred the slideshow audio/imagery/graphics rather than selecting supporting text to understand the material. The merging of the technology with broadcast radio was quickly adopted by listeners, demonstrating the need for further development of this merged technology. Some of those who commented:

- "This is one of the best things I have seen since I have been on the net for the past 5 years."
- "I love how the internet medium was utilized to it's higher than normally occuring potential...about 100%...and all for the greater good of mankind..."
- "A great internet concept whose time has come!..Keep these programs coming."
- "Excellent use of this media. It is a good thing to hear about current astronomy directly from scientists."
- "First time I have listened to a radio broadcast on the internet, and I will listen again. Thanks!"
- "Hearing real voices, rather then reading, was a great change.Please, have more 'episodes' like this one!" (high school student)

The website experienced 18,000 hits during the live broadcast hour and an equal number in the hours surrounding the show. The website continues to be accessed by roughly 7,000 users per month, with some users providing commentary on the material, demonstrating the substantial shelflife of this type of multimedia. ■

The goal of NASA's many outreach programs is to promote to the general public an understanding of how NASA makes significant contributions to American education systems and to institutions dedicated to improving science literacy. This newsletter provides one vehicle for reporting how applications and hardware used for space science and other NASA research and development can be adapted for use by teachers and their students and by non-NASA organizations.

Report on Visiting Student Enrichment Program 1998

Marilyn Mack, VSEP Chairperson, Goddard Space Flight Center

Students participating in this year's Visiting Student Enrichment Program (VSEP) culminated their weeks of hard work with thought-provoking presentations, delivered from August 3 through August 14, during Teas and Poster sessions. The presentations included 15-minute oral reports and World Wide Web reports to peers and management.

VSEP is a 10-week summer program in which mentors from Goddard Space Flight Center (GSFC) work with high school, college, and graduate students on projects that utilize computers for computer science tasks or for other science disciplines. Milton Halem, Chief of GSFC's Earth and Space Data Computing Division (ESDCD) initiated the program in 1984, with just a few students attending. VSEP has since grown both in NASA organizational participation and in the number of students it services.

Speakers and technical experts

VSEP students benefit from talks given by both management and technical experts at GSFC. This summer, for example, management speakers included Dorothy Perkins, then Deputy Director, Code 500; Vincent Salomonson, Director, Code 900; Mary Kicza, Deputy Director, GSFC; Gerald Soffen, Director, University Programs; and Al Diaz, Director of GSFC.

This year's technical speakers included Dr. David Batchelor, Asst. Manager, Gobal Learning and Observations to Benefit the Earth (GLOBE) project; John Dorband, Researcher, Experimental Supercomputer Studies; Horace Mitchell, Manager, GLOBE Project and Scientific Visualization Facility; Richard Lyon, Researcher, Center of Excellence in Space Data and Information Systems (CESDIS) Computation Studies; James Jeletic, Head, Hubble Space Telescope Project; Tom Baxter, Incident Coordinator, GSFC NASIRC Project; and Dr. Fritz Hasler, Researcher, Mission To Planet Earth Earth Observing System Project.

Students were also given tours of the NASA Center for Computational Sciences and GSFC. In addition to the tours and several social events, the students also enjoyed a field trip to Wallops Flight Facility.

VSEP participants

This summer, 27 students participated in the program, working in six different divisions within three GSFC directorates. Many students worked in areas related to information science. For example, Alyson Adams, a sophomore in Math and Computer Science at Gettysberg College, Pennsylvanis, applied Maximum Entropy to Solar Radio Flux under the guidance of Nino Bonavito (588/Applied Information Sciences and Technology Branch). Jason Atkins, a senior in Computer Science and Math at Kalamazoo College, Michigan, worked under Roger Dilling (630) with Allied Technologies on the NASIRC Project to uncover unlawful entry into GSFC machines. John Dorband (Science Computing Branch) directed Cherie Casey, a senior in Mathematics at Trevecca Nazarene University, Tennessee, in the study of Quantum Computing.

Other advanced supercomputing work was done by Timothy Folta, a sophomore in Electrical Engineering at Virginia Tech and Ben Deaton, a Junior in Computer Science at Carson-Newman College, Tennessee. Folta worked with mentors John Dorband (Science Computing Branch) and Udaya Ranawake (CESDIS). Deaton worked with Phil Merkey and Don Becker (CESDIS).

Joshua Fraser, a '98 graduate in Computer Science from the University of Missouri enhanced access tools through work on color editing of images in an interactive spread sheet with mentors Fritz Hasler (912) and Palaniappan (912 Visiting Scientist). Similarly, work by Eric Sokolowsky, a Masters student in Computer Science at Brigham Young University, Utah, under the guidance of Horace Mitchell

(ESDCD), improved the user interface to Digital Earth, a virtual reality program.

Other VSEP projects included various networking advances and web site tool development. Student reports will be available soon through the VSEP web page.

Learn more about VSEP, past and current, and how to apply at < http://sdcd.gsfc.nasa.gov/VSEP/>. ■

VSEP 98 Students. Seated (l to r): M. Munyoki, M. Lear, R. Dimitrov, J. Schwartz, B. Deaton, S. Hughes, M. Long, J. Fraser, M. Ponikvar, C. Kammogne, F. Hernandez. Standing (l to r): M. Mack (VSEP Chair), D. Lake, A. Adams, C. Casey, A. Kulesza, J. Graham, T. Folta, B. Handy, R. Moyer, K. Hussey, A. Morozov, J. Atkins, J. James, K. Pelman, C. Hunter. Not pictured: E. Sokolowsky and A. Manohar.

NASA's wealth of technology is being re-used in the fields of medicine, industry, and education and by the military to develop products and processes that benefit many sectors of our society. Spinoff applications from NASA's research and development programs are our dividends on the national investment in aerospace.

Technology Provides Early Emergency Warnings to Motorists

A new traffic technology developed by with the assistance of Jet Propulsion Laboratory's (JPL) Technology affiliate Program (TAP) can warn motorists of rapidly approaching emergency vehicles and trains. This technology, called the Emergency Vehicle Early Warning Safety System or E-VIEWS, equips emergency vehicles with transponders that communicate via microwave with receivers on large visual displays deployed on the mastarms above the centers of intersections.

As emergency vehicles approach an intersection that is equipped with E-VIEWS receivers, signal lights turn yellow, then red, for cross-traffic. The visual displays flash vehicle symbols to approaching drivers. The E-VIEWS screen also identifies the direction of the approaching or departing emergency traffic by moving the displayed vehicle symbol across the display in synchronization with the actual emergency vehicle's movements.

E-Lite Limited of Agoura Hills developed E-VIEWS, with assistance from TAP. E-Lite's President and CEO, Jim Davidson, has first-hand experience with the dangers of high-speed vehicles, having been nearly broadsided by a speeding fire truck at a Los Angeles intersection. According to Davidson, more than 156,000 accidents involving emergency vehicles occurred at intersections in US cities from the mid-1980s to 1995.

Through TAP, which provides large and small business an opportunity to solve specific tasks, E-Lite was paired with JPL engineers with specialized expertise to solve engineering design issues, such as customized transponders. TAP engineers also assisted with comprehensive designs that blend with existing city communications infrastructures. Currently, E-VIEWS is being further refined for future installation of demonstration models in large metropolitan areas. ■

NASA's wealth of technology is being re-used in the fields of medicine, industry, and education and by the military to develop products and processes that benefit many sectors of our society. Spinoff applications from NASA's research and development programs are our dividends on the national investment in aerospace.

ARC Partners to Implement Virtual Hospital

NASA's Ames Research Center (ARC) signed an agreement with Salinas Valley Memorial Hospital on September 9 of this year to partner in the implementation of state-of-the-art information technologies to develop a "virtual hospital," a healthcare facility with technology to transmit and manipulate electronically 3D high-fidelity resolute images in real time, by January 1999. Under the terms of the Space Act Agreement, ARC will establish a workstation at the hospital capable of transmitting data and receiving 3D images of the human body. Hospital medical teams will be able to transmit diagnostic data to ARC and evaluate and manipulate 3D images over NASA's Research and Education Network (NREN).

When the virtual hospital demonstration begins operations in 1999, hospital physicians will be able to provide feedback to NASA regarding image quality and network efficiency. Future plans call for ARC and the hospital to work cooperatively with Stanford University Medical Center and the Cleveland Clinic exploring the possibility of implementing the virtual hospital technology to remote areas around the world and eventually in space. The three hospitals, all major cardiac centers, will use high speed Internet links to exchange images and information. The virtual hospital will also enable doctors to conduct cooperative training exercises and to perform "dry run" surgeries using 3D images.

Learn more about the virtual hospital by emailing Mewhinney at <mmewhinney@mail.arc.nasa.gov>. ■