GRASSCLIPPINGS

Geographic Resources Analysis Support System Newsletter Vol. 6, No. 2, Summer 1992

The map above displays a three-dimensional visualization of noise contours over terrain at Ft. Knox, using **SG3d**. *Noise contours, depicted by the red, yellow, and white lines, were generated at five degree intervals between simulated sound source and listening points. Surface colors represent elevation, ranging from red at high elevations to yellow in the valleys. (graphic by Dave Gerdes, Bill Brown and Terry Baker, USACERL)*

Jamaica's UWI-MAGIC

by David M. Johnson

The University of the West Indies Centre for Nuclear Sciences (CNS) is the site of the first GRASS installation in the country of Jamaica. CNS, which is located at the University's Mona Campus in Kingston, is using GRASS for the development of a Geographic Information System (GIS) to support "early warning" environmental monitoring. Like all successful systems, CNS's GIS has its own snazzy acronym: The University of the West Indies — Environmental Monitoring and Analysis Geographic Information Computer system or UWI-MAGIC.

Funded by a grant from the Inter-American Development Bank (IDB), CNS is working to foster the development of a sustainable Environmental Monitoring Program for the island of Jamaica. CNS is doing this by providing base-line environmental data, by developing GIS capabilities to support environmental monitoring and by training environmental scientists and technologists from government organizations.

CNS is providing base-line environmental data by island-wide collection and analysis of air, water, and soil samples. These samples are analyzed at the Centre using an array of techniques including: neutron activation analysis, atomic absorption spectroscopy, ion chromatography, and x-ray florescence. These advanced techniques allow CNS to determine, among other things, the concentrations of chemical elements in each sample. Water samples are also tested for bacteriological content. Analytical results, observations, and other information concerning each sampling site are entered into a relational Data Base Management System (DBMS) on the Centre's MicroVAX. Sample site data from the DBMS is fed into UWI-MAGIC for the production of 3-D displays, maps, and other data interpretation aids.

The development of UWI-MAGIC involves four areas of work: the identification and evaluation of GIS applications, the development of the GIS digital map data base, the customization of GIS software and support of on-going CNS environmental monitoring activities. The work started in November, 1990 when DBA Systems, Inc. installed the *Sun SPARCstation*, *Altek* digitizer, *Tektronix* printer and the *GRASS* software that comprise UWI-MAGIC.

CNS is looking at a number of different

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SG3d Upgrade Provides Easier Positioning, Lighting

by Bill Brown

SG3d, a visualization tool for viewing spatial data in three dimensions has been upgraded for release with *GRASS 4.1*. **SG3d** runs on Silicon Graphics workstations under *IRIS 3.X* or *4.0.1*. It was also designed to run on *Indigo* 8 bit color workstations. The software takes advantage of the fast 3D graphics capabilities of the Silicon Graphics GL library for environmental visualization. The upgraded program features allow interactive light positioning, the draping of two-dimensional vectors over a three-dimensional surface, and easier viewpoint positioning.

Required inputs include the name of a *GRASS* raster file containing category values representing the vertical axis and the names of either one or three raster maps to supply surface red, green, and blue (RGB) color values. The vertical axis may represent true elevation values or any continuous data surface (e.g., concentrations of chemical contaminants and siting frequencies).

At program startup, one graphics display window and three graphical user interface panels appear on the graphics screen. Four additional panels pop up as needed. Using the mouse, users may move around the data space and view the surface from any height, direction, and perspective. As the user re-positions the viewpoint, the surface is animated using a wire-mesh representation. Once positioned, the surface may be drawn at a wide range of resolutions, using polygons alone or polygons with a grid draped on top.

Users can easily position a simulated light source when viewing terrain in three dimensions, which enables them to highlight specific features of their data or to enhance fine details that would not be noticeable using a color map alone. The lighting model consists of a simple pop-up control panel for light adjustments and a solid sphere that appears on the surface temporarily while the user adjusts light position, color, brightness, and surface shininess. The sphere is continuously updated during light adjustments, allowing users to immediately determine how lighting changes may affect the image of the data surface. When adjustments are complete, the

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Office of GRASS Integration Updates

from Marji Larson

We are developing something new here in the Office of GRASS Integration ...

A Software Enhancement Catalog.
The catalog is a file containing information about software enhancements being done with *GRASS*, a brief description of the end product, who is doing the work (what individual and organization) and an expected completion date. The information gathering has already begun. If you are working on enhancements to *GRASS* and expect to produce something you think might be of interest to others, please let us know (respond to larson@zorro.cecer.army.mil). We would like to include as much information in this catalog as possible so that it can be a source of help to others in the *GRASS* community. When someone is trying to complete a project and realizes that they need some new module, program, or *GRASS* capability, they can check the software enhancement catalog to see if the development they need is already under way. They might then decide to participate with the developer through an exchange of ideas or as a volunteer for testing the new module when it is completed. This "software enhancement catalog" file will be updated regularly, and a copy will be kept on the ftp site for easy access.

GRASS 4.1:

It looks like *GRASS* version 4.1 will contain many new and exciting software developments. Work is well under way to organize and integrate the many pieces in order to produce *GRASS 4.1*. Development and integration will continue through this summer, with testing scheduled for this fall. GRASS *4.1* is scheduled for release February and March of 1993. Testing has begun on a version of **XGRASS** that provides a graphical user interface (GUI) to most of *GRASS 4.0*. If you are interested in the possibility of being a test site for *GRASS* 4.1, please contact Marji Larson at 217-352-6511. ext. 504 or email larson@zorro.cecer.army.mil.

Documents:
Tutorials on the following subjects have been updated to be consistent with *GRASS 4.0* programs and naming conventions:

- **r.mapcalc**
- **r.combine**
- **r.infer**
- **v.digit**
- **DTED** and **DEM** elevation data extraction
- **DLG-3** data extraction
- image processing
- *TIGER in GRASS*: new *GRASS 4.0* importing routines for line data from the Census Bureau (See *GRASS/TIGER Tutorial Available with GRASS 4.0* in *GRASSClippings*, Vol. 6, No. 1, Spring 1992, pp. 10 and 16):

These tutorials are available on the ftp (file transfer protocol) site: moon.cecer.army.mil. They have been made available in both troff and postscript formats. Tutorials are also available from *GRASS* value added resellers.

Although *GRASS 4.0* programming information has been available through a combination of the *3.0 Programmer's Reference Manual* and some accompanying updating documents, a fully integrated 4.0 version of this manual will be completed sometime this summer.

FTP:
The volume and nature of items being made available for transfer over the Internet computer network continues to increase. The following new things are now available on the ftp site at USACERL:

- *GRASS 3.0 Programmer's Reference Manual*
- *GRASS 4.0 Programmer's Reference Manual* (uncompleted DRAFT)
- a draft version of the *GRASS User's Guide*
- a *Directory of GRASS Icons*
- a simple step-by-step description of the use of **v.in.arc** (*GRASS 4.0* command for importing *ARC/INFO* files)
- an increasing number of *GRASS 4.0* updates (simple enhancement or bug fixes)
- **xgen** information (draft documentation and examples)
- **RIM** documentation
- miscellaneous short documents, such as information on use of the ftp site and use of the "*GRASS Hoppers*" (or *GRASS* user and *GRASS* programmer discussion forums). (See *GRASSClippings*, Vol. 6, No. 1, Spring, 1992 for more information.)

In addition, we continue to have an incoming directory to which people from outside of USACERL can contribute software or information. Several contributions have already been made, such as patches to run *GRASS* on *HP* and *IBM* computers.

The use of the ftp server continues at a rather large-scale rate. In the first 138 days of operation (first made available in December, 1991), there was an average of 17 logins and 73 requests per day, with an average daily transfer of 29 megabytes of information. This adds up to a total of 4.12 gigabytes of information, including the transfer of over 150 copies of *GRASS 4.0* software. As the statistics in column three shows, current use is much higher.

INSIDE THIS ISSUE

Vol. 6, No. 2, Summer 1992

GRASSClippings **circulation**
.... 4930 subscribers

grassp-list
.... 184 members

grassu-list
.... 303 members

file transfers
.... 255 people, 1200 requests, and 500Mb per week, average

Deadline for *GRASSClippings* advertisements and articles in the fall issue .... September 15, 1992

AGENCY NEWS

The Spatial Data Transfer Standard: Status and Plans for Implementation

by Kathryn Neff

Recent advances in geographic information system technologies and digital cartography have resulted in increased demands for digital spatial data. Unfortunately, existing hardware and software capabilities and the lack of data exchange standards have inhibited the transfer of spatial data between data producers and users. To meet this demand, the Spatial Data Transfer Standard (SDTS) was designed to facilitate data transfer between dissimilar spatial data bases. Implementation of the SDTS will increase access to and sharing of spatial data, reduce the cost of developing data bases, and improve the quality and integrity of spatial data and related documentation. In addition, the SDTS will reduce duplication of effort in data production and maintenance and will make a national spatial data infra-structure practicable.

Status

In April 1991, after nearly 10 years of development and testing, the SDTS was issued by the National Institute of Standards and Technology (NIST) as a proposed Federal Information Processing Standard (FIPS). Following a 90-day formal public review and comment period, the Technical Review Board (TRB) overseeing the development of the SDTS met in October 1991 to arbitrate the review comments. The document was then edited according to decisions made by the TRB. The edited SDTS was forwarded to the Department of Commerce for processing as a FIPS in February 1992. Final approval and publication is expected in mid-1992. When implemented as a FIPS, the SDTS will serve as the national spatial data transfer mechanism for all federal agencies and will be available for use by state and local governments, the private sector, and research and academic organizations. The success of any standard, such as the SDTS, depends on its acceptance by the user community. Therefore, the U.S. Geological Survey (USGS), as the designated SDTS maintenance authority, is committed to providing implementation support to the greatest extent possible to increase access to and use of the SDTS.

Implementation Support

The USGS has identified several key program elements necessary to promote acceptance of the SDTS. The first element, FIPS approval of the SDTS, is pending. When the SDTS becomes a FIPS, it enters a 5-year maintenance cycle, at the end of which it will be possible to modify the SDTS in order to meet the changing demands of the user community. Because of its modular design, the SDTS can be changed as the requirements for its use change. Additional approvals will be sought from the American National Standards Institute and the International Standards Organization during 1993 in an effort to broaden access to the SDTS among the commercial and international communities.

Profile development is an important element for the successful implementation of the SDTS. A profile is a clearly defined and limited subset of a standard that is designed for use with a specific type of data. The SDTS contains a full range of capabilities and options designed to handle a wide spectrum of possible geographic and cartographic data structures and content. Because handling this range of options is such a difficult task for encoding and decoding software, the best way to implement the SDTS is to define a profile with few, if any, options. Software can then be designed to handle just these options. Regardless of which options are specified for a given profile, all profiles will share important common characteristics.

The USGS plans to coordinate the development of profiles with the user community. The first of these profiles, the Vector Topological Profile, is currently in a review and testing period; this test period will end late in 1992. The intent is to have this prototype profile rigorously tested to ensure that it appropriately handles vector data and then to forward the profile to the NIST for FIPS approval. Efforts have been initiated recently by the USGS to develop a prototype raster profile; this effort is expected to continue through 1993. The requirement for additional profiles, such as *CAD/CAM* and graphics profiles, will also be evaluated in the future.

Users' guides are critically needed to increase the knowledge and understanding of the SDTS within the community. The SDTS describes content, structure, and format; it is not an easy document to comprehend. To address the complexity of the document, users' guides need to be developed for the SDTS, for the various profiles being defined, and for

(*continued on page 14*)

GIS Applications for Environmental and Facility Planners on Military Installations

by Elly Doyle

The U.S. Army Construction Engineering Research Laboratory (USACERL) will hold a three day, two part workshop October 27-29, 1992 at George Mason University in Fairfax, Virginia. The workshops, which will focus on geographic information systems and GRASS applications, are designed to show facility managers and construction engineers how a geographic information system, in particular *GRASS*, can assist them in preparing environmental master plans for cultural and natural resources, managing and monitoring projects and resources,

(*continued on page 16*)

Cartographic Issues
from Melissa Records

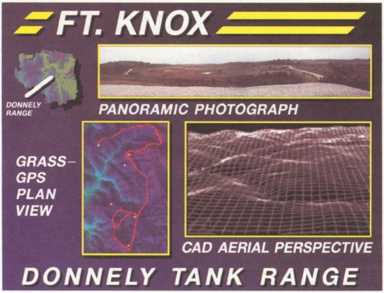
Videographic Enhancement of GRASS Images

by Bob Sullivan

Rapid advances in computer graphic technology have given rise to hardware and software that can be used to create high-quality graphic images quickly, easily, and with great flexibility. The technology, referred to as *videographics* or *video imaging*, is used to create many of the images we now see on television, in movies, and in printed media. Recent research at Argonne National Laboratory and USACERL has investigated the use of this technology to enhance the quality of *GRASS* graphic output and to streamline the *GRASS* graphic production process. This article will briefly describe videographic technology and its applications for *GRASS* users.

There is no standard definition of videographic technology, but for our purposes it can be described as a personal computer or workstation (with associated hardware and software) that is dedicated to creating or manipulating digital graphic images. Associated hardware can include input devices, such as a desktop scanner or a video camera, and output devices, such as a printer, a film recorder (used to create 35mm slides from image files), or a video recorder. Videographic systems usually employ video adapters that can process and display thousands or millions of colors (depending on what platform you use), rather than the 256 colors most *GRASS* platforms employ. Videographic software includes high-end paint and image processing packages that typically employ pull-down or icon-driven menus and are controlled using a mouse or a stylus.

Videographic systems provide several important graphic capabilities to *GRASS* users: First, they can be used to create visualizations of geographic data that cannot be created using *GRASS* by itself, such as the semi-transparent overlay of raster layers to create "tinted" shaded-relief maps (see figure below). The transparent overlay can also be used to merge satellite or aerial photos with corresponding *GRASS* data layers, creating a composite image that allows the viewer to easily associate data values with features visible in the image. Second, videographic text and labeling tools are more versatile and much faster than those available within *GRASS*. And third, videographic systems can output high-quality images in more formats than are typically possible with current *GRASS* systems.



This image of the Donnely Tank Range at Ft. Knox combines GRASS graphics, Global Positioning System data, CAD data and a photograph to show three visualizations of the same area. The photograph was scanned and the entire image composed using videographic software and hardware. (graphic by Bob Sullivan, Argonne National Laboratory)

The most recent research at Argonne and USACERL has employed DOS- and Macintosh-based computers, primarily because these platforms historically have been better suited to videographic production than to *Unix*-based systems. Fortunately, the gap between platforms is closing rapidly, and current research is exploring the use of *Unix*-based videographic systems.

The enhancement of *GRASS* images with videographics usually requires that the *GRASS* images be converted into a different graphic file format, such as industry standard *TIFF*, *TGA*, or *PICT* formats. The research mentioned here employed the *TGA* and *.PICT* formats. Conversion to *TGA* format can be accomplished by one of two methods: use of the *GRASS* command r.out.tga to convert *GRASS* rasters to *TGA* format, or use of *PBMPLUS*, a picture processing utility that converts *GRASS* screen dumps into a variety of formats, including *TGA* and *PICT*. Once converted, the image file must be transported by network or diskette, for example, to the videographics computer for processing.

A paint package is often used to make initial enhancements to the converted *GRASS* image. Typical manipulations might include customizing colors in the image, performing transparent overlays of *GRASS* layers onto a *GRASS*-generated shaded-relief layer, relocating or resizing elements of the image, or adding graphic elements that have been "cut" from other images. Most commands can be selected quickly with a mouse or stylus from on-screen or pull-down menus, with little or no kyboard input. Regions or points of activity are defined with the mouse or stylus as well so that image editing can be performed very rapidly. Extensive use of image buffers by videographic software allows elements to be edited and re-edited "on the fly." For exmaple, if text is created and placed in the image, the font can be changed multiple times with just a few mouse "strokes."

Drawing aids, such as grids, on-screen rulers, and "snap" functions are found in virtually all videographic packages, as well as tools for drawing polygons, creating gradient fills, and performing basic image processing functions such as hue and contrast adjustment. If the system hardware permits, many packages have tools to capture and digitize images from live videotape or still video cameras.

Other videographic packages, often called "graphic design" or "layout" packages, can be

Cartographic Issues
(*continued from page 4*)

used to compose finished images from elements created in the paint package. These packages can create graphic templates that can be used to rapidly produce multiple images that vary only slightly in content, without recomposing the entire image. Graphic design packages are often "resolution independent," that is, they can send an image to an output device at the maximum resolution of the device, regardless of the original resolution of the image. This capability insures crisp, clean images whether the output format is 35mm slides, prints, or on-screen images.

After the image is composed, it can be output to the desired media. Because the *GRASS* image has been converted into a standard file format, a wide variety of software is available to drive output devices. Thus, images can be output to thermal printers, sublimation dye transfer printers, inkjet printers, or electrostatic plotters, for example. The use of a film recorder allows the production of very high quality 35mm slides or prints. If the videographics adapter permits, images can also be output directly to videotape, though image quality is degraded somewhat due to the low resolution and poor color fidelity inherent to the standard video signal. For convenience, service bureaus can produce output in the desired formats from images sent on diskette or data cartridges.

Videographic technology offers *GRASS* users techniques for producing graphics that are more interesting and easier to understand. Videographics also can save valuable time and energy in the graphic production process. For *GRASS* users who frequently need to communicate the result of their work effectively, videographic technology has great potential as a cost-effective tool. For more information about this work, contact Bob Sullivan, Argonne National Laboratory, 9700 S. Cass Avenue EX/372, Argonne, IL 60439-4816; 708-252-5459; email: bobs@camelot.es.anl.gov

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SG3d Upgrade
(*continued from page 1*)

user simply clicks on the 'draw' icon to view the entire surface with the new lighting.

SG3d now also provides users with the ability to drape multiple vector and site files over the rendered surface. Color and line width for vector overlays is adjustable.

Viewpoint positioning is now easier with the addition of a *look here* button that prompts users to simply click on the surface at the position they wish to view; that spot then becomes the new center of view. As the viewer's position changes, inclination and view direction are automatically adjusted to keep the selected spot in the center of view. Option settings, light position, and viewing position may be saved in a *GRASS* data base file to be reloaded later.

Data querying in three dimensions has been implemented with a *what's here* button that prompts users to click on the surface then displays information like that which is output by **d.what.rast**. Other new program features include background color choices, a *no zeros* option that draws the surface only where elevation data is not zero, and an *animate display type* option that allows users with very fast graphics systems to animate a fully-rendered polygonal surface instead of the default wire-mesh surface as the viewing position changes.

As a visualization tool, **SG3d** was developed to be flexible enough to fit a variety of needs. Fast viewpoint positioning, relatively fast drawing, the ability to save program settings for a particular view, and scripting capabilities allow researchers to more quickly turn data into meaningful images, whether for interpretation of experimental data or for publication or presentation.

The upgraded version is now available by anonymous ftp on *moon.cecer.army.mil* in directory **/SG3d**. Full documentation is also included. For more information contact Bill Brown at 217-352-6511 ext. 588 or send email to brown@zorro.cecer.army.mil. Please see page 13 for a related article, *New Capabilities for Interpolation and Topographic Analysis* by Helena Mitasova, in which **SG3d** was used to render images showing various aspects of topographic analysis.

Editor's Note

I would like to extend a warm thank you to Scott Wade, who has taken time to create text using *Mapgen* for the graphic on page 13 of this issue. Scott also created the text for graphics in the Winter 1991 and Spring 1992 issues.

Linda Roush

Jamaica

(continued from page 1)

ways to use GIS technology in support of environmental monitoring. A number of applications have been identified and discussed, including: groundwater contamination potential evaluation, land-cover change detection, watershed modeling, and toxic plume dispersal modeling. During 1992 CNS will be evaluating some of these GIS applications and deciding which ones will best support environmental monitoring in Jamaica.

The Jamaica Survey Department's 1:50,000 scale map series will serve as the base map for the UWI-MAGIC digital map data base. CNS is working with a number of other organizations, comprising the 1:50,000 Scale Digital Map Users Group, to digitize the 20 maps of the series by the middle of 1992. The group is paying special attention to map feature layering, coding, and data exchange formats to ensure that the end-product is compatible with existing and planned systems.

NS selected *GRASS* for a number of reasons, in particular low cost and adaptability. Because of the low cost of *GRASS*, CNS can learn GIS concepts, evaluate GIS applications, build a GIS data base, and teach GIS all without making a major monetary investment in software. Because of the availability of the *GRASS* source code, *GRASS* is very adaptable.

CNS will be taking advantage of the adaptability of *GRASS* by customizing the *GRASS* user-interface, adding new *GRASS* capabilities, and interfacing *GRASS* to other CNS software. New *GRASS* programs will be written in C with calls to the *GRASS* libraries, graphical user-interface programs will be written in C with calls to the *X-Windows/Motif* libraries, and teaching/demonstration programs will be written using *GRASS* and *Unix* shell-scripts. Following are some of the new programs that are being written:

mapbrowse — a graphical user-interface that allows a user to interactively "browse" through the maps stored in a *GRASS* data base.

r.colors.eq — creates a histogram equalized blue-green-yellow-red color table for a *GRASS* raster-map (for geo-chemical maps).

s.to.labels — creates a *GRASS* paint-labels for a *GRASS* site-list; the user specifies the font, color, size, etc., of the site-description text.

s.filter — filters a *GRASS* site-list according to criteria involving the data values associated with sites and/or the current region.

s.in.table — imports an *ASCII* data base table and creates a series of *GRASS* site-lists.

v.cutter — creates a new *GRASS* vector map by copying the portion of an existing vector map that falls within the current region.

Even though UWI-MAGIC is still "under construction," it is already being called upon to support the Centre's monitoring activities. So far, this has involved the digitizing, display, and printing of maps. The CNS Water Group uses UWI-MAGIC to produce maps showing the distribution of well, spring, and water sampling sites across the island. Levels of water contamination are portrayed by varying the size and color of the icons used to represent the sites. The Water group has produced maps showing nitrate, chloride, and fecal coliform levels in this manner. Because these maps require elaborate annotations and legends, CNS has developed a high level of expertise with the GRASS map printing language (p.map).

The CNS Soil Group has been using UWI-MAGIC to produce geo-chemical maps. These raster maps, which show the concentrations of chemical elements in Jamaica's soil, are generated by CNS-developed "krigging" software. The Soil group transfers these raster maps into *GRASS* (using **r.in.ascii**), adds a standard color-scheme and text annotation, and prints them out on the *Tektronix* color printer.

The Centre also provides training workshops and seminars for environmental scientists and technologists. During the fall of 1991, it offered workshops entitled Analysis of Spatial Processes, Introduction to GIS, and Introduction to *GRASS*. The Centre held a "customized" workshop for the Urban Development Corporation (UDC) and converted to *GRASS* format a number of UDC map layers representing elevation contours, areas with sensitive ecology, and landuse. The Centre then used *GRASS* to illustrate how to determine areas best suited for resorts, agriculture, industry, and conservation according to UDC-defined criteria.

The Centre has high hopes for GIS in Jamaica. GIS is seen not just as a way to automate mapping and to analyze maps but also as a way to facilitate information sharing and cooperation between the various organizations concerned with Jamaica's environment.

David Johnson is a computer systems consultant and programmer who specializes in *GRASS*. He is currently retained by the Centre for Nuclear Sciences; previously he was employed by DBA Systems, Inc.

Academic Turf

By
JEFF
WRIGHT

Cook College Remote Sensing Center
Rutgers University

One of the cornerstones of the *GRASS* community's academic affiliates is the Cook College Remote Sensing Center housed within Rutgers University's Department of Natural Resources in New Brunswick, New Jersey. Scott Madry, long-time GRASS user, teacher, and proponent, is the Center's associate director and has been principal liaison between the Center and the *GRASS* User's Group since its inception.

The Cook College Remote Sensing Center is affiliated with the New Jersey Agricultural Experiment Station and is dedicated to research, education, and public service with equal emphasis. Since its founding in 1984, the Center has dedicated its resources and facilities to the improvement of the environment. Support comes through teaching undergraduate and

graduate courses in remote sensing, geographical information systems (GIS), air photo interpretation, and their applications, by conducting pure and applied research in using remote sensing and GIS to protect our environment, and in providing access to modern spatial analysis facilities to students, faculty, and organizations throughout the state. The Center is the only comprehensive remote sensing and GIS teaching and research facility in New Jersey and is widely acknowledged as the most comprehensive facility in the New York metropolitan area.

Madry says that since moving to new facilities in October of 1989, the Center has flourished. Expanded space and equipment has allowed more thorough integration of teaching and research activities in a state-of-the-art setting. The new Center is located in a two-story section of the new Environmental Resources Building located on the Cook College campus of Rutgers. It includes a separate computer room with dedicated temperature and power control, and built-in twisted pair ethernet in all rooms and offices. The Center also has a large image processing and GIS lab and two dedicated computer labs on the second floor capable of holding 10 and 20 students. Additional lecture, reception, and meeting rooms are also available in the building.

Undergraduate and graduate GIS education is a major focus of this program. Teaching activities include coursework at the undergraduate and graduate levels in air photo interpretation, remote sensing, and GIS; these courses draw students from throughout the university community. An undergraduate certificate in environmental monitoring is offered, as well as graduate level programs. Graduate students conducting research using Center facilities come from several departments, including Geography, Anthropology, Human Ecology, Environmental Science, and others. Foreign students from China, Argentina, Kenya, and Russia are currently using the Center. The Center is an interdisciplinary and university-wide resource available to faculty and students from all departments for research, teaching, and public service.

The Center is widely recognized for its use of spatial modeling and analysis technologies in support of environmental research. Research projects in progress or recently completed by Center staff and faculty include the following: in New Jersey, watershed management, non-point source pollution modeling, landcover change detection and black bear habitat analysis; in NewJersey/New York, hazardous waste spills, plumes, and landfills; deforestation in Panama; desertification impacts on estuarine environments in East Africa; in Sicily, landslide potential mapping and reforestation analysis; in Burgandy, France, historical land use patterns and archaeological site pattern analysis; GIS development and applications for municipalities; monitoring and modeling of terrestrial and aquatic ecosystems; monitoring the consequences of wildland fires on aquatic ecosystems; and modeling trace gas fluxes from Northeastern upland forests.

Several major additional projects are pending. A project is in progress with the Kenya Wildlife Service (KWS) under the direction of Dr. Richard Leakey. The Center is working with KWS to institute GIS in the Kenya National Park system, which comprises over 6 percent of Kenya. The Center is cooperating with USACERL to produce and distribute the *GRASS Global CD-ROM*, which has over 500 Mb (50 data layers) of global GIS data. The data can be used directly with *GRASS* or can be exported for use with other packages such as *IDRISI*. Work is

Academic Turf

(*continued from page 8*)

underway on *GRASS GLOBAL II*, which should be available next fall. The Center also conducts sponsored research and contract work for several organizations, including NASA, the National Park Service, the USDA Soil Conservation Service, and the New Jersey Department of Environmental Protection.

In addition to conducting basic and applied spatial analysis research, The Cook College Remote Sensing Center offers a series of GIS and remote sensing continuing education courses. Several *GRASS* GIS specific courses are offered periodically throughout the year. Courses offered in 1991 include a five-day hands-on *GRASS* course, a four-day introduction to GIS, a three-day GRASS imagery and remote sensing hands-on course. New courses offered include an introduction to global positioning systems (GPS). These courses are jointly sponsored by the Center and the Cook College Office of Continuing Professional Education. New courses are offered periodically to meet changing demands, and off-site training is available virtually world-wide.

Madry brings a great deal of experience, as well as expertise, to his managing role within the Center. He was most recently a Senior Project Manager at the Institute for Technology Development Space Remote Sensing Center, located at the NASA Stennis Space Center in Mississippi. He received his Ph.D. from the University of North Carolina at Chapel Hill and is a certified photogrammetrist. Madry chairs the GIS committee of the Remote Sensing Applications Division of the American Society of Photogrammetry and Remote Sensing. He is active in training, development, and applications of the *GRASS* GIS system; he also conducts research in land use changes and in archaeological and anthropological applications of remote sensing and GIS used in France and the U.S. He is active in the International Space University program, serving as a professor and curriculum director of the satellite applications curriculum for four years: the 1988 program held at MIT; the 1989 program in Louis Pasteur University, Strasbourg, France; the 1990 program at York University, Toronto; and the 1991 program at Tolouse, France. He is a member of the Lunar Development Subcommittee of the International Academy of Astronautics, Sigma Xi, and several other honorary and professional organizations. Some of his recent research was featured in the 1991 McGraw-Hill Yearbook of Science and Technology.

Scott works closely with Dr. Teuvo M. Ariola, founder and Director of the Cook College Remote Sensing Center. Ariola is Associate Professor and Chair of the Department of Environmental Resources. He received his Ph.D. in 1977 from Duke University School of Forestry and Environmental Studies. His research interests focus on the use of remote sensing techniques for monitoring environmental conditions and the integration of this information into the decision-making process. His current research involves the use of satellite data, color infrared video data, and digitized aerial photography for the monitoring of land use/landcover in New Jersey, the monitoring and site history reconstruction of toxic waste sites, and frontal pattern analysis in Delaware Bay. A more recent interest is in the integration of remotely sensed data into GIS to improve environmental planning and management decision-making at the state and local level. Under his direction, the Center has received a three-year project to develop a prototype GIS designed to improve watershed management activities in the Black River watershed of New Jersey.

Dr. Richard Lathrop, Assistant Professor in the Department of Environmental Resources, is also involved with the teaching and research activities within the Cook Center. He was most recently a Research Scientist in the Ecosystem Science and Technology Branch at NASA-Ames Research Center. He received his Ph.D. in 1988 from the University of Wisconsin-Madison. His research interests include the application of remote sensing and GIS to monitoring/modeling of terrestrial and aquatic ecosystems.

Mr. Jim Gasprich serves as the Center's lab manager. With a 1991 M.S. in geography from Rutgers, Jim is responsible for general systems operation in the labs, software and hardware installation and maintenance, database development, and scheduling of systems.

The Cook Center has available one of the most diverse and complete hardware environments, with a full range of digital and optical equipment available for the analysis of digital remote sensing data, conventional photographic products, and for GIS analysis. All Center computers are linked through a local area network sharing data and software resources across campus. The Center's digital imagery analysis capabilities currently include over 15 *Unix* workstations and mini computers and 10 DOS computers running *GRASS*, *ERDAS*, *Arc/Info*, *IDRISI*, and other software. Over 10 gigabytes of on-line storage are available to users. An extensive remote sensing tape archive contains data from around the world; *TIGER* data for all of New Jersey is also available. An AVHRR satellite receiving station, which will be able to acquire real-time satellite imagery beginning in August of 1992, is being constructed on the Marine Science Building next door to the Center

The open relationship between USACERL and the Cook College Remote Sensing Center is typical within (perhaps the trademark of) the *GRASS* community. To the extent that *GRASS* plays a major role in the teaching and research activities in the Cook College Remote Sensing Center, the Center and its personnel have played a major role in the evolution of *GRASS*. Hats off to Scott and his colleagues.

Image Processing in GRASS

by Hong C. Zhuang

Within the last decade, the development and application of computer-based Geographic Information Systems (GIS) and Image Processing Systems (IPS) have undergone very rapid and evolutionary advances. The advances are not only in terms of the number of new practitioners involved but also in terms of the increasing sophistication of available tools and techniques and the growing variety of problem areas addressed. The Geographical Resource Analysis Support System (*GRASS*) has addressed these issues by integrating GIS and IPS technologies, resulting in numerous advantages.

When the GIS and IPS are integrated, not only can remote sensing data be used to update and enlarge the GIS data base, but also the GIS thematic data and attributes can be used to guide image classification. *GRASS* is a full phase GIS, but it is also a fantastic image processing software package with GIS capabilities.

The possibilities and benefits of integrating GIS and IPS rest on the parallelism between the main components of GIS and IPS. They all have functions of data input, storage, analysis and reporting. Only the input and analysis elements require different functions for each system. The storage and reporting functions are identical. The current version of *GRASS* has about 256 computer tools composed by about 4000 software files. One third of the GRASS tools are very relevant to image processing. Other *GRASS* tools are also somewhat connected to the functioning of image processing.

Several *GRASS* tools are available for inputing image data into a standard *GRASS* data base. *GRASS* tools **i.tape.mss** and **i.tape.tm**, for example, extract MSS and TM satellite remote sensing image data from the *Computer Compatible Tapes* (*CCTs*) provided by *EOSAT*. The tool **i.tape.spot** extracts remote sensing image data by *SPOT* satellite from the half inch tapes. There are *GRASS* tools (such as **v.in.transects**) that can extract data from medium other than tapes. Other *GRASS* tools (such as **i.rectify** and **r.patch**) allow these raw data to be rectified or patched with another map's data or GIS data. In addition, both IPS and GIS data are stored in the *GRASS* standard form of raster and/or vector files. This category of *GRASS* tools, and some other relevant *GRASS* tools (in parentheses), are listed below:

image data inputing into standard *GRASS* database

from tape

extracts header information of MSS data —	**i.tape.mss.h**
extracts MSS image data from tape —	**i.tape.mss**
extracts TM image data from tape —	**i.tape.tm**
extracts other image data from tape —	**i.tape.other**
extracts SPOT imagery from tape —	**i.tape.spot** *
(describes the files on a 1/2" tape —	**m.examine.tape)**
(select geographic region —	**g.region)**
(establishes or removes mask —	**r.mask)**
(viewing maps —	**d.display)**
(displays raster map layer —	**d.rast)**
(gives location of a user specified point —	**d.where)**
(marks points on an image to be rectified —	**i.points)**

from *LCTA* data base

extracts *LCTA* data along transect —	**v.in.transects**

image rectification

marks points on an image to be rectified —	**i.points**
rectifies coordinates of points on an image —	**i.rectify**
ortho-photo rectification —	**i.camera**
ortho-photorectification —	**i.rectify.blk**
(sets GRASS place to transfer rectified file —	**i.target)**
(digitizes and edits vector map data —	**v.digit)**

patching images

fills 'no data' areas with other map's data —	**r.patch**
raster map layer data calculator —	**r.mapcalc**

Several dozen powerful *GRASS* tools have been developed for analyzing imagery data. For a single image, *GRASS* tools can check and re-assign color scale and intensity; rescale the range of category values; resample specified regions under new spatial resolutions; smooth or sharpen spatial fluctuations; establish or remove masks; perform statistical calculations among pixels; and conduct *Fourier* and inverse *Fourier* transformations. This category of *GRASS* tools is as follows:

single-image management

contrast stretch

assigns histogram equalized grey scale —	**i.grey.scale**
makes pixel function of surrounding values —	**r.neighbors**
change color table —	**r.colors**
(displays histogram —	**d.histogram)**
(raster map layer data calculator —	**r.mapcalc)**

image resampling/scaling

resamples using new resolution and region —	**r.resample**
rescales the range of category values —	**r.rescale**
makes pixel function of surrounding values —	**r.neighbors**
raster map layer data calculator —	**r.mapcalc**
(filters raster map using matrix —	**r.mfilter)**
(filters raster map using matrix —	**r.mfilter)**
(interpolates by distance squared weighting —	**r.surf.idw)**
(interpolates for irregularly spaced map —	**r.surf.idw2)**
(interpolates for irregularly spaced map —	**s.surf.idw)**

rearrangement

establishes or removes mask —	**r.mask**
ortho-rectifies an imagery group files —	**i.rectify.blk**
sets GRASS place to transfer rectified file —	**i.target**
raster map layer data calculator —	**r.mapcalc**

statistics

show lengths and areas —	**d.measure**
calculates average values for each category —	**r.average**
outputs spatial covariance/correlation matrix —	**r.covar**
reports statistics for maps —	**r.report**
creates area statistics —	**r.stats**
outputs statistics of clumps —	**r.volume**
displays area and perimeter information —	**v.area**
displays histogram —	**d.histogram**

transformation

fast Fourier transformation —	**i.fft**
inverse fast Fourier transformation —	**i.ifft**

filtering

filters raster map using matrix —	**r.mfilter**
raster map layer data calculator —	**r.mapcalc**
makes pixel function of surrounding values —	**r.neighbors**

algebraic image processing language

raster map layer data calculator —	**r.mapcalc**

Among different images or different layers of one image, *GRASS* tools can conduct algorithmic calculations; ortho-rectify imagery group files; create a color composite image ; create and edit groups and subgroups; conduct arithmetic operations, and check the statistical relationships. .

multi-image management

color composite

creates a color composite image —	**i.composite**
composes red, green and blue bands to color —	**d.rgb**
combines rgb colors into one color table map —	**i.median**
combines r.g.b. color components of 2 maps —	**blend.sh**
(displays color composite image —	**i.colors)**
(transforms hue-intensity-saturation to rgb —	**i.his.rgb)**
(transforms red-green-blue to his —	**i.rgb.his)**
(select geographic region —	**g.region)**
(establishes or removes mask —	**r.mask)**
(viewing maps —	**d.dispay)**
(displays raster map layer —	**d.rast)**
(gives location of a user specified point —	**d.where)**
(marks points on an image to be rectified —	**i.points)**

imagery group management

(removes data base element files —	**g.remove)**
(rename files/groups —	**g.rename)**

Image Processing
(*continued from page 10*)

multi-image management (continued)

relations and arithmetic operations

tabulates category coincidence for two maps —	**r.coin**
outputs spatial covariance/correlation matrix —	**r.covar**
raster map layer data calculator —	**r.mapcalc**
analyzes principal components —	**i.pca**

GRASS tools allow users to easily correct spatial remote sensing images, such as atmospheric and terrain corrections. Several traditional classification and segmentation operations on images also can be conducted using existing *GRASS* tools. Examples of this are supervised and unsupervised classification using the maximum-likelihood method; edge detection using *Laplacian-Gaussian* filtered zero-crossing method; analysis of canonical components; and multi-resolution classification.

image corrections

atmospheric correction

raster map layer data calculator —	**r.mapcalc**

terrain corrections

extracts USGS elevation data from tape —	**m.dem.extract**
extracts DMA elevation data from tape —	**m.dted.extract**
extracts DMA-USGS elevation from tape —	**m.dmaUSGAread**
creates (slope, aspect) from elevation —	**r.slope.aspect** ,
extracts USGS landuse/landcover data —	**m.lulc.read**
slope/aspect illumination corrections —	**r.mapcalc**

image classification

supervised classification

creates spectral signatures (supervised) —	**i.class**
maximum-likelihood classification —	**i.maxlik**
create spectral signatures from ground data —	**i.gensig**
contextual maximum likelihood classification —	**i.segment**
(creates and edits groups and subgroups —	**i.group)**

unsupervised classification

creates spectral signatures (unsupervised) —	**i.cluster**
maximum-likelihood classification —	**i.maxlik**
contextual maximum likelihood classification —	**i.segment**
(creates and edits groups and subgroups —	**i.group)**

other classifications

analyzes canonical components —	**i.cca**
analyzes principal components —	**i.pca**
prints category values and labels —	**r.cats**
prints terse list of category values —	**r.describe**
combines category values from several maps —	**r.combine**
creates cross product of category values —	**r.cross**
re-classifies category by user's rules —	**r.infer**
re-classifies map using user-given rules —	**r.reclass**
weights the map categories of interest —	**r.weight**
weights the map categories of interest —	**r.weight.**
new multi-resolution method segmentation —	**i.segment**

segmentation

detects edges using zero-crossing approach —	**i.zc**
groups discrete areas into unique categories —	**r.clump**
extracts area edges and outputs vector format —	**r.poly**
filters raster map using matrix —	**r.mfilter**
raster map layer data calculator —	**r.mapcalc**

Powerful *GRASS* tools display images before and/or after the analysis. Beautiful color maps and three-dimensional perspective maps can be produced as hardcopy products of the image.

visualization

displays 3-D images —	**d.3d**
displays several 3-D views of image —	**3d.view.sh**
set colortable —	**d.colors**
develops color table —	**p.colors**
creates/modifies color table —	**r.colors**
viewing maps —	**d.dispay**
displays raster map layer —	**d.rast**
draws arrows representing cell aspect —	**d.rast.arrow**
zoom in or out of regions —	**d.rast.zoom**
changes region settings interactively —	**d.zoom**
select geographic region —	**g.region**
composes red, green, and blue bands to color —	**d.rgb**
assigns red, green, blue to images of a group —	**i.colors**
creates a color composite image —	**i.composite**
transforms Hue-intensity-saturation to rgb —	**i.his.rgb**
transforms red-green-blue to his —	**i.rgb.his**
creates hardcopy color map —	**p.map**
gives location of a user specified point —	**d.where**
gives category content at given points —	**r.what**
converts raster map into ascii text file —	**r.out.ascii**
displays profiles between any two points —	**d.profile**
outputs greys lying on user-defined line(s) —	**r.profile**
outputs values lying along transect lines —	**r.transect**
displays correlation from r.stats —	**dcorrelate.sh**

Satellite image data applications have already been demonstrated in many fields, such as agriculture, botany, cartography, civil engineering, environmental monitoring, forestry, geography, geology, geophysics, oceanography, land resource analysis, land use planning, and water resources analysis.

Different applications rely on different interpretations of the image data. In order to extract ground surface information from the radiance received by the remote sensor, different relationships between the ground feature and radiance must be determined. The most appropriate band (or combination of bands) for spatial remote imagery should be selected for each application. Usually, regression methods are used to determine a model that describes the relationship. A robust linear and non-linear regression tool, named **m.regression**, has been developed in *GRASS*. Modeling and predicting ground vegetation coverage can be operated by the regression tool as one important application tool of image processing.

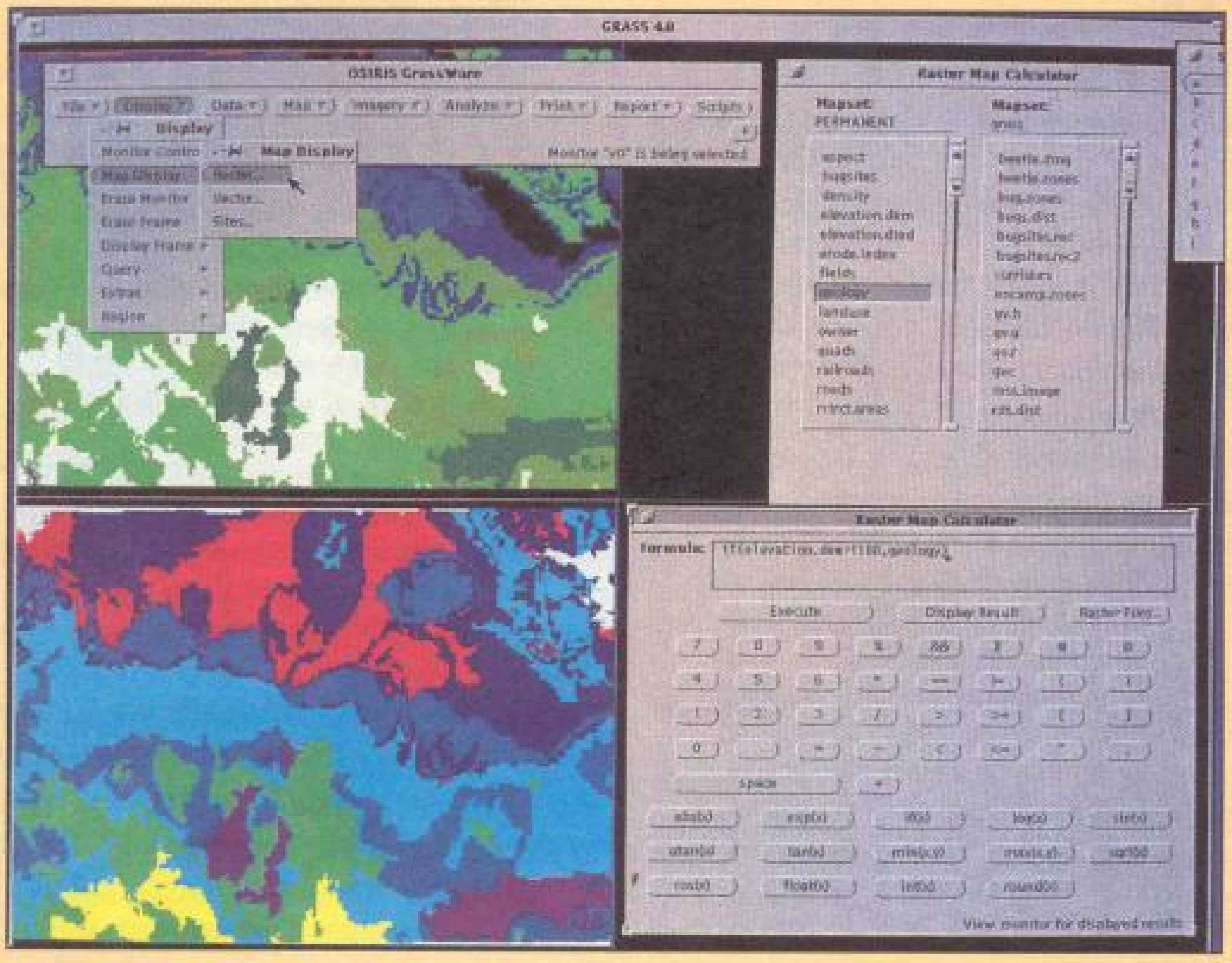
Traditional linear regression modeling for vegetation coverage using normalized differential vegetation index and new nonlinear regression modeling have been tested using *SPOT* remote-sensing data and *Land Condition Trend Analysis* (*LCTA*) ground measurement for Hohenfels region in Germany. *GRASS* tool **m.regression** was used to calculate both the linear and nonlinear model. The correlation coefficient between calculated and observed percent plant cover for a test scene in 1989 reaches 90 percent for nonlinear model while 70 percent for linear model. The testing calculations have further shown that the ability to predict percent plant cover by space remote sensing data for the same scene or the scene in other years is much better using the nonlinear model than the linear model.

In the near future, more *GRASS* tools are expected to appear in the *GRASS* tool warehouse in order to pursue a variety of image processing applications. *GRASS* is developing into a multi-stage image processing package that can analyze multi-temporal, multi-angle, hyper-spectral, and multi-sensors image data in order to meet bigger challenges in a variety of image processing applications in the future.

For more information concerning GIS and IPS integration capabilities in GRASS, please contact Hong Zhuang at 217-352-6511 or send email to zhuang@zorro.cecer.army.mil.

I would like to extend heartfelt thanks to James Westervelt and Michael Shapiro for their encouragement and foundation work.

IMAGINE GRASS OF THE 1990'S



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New Capabilities For Interpolation and Topographic Analysis in GRASS

by Helena Mitasova

Relief, as an important component of landscape, influences all other components (e.g., biosphere and pedosphere) and thus creates specific ecological conditions that can be evaluated by topographic analysis. To enhance the GRASS applications for hydrological, geomorphological, and erosion modeling, new, powerful capabilities for interpolation from site data and topographic analysis are being developed for GRASS as a program s.surf.tps. This article shows also the application of Silicon Graphic's visualization tool, SG3d. Please see a related article by Bill Brown on page 1, SG3d Upgrade Provides Easier Positioning, Lighting.

Topographic Analysis

Several topographic parameters have proven to be significant for landscape processes (Krcho, 1973; Moore et al., 1991): elevation, slope, aspect, profile curvature, tangential curvature, upslope area, and flowpath length.

Slope influences the velocity of water flow and is computed as a magnitude of the gradient vector of elevation surface.

Aspect controls the direction of flow and is given by direction of gradient vector.

Profile curvature (Fig.1) is measured in the direction of gradient. It influences the change in velocity of flow, in convex areas flow is accelerated, in concave areas flow velocity decreases. *Tangential curvature* is computed in the direction of tangent to contour. It reflects the change in the direction of flow and thus controls its convergency/divergency. In convex areas flow is divergent, concave areas have convergent flow.

Upslope contributing area is the area from which the water flows into a given grid cell. It is an indirect measure of surface runoff and is often used in hydrological applications.

Flowpath length (Fig.2) represents the distance that the water flows untill it reaches the given grid cell. It also can be interpreted as a limiting case of upslope area for hillslopes with negligible convergence/divergence of waterflow (Moore and Burch, 1986).

Computation of Topographic Parameters

A new interpolation method — *regularized spline with tension* — for interpolation from point (site) data has been developed (Mitasova and Mitas, subm.) and incorporated into GRASS as **s.surf.tps.** The function simulates the behavior of a thin plate that minimizes its energy while passing through the data points. It has tunable tension to minimize the overshoots in areas with rapid changes in gradient. Topographic parameters *slope, aspect* and *profile, tangential* and *mean curvatures* are computed simultaneously with interpolation. Segmented processing with optimized segment sizes, developed by Irina Kosinovsky, makes the method also applicable to very large data sets (tens of thousands of data points). This function is suitable for digitized contours or other scattered point data (sites), and its application is not restricted to digital terrain modeling.

Flowpath length for each grid cell is computed from flowlines generated upslope from each grid point using the improved algorithm based on a combined vector-grid approach (Fig.2). Upslope area for each grid cell is computed as an area bounded by two adjacent flowlines generated from the points on tangent to contour passing through a given grid point and a boundary line (e.g., boundary of watershed). GRASS versions of programs for construction of flowlines and upslope areas, developed by Jaro Hofierka, are under development.

Modeling erosion and deposition

Results of the analysis can be used in various models of landscape processes using **r.mapcalc.** Topographic factors for standard erosion models like *Universal Soil Loss Equation* (USLE) (Wischmeier, Smith, 1978) and its revised form (RUSLE) can be computed, using slope and flowpath length or, for complex slopes, using slope and upslope area. However, these models can be applied only to areas experiencing net erosion; deposition areas must be excluded from the study.

To localize both areas experiencing erosion and areas with deposition, Moore's model based on the *Unit Stream Power Theory* can be used (Moore and Burch, 1986). For estimation of erosion/deposition rates for each grid cell, slope, upslope area, directional derivative of upslope area, and profile curvature is used (Mitasova et al., in preparation).

For further information on interpolation from site data, surface geometry analysis and its application to erosion/deposition modeling within GRASS, contact Helena Mitasova at 217-244-2167 or by email at:
helena@dunaj.inhs.uiuc.edu or
helena@zorro.cecer.army.mil.

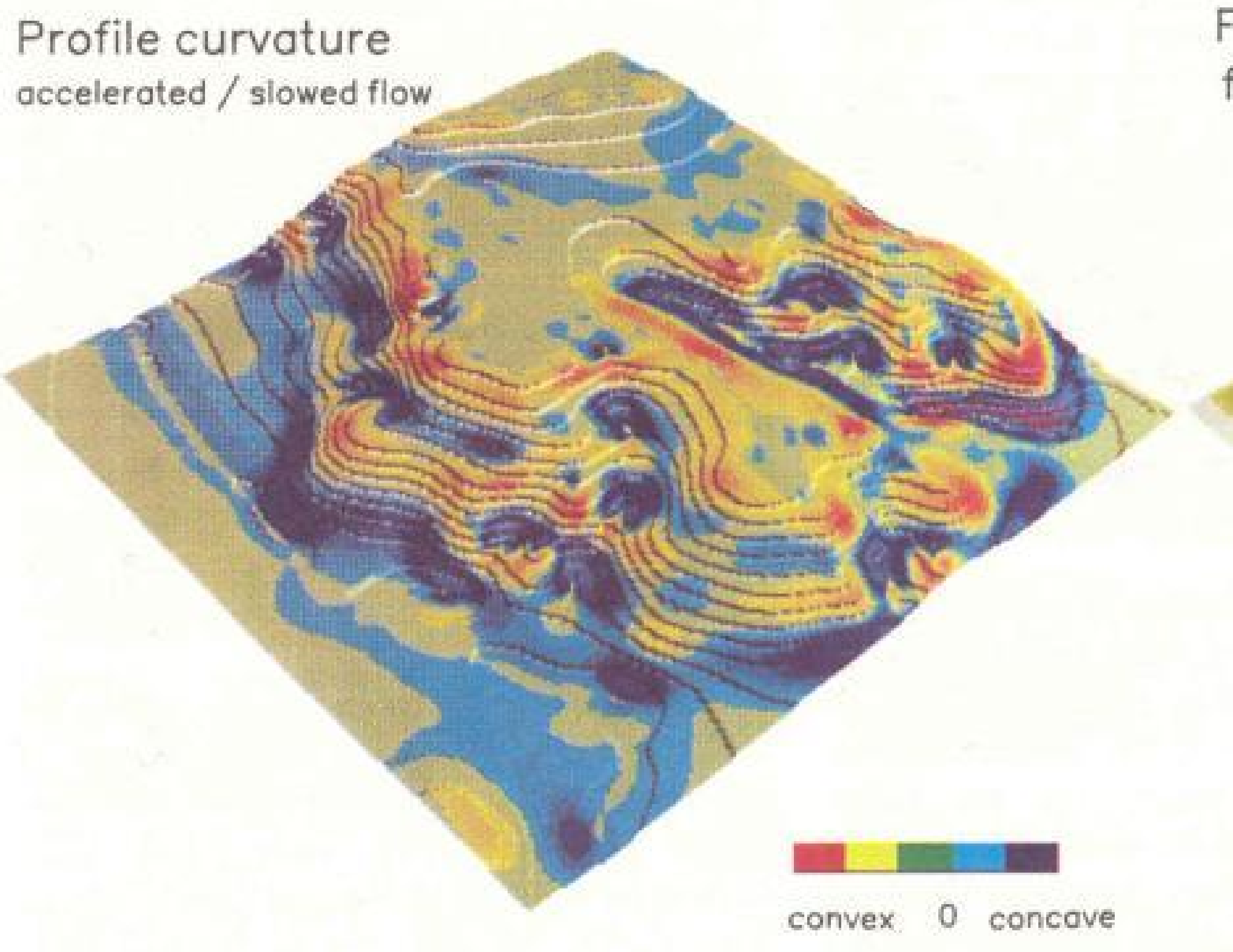

Figure 1

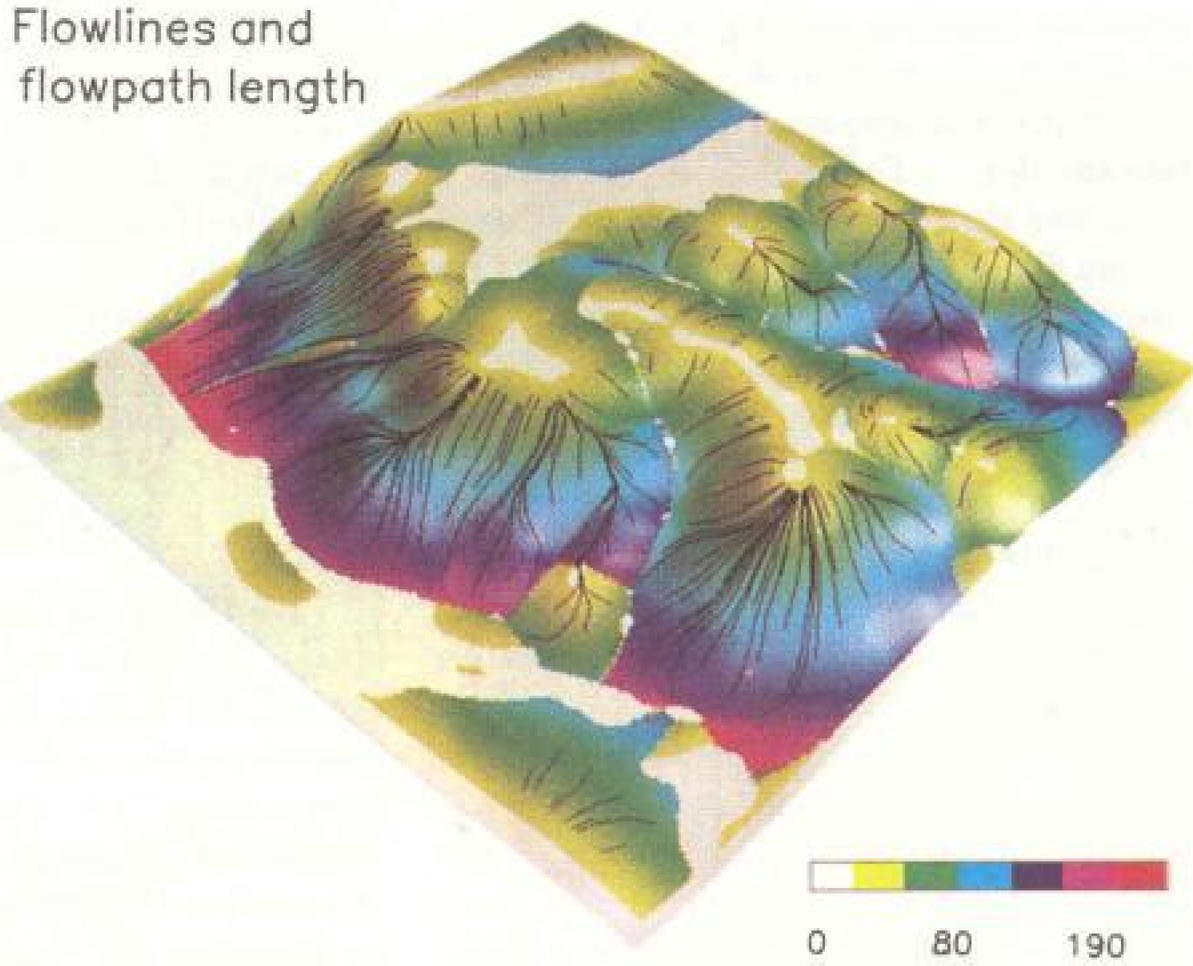

Figure 2

The maps above show the 3D views of terrain i, a small area (500m x 500m) in central Illinois, created with the SG3d program. In Figure 1, a raster map of profile curvature computed with 2m resolution is draped over the terrain. In Figure 2, a vector map of flowlines, together with a raster map of flowpath length, is presented. (graphic by Helena Mitasova, USACERL, Champaign)

Spatial Data Transfer
(*continued from page 3*)

the software tools being developed. The USGS will coordinate the development of these users' guides over the next few years.

Software development is an integral part of SDTS implementation. Software tools, such as **encoding, decoding,** and **display tools,** must be developed. It is expected that the vendor community will assume a large part of this responsibility. The USGS is designing a processing system to support SDTS transfers of its own digital spatial data, such as Digital Line Graphs and Digital Elevation Models. The USGS is also developing a suite of public domain software tools designed to support the encoding and decoding of logically compliant SDTS data in and out of the required ISO 8211/FIPS 123 physical file implementation. This software will be available for use in mid- 1992 by the vendor community to develop turnkey systems conforming to the SDTS.

One part of the SDTS presents a standard model for a spatial features data dictionary as well as a list of terms and definitions for entities and attributes. This feature and attribute glossary provides a foundation for standardizing spatial features. At the present time, the glossary contains only a limited set of hydrographic and topographic features. Because this glossary is not complete, conformance is optional in the prototype Vector Topological Profile; however, conformance to the model is mandatory. For this part of the SDTS to be useful, additional terms and definitions must be included for other categories of data, such as cadastral, geodetic, and geologic, and the current set of hydrographic and topographic features must be expanded.

The NIST intends to establish a Spatial Features Register, designed to facilitate this effort. Input from the Federal community will be coordinated through the data category subcommittees of the Federal Geographic Data Committee (FGDC); however, the USGS intends to solicit input from the non-Federal spatial data community as well. A strategic plan to maintain this part of the SDTS, using the NIST Spatial Features Register, is being developed. Because the register will allow users to dynamically update the glossary, this part of the SDTS will evolve over time.

The USGS will continue to conduct SDTS-related workshops and other presentations to educate the spatial data community and to promote the use of the SDTS. Implementation presentations are planned for the major professional organizations, such as Association of American Geographers, American Congress on Surveying and Mapping, American Society for Photogrammetry and Remote Sensing, Automated Mapping/Facilities Management International, Institute for Land Information, International Society for Photogrammetry and Remote Sensing, and Urban and Regional Information Systems Association. In addition, the USGS, the NIST, and the Standards Working Group of the FGDC plan to sponsor implementation workshops during the coming year.

The final program element necessary to support acceptance of the SDTS is program coordination. This coordination involves developing support activities within the USGS, facilitating similar activities external to the USGS, and interfacing with related standards development activities ongoing in the spatial data community.

The Department of Commerce's approval of the SDTS as a FIPS is a major milestone for the spatial data community. Although the USGS is committed to facilitating a wide range of activities designed to promote acceptance of the SDTS, all members of this community must contribute to these efforts to ensure the success of the SDTS.

For additional information concerning the SDTS program within the USGS, or how to participate in these developmental activities, please contact: SDTS Task Force, U.S. Geological Survey, 510 National Center, Reston, VA 22092, 703-648-4566 or 703-648-4591, FAX: 703-648-5542

Please see a related article by David Stigberg on page 20.

Growing GRASS with Fred Limp

In this column, I want to introduce you to some very powerful, but easy to use, capabilities in **r.mapcalc**. Most of you who use **r.mapcalc** probably use the wide range of mathematical operators, but did you know you can also have access to an equally powerful suite of spatial operators? The general syntax of the math operators is

new.map = map1 + map2

where **new.map** is the simple sum of the value in each cell in map1 added to map2. Alternatively, we can say

new.map = map1[-1,-1] + 1

In this case, the value located in the cell in map1, which is one row and one column behind the current cell, is moved into **new.map**. A small diagram can illustrate this. A small part of map1 is shown on the left; the potential cells in new.map are shown by the letters at the right:

map1				**new.map**			
column	**-1**	**0**	**1**	**column**	**-1**	**0**	**1**
row				**row**			
-1	5	2	1	**-1**	a	b	c
0	4	3	6	**0**	d	e	f
1	7	8	9	**1**	g	h	i

Then the value of the center cell in **new.map** (e) would be 5 + 1; a, b, c, d, and g would be undefined in this small example; cell f would be 2 + 1; h would be 4 + 1 and so on. This may not appear to be particularly exciting initially, but if you will reflect on things a moment, you will see that this provides you with an exceptional suite of tools with which to model all sorts of spatial processes that previously were quite difficult to model.

Let's consider, for example, the spread of a smoke cloud from a pollution source. Let's further suppose that the wind is blowing from the northwest to the southeast and that as the cloud expands it becomes weaker. Pretty complicated, huh? GRASS (as usual) to the rescue. For our example, we will consider the cloud at time t. (All these models use this stilted language; it's a carry over from the time (t) when German science dominated the world ... and the sentences all had verbs at the end.) Anyway, we have our cloud at time t, and at time t(1) — a little later — it will have drifted one unit to the southwest with the density attenuated by one unit. Our little model would now look like this in r.mapcalc-ease:

t = t[-1,-1] - 1

"Great!" you say (maybe), but do I have to type it a zillion times? Shame on you for even asking. Here we can use good old shell programming and put it in a loop. The first thing is to put our r.mapcalc commands in a text file called, for example, "spread". We then create another text file (called go.spread) and make it an executable shell script (remember chmod +x ?). The script might look like this:

```
#!/bin/sh
g.copy rast=t.start,t
d.rast t
i=1
while [ $i != 100 ]
do
   r.mapcalc < spread
   d.rast t
   i='expr $i + 1'
done
```

musią być medzy

musią być medzy

If you have a raster map called *start.t* whose area is some positive value (100 would be good), when you type

go.spread

you will see the smoke cloud move across the map 100 times, getting weaker each time. You might wish to start the script with ":" instead of **#!/bin/sh**. This may depend on your system. Now let's make it more interesting. We want each map to be the cumulative results of the process. We will need to change the r.mapcalc to

t = if(t[-1,-1], t[-1,-1] -1, t)

In this case, if t[-1,-1] is not zero, we subtract 1 from it and put in the current cell. Try it. Let's now add some further realism. We can suppose that the cloud diffuses outward as it moves. Let's suppose that while it is decreased one unit when it's blown downwind, it's diffused more on the edges as the smoke drifts out, perhaps three times as much. Our little model is now:

```
t = if (t[-1,-1]> 0,t[-1,-1] -1, if(t[-2,-1] > 0, t[-
  2,-1] - 3,\
if (t[-1, -2] > 0, t[-1,-2] - 3, t)))
```

If the cell is dead downwind, it's attenuated 1; otherwise, to the north and south of downwind, it drifts but is attenuated by 3. The backslash just tells **r.mapcalc** that the line is continued. If the above is *spread*, then *go.spread* will display a plume that blows to the southwest with a central core and feathery edges to the north and south. BUT ...... We are still not happy. Let's increase our realism. We can assume that the smoke is blowing over the forest and that the density of the forest also attenuates the smoke. If we use the Spearfish *density* map and suppose that the smoke is attenuated by the square of the density values (density ranges from 1 to 4), our **r.mapcalc** text will be:

```
t = if(t[-1,-1]> 0,t[-1,-1] - (density *
   density),if(t[-1,0] > 0,t[-1,0] - \
   (3 * (density * density), \
if (t[0, -1] > 0, t[0,-1] - (3 * (density * density),
t)))
```

Try this, and you will see an even more interesting pattern.

The above script displays the map but does not save any of the results. Probably a good thing. But if you want to save a series of "snapshots" of the results, you could make the following changes:

```
#!/bin/sh
g.copy rast=t.start,t
d.rast t
i=1
while [ $i != 10 ]
do
  n=1
  while [ $n != 10 ]
  do
    r.mapcalc < spread
    d.rast t
    n='expr $n + 1'
  done
g.copy rast=t,t.$i
i='expr $i + 1'
done
```

We have made the 100 step process into two loops, one runs ten times and then is done. A copy of the map is made as t.$1, and the outer loop restarts the inner one. Thus, ten "snapshots" are made of the 100 iterations.

Another way we can use the spatial operators is to consider moving averages or similar measures. The **neighbors** operator and **r.mfilter** allows easy computation of moving averages, but with **r.mapcalc** we can expand the idea. Suppose we want to compute a moving standard deviation (or variance) or ... where the value in the final map equals the number of standard deviations that the cell's value is from (*continued on page 16*)

Growing GRASS
(continued from page 15)

the average of the cells in its vicinity? The following **r.mapcalc** commands will compute this value:

```
var = eval (sum = t[-1,-1] + t[-1,0] + t[-1,1] +
\
   t[0,-1] + t[0,0] + t[0,1] +                \
   t[1,-1] + t[1,0] + t[1,1] ,                \
sum.square = t[-1,-1] * t[-1,-1] + t[-1, 0] * t[-1,
   0] + \
   t[-1, 1] * t[-1, 1] + t[ 0,-1] * t[ 0,-1] +    \
   t[ 0, 0] * t[ 0, 0] + t[ 0, 1] * t[ 0, 1] +    \
   t[ 1,-1] * t[ 1,-1] + t[ 1, 0] * t[ 1, 0] +    \
   t[ 1, 1] * t[ 1, 1] ,                      \
   ave = sum / 9.0 ,                          \
var = (sum.square - 2.0 * ave * sum + 9.0 * ave
   * ave) / 8.0, \
   std = sqrt(var), \
   t.dif = t - ave, \
   t.dif * 10 / std)
```

In the command, we have introduced the *eval* operator and temporary variables. In the *eval* operator, all the arguments are evaluated except for the last one. The temporary variables simply hold the results of computations that will be needed later. In the above, we first compute the sum of all the values in a 3 x 3 window temporary variable "sum". This could be expanded to any size and need not be square. Next, we compute the sum of the squared values (for use later in the formula for variance) and assign it to the temporary variable "sum.square". The average of the values (*ave*) is computed, then the variance, *var*. Take the square root of this number, which is the "floating" standard deviation. We then compute the difference of t and the floating mean and assign it to **t.dif**. The ratio of the difference to the standard deviation is assigned to the cell in map *var*. We multiply by 10 to get one decimal "precision" in the answer.

As an aside, the new version of **r.neighbors** now has a variance and deviation computation that would compute the *var* and *std* results on a square area. The point in presenting them here is to demonstrate the concepts and to give you ideas for other options.

I hope I have piqued your interest in the area of spatial operators. To follow up on some of the ideas presented here, you can get an article on the ftp site *moon.cecer.army.mil* by Michael Shapiro and Jim Westervelt entitled *r.mapcalc an Algebra for GIS and Image Processing*. You might also want to read the enjoyable columns in GIS World by Joe Berry or, for you serious types (you probably didn't read this far anyway) there is Dana Tomlin's GIS and Cartographic Modeling, published by Prentice Hall. Till next time ... if you have any comments or suggestions, please send them to me at fred@kirk.uark.edu.

GIS Workshops for Military Personnel
(continued from page 3)

scheduling training areas, and integrating vector and raster systems.

Dr. Scott Madry (Rutgers University) will present a one-day workshop October 27, entitled *GIS Background and Tutorial*, for people who are unfamiliar with GIS technology. A two-day workshop, held October 28-29, will focus on five current applications of *GRASS* and other GIS systems: GIS Applications on Military Installations; DOD Programs Involving GIS; GIS Implementation and Planning Issues; Case Studies Presented by Installation Personnel; and GIS Support Structures within DOD. Open discussions among users will be encouraged in order to facilitate implementation for new users, to assist experienced personnel with application problems and to identify potential innovations for enhancements. For more information contact Bill Goran (217-373-6735) or Jean Messersmith (317-494-8427).

GRASS: A Geoprocessing Environment for *Unix*

The needs of Geographic Information System (GIS) users are plentiful and diverse, and GIS developers and vendors offer a range of services. As public domain software, *GRASS* can fill some niches that commercial software, because of licensing constraints, is unable to fill. One such niche is data distribution. As CD-ROMs are becoming more popular as a means of GIS and imagery data distribution (in the *Unix* environment), *GRASS* software, logically, joins the list of GISs available on CD-ROM. Distributing *GRASS* on CD-ROMs insures that users can read and "show" data sets or even translate data into other formats; specialized interfaces can be created easily (either by using *GRASS* command-line tools or through an *XGEN* graphical interface) for developing data showing environments for specific data sets. In addition, special menus can be created to provide a range of translation paths for moving the data to other systems and formats. For these requirements, only a subset of *GRASS* is needed, but if adequate space is available on the CD-ROM, the entire system (and possibly related programs) can be provided, thus allowing users access to an entire GIS.

Another potential niche for *GRASS* is as an extension to the *Unix* operating system. Since *GRASS* already runs on most *Unix* environments, it has great potential as an "add-on" that vendors can provide to *Unix*. Certainly, the trend is that higher-level functions and languages be available as part of the "base system" for *Unix* machines — *X Windows* and *Motif* are evidence of this trend. *GRASS*, in a sense, provides a geoprocessing shell (like the Bourne or Korn shells) for *Unix* that still allows users to access all other *Unix* utilities from this *GRASS* shell. While not every user of a *Unix* box will want an extended geoprocessing environment, its availability certainly will attract many users.

Some vendors are already pursuing this vision — providing *GRASS* as an "optional" package when a system is ordered. At present, however, this can create some problems, as these vendors seldom have adequate expertise in providing user support for a complicated software environment. One solution to this problem is for these vendors to connect with one or more of the *GRASS* value-added resellers (VARs) who do have software expertise and offer an option "with support".

Another solution is for a consortium of vendors and VARs to work together (as is the case with several other vendor consortiums) to insure that all parties have the latest and greatest, fully tested and documented release; that users and developers have adequate help sources; that information services are available; and that third-party software developer communities can fully exploit the wide range of utilities provided by this

NEW GRASS Seeds by Bill Goran

"geoprocessing" software.

If *GRASS*, *GRASS* tools, or *GRASS* "show" functions are added to *Unix* and/or data packages, these capabilities will need to be accessed as easily as other standard *Unix* utilities, like "ls" and "cd". Thus, vendors will need to distribute binary or runtime versions of *GRASS* or some *GRASS* subset. Most users are daunted by being required to first compile *GRASS*, and an uncompiled version of *GRASS* can be just another item requiring disk space rather than a window to a geoprocessing world.

Providing and testing the latest compiled version of *GRASS* (and a special *XGEN* data show and/or data translation environment, running on each vendors latest O/S version) could provide a signficant role for a vendor consortium ... and an important service to both *Unix* and *GRASS* GIS users.

GIS APPLICATIONS for ENVIRONMENTAL and FACILITY PLANNERS on MILITARY INSTALLATIONS

(All DOD or military installation personnel invited to attend; others welcome, space providing)

George Mason University Institute of Public Policy
Fairfax, VA 22030-4444
October 27 - 29, 1992

October 27

GIS Background and Tutorial

October 28 - 29

GIS Applications on Military Installations
DOD Programs involving GIS
GIS Implementation and Planning Issues
Case Studies presented by Installation Personnel

Graphic Digitizer Accuracy

by Dominic Giovachino

Graphic digitizer accuracy is a specification that is often not very well understood. This is most unfortunate, since it is also the most important parameter to consider when specifying a digitizer.

If the output of your work is a map product or analysis of map data, it is clear that accuracy of your output can be no better than the accuracy of what is input. When input data comes from digitizing a map sheet, the digitizer becomes the critical path in achieving a high accuracy result. Yet, many systems are put together with considerable attention paid to the acquisition of state-of-the-art computer workstations with expensive high resolution displays and sophisticated plotters for output and relatively little attention paid to the input device.

The following discussion of digitizer accuracy is presented to provide an understanding of the sources of digitizing errors so that an intelligent evaluation of digitizers can be made.

The Importance of Digitizer Accuracy in a Mapping Environment

A map is a graphic representation of geographic features. To display these features on a flat sheet of paper has always been a challenge. Great care is taken in collecting and verifying the data presented on maps, with new and more accurate methods always in development. In converting maps to digital form, the inherent accuracy should be maintained. Why would anyone intentionally degrade the accuracy of an existing map?

When digitizing a map, any errors introduced during digitizing will be carried through the entire process and added to the other errors introduced in processing and plotting. Therefore it is essential to minimize the errors introduced at this first, critical step.

The ACSM-ASPRS Geographic Information Management System (GIMS) Committee states that all map products within a Geographic Information System should meet acceptable industry standards such as the National Map Accuracy Standards.[1] The United States National Map Accuracy Standards call for an accuracy of .02 inches for maps on a scale of 1:20,000 or smaller. To put this in perspective, .02 inches represents 12.2 meters at a scale of 1:24,000 and 127 meters at a scale of 1:250,000. Digitizer accuracy is normally specified for the horizontal (x) and vertical (y) directions independently. However, the x and y errors combine to produce a radial error which can be greater in magnitude than either the x or y error.

Take, for example, a digitizer with a specified accuracy of +/- .007 inches. In the worst case, both the x and y coordinate will be in error by .007 inches. The radial error, in this case, is .01 inches. At another point on the digitizer, the errors could be in the opposite direction.

The total error between these two points is then .020 inches. In this example, the National Map Accuracy Standard of .02 inches can be met only if the rest of the system, including the source document and operator, is error free. Clearly, the digitizing error is important.

Source of Digitizing Error

The method of determining and specifying accuracy varies from manufacturer to manufacturer. Often the accuracy specified is for the digitizer table itself and does not include errors from other sources that also add error to the digitizing process. In some cases, errors are measured only along a single horizontal or vertical line, rather than over the entire area. Some manufacturers may require that every point measured on the digitizer surface be within the accuracy limit, while others may allow a percentage of points to exceed the limit, or define the limit as the standard deviation of the error distribution. When evaluating accuracy specifications, you should always ask for details on how the accuracy is defined and measured.

The following sections will identify several sources of digitizer error and will suggest methods for evaluating your own digitizer to determine its accuracy relative to the National Map Standards.

Cursor Errors

It is assumed that a cursor (puck) will be used for digitizing the map (a pen stylus is simply inadequate for "electronic center" of the cursor. It is the job of the operator to place this electronic center directly over the point to be digitized. Since the only reference is the crosshair provided in the cursor, it is essential that the crosshair mark the electronic center. If the cursor and crosshair are not manufactured with precision, the crosshair will be offset from the electronic center, causing an error.

To test for this, digitize a single point eight times, each time with the cursor at a different orientation, rotating the cursor 45 degrees for each measurement. The coordinates output by the digitizer should be the same for each measurement. The coordinates output by the digitizer should be the same for each measurement. The difference between the minimum and maximum values reported for each of the X and Y coordinates is the total error. You may be astonished to find many cursors that exhibit a total error in excess of .03 inches in this test. The National Test Standards will have been exceeded even before you begin digitizing.

Additionally, the crosshairs should be easily visible, yet fine enough to resolve a point location to a few thousandths of an inch. A magnifier is a must for accurately placing the crosshairs. The crosshairs should be mounted so there is little or no gap between the crosshairs and the map surface in order to minimize parallax errors.

Repeatability

Repeatability is the ability of the digitizer to report the same coordinate value when the same point is digitized at different times. To test for this, locate a point on the digitizer surface and digitize the point 10 or 20 times, each time moving the cursor away and bringing it back to the same spot. Note the variation in the coordinates. The difference between the maximum and minimum values reported for each of the x and y coordinates is the repeatability. This tests both the repeatability of the digitizer and the ability of the cursor to be positioned accurately each time.

To eliminate the contribution from the cursor, the following test can be performed. Tape the cursor to the digitizer so it can not move. With the resolution set for .001 inches and the digitizer operating in stream mode outputting coordinates at 10-20 points per second, view the coordinates as they are output. There should be a change of no more than .001 inches, or one digit, in the output. If the last digit changes by two or more counts over time, then the total variation in the output represents the repeatability error of the digitizer alone. This is sometimes referred to as digitizer "jitter."

Stability

Stability is the long-term repeatability of the system. With the cursor still fixed in place, read the output coordinates once an hour over a period of several hours, or even days. Turn the digitizer off at night and on again in the morning as it would be in normal use. The coordinate value should always be the same. Any change over this period represents an error.

Operator and Source Document

The operator must be careful to not introduce error. With the aid of a magnifier, experienced operators can digitize with an error not exceeding .001 inches. A good operator probably contributes the least error in the entire process.

A map itself may not behave as well. Source material will expand and contract and otherwise distort as the temperature and humidity vary. During the course of a digitizing session, assuming you have a digitizer with a good long-term stability, you can check this by digitizing certain control points periodically to see if the map sheet is moving.

Digitizing Table

The accuracy of the digitizing table itself is difficult to measure. The main problem is in establishing a sufficiently accurate reference that covers the entire digitizer active area. Ordinary paper, rulers, metal scales, or mylar sheets are not accurate or stable enough. However, an accurate reference printed on glass is available from Optical Gaging Products, in sizes up to 36" by 48"[2]. It is printed with horizontal and vertical lines at .1 inch spacing with an accuracy of .001

(*continued on page 21*)

SDTS at USACERL
by David Stigberg

We at the U.S. Construction EngineeringResearch Laboratory (USACERL) are very enthusiastic about USGS's efforts to bring the many years of SDTS development to fruition and are working with USGS in support of these efforts. We are currently testing the SDTS Vector Topological Profile and are in the first stages of interfacing SDTS with *GRASS*. We are writing software to encode *GRASS* vector data in the SDTS exchange format in conformance with the Vector Topological Profile. We are also writing programs to decode *DLG* and *TIGER* as well as *GRASS* sample data sets from SDTS into *GRASS*; this effort will help us in our evaluation of the Vector Profile, while laying the foundation for the development of more general purpose SDTS-to-*GRASS* importing software. For these tasks we are using and evaluating the prototype version of the suite of software tools that have been created by USGS to facilitate the import and export of SDTS vector data. Finally, beginning in Summer 1992 USACERL will be participating in the design of the SDTS raster profile. For more information, contact David Stigberg at 217-352-6511 or email stigberg@zorro.cecer.army.mil.

ERIM
Ninth Thematic Conference on Geologic Remote Sensing: Exploration, Environment, and Engineering
February 8-11, 1993
Pasadena, California
Contact: Nancy Wallman, ERIM
P.O. Box 134001
Ann Arbor, MI 48113-4001
Phone: 313-994-1200, ext. 3234
FAX: 313-994-5123

GRASS Inter-Agency Coordinating Committee Meeting (GIACC)

September 22-23, 1992
Quantico, VA
Hosted by the FBI

For more information, contact Marji Larson at USACERL, 217-352-6511 or send email to larson@zorro.cecer.army.mil

1993 GRASS GIS Users Conference

the week of March 15, 1993 at the Hyatt Regency Hotel in Reston, VA.

Look for more information in the fall 1992 issues of *GRASSClippings*.

Digitizers

(*continued from page 19*)

inches.

To use such a reference, the grid must first be aligned with the digitizer axes. Choose two points on a horizontal line (as far apart as practical but still well within the digitizer active area), and carefully adjust the glass grid so that the y coordinate value for each point reads the same (this will take some time and patience). It is desirable that the actual coordinate values of the two points end up an exact multiple of .100 inches. This will make it much easier to interpret the results.

With the grid aligned, digitize points every few inches in a line, then move up a few inches and digitize another line, until the entire active area has been covered. Maintain the cursor at the same angle throughout the test to eliminate the effects of cursor rotation from the measurement. Use a magnifer if one is available. Record the difference between the x coordinate of each point and the nearest multiple of .100 inches. The error may be positive or negative depending on whether the digitizer value was greater than or less than the expected value. The difference between the most positive and most negative error is the total error. Do the same for the y values. The larger of the two total errors is the digitizer error.

Summary and Conclusions

The total digitizing error is the sum of the errors introduced by each of the contributing error sources discussed in the previous section. It is easy to see how the compounding of these errors can quickly degrade the accuracy of the digitizing process. The true accuracy will often be significantly poorer than the stated accuracy of the digitizer. Since the accuracy of the final product can be no better than the accuracy of the digitized input, it is important to evaluate your digitizer for its total error contribution.

To make an intelligent choice of digitizers, you will need to investigate all of these areas and ask lots of questions in order to assess the level of accuracy you can expect from your system.

For more information please contact Domenic Giovachino at Altek, Corp.

1. ACSM-ASPRS Geographic Information Management System Committee, "Multi-Purpose Geographic Database Guidelines for Local Governments", ACSM Bulletin, August 1989, pp. 42-50.

2. Optical Gaging Products, 850 Hudson Ave., Rochester, N.Y. 14621.

GRASS Information Center

GRASS GIS MEETINGS and WORKSHOPS

Central Washington Univ.
Ellensburg, WA
Phillip Richins
509-963-1504

Colorado State Univ.
Fort Collins, CO
Conference Services
303-491-7501

Univ. of Illinois
Champaign, IL
Scott Tweddale
217-244-1222

Purdue Univ.
W. Lafayette, IN
Tom Robertson
317-494-7220

Rutgers University/Cook College
New Brunswick, NJ
Julianne Mosolgo
908-932-9271

University of Arkansas
Fayetteville, AR
Marsha Bolstad
501-575-6159

George Mason University
Fairfax, VA
Elly Doyle
307-993-3351

1992 Workshops

July		
13-17	GIS Basic Course —	CWU
20-23	Advanced GRASS Applications —	CWU
27-31	GRASS for Resources Analysis —	CSU
29-30	TIGER & Census Programs in GRASS —	UI,
August		
3-7	Introduction to GRASS 4.0 —	Purdue
17-21	Introduction to GRASS 4.0 GIS —	Rutgers
17-21	GIS Basic Course —	CWU
17-21	Introduction to GRASS 4.0 —	Arkansas
17-21	Introduction to GRASS 4.0 —	UI
24-27	Advanced GRASS Applications —	CWU
September		
14-17	Introduction to GIS: A Tool for the 90's —	Rutgers
October		
5-9	Introduction to GRASS 4.0 —	Arkansas
7-9	Fundamental Concepts In Map Analysis, GIS Short Courses —	CSU
19-23	Introduction to GRASS —	Rutgers
21-22	GIS and Soil Science —	Arkansas
27	Introduction to GIS (Military Installation Personnel Only) —	George Mason
28-29	GRASS Applications Workshop (Military Installation Personnel Only) —	George Mason
November		
12-13	Introduction to GIS —	Arkansas
16-18	Using GRASS 4.0 and the GRASS Global CD-ROM Data Set for Environmental Modeling —	Rutgers
18	Global Positioning Systems (GPS) —	Arkansas
23	Overview of GIS: A One-Day Seminar —	Rutgers
December		
2	Introduction to Global Positioning Systems —	Rutgers
1-3	GIS Tech InLand & Resource Mngt.: A Short Course For Rsrc. Specialists —	CSU
7-11	GIS Basic Course —	CWU
8-10	Implementing GIS On Your District: A Short Course for US Forest Service Rsrcs Mgr —	CSU
14-17	Advanced GRASS Applications —	CWU

1993 Workshops

January		
4-8	Introduction to GRASS 4.0 —	Purdue
11-15	Introduction to GRASS —	George Mason
11-15	Introduction to GRASS 4.0	UI
March		
8-10	Data Development using GRASS —	Purdue
15-19	Introduction to GRASS 4.0 —	Rutgers
22-25	Advanced GRASS 4.0 —	Rutgers
April		
26-29	Introduction to GIS: A Tool for the 90's —	Rutgers
May		
4	Introduction to Global Positioning Systems —	Rutgers
June		
7-11	GIS Basic Course —	CWU
14-17	Advanced GRASS Applications —	CWU

GRASS Information Center Coordinator
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Training and Workshop Schedules
If anyone has upcoming workshops, please contact Melanie Mayfield so we can announce them on this page in *GRASSClippings*; if you wish not to have the schedule publicized, we would still appreciate receiving your workshop schedules so we can keep our files up-to-date. In order to announce your workshops and training sessions in *GRASSClippings*, we must receive your schedule no less than two weeks prior to the submission deadlines for articles specified on page two of this issue of *GRASSClippings*.

Mailing List Requests
People requesting information about or desiring to be added to (or deleted from) the mailing list, should contact Melanie Mayfield.

GRASS GIS Conference 1992

Awards Presented

This year's conference was a great success — attendance was higher than ever, workshops were well attended, and presentations sparked interesting discussions. ,We would like to extend a special thank you to *GRASS* contributors and conference attendees for their superior efforts toward the continued development of *GRASS*. We would also like to thank the National Park Service for hosting the conference, Gary Waggoner for coordinating, Meredith McCarthy for handling registration nightmares, and others for the excellent job they did organizing the event.

The GRASS Inter-Agency Steering Committee recognized several members of the *GRASS* community for their outstanding work in *GRASS*. Awards were presented for "Best New *GRASS* Software Tool"; "Best Paper"; "Best Poster"; "Outstanding Interagency Cooperation"; "Appreciation for Coordinating Vendor Exhibits for the past four GRASS GIS Users Conferences"; and "Special Awards". The "Best New *GRASS* Software Tool" award was presented to Marty Holko for *MAPGEN Interface to GRASS* and to Jim Farley for *DBSQL*.

"Best Paper" awards were presented to John Knoerl, *GRASS and the Civil War*, and William Doe and B. Saghafian, for *The Spatio-Temporal Effects of Army Maneuvers on Watershed Response: Integration of GRASS and a Two-D, Distributed Rainfall Runoff Model*. Honorable mention for best paper went to Robert Sullivan, David Gerdes, and Doug Youngs (*Enhancing GRASS Data Communication with Videographic Technology*), Terri Betancourt (*Automated Flood Plain Analysis Using HEC2 and GRASS*), and Pamela Sydelco (*Use of GRASS for Routine Gas Pipeline Rights of Way*).

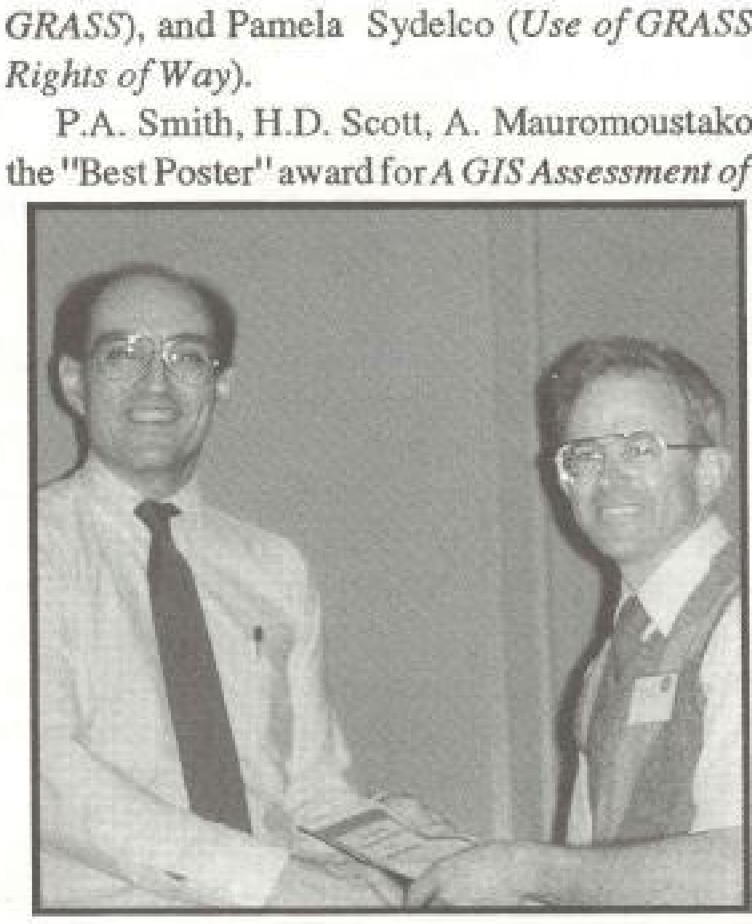
P.A. Smith, H.D. Scott, A. Mauromoustakos, and W.F. Limp received the "Best Poster" award for *A GIS Assessment of Landscape Characteristics and Water Quality in the Muddy Fork Watershed*. Honorable mention for best poster was awarded to Helena Mitasova, Dave Gerdes, Louis Iverson, Jaroslav Hofierka, and Anatha Prasad for *Surface and Volume Modeling with Topography Analysis Using Regularized Splines with Tension*.

Gale TeSelle was awarded for his efforts toward interagency cooperation, and Doug Brooks for coordinating conference vendor exhibits for the past four years. Two Special Awards were presented, both to Jim Westervelt: one was for the *Command Line Parser* and the other for *Linnaean Luminary* (for the name *GRASS*).

Organizational Meetings

After the close of the conference, the *GRASS* Inter-Agency Steering Committee (GIASC) and its related organizations met to discuss future goals and developments. The long standing organization called the GIASC is continuing to produce offspring with slightly different identities and different names. One currently existing entity is the GRASS Inter-Agency Coordinating Committee (GIACC), which consists of federal agency representatives only. The main purpose of this organization is to provide coordination services for the Office of GRASS Integration (OGI) at USACERL.

The broader purpose of the old GIASC was to unite *GRASS* users from military; federal, state, and local governments; universities; and private organizations for the exchange of ideas about GRASS developments as well as coordinating *GRASS* user services, such as publishing and distributing *GRASSClippings* and hosting GRASS GIS User Group Meetings. These aims will now be pursued by the new GRASS User Forum organization.



GRASS User Forum Board Members:

David Schell, Exec. Dir.	Quentin Ellis (DBA)
Kenn Gardels, Sec.	Ed Escowitz (USGS)
Fred Limp, Treas.	Emil Horvath (SCS)
	Scott Madry (Rutgers)

Around the World

GRASSCLIPPINGS
Volume 6, #2 Summer 1992
ISSN 0899-7853

1992 European GRASS User Group Meeting

by Wim Ploeg and Bob Lozar

The Third Annual European GRASS User Group Meeting, held March 27 in Munich, Germany, produced posters, presentations, and decisions. The meeting, held in coordination with the Third European GIS Conference, featured a series of interesting and exciting speakers. Speakers from Sweden, Germany, Greece, and the U.S. presented talks:

GIASC Activities - Kenn Gardels,
International Activities - Scott Madry
Global Modeling by Hydrology - Bob Lozar
Methods to Generalize Raster Databases - Lars Schylberg
Visualization as a Tool for Assessing Errors in DEMs - Joseph Wood
Sequoia Project - Kenn Gardels
Remote Sensing Data for GIS - Susan Ribansky

One warming item was that both the speakers and audience were clearly well acquainted with *GRASS* and enthusiastic about its capabilities. Particularly noticeable was the interest expressed by Eastern and Southern European representatives. The sense one walked away with from this meeting is that a transition is occurring in Europe: *GRASS* is moving from a look-see status to being recognized as a real working tool.

During the Plenary meeting, the European GRASS Foundation established an organizational structure for future development of the European *GRASS* community; the GRASS User Group elected seven members for the Board of the European GRASS Foundation, elected at least three members for the Editorial Board of the *European GRASS Community Newsletter*, and appointed a main coordinator for the European GRASS Network. The editors are planning to produce the newsletter twice a year.

European GRASS Foundation Board Members:

President — Rob de Waard, Bureau Nieuwland, Netherlands
Secretary — Hilaire De Smedt, Free University of Brussels, Belgium
Treasurer — Roel Brandt, Netherlands
Network Coordinator — Jan Hartman
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