LAS NEWS

Land Analysis System

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Contents

Sharing in LAS

by Marilyn Mack (GSFC) - Editor

Our list of those receiving "LAS NEWS" currently contains more than 625 names! There are now 83 user sites as well! The system is experiencing tremendous changes and is maturing in its new version 5 portable form. The keynote of this effort has been sharing. The conversion process would not have been possible without the cooperative sharing between the EROS data center and Goddard Space Flight Center. This same spirit of sharing between the same two groups helped in the project to support the UNEP GRID. Personnel from another user site, the Laboratory for Terrestrial Physics at Goddard, have also shared with us in many ways. In addition to their cooperative efforts on the Configuration Control Board, they have given us several routines for our CONTRIB library. Our LAS Support Office has shared their expertise with you whenever you have called. If you have not yet done so, remember that you can contact them at (301) 286-9412. Our software is currently in a shareable image form and this issue describes how to alter that shareable form if desired.

This newsletter is a product of sharing as well. Those generous persons who have volunteered their time and talent to submit articles are sharing their valuable information with the entire LAS community. To serve the whole community better, that same spirit of sharing will have to be shown by more of our other active users. By now you are probably more familiar with the system and can tell us about your experiences. Send your articles, short notes, meeting notices, and general comments to: Ms. Marilyn Mack, LAS NEWS, Code 636, Goddard Space Flight Center, Greenbelt, MD 20771. In addition, if you have made prior arrangements with me by calling (301) 286-4638 and you have access to a FAX machine, you may send any printed material for the LAS NEWS using (301)286-3221. Share with other LAS community members as they have shared with you!

Status of LAS 5.0

by Marilyn Mack (GSFC)

As our last issue reported, members of the LAS staff both at the Goddard Space Flight Center and at the EROS Data Center have been busy converting the application software in LAS to a more portable form (primarily through a recoding in the C language). By the end of 1988 all of the LAS libraries had been converted to C. The codes were converted according to the priorities given by users in an earlier survey taken more than a year ago. To date seventy-nine application functions from LAS 4.1 have been delivered for testing in the new portable form. The seventy-seven converted to C include:

ABS	ADD2STAT	ADDPIC	ANDPIC
BANDRATIO	BAYES	CANAL	CCTTIPSP
CLASSMAP	COMPARE	CONCAT	CONTABLE
CONVERT	COPY	COVAR	DDREDT
DESTRIPE	DIVPIC	DSPGLOB	DSPGRID
DSPLBL	FACTOR	FILM	FILTER
FLIP	GEOM	GRIDGEN	HIS2RGB
IENTER	INSERT	ISOCLASS	ITRANSFER
KARLOV	KMEANS	LASDEL	LIST
LISTCAT	LOWCAL	MAGNIFY	MAKEIMG
MASK	MASKSTAT	MAX	MIN
MINDIST	MINMAX	MULTIPLY	MULTPIC
NORMD	ORPIC	OVERLAY	PERSPEC
PLENTER	PROCCHECK	RECLASS	REGISTER
RENAME	RENUMBER	RGB2HIS	ROTATE
ROTRNSCL	SEGMREPR	SPECCOMB	SPECSTRT
SPREAD	STATS	SYSSAMP	TESTGEN
TIEFIT	TIEMERGE	TOPO	TRANCOORD
UNKNOWN	WHATISIT	XORPIC	ZIP
ZOOM			

Note that among these, several will appear under new names or will be incorporated into existing routines. ADDPIC, ANDPIC, DIVPIC, MAX, MIN, MULTPIC, ORPIC, and XORPIC have been combined in a new function called MATH. HIS2RGB and RGB2HIS are combined in a new function, HIS. CONVERT was incorporated into COPY. COMPARE was replaced by DIFF and, finally, WHATISIT was replaced by MAPPER. Two routines were delivered in portable, UNIX compatible FORTRAN: MAP and PIXCOUNT.

An additional thirty-nine functions coded in C will be complete by November, 1989. These include:

ANNOTATE	ANNOTE	ARCHIVE	AVERAGE
BANGLE	BDIST	COEFFEDT	CONTROL
CONVOLVE	COORDEDT	CWTGEN	DELLUT
DEMENTER	DIVERGE	DPFMAP	DSPRLT
EDGECORR	EDIPSIN	EDITSTAT	GREYCORR
GRNDSPOT	HINDU	HISTEQ	HISTPLT
LACIN	LOGICAL	NEIGHBOR	RADIOM2
RASTERIZE	REMAP	RETRIEVE	SCATTER
SEARCH	STATPLOT	STRETCH	STVEDT
SURFACE	TEXTURE	TRANSPOS	

In addition, a UNIX compatible, FORTRAN version of FIXLIN will be delivered. To insure the portability of the transformed code, each delivered function is being tested on a SUN II under UNIX, a VAX 11/780 under VMS, a MicroVAX under ULTRIX, a PowerNode (PN) 9050 under UNIX, and an IBM RT under AIX at the two installations and at previously selected cooperating, qualifying Beta sites.

If any of you have converted LAS code to C or if you have developed code in C which you feel might be suitable for use in the new release, please contact the LAS Support Office at (301) 286-9412. A preliminary version of the portable system will be available through COSMIC by the summer of 1990. The fully converted system will be available before January, 1991. You may obtain further information about the release by calling the LAS Support Office at (301) 286-9412.

Update on LAS Workshop Plans at GSFC

by Marilyn Mack (GSFC)

As you may recall from the last several issues, a workshop had been tentatively planned. We had hoped to cover many areas of interest such as:

- Applications Using LAS
- Application Programming With LAS
- Workstation Usage With LAS
- System Installation Experiences
- Future Plans for LAS at User Sites
- Forum on Future Directions for the LAS Project
- A tutorial session on LAS

Since we have had only one response from among the more than eighty user sites, we have tabled the idea. Certainly, we do not wish to force anything in which you have no interest.

If we begin to receive requests from more of you, then we will re-open this topic. Send any suggestions or requests to Dr. Lu, Code 636, Goddard Space Flight Center, Greenbelt, MD 20771 or call (301)286-4093. As always, we look forward to hearing from you!

GSFC Continues Support of the UNEP/GRID

by Fred Irani and Dean Gesch (ST Systems Corp. - GSFC)

The GSFC LAS development team has been providing support to the United Nations Environmental Program (UNEP) Global Resources Information Database (GRID) project for the past eighteen months. GRID is one of several projects under the UNEP Global Environmental Monitoring System (GEMS) headquartered in Nairobi, Kenya. The UNEP/GRID office has selected LAS as its primary image processing resource.

The GRID project is only a few years old. The objective of GRID is to collect and disseminate geographic information world-wide. A second objective is to train groups of individuals from developing countries in the Geographic Information System (GIS) and in Remote Sensing technology. To achieve this, Grid offices or "nodes" have been established in Nairobi, Kenya, in Geneva, Switzerland, and in Bangkok, Thailand. A South American node is anticipated for the near future and other cooperating offices may be identified in the future. Currently a variety of computer hardware and software is being used in these nodes ranging from an IBM 4381 mainframe, soon to be running AIX, to a MicroVAX 3600 under VMS as well as to various workstation and PC-sized computers.

LAS was chosen by the United Nations largely for its online help and friendly user interface. The speed at which new users can be trained on the system is also of high importance. In addition, the conversion of LAS to run on different hardware and under different operating systems, especially under the IBM AIX operating system, and the ability of LAS to interface with other systems such as ARC-INFO, SPSS, and others via EDC's labelled-table files made LAS a more viable choice for the UN. LAS version 4.0 was first installed on the GRID MicroVAX 3600 machines in Geneva and Nairobi in July, 1988 and was upgraded to version 4.1 this past May.

Certain new requirements for LAS came from the GRID project. Since the UN is primarily interested in Global datasets, enhancements such as increased image sizes, number of bands, and mosaicing capabilities were requested. Capabilities to ingest data in new CCT formats and for a more comprehensive set of map projection transformations were also requested. The UN also has plans to acquire EDC's Large Area Mosaicing System (LAMS) that is currently running under the LAS version 5.0 environment.

Efforts have continued to provide display capabilities for the GRID Comtal 8000/R30-SER display device under DMS. The most recent development took place in Nairobi in April of this year, but efforts were thwarted by hardware and electrical problems encountered in Nairobi. Display capabilities for GRID under VAX/VMS are minimal at present and future directions are as yet to be determined. Mr. M. Snyder at the University of Rhode

Island has possession of the most recent Comtal device dependent software and is making efforts to finalize implementation of this software for a Comtal 8000R-65SER. The only difference between his device and that of the GRID project is its 1024 x 1024 resolution compared with the 512 square resolution of the GRID devices.

An RT and 5081 display had been made available to the LAS development team in October, 1988 and prototype display capabilities had been demonstrated to the representatives of the United Nations in mid-December. This past May a prototype version of the LAS version 5.0 running under AIX on an IBM/RT workstation was installed on GRID RTs in Nairobi and Geneva. The 1024 x 1024 resolution, 8-bit deep, IBM 5081 color display device is currently being used with the RT at all GRID offices. The AIX LAS implementation was used for demonstrations during the bi-annual UNEP Governing Council meeting of May 15-26 in Nairobi. Display capabilities were provided by LAS through the Display Management System (DMS). Device dependent (DD) routines were developed at GSFC for the X-window or "X10" protocol. X10 was used because IBM had not implemented X11 under the AIX operating system when the project began. Most of the software design and development of the X10 DMS DDs was performed by Mike Mazzella at GSFC. UNIX expertise and technical support was also provided by the newest GSFC LAS development team programmer, John McGuthry. After Mike Mazzella left Goddard, Bani Allam completed Mike's early work on graphics capabilities for the RT and Dean Gesch provided technical support to finalize the UNEP demonstration shown in Nairobi. Of course, the RT port relied on the completion of LAS version 5.0 applications by programmers at both GSFC and EDC. DMS applications and "CX" routines ported readily to the RT. Some differences in MAKE files, Include files, and C language "#define" statements required changes to build LAS version 5.0 and DMS on the RT while maintaining its portability to other hardware.

Implementation of LAS display functions on the RT was expedited by the Display Management System "umbrella" program. This was discovered during early investigations into the X10 environment. It turned out that the display windows created by a process are lost at the termination of that process. If LAS application modules had been implemented under the DMS version 1.0, under which each application performs a particular task and then terminates, some form of a controlling process would have been required to create and maintain the X10 display windows.

Since the DMS umbrella program runs continually during a display session, windows are not lost until a user exits the DMS program. This may still present a problem to users who wish to leave DMS momentarily to run LAS applications and then pick up their display work at the place at which they had left. A solution to this problem will have to wait, however, until users ask for it specifically and the system enhancement receives LAS CCB approval.

Mike Mazzella had used X-window pixmaps to define 10 virtual image planes on the RT. SHOIMG could then be run to display one of these virtual images at a time. This helped to speed the UNEP demonstration by allowing ten images to be brought into the display prior to the start of the demonstration. These images could then be displayed quickly without going out to disk. The definition of ten 1024 x 1024 virtual screens required more paging space than is usual for the RT and adjustments had to be made to the minidisk configuration in Nairobi to run the demonstration. Note that DEVADD can be run to specify different image window sizes and/or number of virtual image planes. This provides flexibility in the use of the workstation's resources.

Graphics capabilities were provided through the use of X10 "Transparent Windows". The color of the "graphics planes" can be changed and points and lines are selected using the RT mouse. Tie-point and training-field selection is now possible but may not be useful until the hardware provides a range of 256 grays or until algorithms are implemented to produce "colorized" representations of 24-bit data which can then be displayed. Even with the 24-bit color pallette only 256 colors can be shown at one time on the IBM 5081 display.

Hardware limitations prevented applications such as ZOOPAN from being implemented on the RT. The hardware color pallette provides only sixteen levels of gray in the UNEP configuration so that black and white displays of raw image data are coarse and interactive contrast stretches are not practical. The best use of the machine is to pseudo-color classified images using the PSD command. Other minor hardware problems or annoyances include the apparent inability to turn off the screen timeout which can cause the image to disappear while a scientist is working or while waiting for a demonstration to begin. In addition, moving the displayed image window causes the image to disappear and images can not be displayed in a window that has been resized with the mouse.

More work on the graphics and display capabilities will be required since IBM now has an X11 implementation for the RT and plans to implement DMS capabilities on the RT under X11 and TAEPLUS are now in the works. Unfortunately, transparent windows are not available as such in X11 and other LAS retrocoding will be required. Efforts may be made to build TAEPLUS under AIX at Goddard. This would allow smoother operations under DMS.

Currently tie-point and polygon selection is somewhat cumbersome. The RT configuration consists of a single keyboard, to control both a color and monochrome monitor. Control must be toggled between monitors to operate the mouse for graphics plane point selection. In order to activate DMS a virtual terminal is opened on the 5081 color display. Keyboard control is then toggled back to the monochrome display using ALT and ACTION keys together. Polygon vertices are selected using the PUT application. The scenario is to toggle control to the color display, move the mouse to the desired location, toggle control back to the monochrome device and press the number "1" to select the cursor location. Control is then toggled back to the color display to move the mouse to the next location. Clearly an improvement to this situation is needed.

The use of TAEPLUS would allow control to remain on the color display. The mouse could then be used to select points as well as to direct commands to the software. This would represent the first use of TAEPLUS by the GSFC LAS development team. It is hoped that use of this user interface can be explored next year.

The next delivery of LAS/DMS software to GRID is scheduled for October, 1989, and a full implementation of LAS version 5.0 is planned for completion before 1991. Special enhancements requested by GRID are yet to be scheduled. Contact the LAS User Support Office at (301) 286-9412 for more information concerning the DMS X10 software and LAS version 5.0 capabilities.

Making Changes to the LAS Shareable Image

by Philip Pease (GSFC)

LAS support subroutines are contained in a shareable image named LASSHARE. In order to understand how to alter the set-up you receive with your LAS delivery, let me first provide some background information on the feature.

Shareable images provide the benefit of reducing the size of an appications program's executable image since the support subroutines are not included in that image. They are only referenced. Another advantage of shareable images is that the applications do not need to be relinked whenever a change is made to a support subroutine in order to use the new subroutine. Instead, only the shareable image needs to be relinked. This last feature requires that the order of the modules included in the LASSHARE does not change. The format of shareable images has a set of vectors at the top of the image which point to the various module entry points. These vectors are followed by the modules themselves.

One drawback of using shareable images is that the execution of the application requires an extra image activation because the supports are in a separate image from the executable. Image activation is fairly time consuming. In order to minimize the image activation time the LASSHARE shareable image is installed on the system during system startup operation.

With this background information, let us now consider the procedures for adding new subroutines into the LASSHARE shareable image and for making changes to an existing LAS support subroutine module.

The LAS support modules are located in subdirectories of [LAS.V41.BASELINE.SOURCE.CORE.SUPPORT]. One of the subdirectories is named ZZZSPARE. This subdirectory has been setup specifically to allow the inclusion of new modules. The module ZZZSPARE_VEC.MAR currently reserves space for 41 vectors (which would point to the new modules to be added into LASSHARE). In the link of LASSHARE, the ZZZSPARE_VEC routine is located at the bottom of the set of vectors in LASSHARE. This was purposely done so that additional modules can be added without affecting the vectors which point to the existing modules.

To add a new subroutine, first copy your new subroutine into the ZZZSPARE directory. Edit the module ZZZSPARE_VEC.MAR to add a vector for your new subroutine and decrease the .BLKQ value by one (i.e., from 41 to 40). For example, for a subroutine named NEWSUB the revised ZZZSPARE_VEC.MAR module would be:

```
; PROCEDURE ZZZSPARE_VEC
   .TITLE  ZZZSPARE_VEC TRANSFER VECTOR
   .PSECT LAS_VEC,PIC,SHR,NOEXE,NOWRT,LONG
;
  .MACRO VECTOR EP
  .TRANSFER EP
  .MASK  EP
  JMP  EP+2
  .ENDM
;
;      TRANSFER VECTOR
;
  VECTOR NEWSUB
  .BLKQ  40
  .END
```

Next, edit the COMPILE.COM and LIBRARY.COM procedures to compile your new module and to insert it into the ZZZSPARE.OLB subroutine library file. Finally, invoke the BUILD_1.COM procedure which invokes the compile and library procedures.

With these steps completed you are now ready to relink the LASSHARE shareable image. This procedure is [LAS.V41.BASELINE.SOURCE.CORE.SUPPORT]LINK_LASSHARE.COM. After invoking this procedure, the remaining step is to get the new shareable image installed in place of the old one. This is performed via invoking the LAS shutdown procedure, and then the LAS startup procedure. They are:

[LAS.V41.BASELINE.RUN.ASSIGN]LAS_SHUTDOWN.COM

and

[LAS.V41.BASELINE.RUN.ASSIGN]LAS_STARTUP.COM.

These procedures need to be run from a privileged account, and should be run when LAS is not being used. Once this is accomplished the LAS will be using the new LASSHARE which contains your new subroutines.

If the need arises to modify an existing LAS subroutine, the steps for getting the revised subroutine into LASSHARE are:

- Compile the revised routine and insert it into the package subroutine library.
  - This can be done by invoking the package's BUILD_1.COM procedure.
- Relink the LASSHARE by invoking the LINK_LASSHARE.COM procedure.
- Deinstall the old LASSHARE and install the new one by invoking the LAS_SHUTDOWN.COM followed by the LAS_STARTUP.COM procedures.

Note, since all existing subroutines are subject to change by the LAS project, you are cautioned to maintain any local changes separate from the released software in order to prevent your changes from being lost when a new LAS release is made.

For further information on the use and altering of the Shareable Image contact either the LAS Support Office at (301)286-9412 or call Phil Pease directly at (301)286-4418.

Rastering a pcARC/INFO Soils Map of Canada

by Bill Kovalick (ST Systems Corp. - GSFC)

[Reprinted with permission of the author from an article in LTPCF News, April, 1989]

A combination of pcARC/INFO commands, DCL commands, LAS image processing functions, and user-written programs were used to rasterize a soils map of Canada which was stored on floppy disk in the pcARC/INFO vector format. The digitized data was acquired from the Canadian government by Dr. Elissa Levine who plans to use it for studying soil and vegetation conditions in the boreal forest. Since the data covers all of Canada (approximately 5366 by 4591 kilometers), it presented an opportunity for assessing the capability of the LTPCF's (Laboratory for Terrestrial Physics Computer Facility) GIS and image processing capabilities on a large data set. The procedures used for the rasterization are briefly described here. For a more detailed description, contact Bill Kovalick (286-3866, LTP::KOVALICK).

The data on floppy disk were transferred to the PC using the MS-DOS RESTORE command and converted to the appropriate pcARC/INFO format using the pcARC/INFO IMPORT command. A listing of the Polygon Attribute Table showed that each digitized polygon was previously assigned to one of 754 unique soil classes. In order to rasterize the data, each of these class names had to be associated with a numeric raster code via a look-up table. For example, soil class 'A1001' might be assigned a raster code of 1, 'A1002' a raster code of 2, and so forth. These codes represent the output pixel values. The look-up table was created using a series of pcARC/INFO commands, the DCL SORT command and a simple program that assigned a raster code to each name based on the "uniqueness" of the first n characters. Using all five characters resulted in 754 unique raster codes.

The pcARC/INFO POLYGRID program was used to rasterize the digitized soils polygons. A 4000 meter by 4000 meter pixel size was used which resulted in an image size of 1350 pixels by 1150 lines. Unfortunately, the image had to be processed as four separate vertical strips due to POLYGRID software limitations and limited disk space on the PC. Each strip required approximately 20 minutes to process and twice that much time to transfer to the VAX. Back on the VAX, each strip was converted to a LAS image using the LAS ARC2LAS function and the strips were mosaiced into one image using LAS CONCAT. Based on a visual analysis of the final image, there were no discernible discontinuities between the four strips.

In the upcoming months, the rasterized soils map will form the basis for various GIS and image processing analyses. It will be registered to an AVHRR image and Normalized Vegetation Difference Index (NVDI) values will be examined to study how different soil types are affecting vegetation. The relational data base capabilities of pcARC/INFO will also be used to study different physical and chemical soil properties that were included as polygon attributes. As an example, pcARC/INFO could be used to select soils polygons that have a specific pH, fertility level and organic matter content, and then plot these polygons out along with a summary table listing the area and perimeter of each. The experience gained here will be used to perform similar analyses on data sets of South America and the remainder of North America.

The rasterization process demonstrated that an externally generated geographic data set could successfully be ingested and incorporated into a digital image with most of the processing relegated to a personal computer. The integration of GIS and image processing capabilities provides a powerful resource that other LTPCF researchers are encouraged to exploit.

Again, for further information on this procedure, please contact: one of the members of the research team: Elissa Levine (GSFC code 623 - [301] 286-5100), Ned Horning (GSFC Code 623 - [301] 286-4837) or Bill Kovalick (ST Systems Corp. at GSFC - [301]286-3866).

University of Texas Uses LAS

by Nahid Khazenie (University of Texas at Austin)

The Center for Space Research (CSR) at the University of Texas acquired LAS software for its computing facilities. Initially, the LAS version 4.0 was installed on a VAX 8200 and a VAX 11/780. The research staff at the Center have successfully utilized this software for ingestion, processing, and some analysis of a variety of data sets. These data sets included SPOT, LANDSAT TM, and AVHRR.

A major focus of CSR research is the development of algorithms for processing multispectral image data. Algorithms have been developed and implemented for supervised classification of image data using a spatial-temporal contextual model, unsupervised segmentation of images using a multi-window statistically based clustering algorithm, statistical reconstruction of noisy images from multiple spatial-temporal filters applied to a sequence of image data, and segmentation of images using a system of hierarchical filters and an AI based connected components algorithm. The algorithms are being applied to sequences of images for which it is desired to detect and monitor change in features over space and time. One project involves analysis of vegetation signatures in a sequence of TM images prior and subsequent to the Chernobyl incident. The objective of another study is to develop an automated procedure for monitoring cotton plough down after harvest in the Rio Grande Valley. A third study involves application of the restoration algorithm to oceanic images for cloud screening and replacement of bad data. The restored image is then analyzed and mesoscale features are detected and tracked through time.

The Center is currently using primarily the non-display functions within LAS due to incompatibilities in CSR display software.

CSR has found the LAS software to be one of the most powerful and diverse packages in existence for image processing. However, some problems are reported at times. The most frequent one involves the difficulties associated with the Catalog Manager (CM). Some of the difficulties were resolved after the recent installation of LAS version 4.1, but not all.

An inconsistency in using the program called IENTER was also noted. The IENTER function is used for reading files from tape to disk. One of the user parameters is the number of lines to read per file. After entering the run command, the program responds with an informational message detailing the current line number being processed. The message takes the form of: line number x out of y of band 1 for file 1. The problem is that the band and file number remain the same for all remaining files processed regardless of the parameter value entered. With the exception of the informational message, the process worked correctly.

CSR is looking forward to the completion of version 5.0, which, as they understand it, overcomes most of the CM problems.

In the fall of 1989, the Center will begin a port of the LAS (version 5.0) to an HP 835 Turbo SRX computer. [Ed. note: CSR is one of the beta sites for LAS version 5.0.] The computer is currently configured with 32 Mbytes of RAM, 32 Mbytes of display memory, two 571 Mbyte disks, and a tape drive. The 1024 x 1280 display has 24 bit color and 4 overlay planes. The computer system is currently being utilized for processing AVHRR HRPT data from the NOAA-n satellites that is acquired using the Sea Space Terascan system, for development of image processing algorithms, for rapid display of imagery in true color, and for application projects requiring GIS. The LAS system will be used in a complementary mode to the Terascan software system and as an image preprocessor to the GRASS GIS system that is used for agricultural studies and mapping projects. The Center also plans to port the software to a Tektronix 4337 graphics workstation that is being used primarily for GRASS GIS projects.

For further information on the Center programs, contact Dr. Nahid Khazenie at (512) 471-3079 or by writing her at The Center for Space Research, The University of Texas at Austin, WRW 402, Austin, Texas 78712-1085.

LAS IENTER Program Input Parameters for New Landsat Full Scene CCT Format

by Lalit Wanchoo (ST Systems Corp. - GSFC)

EOSAT (Earth Observing Satellite) Company provides geometrically uncorrected (AT) and corrected (PT) Landsat data to the user community on computer-compatible tapes (CCT). The standard CCT product carries data for one quadrant (one-fourth of a TM full scene). In order to obtain data for a full scene, one has to order all four quadrants. This means four tapes - one for each quadrant (6250 bpi). EOSAT has started providing Landsat full scene data in 6250 bpi band sequential (BSQ) format on three physical computer compatible tapes. Each CCT contains full scene data for few bands. Two tapes have data for six bands (three bands on each) and the third tape has data for one band only (band 7). The text record is the last record in the volume directory file and contains information relevant to scene and TIPS (Thematic Mapper Image Processing System) processing. The quadrant field of this text field is labelled as "tape num", instead of "F" for the full scene data and contains 1, 2, or 3 signifying the physical CCT number. Tape 1 of 3 has bands 1,2, and 3 data, tape 2 of 3 has bands 4, 5, and 6 data and tape 3 of 3 contains band 7 data. The image data is written on the tape with a blocking factor of three, i.e., three lines per block. The arrangement of files on these tapes are:

- Volume Directory File
- Leader File
- Image Data File
- Trailer Files
- Supplement Volume Descriptor File
- Supplement File
- Null File

Leader, Image Data, and Trailer Files are repeated for various bands based on the physical tape number. For tape 1, these files will be repeated for bands 2 and 3 after band 1, for tape 2 these files will be repeated for bands 5 and 6 after band 4, and for tape 3 these files will be only for band 7.

The LAS programs CCTTIPSA and CCTTIPSP that are used to ingest CCT data cannot be used in their current version because of the new format described above. However, new format full scene data can be ingested by using the IENTER LAS program. Important input parameter values for ingesting full scene data based on this new format should be:

Tape 1 (Bands 1, 2, and 3) and Tape 2 (Bands 4, 5, and 6):

Parameter	Input Value (Bands) 1/4	2/5	3/6
INLINES	5965/5965	5965/5965	5965/5965
INSAMPS	7200/7200	7200/7200	7200/7200
FILENUM	3/3	6/6	9/9
BANDS	1/1	1/1	1/1
SS	33/33	33/33	33/33
NS	6967/6967	6967/6967	6967/6967
SKIP	1	1	1
BLKSIZE	3/3	3/3	3/3

Tape 3:

Parameter	Band 7
INLINES	5965
INSAMPS	7200
FILENUM	3
BANDS	1
SS	33/33
NS	6967/6967
SKIP	1
BLKSIZE	3

Values for other input parameters may be as desired according to the program guidelines. For further information about this procedure, please contact Lalit Wanchoo (301) 286-9512.

Spatial Filtering to Remove TM Scan-Line Noise

by Bill Kovalick (ST Systems Corp. - GSFC)

[Reprinted with permission of the author from an article in LTPCF News, April, 1989]

The March Issue of Photogrammetric Engineering and Remote Sensing contained an article on pages 327-331 entitled "A Simple Spatial Filtering Routine for the Cosmetic Removal of Scan-Line Noise From Landsat TM P-Tape Imagery". The article presented a simple four step procedure to filter out the detector banding or striping that is sometimes present in TM imagery. This noise removal technique can be performed on the LTPCF VAX-cluster using only two LAS programs: FLT8B and ADDPIC. If you've ever tried to remove scan-line noise before, the simplicity, speed, and effectiveness of this technique will impress you. Here are the four steps:

1. Apply a 101-sample by 1-line low-pass filter to the original image using the LAS program FLT8B with the following parameters: BL=1, BS=101, MODE =LP.

2. Use FLT8B to apply a 33-line by 1-sample high-pass filter to the output from step 1. Parameters: BL=33, BS=1, NORM=128, MODE=HP.

3. Use FLT8B to apply a 31-sample by 1-line low-pass filter to the output from step 2. Parameters: BL=1, BS=31, MODE=LP.

4. Subtract the noise image produced in steps 1, 2, and 3 from the original image using ADDPIC with these parameters: IN1=(original image), IN2=(step 3 output image), S1=1, OFFSET=128, S2=-1.

Just for fun, display the output image from step 3 to see how much noise was actually present in the original data. If signal loss seems to have occurred, the author of the article referenced above discusses a way to avoid this.

For additional information on this procedure, please contact Bill Kovalick (ST Systems Corp. - GSFC - [301] 286-3866 or send a message to LTP::KOVALICK).

[Ed. note: FLT8B may be found in the Contrib library. Contact the LAS Support Office at (301) 286-9412.]

Submitting Image Files for Photo-Products Processing by the COLORFIRE 240

by Raul Garza-Robles (GSFC)

Two programs, CATTAE and CONCATW, have been developed at Goddard Space Flight Center to process image files under VAX/VMS through the MACDONALD DETTWILER COLORFIRE 240 high speed film recorder. The COLORFIRE 240 is capable of producing color or black and white photo products of size 8192 samples (pixels) by 8192 lines. That size is approximately equal to an eight inch square. The image files may be on the local node, IAF VAX, or a remote node accessible through the DEC network.

CATTAE will expose one image per picture frame and CONCATW will expose multiple images per picture frame. CONCATW can expose up to 99 images per line. For example, 6724 images of size 82 samples per line by 82 lines could be fitted onto one frame.

Both programs run interactively and prompt for all the necessary pertinent data and verify that the required files, such as the file of image file names, the image files themselves, and the look-up tables, exist.

These programs will copy VAX/VMS files from the local VAX node, IAF, or a remote node with file attributes of unformatted, sequential access, fixed record type, and will catalogue the new file under LAS (TAE) for processing through the COLORFIRE 240 for photographic products. The programs will process image files for color and/or black/white products in the same session. The input requirements consist of the file containing names of the image files to be processed, access to the image files, and parameters such as who is submitting the job, for whom, initial image parameters and final photo product parameters. The program will generate a TASK ORDER and ACCOUNTING INFORMATION files and send them via VAX/VMS MAIL to OPERATIONS for processing and to G. Wolford, Code 635, for accounting and billing. The person submitting the images for processing will get a copy of the ACCOUNTING INFORMATION via VAX/VMS MAIL also.

Note that these programs were needed because the COLORFIRE must have the image line as soon as it asks for it. It cannot wait for transfer of a line over a network. Therefore, a remote user whose files were not locally catalogued under LAS previously could not have utilized the hardware. CATTAE and CONCATW are not a part of LAS and do not run under its control, but serve to unite the remote user with LAS and COLORFIRE. If you have a VAX with LAS installed and a COLORFIRE, and if you must service other remote users desiring COLORFIRE output, these programs may be of use to you. For further information about them, please contact Raul Garza-Robles (301) 286-9513.

Two Methods Achieve the Same End

by Fred Irani and Dean Gesch (ST Systems Corp. - GSFC)

Programmers and analysts at the Goddard Space Flight Center became involved in preparations for an LAS/DMS demonstration on an IBM RT to be used during the bi-annual Governing Council meeting at the United Nations Environmental Program (UNEP) headquarters in Nairobi, Kenya. Analysts at the Global Resources Information Database (GRID) in Geneva, Switzerland, prepared a set of global and continental scale map-images that displayed many of the global data sets which they use and disseminate.

For technical reasons the demonstration had to be prepared in Geneva under the ELAS image analysis system under VAX VMS. The resultant ELAS images and look-up tables (LUTs) had to be shipped to GSFC and then transferred to the IBM RT workstation. The remaining problem was the selection of the best method of converting the ELAS LUT data into DMS Display and Look-up Table Files (DLTFs) compatible with the RT. Analysts at GSFC were able to extract the LUT information from the ELAS images using a scenario of LAS application programs. A description of the scenario and the reasoning behind it follows.

The objective for LAS personnel was to prepare a demonstration on an IBM/RT workstation running LAS/DMS. The RT can only display single-band images, so the task involved converting the ELAS format pseudocolor LUT into a DMS Display Look-up Table File (DLTF).

The images provided to GSFC by UNEP/GRID were single-band pseudocolor images that were 512 pixels by 515 lines with image data extending only to line 512. The last three records were ancillary data, including line 515 which contained the pseudocolor LUT. The image data type was BYTE, and 16 bits (or two pixels) were used to store the red, green, and blue (RGB) values. Thus, in line 515, pixels 1 and 2 contain the RGB values (in the range 0-15) for the image DN 0, pixels 3 and 4 contain the RGB values for image DN 1, etc. The following is a description of the scenario in which several LAS programs were used to extract the ELAS LUT and convert it into a DLTF for use with DMS.

As noted above, the red and green components for each LUT entry are in the odd numbered pixels of line 515, starting with pixel 1. ZOOM-REDUCE was used to subsample line 515 to produce a one line image with 256 pixels that contained the red and green components for each LUT entry. Two runs of ANDPIC were used to separate the red and green components. For red, the one line red/green "image" was compared to an image of the same size that was created with TESTGEN-UNI with a value of 240. The output of ANDPIC was submitted to RENUMBER with FROM=(0, 16, 32, 48, 64, 80, 96, 112, 128, 144, 160, 176, 192, 208, 224, 240) and TO = (0, 16, 33, 50, 67, 84, 101, 118, 135, 152, 169, 186, 203, 220, 237, 255). For green, ANDPIC was used to compare the one line red/green "image" with an image of value 15 created by TESTGEN-UNI. The output of this run of ANDPIC was a 1 x 256 image containing the green LUT component in the range 0-15.

The blue components for each LUT entry are in the even numbered pixels of line 515, starting with pixel 2. ZOOM-REDUCE was used to subsample line 515 starting at pixel 2 to produce a one line image with 256 pixels that contained the blue components for all 256 LUT entries. Prior to subsampling, line 515 had to have one extra pixel (pixel 513) added to the end because only 255 pixels will be included in the output image, and the blue component for the last LUT entry (pixel 512) would be left out when starting at pixel 2 and subsampling by 2. The addition of the extra pixel was accomplished by generating a 1 x 513 image with TESTGEN-UNI and then using CONCAT to copy line 515 over pixels 1-512. This 1 x 513 image was then input to ZOOM-REDUCE to create the 1 x 256 "image" of blue LUT components.

The green and blue 1 x 256 "images" had values 0-15 so they were input to RENUMBER with FROM = (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15) and TO = (0, 16, 33, 50, 67, 84, 101, 118, 135, 152, 169, 186, 203, 220, 237, 255). The 1 x 256 red, green, and blue "images" with values 0-255 were then grouped with GROUP. That three member group was then input to a program that reads the three "images" and outputs a text file. The FORTRAN program runs under TAE, and it outputs a text file with 256 lines, each line with a format of DN R G B where DN and R, G, and B are the color components in the range 0-255. EDITLUT was modified to accept a text file in this format, and it was used to produce the output DLTF.

The process of extracting ELAS format LUTs and converting them into DMS DLTFs had to be completed for forty images, so the obvious choice was to use TAE script files. Use of script files greatly facilitated the processing, and it was successfully completed for all forty images. Script files were also used to automate the demonstration as each image and its corresponding pseudocolor LUT was loaded.

Coincidentally, Fred Irani was faced with the same conversion problem while in Nairobi just prior to the UNEP Governing Council meeting. A set of single-band pseudo-color images that were originally to be shown using the ELAS system utilizing a Comtal display device could not be shown because ELAS was unable to operate the display due to hardware problems. The LAS system was able to show images but only as three-band images with no pseudo-color mappings applied. The problem then was to produce three band images based on the single-band ELAS images and their associated Look-up Tables.

To solve this problem, the direct approach of writing a FORTRAN-77 routine to read each LUT record and write out a text file which could later be read by the LAS application MAP to produce Red, Green, and Blue images was taken. These images were then grouped (using GROUP) and displayed on the Comtal device. Of course the LUT information had to be scaled from 0-15 to 0-255 to render the desired output.

It never occurred to Fred to use the LAS applications to achieve the same effect and it was with interest that he learned of Dean Gesch's LAS scenario. The algorithm that had been used under FORTRAN follows. It is a fairly classic approach to the problem.

The ELAS Look-Up Tables (LUTs) used for the United Nations demonstration were located in image data files. The entire LUT is contained in a single record. Each LUT entry is stored in a single Integer*2 (16-bit) variable. The highest-order four bits of the sixteen-bit word are unused.

In order to separate out each Red, Green, and Blue value, the FORTRAN-77 program read the entire binary LUT record into a Character*80 array. Then, by equivalence with a byte array, each byte of each LUT word could be accessed individually. Each byte LUT element was assigned to a dummy variable to preserve the original array.

The FORTRAN ISHFT function was then called several times to clear the four high-order (Red) bits from the low-order (Green) bits in the first entry byte and an assignment statement was used to capture the LUT value for green in an array for green. The process was repeated to clear the four bits for green from the same LUT entry and enter the resultant Red values into an array for Red. Since the high-order bits wre not used in the second byte of each LUT entry, bit shifting was unnecessary to make a direct assignment into an array for blue.

The resultant Red, Green, and Blue arrays were then printed to an ascii file in a format compatible with the LAS MAP function with FROM and TO values represented by the LUT entry number and the LUT value respectively. Separate files were created for Red, Green, and Blue. TAE script files were written to create each set of Red, Green, and Blue images using MAP and then each set was logically grouped under an appropriate name. Approximately ten three-band images were created in this way for use during the Governing Council meeting.

The hardware began to work properly during the council meeting so ELAS was used to show the pseudo-color images as originally planned. Another corollary to Murphy's law: "If great pains are taken to correct something which has gone wrong, the thing which went wrong will go right immediately after the alternative approach has been perfected, rendering it obsolete."

In any case, it was a worthwhile experience in another way: once the alternative LAS approach was seen, the versatility of the LAS package when properly utilize was apparent!

For further information about the two methods described, contact either Fred Irani (301) 286-9531 or Dean Gesch (301) 794-5017.

LAS Implementation Table

As was mentioned in our last issue, some readers have requested that we print the list of those machines, operating systems and display devices which are compatible with LAS and on which LAS is successfully running. Below is the list of machines (including those implementations in progress) about which we have been informed.

Computer (Operating Systems)	Display Devices (Software Version)
** Cray II (UNICOS)	Comtal Vision/120
** IBM PC AT (XENIX)	* Comtal 8000 R 30 SER
** IBM RT (AIX)	* Comtal 8000 R 65 SER
** PN 9050 (UNIX)	DeAnza FD 5000
** SUN 2 (UNIX)	DeAnza IP 8500
** SUN 4 (UNIX)	IIS IVAS
VAX 11/780 (VMS)	IIS Model 75 (575)
MicroVAX (VMS)	IIS Model 75 (600)
** MicroVAX (ULTRIX)	Rastertek One/125

* means in development
** means in development for 5.0 (only a subset has been implemented)

If you are aware of any other machines on which the system is running and/or of any display devices for which device dependent (dd) code has been successfully developed, please let us know so that we can share that information with the whole LAS community. Call the LAS Support Office at (301) 286-9412.

LAS "Contrib" Contents

The LAS project has provided a mechanism for user sites to contribute functions, which they have implemented for use with the LAS, and which may then be made available to other sites.

These contributed functions are provided on an "as is" or "caveat emptor" basis. That is, LAS development staff will not provide maintenance for these codes. The LAS Support Office may pass any discovered problems to the site which provided the functions originally and they may assist you if they choose to do so. No guarantees are made, however.

Functions currently available from the LAS contributed library as of the date of this issue are:

CALC	-	Calculator
CCTBRAZIL	-	Ingest TM tape in the Brazilian format
CCTEDCN	-	Obsolete tape format ingest
CCTEDCS	-	Obsolete tape format ingest (LGSOWG MSS tape)
CCTF	-	Output a tape in the format used by Optronics or Dicomed film recorder
CCTL4	-	Obsolete tape format ingest
CCTTIPSA(w)	-	Window selection from a TIPSA tape
CCTTIPSP(w)	-	Window selection from a TIPSP tape
CCTSPOT	-	Spot data tape processing
COMPRSLAB	-	Compression of a label file in batch mode; the interactive capability is in the program CATMAN
DALIN	-	DAL format tape ingest that was originally in the 4.0 baseline release
DALOUT	-	DAL format tape output that was originally in the 4.0 baseline release
DSPLAB	-	Display of the label file in batch mode; the interactive capability is in the program CATMAN
DSPLOG	-	Version of DSPLOG that allows output to terminal, file or line printer (LP).
FASTCLAS	-	Parallelepiped classifier
FLT8B	-	Filtering program
LNFILL	-	Replacement of lines of data by neighboring line averaging
LOWCAL(AP)	-	FPS AP version of LOWCAL (needs AP-Fortran)
LT	-	Overview of labeled tables (note: labeled tables are used by some LAS functions, but are not documented).

LUTS	-	Use of DMS look-up tables in LAS functions that include support routines, EDITLUT to edit/create a LUT, and revised versions of CLASSMAP, COPY, FILM, and STRETCH programs
MAIL	-	VAX Mail
MINC	-	Grid interpolation from random data using Biharmonic equation
NOMFIL	-	Stepwise nominal filtering that calls REGLABEL, FLAG, SMOOTH, ABS, and CONVERT in sequence up to five time.
PLENTER(w)	-	Window selection from a CCTX tape
SCHEDULE	-	Schedule Tracking and Reporting Package
TAPEFEET	-	Calculation of the number of feet of tape that will be required to store an image onto tape using archive.
TMSENTER	-	Ingest NS-001 Thematic Mapper Simulator imagery tape
TRANCOORD	-	Like the LAS TRANCOORD, but adding some conversions while deleting others
WINDOW	-	A DMS function to interactive select and display of a window of a subsampled scene on another display memory in full resolution.

To obtain any contributed functions or information about them, or to contribute new functions, contact the LAS Support Office.

LAS Problems and Solutions

Since the LAS 4.1 was released this past Winter, the following problems were reported:

CMSEARCH	-	ATTR DISK='diskname' gives no entries found when the diskname parameter is entered in lower-case. Specify disk name in upper-case.
DIVERGE	-	The User's Guide fails to inform that there are differences between the baseline version and the ancillary AP version. The AP version is limited to 32 classes and 14 bands.
KMEANS	-	The User's Guide fails to inform the user that there are differences between the baseline version and the ancillary AP version in regard to max_pixel, max_class, and max_bands. Error message 2 is invalid for the baseline version. The routine mentioned in user note 1 is not in the baseline. Error messages refer to user note 3 which is not there.
LASDEL	-	When deleting with confirmation of all on-line images, all off-line images are listed also; but they are not deleted even if responding with a yes to the confirm prompt.
LOGICAL	-	The output has number of lines and samples swapped.
MAGNIFY	-	The window coordinates are interpreted as sample/line instead of line/sample.
PERSPEC	-	User reported getting an INSVIRMEM error (i.e., insufficient virtual memory). Tom Bodoh at the EROS Data Center (605)594-6830 responds with the following information: PERSPEC uses two I*2 arrays, each 3072 x 3072. Using this number they calculated that PERSPEC (at full size) would need about 75,000; but they had to double that figure to make it work at EDC. To deal with smaller images he suggests the following: + Use the smallest size image possible; calculate the number of pages needed by using PERSPEC_PAGES = 2 * (((NL * NS) *4) /512) + 2000 + Set the SYSGEN parameter VIRTUALPAGECNT to PERSPEC_PAGES or higher. + Set the authorization file parameter PGFLQUO to PERSPEC_PAGES (Suggest setting up a special usercode to be used only for running perspectives, so the number of concurrent users with high PGFLQUO can be controlled. Also suggest queuing up your PERSPEC runs for nighttime batch runs.) + NOTE, make sure your page files total more than VIRTUALPAGECNT. All users must share the pagefiles, and any one user may use PGFLQUO pages. This will restrict you to running one PERSPEC at a time. Also note that if you overallocate your pagefile by allowing too many high PGFLQUO jobs to run concurrently, you may hang your system.
PIXCOUNT	-	Access violation occurred when running PIXCOUNT-NOBCKGRD in batch mode.
TSCLASS	-	TSCLASS-BAYES does not accept lower case responses when prompting for class names; it also does not work with a stats file owned by another user.
UHIST	-	The parameter HISTOUT has VERS in the valid list; but it is not an acceptable value to use.
WHATISIT	-	In using WHATISIT on a tape that was created using ITRANSFER the number of lines in a file was one greater than actual number for second and subsequent files (i.e., the first file was reported correctly).

If you discover a new problem or if you want to determine the status of any problem fixes, you should contact your LAS Site Manager (identified with INFO-WHO). Then, if your Site Manager is unable to resolve the problem, he/she should contact the LAS Support Office (LASSO) at (301) 286-9412.

LAS "Bits"

Towanda Plater, our previous LAS Support Office person, left the position for a new job. Karen Carbone, an employee of ST Systems Corporation on-site at Goddard Space Flight Center, has taken her place. She may be reached at the LAS Support Office by calling (301) 286-9412.

LAS has become an even greater international "commodity"! In addition to United Nations sites there is now a site at the Center for Space and Remote Sensing Research at National Central University in Chung-Li, Taiwan (arranged by that Center through COSMIC). We welcome them to our community of users!

If anyone wishes to develop new code for either the Contributed library or, ultimately, the Baseline LAS, please contact GSFC at (301)286-9412. We will be happy to get you started to insure compatibility with proposed new LAS standards.

If you are reading "LAS News" but are not yet an LAS user and would like to be, you can purchase the package through the Computer Software Management and Information Center (COSMIC), by writing to COSMIC, University of Georgia, 382 East Broad St., Athens, Georgia 30602 U.S.A., or by calling (404)542-3265 for further information.

If you know of anyone else interested in being placed on the LAS NEWS distribution list, please send their complete name and address to LAS NEWS, Code 636, Goddard Space Flight Center, Greenbelt, MD 20771 or call Dr. Lu (GSFC LAS Project Manager) at (301)286-4093.

Calendar of Activities

Aug	8-12	'89-	1989 International Conference on Parallel Processing (Sponsor: Pennsylvania State University) at St. Charles, IL
Sep	1	'89-	Full paper submission deadline for Fifth International Conference on Image Analysis and Processing (Sponsor: Italian Association for Pattern Recognition) at Positano, Italy
Sep	5-8	'89-	ICIP 89, International Conference on Image Processing (Sponsors: IEEE Singapore Section and National University of Singapore) at Singapore, Republic of Singapore
Sep	6-8	'89-	Sixth Workshop on Multidimensional Signal Processing (Sponsor: IEEE Acoustics, Speech, and Signal Processing Society) at Monterey, CA
Sep	17-20	'89-	1989 ASPRS/ACSM Fall Convention (Sponsors: American Society for Photogrammetry and Remote Sensing [ASPRS] and American Congress on Surveying and Mapping [ACSM]) at Cleveland, OH
Sep	18-19	'89-	Earth Observations and Global Change Decision Making: A National Partnership (Sponsors: NASA, NOAA, and ERIM) at Washington, DC
Sep	19	'89-	Full paper submission deadline for the Earth Observations and Global Change Decision Making: A National Partnership (Sponsors: NASA, NOAA, and ERIM) at Washington, DC [Ed. note: This conference accepts the paper on the basis of a committee evaluation of all papers received before the end of the conference and the acceptance results in inclusion in the conference proceedings. Those interested in obtaining an author's kit prior to that date need to contact: ERIM/Global Change Conference; Dr. Robert H. Rogers; P.O. Box 8618; Ann Arbor, MI 48107 or call (313) 994-1200]
Sep	20-22	'89-	Fifth International Conference on Image Analysis and Processing (Sponsor: Italian Association for Pattern Recognition) at Positano, Italy
Sep	30	'89-	Full paper submission deadline for Tenth International Conference on Pattern Recognition (ICPR) (Sponsors: IEEE Computer Society and the International Association for Pattern Recognition [IAPR]) at Atlantic City, NJ
Oct	2-6	'89-	Seventh Thematic Conference on Remote Sensing for Exploration Geology: Method, Integration, Solution (Sponsor: ERIM) at Calgary, Alberta, Canada
Oct	11-13	'89-	The 18th Applied Imagery Pattern Recognition (AIPR) Workshop (Sponsor: AIPR Committee, Rome Air Development Center, and the International Society for Optical Engineering) at Washington, DC
Oct	16	'89-	Paper submission deadline for Second International Symposium on Databases in Parallel and Distributed Systems (Sponsor: ACM) at Dublin, Ireland
Oct	17-18	'89-	First IEE International Conference on Artificial Neural Networks (Sponsor: Institution of Electrical Engineers [IEE - United Kingdom]) at London, United Kingdom
Nov	17	'89-	Summary and Abstract submission deadline for International Geoscience and Remote Sensing Society Symposium (IGARSS) (Sponsor: IEEE Geoscience and Remote Sensing Society and URSI) at the University of Maryland, College Park, MD
Nov	20-24	'89-	Fourth Latin American Symposium on Remote Sensing (Sponsor: Society of Latin American Specialists in Remote Sensing) at Bariloche,

Argentina

Dec 1 '89 - Deadline for submission of articles for the January '90 issue of LAS NEWS

Dec 11-13 '89 - Fourth SIAM Conference on Parallel Processing for Scientific Computing (Sponsor: Society for Industrial and Applied Mathematics) at Chicago, IL

Jan '90 - International Joint Conference on Neural Networks - Winter 1990 (Sponsors: IEEE and International Neural Network Society) - [Ed. note: location unknown to us]

Feb 16 '90 - Final paper due date for International Geoscience and Remote Sensing Society Symposium (IGARSS) (Sponsor: IEEE Geoscience and Remote Sensing Society and URSI) at the University of Maryland, College Park, MD

May 20-24 '90 - International Geoscience and Remote Sensing Society Symposium (IGARSS) (Sponsor: IEEE Geoscience and Remote Sensing Society and URSI) at University of Maryland, College Park, MD

Jun 17-21 '90 - Tenth International Conference on Pattern Recognition (ICPR) (Sponsors: IEEE Computer Society and the International Association for Pattern Recognition [IAPR]) at Atlantic City, NJ

Jul 2-4 '90 - Second International Symposium on Databases in Parallel and Distributed Systems (Sponsor: ACM) at Dublin, Ireland