

**VICAR IMAGE PROCESSING USING UNIX, X WINDOWS, AND CDROMs; D. Anderson and M. Mann, Department of Geology, Arizona State University, Tempe, Arizona, 85287.**

The VICAR image processing system, developed by the Jet Propulsion Laboratory's Multimission Image Processing Laboratory, has been used to analyze data from NASA spaceflight projects for at least twenty years. Its current incarnation at JPL runs under the VMS operating system and uses the Transportable Application Executive (TAE) as the user interface.

Recently, the VICAR system has been converted to Unix on a Sun Microsystems 3/160C color workstation, using the X window system for image display [1]. The major effort of this work has been addressing portability through the use of standards. For example, all converted FORTRAN code adheres to the ANSI X3.9-1978 standard. Similarly, X has been chosen as the window system because of its widespread use and public domain access. The conversion of VICAR to run under Unix can be divided into three parts: the executive, the application programs and the image display system.

The Unix version of VICAR executive begins with Goddard TAE Plus and adds several enhancements. These include routines for handling program parameters and input/output routines for image data.

VICAR has a well defined file format for storage of image data. This includes full history labels of programs that have modified the data. The I/O routines have been converted to use the standard Unix read/write/lseek calls. Eight-bit VICAR image files are identical on both the VMS and Unix systems. Therefore, they can be freely interchanged. Sixteen-bit image files must be byte swapped, due to different byte ordering between the VAX and 68000 processors.

VICAR has a wealth of application programs for image analysis, the majority of which are written in FORTRAN. This presents a problem in that VMS FORTRAN has a number of extensions to the standard which are not understood by the Unix *f77* compiler. A series of filters, accessed through a shell script, have been written to convert the VMS FORTRAN extensions to ANSI FORTRAN 77 (e.g., DO-END to DO-CONTINUE). These take most of the work out of program conversion.

To date, a substantial subset of the programs have been converted. These include programs for contrast enhancement (stretches), spatial filtering, geometric transformation, image registration, mosaicking, algebraic manipulation, and image display. Programs to handle first order calibration of the Viking and Voyager images are currently being converted.

A Virtual Raster Display Interface (VRDI) has been defined in VICAR to handle communications between application programs and display processor hardware. The VRDI is a set of standard ("virtual") calls to access the capabilities of a generic display processor. These include reading/writing image memory planes, access to lookup tables, cursors, graphics overlay planes, I/O devices (trackballs, joysticks), etc. The device-dependent side of the interface must be written for each new display processor added to the system.

An X Window VRDI interface has been written for VICAR. It currently uses the eight-bit color display on the Sun. It runs under version 11.2 of X windows and is written using standard Xlib routines. The device is a complete software emulation of a display processor, with a Macintosh-like user interface. The interface includes scroll bars, zoom box, resize box, and close-to-icon box. The software is currently configured with an eight-bit grayscale image memory plane (IMP), an eight-bit color non-destructive graphics overlay plane (GOP), software lookup tables, and a mouse-driven cursor. As the video is only eight-bits deep, the software merges image and graphics data before display to the screen.

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Each display processor is just another window program to the X system. Thus, the user can allocate as many display processors as needed. And since X is a network window system, all network users can allocate display processors on the screen. A potential drawback to multiple display processors is access to the one hardware lookup table for dynamic contrast enhancements. Software lookup tables were implemented to alleviate this problem, allowing each display to simultaneously have its own unique stretch values.

The line and sample dimensions of the IMP/GOP for each display processor are definable by the user. Thus, their size can match the task at hand: a 512x512 CCD image, an 800x800 Voyager image, a 2000x1500 mosaic, etc.

Using M. Martin's IBM PC High Sierra software as a guide, an application program with an associated subroutine library has been implemented for CDROMs on the Sun (High Sierra is the precursor to the international standard: ISO 9660). The program provides access to a CDROM disk through directory listings, file listings, and the ability to copy data from the CDROM to magnetic disks. The subroutine library allows new applications to be created which can access files on a disk. A key feature of the software is its ability to transparently read both High Sierra and ISO 9660 format disks.

*References.* [1] Anderson, D., and Mann, M., *NASA Infosystems Newsletter*, 15, 1988.