# Java Image Display Components

## Two Components for High-Performance Image Displays

Developed by the Multimission Image Processing Lab (MIPL)
Section 382
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For More Information Contact:
Bob.Deen@jpl.nasa.gov (x4-7492)
or Oleg.Pariser@jpl.nasa.gov (x4-8443)

## JadeDisplay

High-performance image display component

### Features:

- Fast and responsive
- Graphics overlay supported
- Support for large images (>2GB)
- Displays any Java2D RenderedImage
- Asynchronous display updates
- Background loading/processing of images
- Standards-based (JAI/Java2D)
- Component Architecture (JavaBeans)
- Diagonal scrolling
- 3 repaint policies: immediate, deferred, cache
- Manages double-buffering for efficiency
- Full javadocs

## StereoDisplay

Device-independent stereo image display component

### Features:

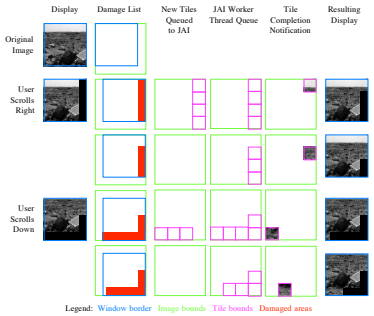
- Based on JadeDisplay
- Common API for all stereo display modes
- Hardware display mode via Java3D
- Anaglyph/"colorglyph" modes for standard workstations
- Modes can be switched on the fly
- Supports color stereo images

## How the Display Works

The JadeDisplay component asynchronously requests tiles as they are needed for the image display. The tiles are loaded and computed in the background using JAI worker threads, and are painted onscreen when the computation is complete. This has the following advantages:

- User interface remains active and responds to events even while the image is loading... no waiting for the computer. Experience has shown that this is a prime factor in usability.
- Viewing of enormous images is practical because the user does not have to wait for them to load in their entirety. The display has been tested with images larger than 2 gigabytes.
- Scrolling is instantaneous, even for slow-loading images.
- Computations of tiles which are in the queue, but become unnecessary because of subsequent scrolling, are cancelled, thus improving overall throughput.
- Threaded computation allows for greater throughput for compute-intensive operations on multiprocessor machines (e.g. rotation, filtering).

Tile Computation Sequence of Events



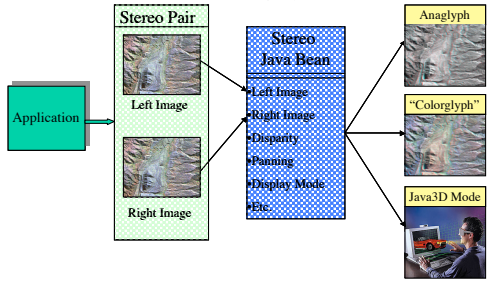

When Java sends a repaint event, the affected area is saved in a "damage list". Tiles affected by the repaint are queued with JAI for computation (unless the tile has already been queued). When JAI sends a tile completion notification, the part of the tile intersecting the damage list is immediately painted, and the tile's area is subtracted from the damage list. Multiple worker threads can be active simultaneously (omitted from the drawing for clarity).

## Stereo Display Modes

The stereo display component provides a common interface for both high-end stereo display hardware (e.g. LCD-shuttered or polarized glasses), and standard workstation displays using anaglyphs (red/blue stereo pairs). An application program using this component will work without modification in either environment, providing portability and enabling stereo software to reach a wider market (anaglyphs) without sacrificing the higher quality available with dedicated display hardware. The display modes are:

- Anaglyph: Uses red/blue glasses to display a single-banded image on any monitor. For color images, a single band is chosen for display. JAI is used to combine the bands, and the asynchronous display component is used to display the image.
- "Colorglyph": Similar to anaglyph but provides an approximation of color by using the red band of the left image and the green and blue bands of the right image. Not appropriate for all images but can convey a feeling of color in some cases.
- Hardware: Uses Java3D to control stereo display hardware (display cards). Most commonly, this hardware doubles the monitor's refresh rate, displaying alternate left and right eye views. An infrared emitter synchronizes with liquid-crystal shutter glasses to create the stereo image.

Stereo Display Architecture




## Users of JadeDisplay

- IADE - Java Advanced Display Environment. Next-generation general purpose image display program for MIPL.
- WITS/SAP - Web Interface for TeleScience/Science Activity Planner (Section 348). Primary rover operations planning and downlink data analysis tool for the Mission Science Team for MER, FIDO, and other rovers.
- MICA - Mosaic Interactive Correction Assistant. Interactive tool to correct pointing errors in Mars surface-based mosaics.
- ove - Orbital image viewer for MarsNetViewer, intended for MGS, Odyssey, and future Mars orbital missions.

## Future work

- Support for image layers
- Stereo graphics overlay
- Stereo cursor with a number of modes
- Integration with Java3D geometry to display models with images
- Plugins for cursor control (e.g. terrain-following cursor)
- Plugins for camera models (used to convert disparity to XYZ space)
- JDK 1.5 *may* directly support stereo framebuffers, eliminating need for Java3D

## Current Status

- JadeDisplay has been operational since August 2001.
- StereoDisplay just went operational (some Linux issues).
- Both have been submitted to TU office for wide public release.
- Available now for JPL users, or via TU license for others.
- Tested on Solaris, Linux, and Windows. Mac OS X just demonstrated (Jaguar required); not yet fully supported.

## Standards Group Participation

One of the authors (Deen) is a member of the JAI Expert Group, part of Sun's Java Community Process. The EG defines public API's and sets requirements for them. Thus MIPL has had considerable influence over the evolution of JAI 1.1 and this is reflected in the ease with which the image display component was developed. It has been an enormously positive experience and will continue to be very beneficial to MIPL and JPL as more new features are exercised. It is this author's opinion that others at JPL should get involved in similar standards-related work whenever possible; the benefits in this case have been substantial.

## COTS Architectural Foundation

- Java Advanced Imaging (JAI) 1.1: An "optional package" for Java, written by Sun Microsystems. JAI provides many fundamental image processing facilities, including an extensible framework, tiling of images, deferred execution, remote (network) execution, image I/O functions, support for byte/short/int/float/double images, and background processing of tiles. It comes "out of the box" with more than 80 common imaging operations and support for many popular image file formats.
- JavaBeans: A standardized architecture for creating reusable components.
- Java3D: An "optional package" for Java from Sun, primarily intended for rendering of 3-D geometry. Also provides a wrapper around OpenGL for stereo control.
- Image I/O: An API for loading and saving images in a variety of formats. Part of the JDK 1.4 core.