Developed by the Multimission Image Processing Lab (MIPL)

- Supports color stereo images
- Modes can be switched on the fly
- Anaglyph
- Common API for all stereo display modes

Device-independent stereo image display component

- Fast and responsive
- Graphics overlay supported
- Support for large images (>2GB)
- Standards-based (Java2D)
- Component Architecture (JavaBeans)
- Background loading/processing of images
- Displays any Java2D RenderedImage
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- Component Architecture (JavaBeans)
- Threaded computation allows for greater throughput for compute-intensive operations on multiprocessor machines (e.g., rotation, filtering).

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 (for tiles that have 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).

Users of JadeDisplay
- JADE - 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.

Future work
- Support for image layers
- Stereo graphics overlay
- Stereo cursor with a member 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

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.

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.

Stereo Display Architecture

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 (Java2D)
  - Component Architecture (JavaBeans)
  - Diagonal scrolling
  - 3 repaint policies: immediate, deferred, cache
  - Manages double-buffering for efficiency
  - Full javadocs

Stereo Display
- 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).

The JadeDisplay component synchronizes with liquid-crystal shutter glasses to create the stereo image. 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.