LuraTech White Paper
JPEG2000 – The Emerging Standard for the Millennium

Overview : Next Generation Image Compression

The explosive rise of the Internet and faster information transfer, coupled with continuing advances such as lower cost, high-resolution cameras, escalating desktop computer performance, improved printing and user-friendly imaging software, and image-transferable wireless devices have all created an environment where more people are creating and using digital images on a daily basis. This enormous growth in digital imaging has created the need for a new image coding standard. The original JPEG image, based on technologies and methodologies from the 1970s, is no longer sufficient to meet this growing need for high-quality digital images. To address this issue, the Joint Photographic Experts Group (JPEG) has been actively working under the auspices of International Standards Organization (ISO) on the development of JPEG2000, a new still image standard.

What is JPEG2000?

Currently, the JPEG committee is working on the next generation of digital image compression technology, code-named JPEG2000. JPEG2000 is a wavelet-based file format and an emerging standard for coding and compressing still images. The JPEG2000 standard is being designed to serve a number of markets and applications in which the current JPEG standard fails such as low bandwidth dissemination of images on networks over the Web, image archiving applications, digital databases and libraries, medical imaging, digital photography, and scanner applications. On December 6, 1999, ISO met in Maui, Hawaii and defined the committee draft of the standard. The international standard draft is expected to be finalized by the end of the year.

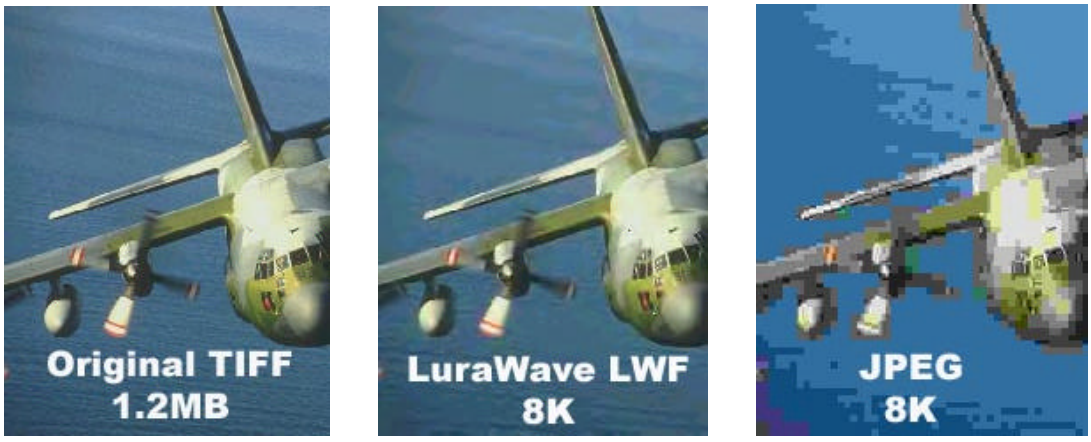

Figure 1. A sectional comparison between LuraWave (wavelet compressed) and JPEG (DCT compressed). The original full size image was a 1.2MB TIFF.

Features Enabled by Wavelet Technology

> *"Over 90% of the data contained in an image is unnecessary; the wavelet transform identifies redundancies and eliminates the unnecessary data."*
> *-Kai Barthel, Director of Research, LuraTech*

Smaller File Sizes

JPEG2000 uses wavelet compression technology to outperform the existing JPEG standard. Wavelets enable lossy or pure lossless compression, while JPEG always imposes some sort of loss. (Pure lossless compression means that there is no loss of data- the compressed image is pixel-identical to the original image. Lossy compression discards data that is considered visually less important). For lossy compression at a given quality, wavelet-compressed files are generally three to five times smaller than a JPEG-compressed file. For a given file size, a wavelet file offers better quality than a JPEG (see figure 1). For lossless compression, wavelets can cut the file size by at least half its original size, offering a smaller file than LZW or Zip.

Better Image Quality

Traditional JPEG compression uses the Discrete Cosine Transformation (DCT), which compresses an image in 8x8 blocks and results in visible artifacts at high compression rates. JPEG artifacts include visible seams at the tile edges, dubbed as "blocking artifacts". The wavelet transform encodes an image in a continuous stream allowing it to avoid the artifacts that result from DCT's division of an image into discrete compression blocks. Wavelet artifacts take the form of blurring high contrast lines, merely making the image look softer. The wavelet transform performs what's called, multi-resolution compression—it stores image information in a series of bands, with the most important image information at the beginning of the file. Each band contains a representation of the entire image, with the various bands containing details of the image at every level, from coarse resolution and textures to fine details.

Progressive Image Downloading

> *"Wavelet compression structures an image file in a way that allows users to access only the amount of resolution that they need. The technology offers a more efficient way of displaying and downloading images that eliminates needless waiting."*
> *--Michael Thierschmann, president & CEO, LuraTech*

An inherent benefit of the wavelet's multi-resolution architecture, is the ability to progressively access the encoded image in a smooth continuous fashion without having to download, decode and/or print the entire file. Wavelet compressed images appear first as

an image with coarse resolution and then finer resolution details are progressively filled in. Since the most important details are stored at the front of the image file, users will first see a blurry version of the image and the remaining details appearing as the bitstream arrives. Usually with about 10% of the image data, the user can tell what the image will be and can decide whether or not to wait for higher resolution. The current JPEG is single-resolution, so with 10% of the data, the user will have barely gotten a peek at the top of the image and has wait for the entire download.

Figure 2: Demonstration of Progressive Image Downloading.

CMYK Support

JPEG2000 will support CMYK and LAB, and can handle up to 256 channels of information, as compared to the current JPEG, which is limited to only RGB data. JPEG2000 will also include full ICC profile information within each image file, allowing it to work seamlessly within color managed environments.

JPEG2000 & LuraTech

While the JPEG2000 standard is under its stages of finalization, LuraTech can offer key technology that contains the features of JPEG2000—today. LuraTech's *LuraWave* technology meets the current need for wavelet-based image compression software and related hardware.

"We are actively participating in the JPEG2000 standardization process, so that we will be fully compatible with the new standard. However, the fact of the matter is, better compression solutions are needed now. LuraTech offers state-of-the-art wavelet technology today and we will provide a migration path to JPEG2000 when it's eventually defined. Moreover, we will have the expertise to implement JPEG2000, not only through our involvement with the standardization process, but because we've already implemented many of the key features into our current software."

--Michael Thierschmann, president & CEO, LuraTech

- LuraTech has been pioneering wavelet-based compression solutions for the past 7 years and has established itself as a technology leader in the market, having been integrated into products and plug-ins from software leaders such as Adobe, Macromedia, Informix, and Oracle.
- LuraTech is being funded by the German Research Ministry to implement JPEG2000.

- LuraTech is an active member of the Digital Imaging Group (DIG), an industry consortium involved in standardizing JPEG2000, and Photo Marketing Association International (PMAI).
- LuraTech has partnered with MGI, a leading provider of visual media software and infrastructure solutions, to advance the implementation of wavelet compression and the features of JPEG2000 into current image compression Software Developer Kits (SDKs).

LuraTech Products: *LuraWave*Ò

LuraWave is a proprietary image format that uses wavelet-based compression to reduce file sizes while achieving better image quality than conventional methods such as JPEG and TIFF. LuraWave, (file extension *.LWF) can achieve compression rates of 200:1 and higher.

***LuraWave* Features:**

- Pure lossless or lossy compression
- Progressive image downloading
- User may select desired compression rate or designate target file size for compressed image
- Scalable image size and quality allows multiple images to be displayed from one image file. Webmasters no longer need to store, manage and track multiple files (i.e. thumbnails).
- Region of interest compression flexibility
- Password protection option

LuraTech Products: *LuraDocument*Ò

LuraDocument is a highly innovative software tool designed for compressing and archiving scanned, colored documents or images that contain text. Users can take high-resolution color scans and make them available as highly compressed files viewable through a browser window.

LuraDocument enables users to overcome the bandwidth challenges of storing scanned documents. Prior to LuraDocument, the high resolution required to preserve the quality of images and at the same time keep text readable, created file sizes that were too unwieldy for acceptable download and transfer speeds.

LuraDocument reduces file sizes by separating the original document into text and image regions and applying algorithms best suited to the different data structures. Text regions are compressed with a bitonal algorithm, while image regions are compressed with LuraWave, LuraTech's patented wavelet compression scheme.

Figure 3: Scanned document compressed with LuraDocument. 7,204 KB original TIFF file compressed down to 37 KB as a LuraDocument.

LuraDocument Features

- Dramatic file size reduction
- Text compressed losslessly & remains clear/legible for OCR (Optical Character Recognition)
- Images remain sharp
- Color text remains colored, reversed colored text also recognized (i.e. white text)
- Exportable to Fax Group 4

Multi-Platform Support, Software and Hardware Implementations

LuraTech's key strength is the broad spectrum of wavelet-based implementations that their products offer. LuraTech products cover all the major platforms offering everything from stand-alone applications and software plug-ins, to software development kits (SDKs) that allow developers to integrate the technology into their own applications.

In addition to "save-as" software packages, LuraTech has implemented wavelet technology into hardware such as scanners, for on-the-fly compression. Other implementations include dedicated ASIC processors, DSPs, Windows CE, and multi-Unix platforms (SGI, Solaris, and Linux).

Sample Customers and Applications of LuraTech Technology

- ACD Systems: ACDSee, image viewer software (bundled with Canon cameras)
- AccuSoft Corporation: digital imaging toolkits for developers
- Amicas: medical imaging
- Informix: Media360, media asset management database
- Easy Software: document management software (DMS solution)
- Ericsson: Mobile transmission of images and scanned documents
- FujiColor: Internet service to transfer digital images over the Web to professional photo/minilab service centers
- Pedagog Ltd.: handheld remote surveillance systems

- German Space Agency: Hardware design of a wavelet-based image compressor (ASIC)
- Heinrich Bauer Publishers (2nd largest publisher in Europe): Document database of all magazine covers (>100/week) for archiving and trend analysis
- HMR, Inc.: Geographical Information Systems (GIS) – Image server clients (microstations)
- MGI Corporation: developer application tools
- National Museum of Berlin: visitor information systems/kiosks with image & text databases
- Otto Catalogs Co. (world's largest mail order company): product catalog CDs
- T-Mobil (German Telecom): wireless transmission of images through cellular phones

About LuraTech

Founded in 1993 by Michael Thierschmann, LuraTech is a privately-held software and visual communications service provider with offices in Menlo Park, California and Berlin, Germany. LuraTech received its start with a $10,000 prize awarded to Mr. Thierschmann in an engineering competition that he entered in 1993, while still attending the Technical University of Berlin. The German National Space Agency selected Thierschmann for his innovative wavelet-based image compression algorithms and proceeded to become LuraTech's first client, using the technology for satellite imaging as a hardware implementation.

Today LuraTech's compression products are utilized not only in space and industrial applications, but in a wide variety of software applications including graphic design & web authoring tools, image and document archive systems and work-flow solutions. Leveraging its expertise and patented technology, LuraTech also creates custom multimedia systems that integrate dynamic databases, customized graphical user interfaces and visual management systems.

LuraWave Image Solution Products

Stand Alone Freeware

- *LuraWave* SmartCompress (Win95/98/NT): FREE
- XV with *LuraWave* Stand Alone (Solaris, Unix/Linux): FREE

Application Add-Ons

- *LuraWave* PhotoShop Plug-In (Win95/98/NT, Mac): $79
- *LuraWave* PaintShop-Pro Plug-In (Win95/98/NT): $29
- *LuraWave* QuickTime Plug-In (Mac, available only as a bundle when purchasing LuraWave Photoshop Plug-In): FREE
- *LuraWave* Cumulus Plug-In (Win95/98/NT, Mac): FREE
- *LuraWave* Quark Xtension (Mac): $129
- *LuraWave* Macromedia Director Xtra Plug-In (Win95/98/NT, Mac): $149
- *LuraWave* Macromedia Director Xtra Plug-In bundled with LuraWave Photoshop Plug-In (Win95/98/NT, Mac): $199
- *LuraWave* Java-Applet (Java): FREE
- *LuraWave* 4D Plug-In, Developer Version, Single-User (Win95/98/NT, Mac): $210
- *LuraWave* 4D Plug-In, Developr Version, Multi-User (Win95/98/NT, Mac): $210
- *LuraWave* 4D Plug-In, Deployment Version, Single-User (Win95/98/NT, Mac): $315
- *LuraWave* 4D Plug-In, Deployment Version, Multi-User (Win95/98/NT, Mac): $470

OEM Developer Tools *(prices for single-user licenses)*

- *LuraWave* Command Line Tool (Win3.x/95/98/NT, Linux x86, Sun Solaris): $1390 (for IRIX OS or other systems, contact LuraTech Sales)
- *LuraWave* C-SDK (Win3.x/95/98/NT/CE, Linux x86, Sun Solaris, Mac): $2500 (for IRIX OS or other systems, contact LuraTech Sales)
- *LuraWave* OCX-SDK (Win95/98/NT): $1390
- *LuraWave* Java™-SDK: $2,500

Browser Plug-Ins

- *LuraWave* Netscape Plug-In (Win95/98/NT, MacOS, Unix/Linux, Sun Solaris): FREE
- *LuraWave* Explorer Plug-In (Win95/98/NT, MacOS, Unix/Linux, Sun Solaris): FREE
- *LuraWave* ActiveX-Control for Explorer: FREE

LuraDocument Scan-to-Web Solution Products

Stand Alone Software

- *LuraDocument* Capture, Lite Version (Win95/98/NT): FREE
- LuraDocument Capture, Profession Version (Win95/98/NT): $19.95

Application Add-Ons

- *LuraDocument* PhotoShop Plug-In (Win95/98/NT, Mac): $129

OEM Developer Tools

- *LuraDocument* Command Line Tool (Win95/98/NT, Linux x86/Unix, Sun Solaris): $1800 (for other systems, contact LuraTech Sales)
- *LuraDocument* C-SDK (Win311/DOS, Win95/98/NT, Linux x86/Unix, Sun Solaris, Mac): $3250 (for other systems, contact LuraTech Sales)

Browser Plug-Ins

- *LuraDocument* Netscape Plug-In (Win95/NT, MacOS, Unix/Linux, Solaris) FREE
- *LuraDocument* Explorer Plug-In (Win95/NT, MacOS, Unix/Linux, Solaris) FREE

For latest pricing information and LuraTech news, visit www.luratech.com

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