

JPEG – Still photography brought to life

by Daniel T. Lee, Convenor,
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Coding of still pictures

Sharing photographs over the Internet has become one of the most interesting modes of social interaction since the advent of modern digital media.

Millions of images are shared every day among friends and family in e-mails, photo-hosting Web sites and the enormously popular social networking sites, like MySpace, Facebook and Flickr, where users can even instantly upload photos taken with their mobile phone cameras. Digital photos are also widely printed at home or through commercial printing services.

Digital photography has not replaced traditional chemical photography, but rather given photographers new creative tools and many new modes of printing. It has also contributed to the progress of e-commerce, where digital images of products and services offer new merchandising opportunities.

One enabler of this phenomenon is the availability of powerful and inexpensive digital cameras. Less visible to consumers, but nonetheless key, is the JPEG imaging standard – a joint project between ISO and the International Telecommunication Union's Telecommunication Standardization Sector (ITU-T). The JPEG standard, ISO/IEC 10918-1 or ITU-T recommendation T.81, giving requirements and guidelines for digital compression and coding of continuous-tone still images, was approved in 1992.



Main Focus

Recipe for success

The Joint Photographic Experts Group – also known as the JPEG committee – is the name used for working group WG 1, *Coding of still pictures*, under ISO/IEC JTC 1/SC 29, *Coding of audio, picture, multimedia and hypermedia information*. The “J” in JPEG refers to the joint development work between ISO and ITU-T.

The baseline technology was based on a simple, efficient 8 X 8 discrete cosine transform compression algorithm that uses Huffman coding, operated in sequential mode and restricted to 8 bits per pixel input.

Besides its technical merits, the success enjoyed by JPEG can be attributed to the availability of free and efficient software developed by independent groups, such as the Independent JPEG Group. Part of its success was also due to the introduction of the JPEG file interchange format (JFIF), and later the exchangeable image file format (EXIF) that make the popular file extension .jpg synonymous with JPEG compressed images.

Since the publication of the JPEG standard, the JPEG committee has continued to work to deliver innovative imaging standards that can serve new requirements, using the most advanced technology from research in the imaging field.

A new generation – JPEG 2000

A number of imaging applications were not addressed when the original JPEG standard was published. These include high resolution imagery, digital libraries, cultural archives, high fidelity colour imaging, wireless, medical imaging and digital cinemas.

All these applications require enhanced functionality from a compression standard, which JPEG does not satisfy due to design points that were beyond its scope when it was developed. The committee therefore started a new work item to address these issues, resulting in the JPEG 2000 family of standards – the ISO/IEC 15444 series (JPEG 2000 image coding system).

JPEG 2000 makes use of several advances in compression technology (including wavelets transform) to deliver superior compression and systems performance, providing many advanced features in scalability, flexibility and systems functionalities that outperform its predecessor.

After publication of the first six parts of the JPEG 2000 standards, which included the core, extensions, motion, conformance, reference software and multi-layer compound image file format, the JPEG committee began investigating four important application areas. The resulting four parts addressed security (JPSEC), interactive protocol (JPIP), multi-dimensional datasets (JP3D) and wireless applications (JPWL).

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About the author



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JPEG 2000 provides a rich set of technology. Since its publication, the standard has been successful in areas such as digital cinemas, security applications, video surveillance, defence imaging, remote sensing, medical imaging, digital culture imaging, broadcast applications and 3D graphics. The work of JPEG 2000 is continuing with technology maintenance, and work on a new part to address the XML interface to JPEG 2000 objects.

Misplaced image?

While advances have been made on many fronts in Internet search engine technology, the area of image search has met some limitations.

When entering a key word in a typical search engine, users will often find the results unsatisfactory, either because the wrong image is retrieved or the desired context is not accurately interpreted.

These limitations are partly due to lack of standardization in the following areas:

- Ability to reuse metadata (lack of interoperability of metadata)
- A common query format and search semantics for image search
- A common format for handling context in image search.

Other aspects that need to be addressed include how metadata can be created, modified and stored, and also how image collections can have metadata different from that of a single image. The JPEG committee therefore started a new work item to address these problems.

Organized into five parts, Part 1 of ISO/IEC 24800, *Information technology – JPSearch*, was published in 2007. It provides a framework for interoperability for still image search and retrieval, specifying two related items.

The first is a framework for interoperability for still image search and retrieval. The second identifies the architecture and the components in this framework, the linkages between components, and which of these compo-

nents and links are to be standardized in JPSearch.

The image search and retrieval framework is determined by actual use cases, leveraging the experience of text retrieval where, for example, different users issuing the same query may be looking for different results. The JPSearch framework is general enough to support many possible approaches to image retrieval, e.g., from using only low-level image features, to text annotations, to community input, or a mixture of such approaches.

The other parts, which are still under development, will be:

- Part 2: *Registration, identification, and management of schema and ontology*
- Part 3: *JPSearch query format*
- Part 4: *File format for metadata embedded in image data (JPEG and JPEG 2000)*
- Part 5: *Data interchange format between image repositories.*

Full image fidelity

The latest work item initiated by the JPEG committee is the JPEG XR standard, ISO/IEC 29199 (JPEG XR image coding system), also in five parts. The overall goal of JPEG XR is to support a wide range of colour encoding formats, especially in high-dynamic-range imagery settings, where the associated numerical range, colour fidelity, colour gamut and precision are maintained using a variety of fixed and floating-point numerical representations.

JPEG XR addresses the needs of high-dynamic-range applications that are beyond the common usage of standard baseline JPEG, which uses 8-bit representation. It supports a variety of colour profiled pixel formats using integer representations in bit depths of 8 to 16, while maintaining full compatibility with existing legacy devices.

In addition, JPEG XR supports a number of advanced pixel formats to avoid some of the limitations and complexities that result when converting between different, range-limited, unsigned integer representations.

The ultimate goal is to maintain full image fidelity and precision and avoid intermediate data corruption due to insufficient dynamic range representation of image data in high-dynamic range imagery settings.

JPEG XR is designed to optimize image quality and compression efficiency while also enabling low-complexity encoding and decoding implementations. ISO/IEC 29199, Part 2, giving the specification of JPEG XR, is expected to be published sometime this year.

Triumph of innovation and teamwork

The JPEG committee is proud of the success of the imaging standards it has developed over the past 20 years. The JPEG standard is used every day by millions of people to share and print digital photos. The adoption of JPEG 2000 in a wide variety of imaging applications is a mark of its success. The work of JPSearch will propel growth in image search and retrieval systems, and JPEG XR will address the need for high-dynamic-range imagery still to come.

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The JPEG family of imaging standards is indeed a triumph of innovation and teamwork. Under the international standardization process, the best minds in image coding technology gather from all over the world in a consensus-driven process to develop comprehensive image coding systems. ■

