DEPENDENCE OF IMAGE QUALITY MEASURES ON THE LOSSY JPEG COMPRESSION RATE. CAN THE OPTIMAL COMPRESSION RATE OF IMAGES INTENDED FOR PRESENTATION OF ART ON THE WWW BE FOUND?

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The JPEG standard derived its name from the Joint Photographic Experts Group, a committee of the International Standards Organisation (ISO), the International Telephone and Telegraph Consultative Committee (CCITT) and the International Electromechanical Commission (IEC).

Work on JPEG began in 1986 and it was approved as a international standard in 1992 (IS 10918-1). The compression algorithm of JPEG is based on a Discrete Cosine Transform (DCT) applied to 8 by 8 blocks of image data and is combined with a lossless entropy coding method.

Because of the growing significance of image communication methods, the assessment of image quality is becoming an increasingly important issue

However, very different procedures have been used for such tasks, so that frequently neither comparison, nor evaluation could be made. As a consequence, for instance, the rendering of the image colours, derived from graphic data processing methods on different monitoring devices is not exact. In order to obtain comparable results, test images and procedures (e.g. from television technology) have to be modified and new methods will have to be developed. Due to the predominant significance of image information in multimedia systems, quality analyses for this type of information are of particular importance.

Most JPEG compressors let the user to pick a file size vs. image quality loss by selecting a quality setting. There seems to be a widespread confusion about the meaning of these settings. "Quality 95" does NOT mean "keep 95% of the information", as some assume. The quality scale is purely arbitrary; it's not a percentage of anything measurable. In fact, quality scales aren't even standardised across JPEG programs.

The quality settings discussed in this article apply to the free IJG JPEG software and to many programs based on it. Some other JPEG implementations use completely different quality scales; for instance, Apple™ uses a scale running from 0 - 4, not 0 -100. A few programs even use a scale running in the opposite direction, with higher numbers indicating lower image quality (more compression). Other programs don't use a numeric scale at all, just "high/medium/low" style choices. Fortunately, this confusion doesn't prevent different implementations from exchanging JPEG files. However, the user has to keep in mind, that quality scales can vary from one JPEG-

creating program to another. In most cases the user's goal is to pick the lowest quality setting, or smallest file size, that decompresses into an image indistinguishable from the original. These settings are unfortunately dependent on the image structure and the user visual system features. However some rules for good-quality, full-colour source images can be established.

The default IJG quality setting (Q 75) is very often the best choice. This setting is about the lowest, which can be used without expecting to see defects in a typical image. So the rule is: Try Q 75 first; if you see defects, then go up. If the image was of perfect quality to begin with, you might be able to drop down to Q 50 without objectionable degradation.

Another rule is that except for experimental purposes, never go above about Q 95; using Q 100 will produce a file two or three times as large as Q 95, but of hardly any better quality. Q 100 is a mathematical limit rather than a useful setting. If you want a very small file (say for preview or indexing purposes) and you are prepared to tolerate large defects, a Q setting in the range of 5 to 10 is about right.

If your image contains sharp coloured edges, you may notice slight fuzziness or jaggedness around such them no matter how high you make the quality setting. This can be suppressed, at a price of file size, by turning off chroma downsampling in the compressor.

The IJG encoder regards downsampling as a separate option which can be turned on or off independently of the Q setting. With the "cjpeg" program, the command line switch "-sample 1x1" turns off downsampling; other programs based on the JPEG library may have checkboxes or other controls for downsampling. Another JPEG implementations may not provide user control of downsampling. Adobe Photoshop™, for example, automatically switches off downsampling at its higher quality settings. On most photographic images, we recommend leaving downsampling on, because it saves a significant amount of space at little or no visual penalty.

Quality settings around 50 are often perfectly acceptable on the Web. In fact, a user viewing such an image on a browser with a 256-color display is unlikely to be able to see any difference from a higher quality setting, because the browser's colour quantization artefacts will swamp any imperfections in the JPEG image itself.

It's also worth knowing that current progressive-JPEG-making programs use default progression sequences that are tuned for quality settings around 50-75: much below 50, the early scans will look really bad, while much above 75, the later scans won't contribute anything noticeable to the picture.

As could be expected we encountered great problems in finding an efficient compression level for the JPEG method. It seems that at the current state of research, an automatic setting of an optimal compression rate is impossible. Further research is needed, as the problem is too important to be left unsolved.

In our opinion the image texture is playing a crucial role, with regard to the result of JPEG compression. Our future work will concentrate on the analysis of the dependence of the compression efficiency on the textural features of the image. This seems to be a promising approach, as the most defects occur just in image region, which are characterised by a texture.