Progressive Division - A New Methodology for Visually Evaluating Still/Video Imagery

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Abstract

image and video technology is being used in an ever expanding number of applications ranging from science and technology to remote management, consulting, and education. Due to the relatively limited transmission bandwidth that exists in many of these areas of application it is often necessary to digitally compress the video signal before transmission and then decompress it upon its arrival, display, and use, Unfortunatel y, there are no objective means for evaluating compressed, transmitted still and video images other than pure] y optical (e.g., modulation transfer function). So far the many important and varied subjective requirements of the viewer(s) have not been taken into account. This paper describes the design and testing of a new human behavioral and perceptual test technique (known as Progressive Division), largel y deri vecl from the space program, to quantify the ultimate, usefulness of compressed-tr ansmitted-deco mpressed-displayed still and video images.

A preliminary test of a part of this powerful new method involved both JPEG and MPEG algorithms for transmitting static and moving life science imagery, respectivel y, say from Space Station to principal investigators on earth, who must make various judgments about these biological specimens. Life scientists at Ames made careful visual comparisons of color digital images located side by side on a high resolution monitor but without knowing anything about the two images, All they had to do was judge which of the two images possessed the best overall qualities (using various criteria) and then give a numeric scale rating of the final best image selected. inform at ion was also obtained about their scientific specialities, image detail requirements, and subjective interests to correlate with their (later) judgments. 1 n this way each image evaluator was pre-calibrated to provide useful insights about why they selected one compression level over another for a given kind of scene. It was found that involving each scientist in image evaluation proved to be a powerful and important aspect of the methodology.

in a more recent experiment using Progressive Division, Galileo spacecraft imagery (800 x 800 pixels x 8 bits of grey) were compressed using the integer cosine transform (ICT) in conjunction with four different quantization (i.e., weighting functions) tables. Different types of monochromatic astronomical images were studied by members of the.

Galileo Solid State imaging experiment team ant] others using the present methodology. The Progressive Division method involved presenting the first observer with a very broad range of quantization levels and requiring that he or she select either the upper or lower half of the range presented (if possible) as having the most acceptable image quality. Again, two i dent ical images were presented side by side but without an y identifying information. The chosen half-range was then presented to the second subject, who again, had to judge between the upper or lower-half of the now-bisected range, 'I'his was continued with subsequent image evaluators until an acceptably small quantization range was found. 'I'his process can be computer automated. This approach m adc it possible to converge on an acceptable solution rapid] y and with remarkabl y good inter-rater consistenc y. It was found that simulated radiation noise significant y reduces acceptable ICT compression ratios. 1 n the most extreme case, compression of the same image was reduced by as much as 19 times (from 57:1 down to below 3:1) due to the presence of the noise.

The Progressive Division methodology may find use in a variety of commercial applications where video imagery must be transmitted without incurring perceptible amounts of quality loss.