ON VIDEO FORMATS AND CODING EFFICIENCY

Gerard de Haan and Erwin B. Bellers
Philips Research Laboratories, Eindhoven, The Netherlands

ABSTRACT
We have studied the effectiveness of MPEG-2 coding for interlaced and progressive video, and compared de-interlacing and picture-rate up-conversion before and after coding. We found receiver side processing to be superior.

INTRODUCTION
Recently, new options for digital video broadcasting have restarted the discussion on interlaced video in broadcast standards. Although earlier publications [1, 2, 3] have compared the effectiveness of MPEG-2 coding on interlaced and progressive sources, we found some very relevant aspects were missing. Particularly, the effect on “blockiness” of interlaced vs. progressive data in the decoded images has not been investigated, and up-to-date de-interlacing algorithms at the decoder side are absent from the published experiments. Finally, we found that the research focused on highly vertically detailed image sequences and largely neglected the effect of less challenging, but perhaps more common, picture material. Our paper reports on these aspects of interlaced video and MPEG-2 coding. Additionally, we investigated combinations of coding and motion-compensated picture-rate conversion at the receiver side, to answer whether the motion portrayal of movies can best be improved at the receiver or transmitter side.

THE ALGORITHMS USED
The MPEG2 codec used in our investigations is the Berkeley software codec, referenced by and available to many. The de-interlacing algorithm used in the test was the Adaptive Recursive (AR) de-interlacing method [4], which we believe to be the most advanced algorithm announced or available on the consumer market. It is a motion compensated de-interlacer. The motion vectors are estimated using a high quality, low cost, 3-D RS block-matcher [5], also available in a consumer product [6].

THE EXPERIMENTS
In our experiments, we compared the coding chains as shown in Figures 1, 2 and 3.
Two sets of test sequences were used. The first set contained sequences with abundant vertical detail, whereas the second set contained picture material with less vertical detail and faster motion. In the evaluation, we used the common peak signal-to-noise ratio, PSNR, and the blockiness impairment metric, BIM, of the decoded images. This quantitative quality measurement was designed by Wu and Yuen [7] to match the subjectively perceived blockiness. It evaluates horizontal and vertical edges in the video near block boundaries, taking into account the effects of spatial masking [8, 9] and the luminance level [10] on the visibility of block distortions.

CONCLUSIONS
From our experiments, we draw these conclusions:

- It is better, subjectively and in terms of PSNR and BIM, to de-interlace at the decoder side than at the encoder side.
- It is better, subjectively and in terms of PSNR and BIM, to up-convert movie material at the decoder side than at the encoder side.
- The PSNR of the all progressive coding chain is usually better than that of the interlaced coding chain.
- The BIM of the interlaced coding chain is usually better than that of the all-progressive chain.
- The PSNR is a poor indicator of subjective image quality. Evaluations of coding systems should include the BIM.
- For low bit rates (≤4 Mbit/s) the interlaced coding chain will be subjectively superior to the all-progressive chain. For high bit rates (>4 Mbit/s) an all-progressive chain is best.

- For bit rates that are common in television broadcasting, a fair answer to the question “to interlace or not to interlace?” depends on the statistics of the programme material in terms of vertical detail and motion. Without investigating these statistics, we conclude that the general opinion concerning the effectiveness of MPEG-2 coding on interlaced picture material is negatively biased by the focus on vertically detailed sequences, while the omission of blockiness metrics in the evaluation further increases this bias.

REFERENCES