

Internal Memorandum

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From	S. B. Ng	Location	W-333	Telephone	x3035
Subject	ATRC 8/1/90 Video Study Group Meeting Summary				

The ATRC Video Study Group met on 8/1/90 at the Sarnoff facility in Princeton. R. Hingorani, K. Joseph, S. Ng, J. Shapiro, and C. Wine from Sarnoff, and F. Azadegan, A. Cavallerano, Y. Ho and D. Teichner from NAP were present at the meeting. G. Reitmeier was present briefly during the morning discussion.

The following is a list of topics covered in the meeting.

- Progress reports.
- Demonstration of some images by Sarnoff members.
- Testing and evaluation criteria.

Our NAP colleagues informed us that the DVS system to be installed at NAP has encountered some delay. The new date for its operation is in September.

As a response to Sheau's previous request for QMF filter comparison, Yo-Sung reported on some filter comparison work in the context of sub-band analysis and synthesis. He compared the sub-band reconstruction error (without intermediate quantization) using a number of Johnston's filters. The reconstruction error seemed to have been caused largely by edge effect. In his experiments, Yo-Sung used a number of simple edge treatments: zero padding; holding of edge sample; edge reflection that produces a continuous signal (but with discontinuity in first and higher order derivatives); and edge reflection that produces a continuous zeroth and first order derivatives. He concluded that amongst the Johnston's filters, the 16B filter with normalized coefficients, together with simple edge reflection (holding of edge sample) results in the lowest overall reconstruction distortion. All his experiments were conducted using floating-point computation.

Raj commented that better edge treatment can improve the results. Raj had invented a more sophisticated edge treatment — one in which the analysis and synthesis filtering receive different edge treatment — and together with perfect reconstruction filters, results in virtually no edge effect. The question of perfect reconstruction filters was raised. It was stated that the choice of filters, in the context for compression (and quantization), ought to be made based on both the

energy compaction property and the reconstruction distortion in the presence of quantization. It was also suggested that edge treatment may be more important an issue than the choice of filters because the difference between one set of sub-band filters and another tends to be relatively small.

Jerry then reported on the RM1 progress for the flow-field approach. The RM1 is running, with a variable macro-block size. The choice of the macro-block size for the test run is 256 pixels by 80 lines and is made based on the DVF window 1 size. There was discussion on whether the quantizer parameters should not be changed over a larger area than a macro-block. From the buffer control viewpoint, the parameters can be changed once every few macro-blocks. From the local adaptivity viewpoint, however, it is desirable that each macro-block be allowed its own set of parameters. This can potentially result in better compression performance. Kuria showed a plot of the macro-block data rate variation for the first 20 frames of Caltrain sequence, and noted that within each frame, there is a substantial variation from one macro-block to another.

Jerry also talked about a “frame-dropping” system that seems promising. Using different distortion requirements for alternate frames, e.g., target SNR of 40 dB for odd frames and 30 dB for even frames, the resultant system effectively stops transmission of most of the macro-blocks in the low-quality frames (the even frames in the example,) except in macro-blocks where the SNR falls below the minimum requirement (30 dB in the example.)

He also discussed some recent work on perceptual weighting applied to the flow-field system. He tried a distortion distribution of 1:2:2:4 for the LL, LH, HL, and HH bands, respectively, and found that there was some gain in subjective performance. He later gave a demo of both the alternate high-low SNR frames (“frame-dropping”) system and the perceptual weighting simulation results running on Caltrain and Keil Harbor sequence.

Sheau showed two simulation results produced by his block-match motion compensated sub-band (BM-MC-SBC) system using a logarithmically spaced and equally spaced sub-band decomposition.

Following the demo, Sheau discussed his BM-MC-SBC work. He stated that his recent effort has been directed toward the overall frame structure of the system. Specifically, he described his superframe structure in which each superframe contains a high-quality first frame. The remaining frames are coded with forward and backward block-match motion compensation and quantized in a sub-band coder. The first frame of each superframe is coded using either a spatial sub-band coder with 2-D DPCM on the LL band, or a forward BM-MC using the previous high-quality first frame as reference for the motion compensation. The quantization for the first frames in each superframe is carefully kept to be lower than those used for the non-first frames.

He showed the comparative results of a number of modifications, including single- versus half-pixel accuracy for the block-match motion compensation, forward only versus forward and backward motion compensation, and fixed search area for the block match versus a block match search area which is proportional to the temporal distance between the coded frame and the reference frame. These comparisons were done in the context of his BM-MC-SBC running on his superframe structure.

Faramarz then talked about his spatial compression work. His work is based on sub-band decomposition followed by VQ of the mid- and high-bands. He listed three possible coding schemes for the low band: (1) VPQ (vector predictive quantizer), which he described in previous meetings and had since concluded the work; (2) DPCM with entropy coding, which he put aside because of the potential drawback associated with variable-length coding (VLC) in the presence of channel error; and (3) DCT (Chen and Smith style), on which he is current working. He stated that the VPQ performance is not substantially better than other spatial compression, and carried the penalty of error propagation (due to its predictive nature). He is therefore looking at the simple spatial compression technique of DCT, since it offers good error confinement property in addition to its well-known compression efficiency. Currently, he is getting 1.3 bpp at SNR of 35 dB for an image called Flower (NAP's own image).

Yo-Sung then reported on his VQ work. He is currently looking at 4x4 sub-band (using Johnston's 16-tap filter) with adaptive bit allocation for his two-stage VQ. He has also started looking at block-match motion compensation. He raised the question of distortion criteria with regards to block-match search. In particular, he is looking at the difference between the minimum MSE and the minimum absolute difference (MAD) criteria. It was agreed by many who had previous experience in block-match search that the difference between the MSE and MAD criteria is very slight.

A concern on the expected improvement from temporal processing when included in the spatial VQ work was raised. Yo-Sung stated that he hoped to get better than a factor of 2 improvement. Sheau cautioned that the expectation may be optimistic. The improvement may be no more than a factor of two; indeed it will probably be less than two.

There was also a discussion on variable-length code versus fixed-length code. Faramarz expressed his concern over the severe impact of error on VLC, particularly the potential loss of codeword synchronization. Jerry felt that since we are still far from achieving the compression goals of the simulcast system, we should focus our attention on improving the compression efficiency of our system.

The last item covered in the meeting was testing criteria. Some felt that the topic should be addressed in the T&E group. Detlef, however, explained that he wanted to solicit input from the

Video Compression Group regarding these criteria. (The T&E group consists of Detlef and Sheau.) He went on to talk about identifying test sequences. He will provide Sheau with a catalog of image sequences available at NAP. He expects to have access to some new HDTV image sequences from Italy. Charlie pointed out that the test sequences from FCC should make a significant addition to the library of test sequences available for ATRC testing and evaluation. Detlef wrote a test plan for FCC submission, and will submit the same for the T&E group. (A copy was distributed at the weekly Digital Simulcast meeting. Further copy can be obtained from Sheau.)

On a different plane, Detlef expressed concern that the parallel efforts do not seem to lead to a convergence of solutions. He called for more cooperative effort in the compression work. Allan, on the other hand, reiterated the importance of keeping the efforts separate. Sheau supported Detlef in calling for more hybridization in our system research efforts.

Detlef also pointed out that an important consideration that should not be forgotten is how well a particular system is positioned for future expansion, a point which Charlie and many others concurred. Finally, Detlef proposed for a dry-run comparison of the various systems in October. There was no definite agreement on his proposal.

Remarks:

I was happy to hear Detlef calling for a “merging” of efforts. Our NAP counterparts appear to have a loose agenda with regards to their compression work. My earlier request to Faramarz for his help in the study of QMF filter selection, a trial balloon on my part, has had a positive response. If we believe in synergy, it is high time that we should involve our colleagues from NAP in our software development effort. A good starting point is to have in place, as soon as possible, a formal software exchange policy so that a more integrated, and probably more productive, research effort can be organized. It is likely that many of the systems under study now will end up quite similar to one another. Given the stringent time budget we are facing, such an overlap in effort, I believe, should be avoided.



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