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Purpose: Information and Discussion
Title: Cost and benefit analysis for Matching Pursuits as a version 2 tool
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In response to the request posted by the Video Group Chairman, Thomas Sikora, to the mpeg-video reflector on June 11th 1998, we have prepared a cost and benefit analysis for Matching Pursuits as a candidate tool for Version 2 visual standard.

Functionality

MP is a inter-frame texture coding scheme that was originally proposed to MPEG-4 standardization body in November of 1995. It is used to code the residual signal resulting from motion estimation and compensation. The basic idea is to decompose the signal along an over-complete set of basis functions that are more naturally suited to the features found in typical residue signals. It provides the following functionality that are currently not in version 1.

1. Significant improvement in subjective visual quality.
   - Sharper details across all test sequences due to lack of need for post-processing filters.
   - Significantly less blocking and mosquito artifacts than DCT coding with no post-processing filters.
2. Significant improvement in coding efficiency [m3832]:
   - average of 1.21 dB for 10kbps sequences
   - average of 1.00 dB for 24kbps sequences
   - average of 0.88 dB for 48kbps sequences
   - average of 1.28 dB for 112kbps sequences
   - average of 0.37 dB for 1 Mbps sequences
3. Lower decoder complexity as no post-processing filters such as de-blocking or de-ringing are required.
   - Theoretical and operational counts and simulation results via IPROF show that postprocessing filters add 30 to 50% to the decoder complexity. [m3120]
4. Significantly superior capability for texture coding of arbitrary shaped objects [m2877]:
   - Superior visual quality and coding efficiency,
   - Natural extension from rectangular shape to arbitrary shape with no extra complexity.
5. Significantly superior SNR scalability functionality [m3833]:
   - Superior visual quality and coding efficiency.
   - Fine granularity of available bit rates for multiple enhancement layers, e.g. as fine as 20 bits per second.

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6. Significantly superior rate control capability :
    - bit rates can be controlled with granularity of around 20 bits per frame.

Applications

Since MP is an inter-frame texture coding tool, it can be used in most of the applications of MPEG-4, ranging from interactive applications such as video conferencing, to playback applications. However, we feel that Internet video is the application with the largest potential impact by MP.

1. It is particularly useful in encode once, decode many applications where the decoder complexity must be small. Examples of such applications include video communication on hand held PDA devices with limited power, or Internet video.

2. It is also attractive in applications where SNR scalability with fine granularity of available bit rates is required. Example of such an application is internet video where the available bandwidth is constantly changing and as such the encoder has to respond to the dynamics of the channel.

3. It is also attractive in low bit rate applications, e.g. from 10 to 112 kbps, as on average it provides more than 1 dB gain over version 1 tools. Examples of such applications include communication over 14.4, 28.8, 56 kbps modems and 128 kbps ISDN lines.

Cost

MP has a more complex encoder than Discrete Cosine Transform. We have shown that at low bit rate such as 10, 24 and 48 kbps, it is possible to do real-time encoding on today's PC's [m1817].

Profile

We propose two new object profiles for MP, "Core MP" and "Scalable MP". Core MP profile is similar to the Core object profile with the MP-VOP replacing the P-VOP. Scalable MP profile is built on top of Core MP profile with added SNR scalability.

Visual Tools	**Core MP**	**Scalable MP**
I-VOP	X	X
Matching Pursuit Mode (MP-VOP)	X	X
AC/DC Prediction	X	X
Slice Resynchronization	X	X
Data Partitioning	X	X
Reversible VLC	X	X
4MV, Unrestricted MV	X	X
Binary Shape Coding	X	X
H.263/MPEG-2 Quantization Tables	X	X
P-VOP based temporal Scalability Rectangular Shape	X	X
P-VOP based temporal Scalability Arbitrary Shape	X	X
B-VOP	X	X
SNR Scalability Rectangular Shape		X
SNR Scalability Arbitrary Shape		X

Maturity of tools

MP has been under consideration at MPEG-4 since November of 1995. In July of 1997, the MPEG-4 standardization body voted to accept MP as a tool in the Verification Model. D1 tapes showing results based on MP have been shown in nearly every MPEG-4 meeting since November of 1995.

U.C. Berkeley has already completed the MoMuSys implementation. Microsoft implementation is currently underway.

MP was completely verified as a core experiment by Philips LEP in 1997. The bit stream exchange experiments are currently underway with Philips, LEP. In addition, a large number of organizations have run the MP code. These include University of Erlangen, Motorola, Hughes Research Labs, Samsung, Ericcson, Rockwell, Nokia and Iterated Systems.

MP is fundamentally compatible with all coding modes.