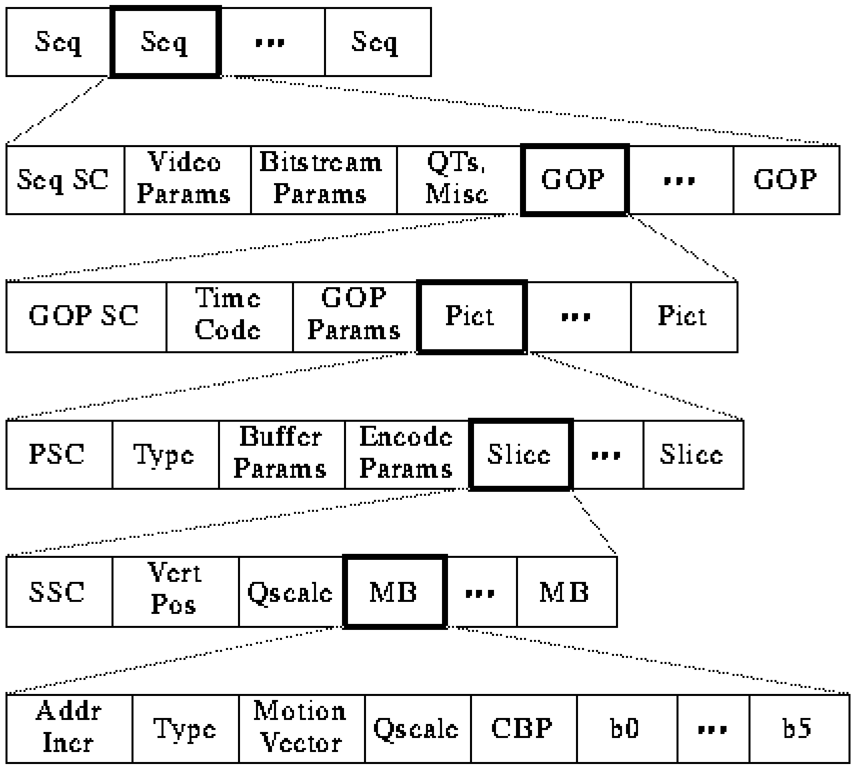
The MPEG Video Bitstream

The MPEG Video Bitstream is summarised as follows:

- Public domain tool **mpeg_stat** and **mpeg_bits** will analyze a bitstream.



- **Sequence Information**

1. Video Params include width, height, aspect ratio of pixels, picture rate.

2. Bitstream Params are bit rate, buffer size, and constrained parameters flag (means bitstream can be decoded by most hardware)

3. Two types of QTs: one for intra-coded blocks (I-frames) and one for inter-coded blocks (P-frames).

Group of Pictures (GOP) information

1. Time code: bit field with SMPTE time code (hours, minutes, seconds, frame).
2. GOP Params are bits describing structure of GOP. Is GOP closed? Does it have a dangling pointer broken?

- **Picture Information**

1. *Type*: I, P, or B-frame?
2. *Buffer Params* indicate how full decoder's buffer should be before starting decode.
3. *Encode Params* indicate whether half pixel motion vectors are used.

- **Slice information**

1. *Vert Pos*: what line does this slice start on?
2. *QScale*: How is the quantization table scaled in this slice?

- **Macroblock information**

1. *Addr Incr*: number of MBs to skip.

2. *Type*: Does this MB use a motion vector? What type?

3. *QScale*: How is the quantization table scaled in this MB?

4. *Coded Block Pattern (CBP)*: bitmap indicating which blocks are coded.

Decoding MPEG Video in Software

Software Decoder goals: portable, multiple display types

Breakdown of time

Function	% Time
Parsing Bitstream	17.4%
IDCT	14.2%
Reconstruction	31.5%
Dithering	24.5%
Misc. Arith.	9.9%
Other	2.7%

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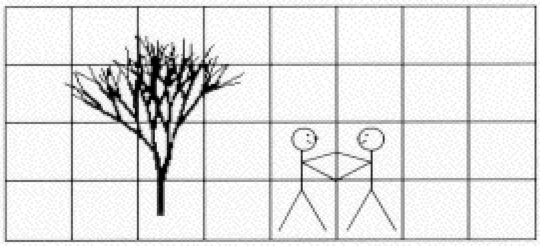
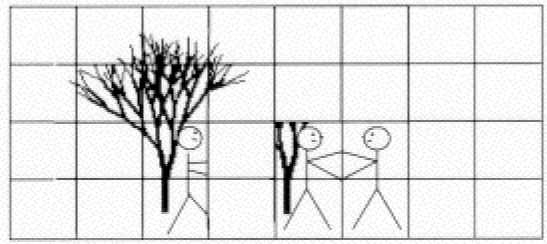
Intra Frame Decoding

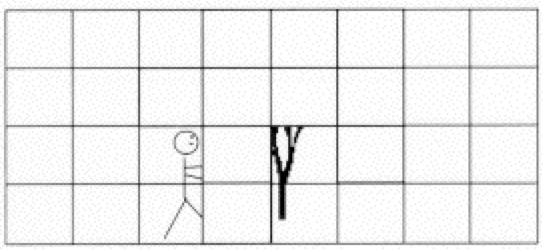
To decode a bitstream generated from the encoder of Figure 7.20, it is necessary to reverse the order of the encoder processing. In this manner, an I frame decoder consists of an input bitstream buffer, a Variable Length Decoder (VLD), an inverse quantizer, an Inverse Discrete Cosine Transform (IDCT), and an output interface to the required environment (computer hard drive, video frame buffer, etc.). This decoder is shown in Figure.



Desired Picture



Minus Predicted Picture



Residual Error Picture
(Coded & Transmitted)

Intra Frame Encoding

Intra Frame Decoding

The input bitstream buffer consists of memory that operates in the inverse fashion of the buffer in the encoder. For fixed bit-rate applications, the constant rate bitstream is buffered in the memory and read out at a variable rate depending on the coding efficiency of the macroblocks and frames to be decoded.

The VLD is probably the most computationally expensive portion of the decoder because it must operate on a bit-wise basis (VLD decoders need to look at every bit, because the boundaries between variable length codes are random and non-aligned) with table look-ups performed at speeds up to the input bit-rate. This is generally the only function in the receiver that is more complex to implement than its corresponding function within the encoder, because of the extensive high-speed bit-wise processingnecessary.

The inverse quantizer block multiplies the decoded coefficients by the corresponding values of the quantization matrix and the quantization scale factor. Clipping of the resulting coefficients is performed to the region 2048 to +2047, then an IDCT mismatch control is applied to prevent long term error propagation within the sequence.

The IDCT operation is given in Equation 2, and is seen to be similar to the DCT operation of Equation 1. As such, these two operations are very similar in implementation between encoder and decoder.

Non-Intra Frame Decoding

It was shown previously that the non-intra frame encoder built upon the basic building blocks of the intra frame encoder, with the addition of motion estimation and its associated support structures. This is also true of the non-intra frame decoder, as it contains the same core structure as the intra frame decoder with the addition of motion compensation support. Again, support for intra frame decoding is inherent in the structure, so I, P, and B frame decoding is possible. The decoder is shown in Figure 24.

MPEG-2, MPEG-3, and MPEG-4

MPEG-2 target applications

Level	size	Pixels/sec	bit-rate (Mbits)	Application
Low	352 x 240	3 M	4	consumer tape equiv.
Main	720 x 480	10 M	15	studio TV
High 1440	1440 x 1152	47 M	60	consumer HDTV
High	1920 x 1080	63 M	80	film production

Differences from MPEG-1

1. Search on fields, not just frames.

2. 4:2:2 and 4:4:4 macroblocks

3. Frame sizes as large as 16383 x 16383

4. Scalable modes: Temporal, Progressive,...

5. Non-linear macroblock quantization factor

6. A bunch of minor fixes (see MPEG FAQ for more details)

- MPEG-3: Originally for HDTV (1920 x 1080), got folded into MPEG-2

MPEG-4: Originally targeted at very low bit-rate communication (4.8 to 64 kb/sec). Now addressing video processing...