Video Compression
— MPEG

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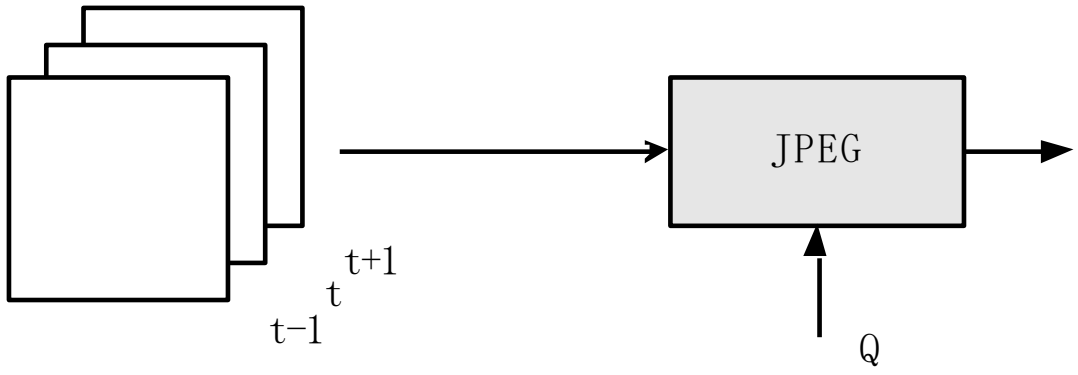
Still Image Coding vs. Video Sequence Coding

- Within a frame, it is the same as still image coding.
- Make compression in temporal dimension different from spatial ones

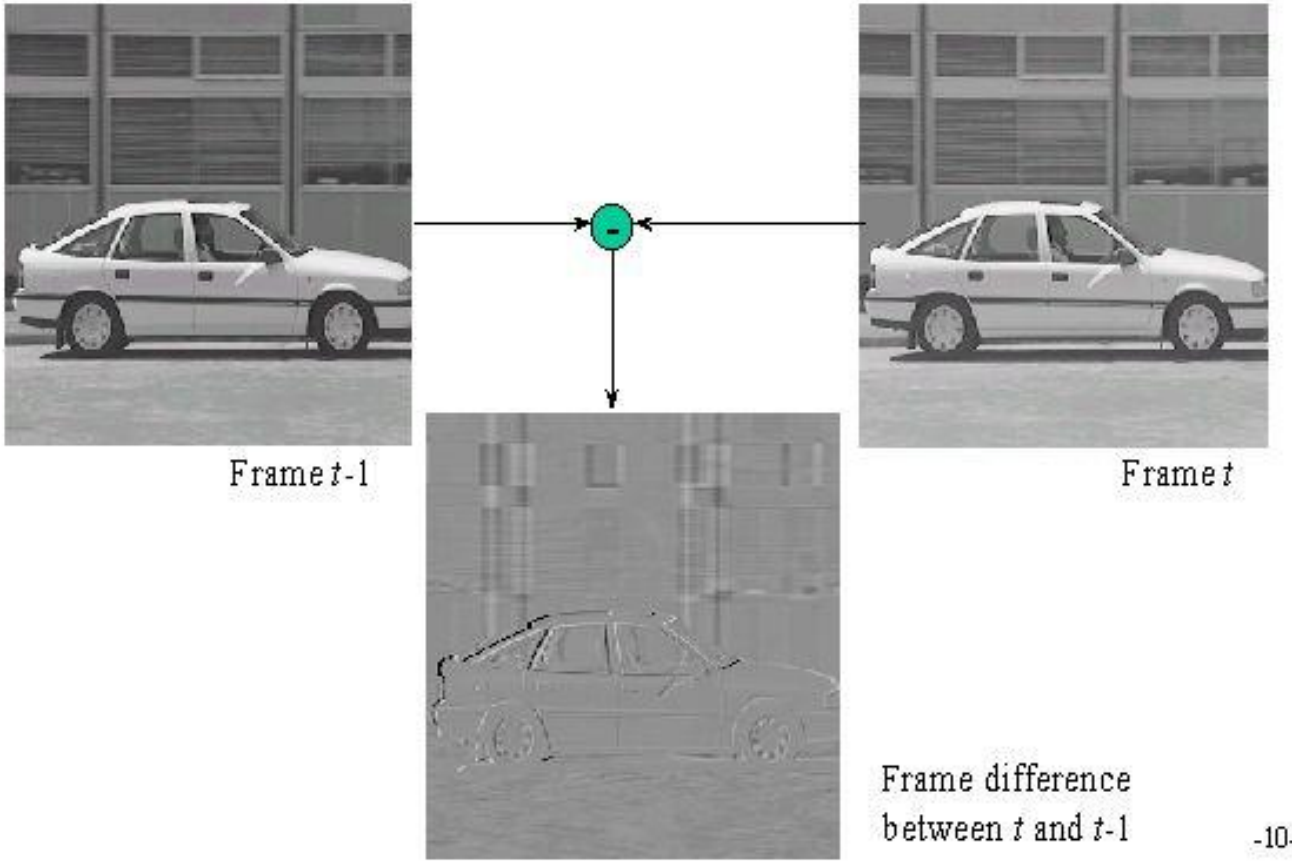
Intra-frame Coding

- Encode frame by frame, disregarding all temporal information.
- Easy bit allocation per frame.
- Random access is possible.
- Robust to decompression / transmission problems.
- Moderate compression capabilities.
- Example: Motion-JPEG (AVI compressed)

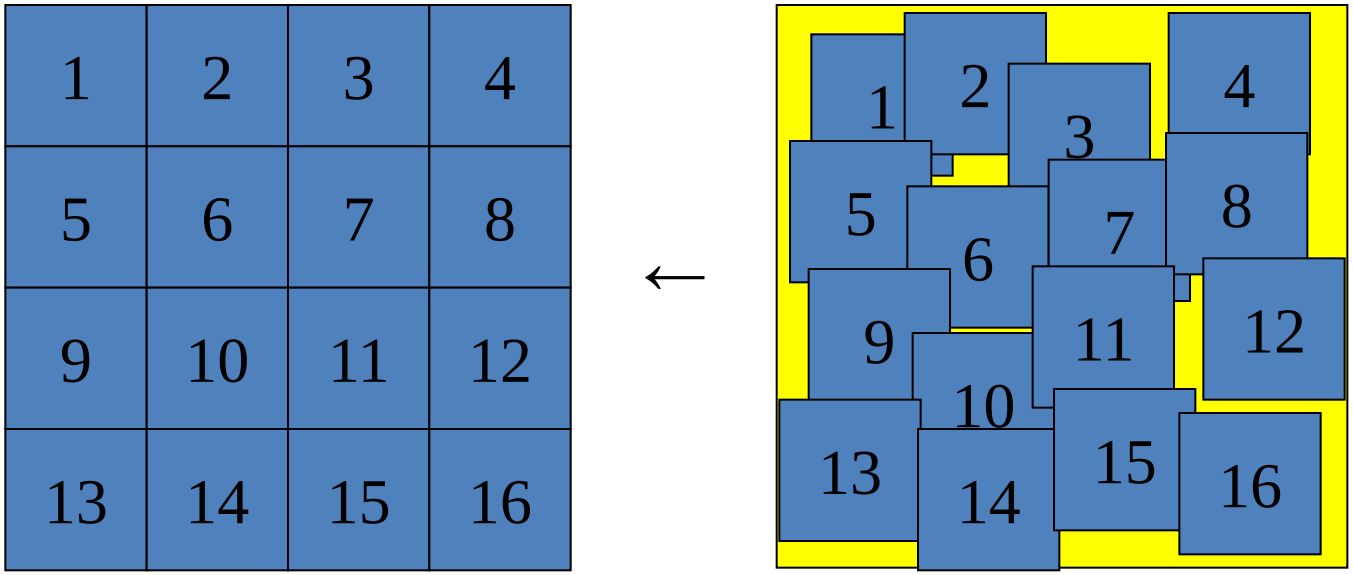


Temporal Redundancy

Example



Forward Motion Compensation



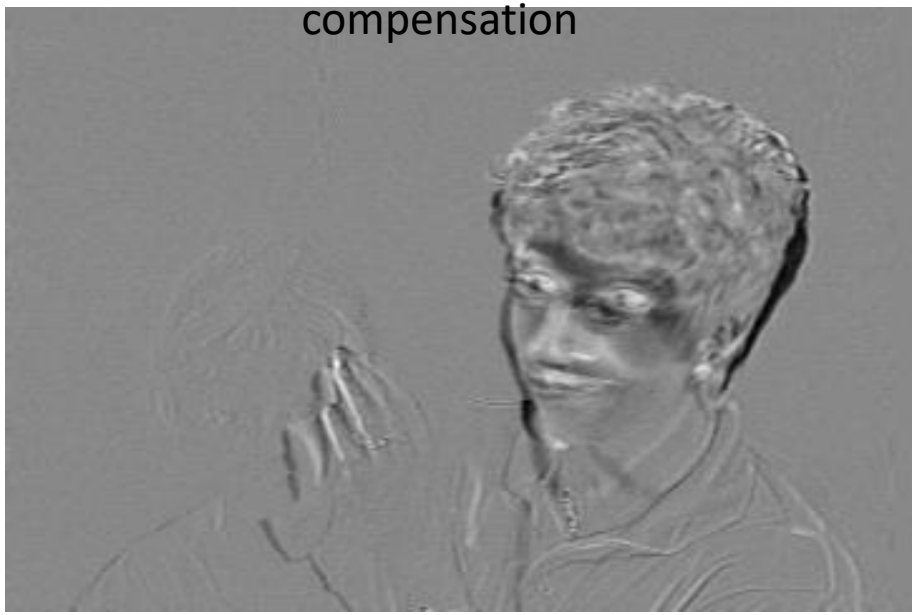
Predicted frame $\hat{x}(t)$ constructed from different parts of reference frame

Reference (decoded **NOT** raw) frame $\tilde{x}(t-1)$

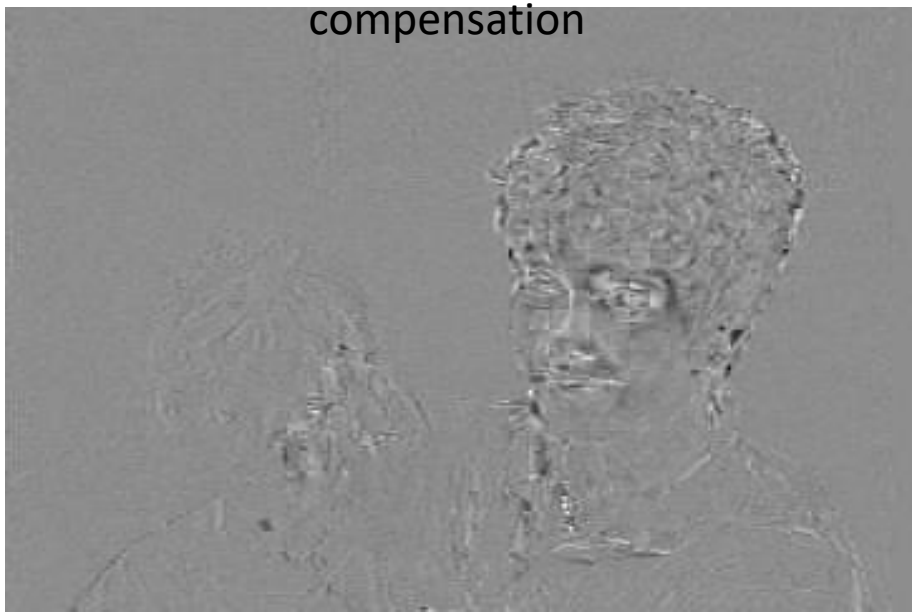
Frame 1

Frame 4

Absolute difference **without** motion compensation



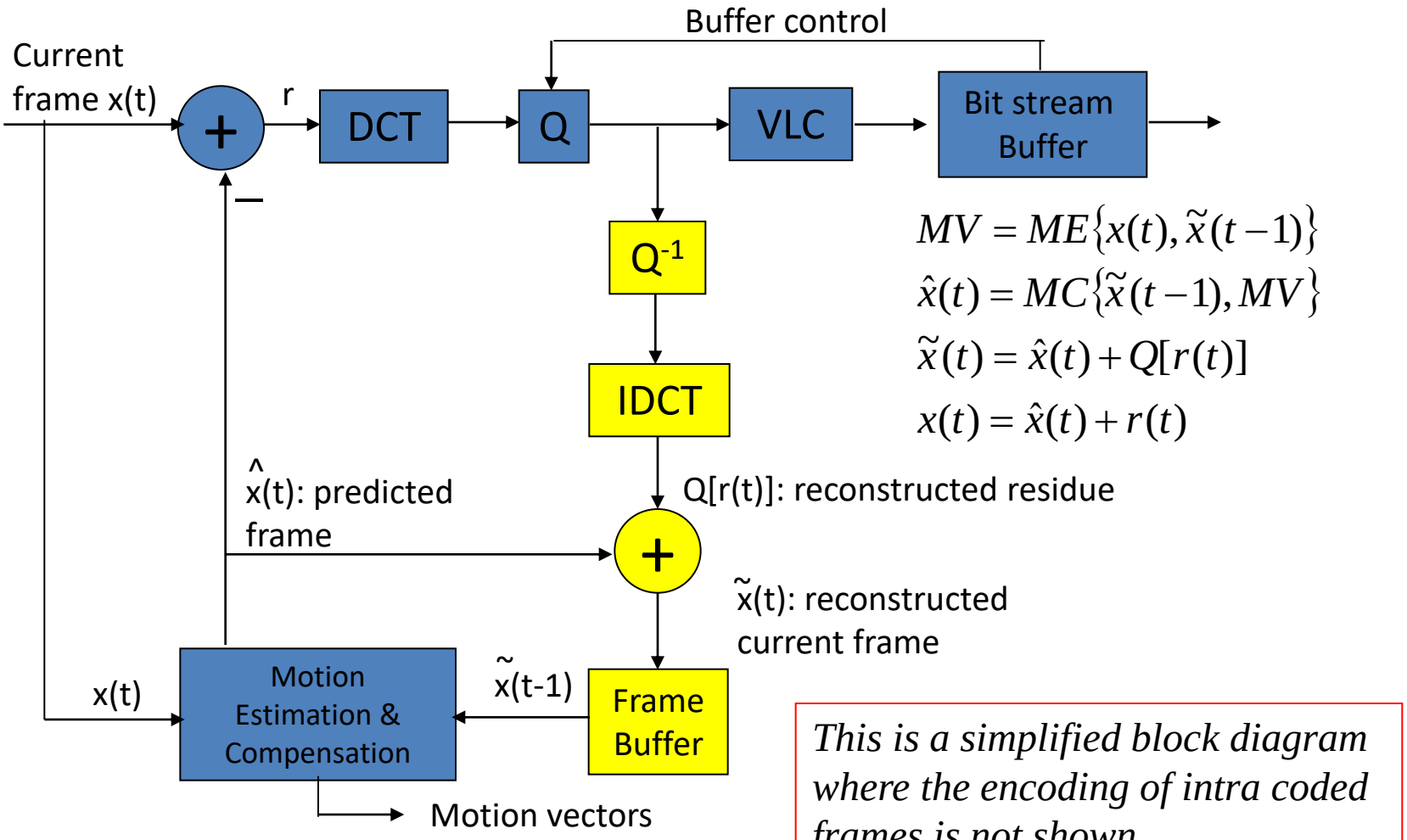
Absolute difference **with** motion compensation



Motion Estimation Methods

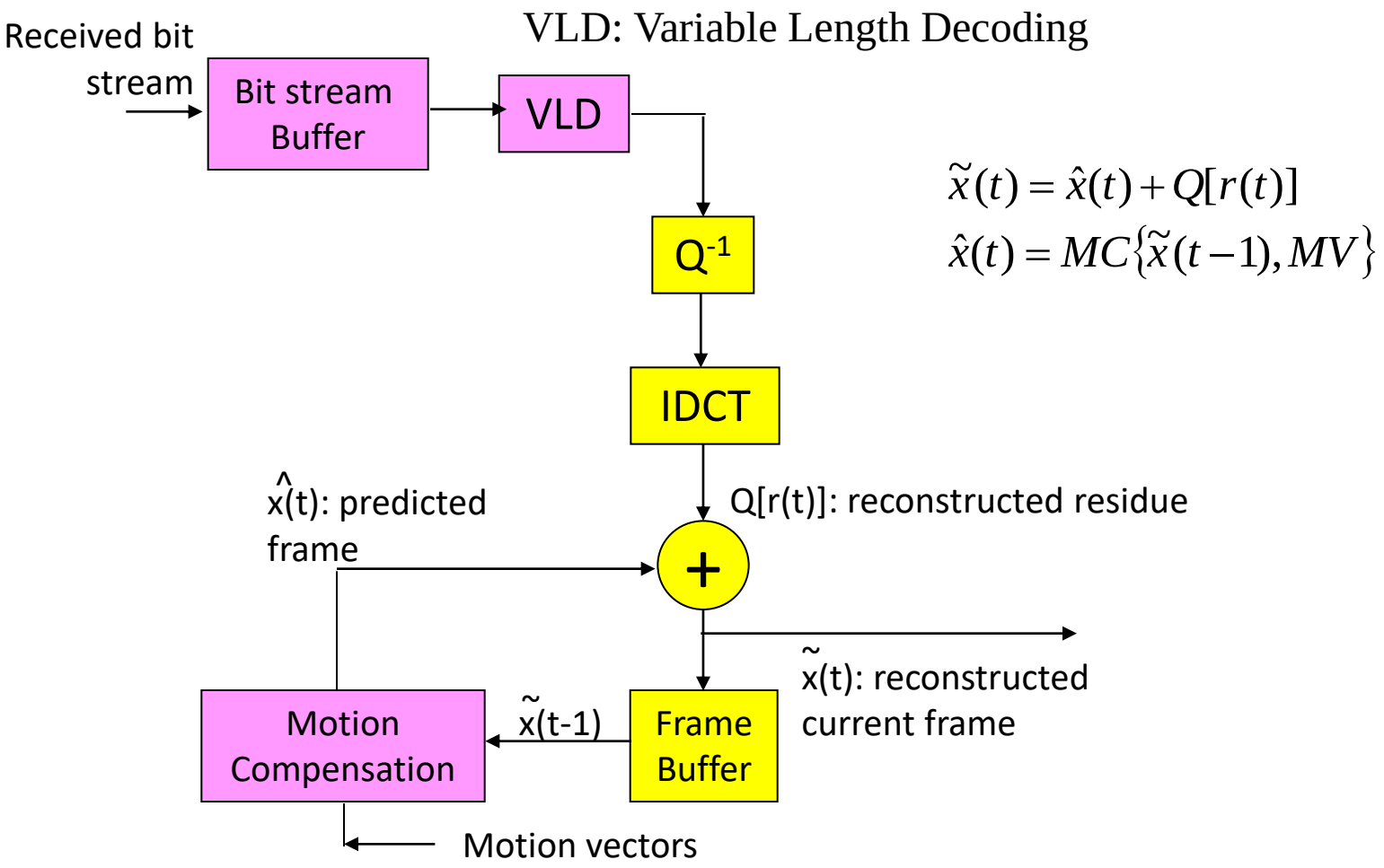
- The basic motion estimation methods used in video compression:
  - **B**lock-**M**atching **A**lgorithm
    - Full Search
    - Three Step Search
    - New TSS
    - Four-Step Search
    - Diamond Search Algorithm

MPEG Encoding Framework



This is a simplified block diagram where the encoding of intra coded frames is not shown.

MPEG Decoding Framework



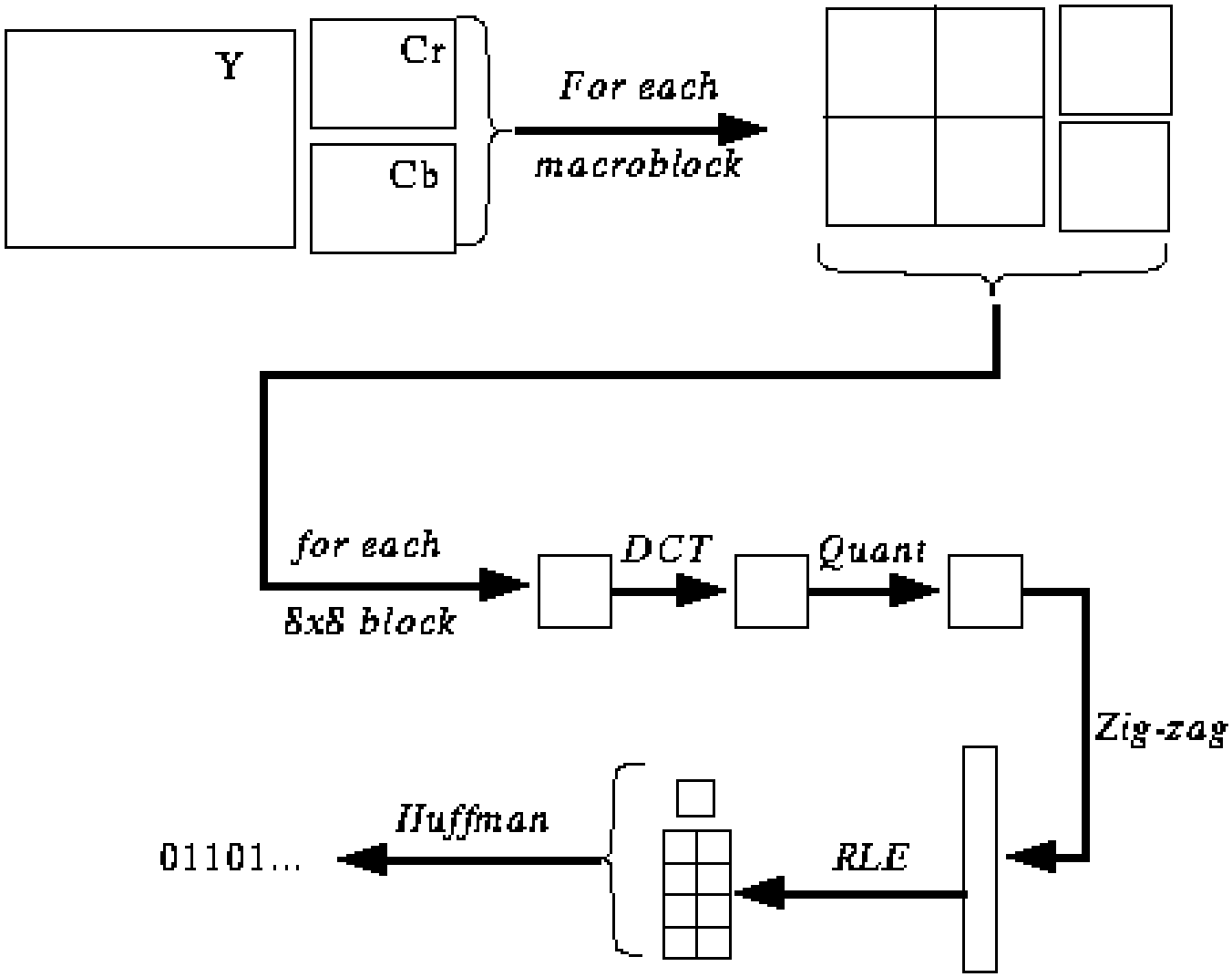
Motion Estimation

- Three types of frames:
  - Intra (**I**): the frame is coded as if it is an image
  - Predicted (**P**): predicted from an **I** frame
  - Bi-directional (**B**): forward and backward predicted from a pair of **I** or **P** frames.
- A typical frame arrangement is (subscripts are used to distinguish them):

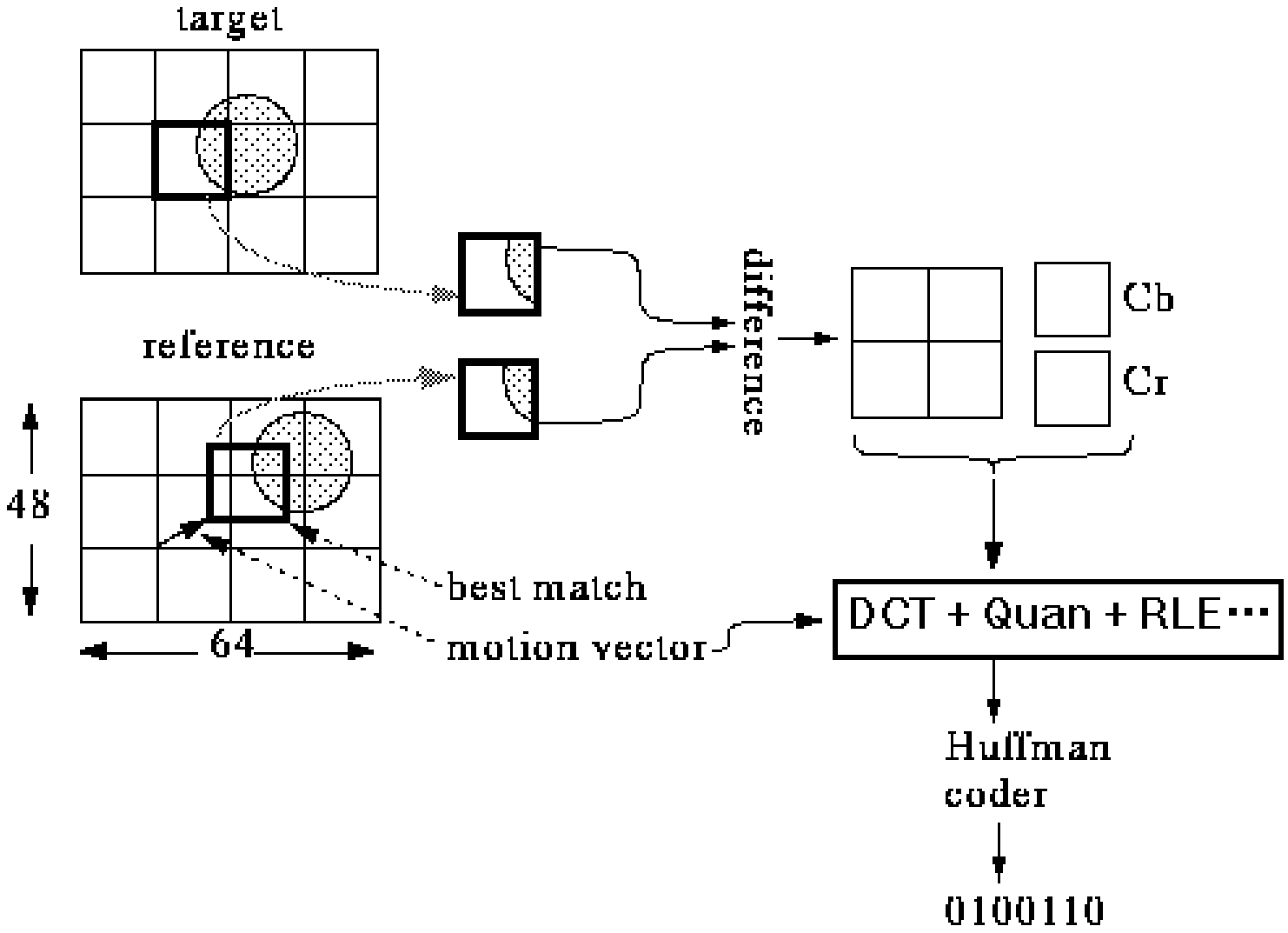
$$I_1\ B_1\ B_2\ P_1\ B_3\ B_4\ P_2\ B_5\ B_6\ I_2$$

- P_1, P_2 are both forward-predicted from I_1. B_1, B_2 are interpolated from I_1 and P_1, B_3, B_4 are interpolated from P_1, P_2, and B_5, B_6 are interpolated from P_2, I_2.

Intra-frame Coding (I-frame)

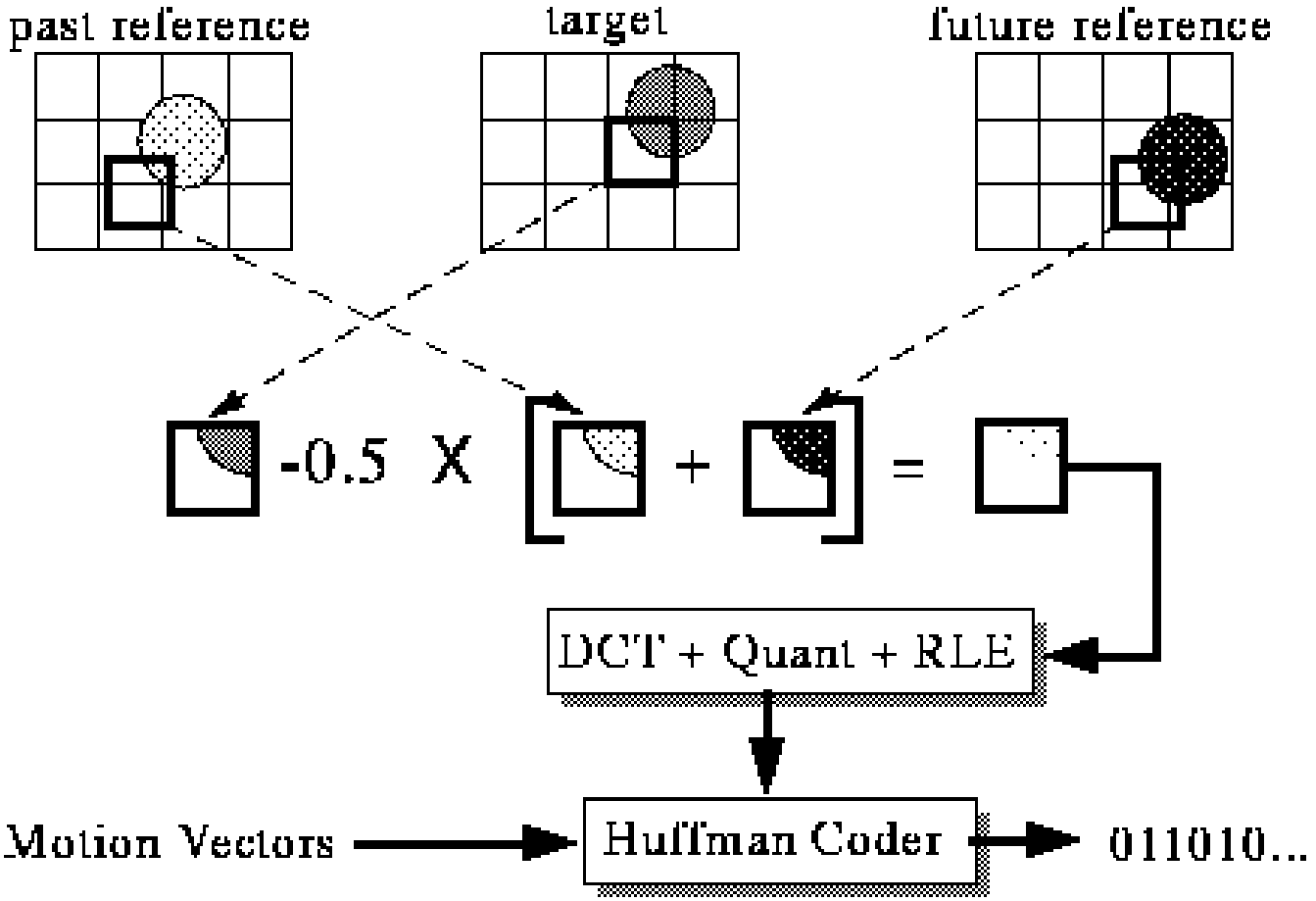


Inter-frame Coding (P-frame)



B-frame

- B frame macroblocks can specify *two* motion vectors (one to past and one to future), indicating result is to be averaged.



Thank You!

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