2.8 Digitization/Compression of Video Signals

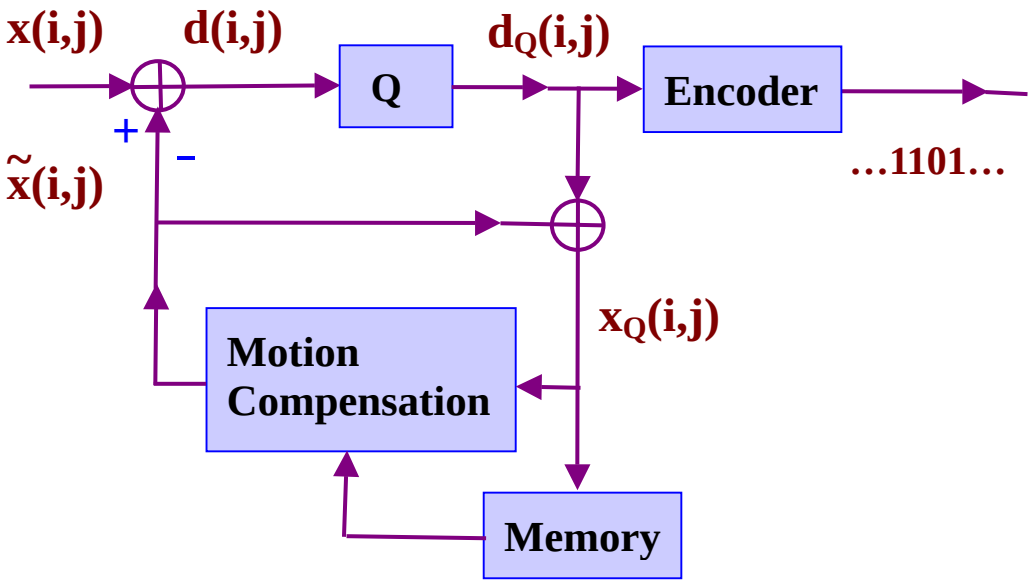
Motion Compensation

- **Concept**
  - moving parts of a picture estimated by its motion, while stationary background using previous pictures

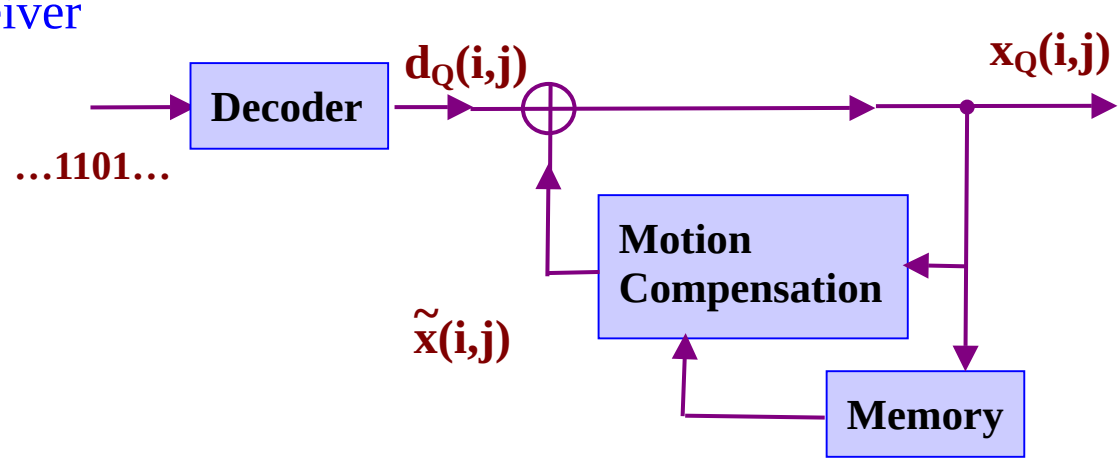
    $d(i , j) = x(i , j) - \tilde{x}(i , j)$ prediction error

    only d(i , j) needs to be encoded

transmitter



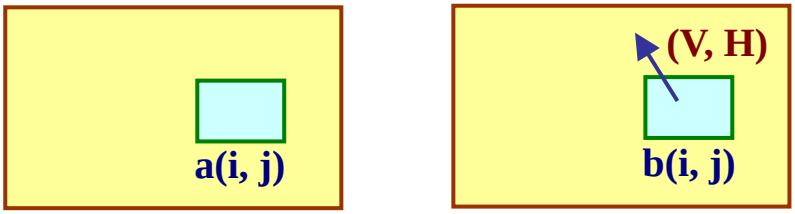
receiver



Motion Compensation

- **Motion Estimation**
  - performed on small blocks (e.g. 16×16)
  - an example

$$(V, H) = \min_{-L \le v,h \le L} \left[\sum_{i=1}^{16} \sum_{j=1}^{16} |a(i, j) - b(i+h, j+v)| \right]$$



n–1 n

See Fig. 7 , p. 88 of Ref [B]

2-dim DCT (Discrete Cosine Transform)

$$\overline{X} = \overline{C}\,\overline{x}\,\overline{C}^{t}$$

$$[\overline{x}(i , j)]_{N\times N} \xrightarrow{\text{DCT}} [\overline{X}(u , v)]_{N\times N}$$

performed on small blocks (e.g. 8×8)

- fast computation algorithms
- in terms of spatial frequencies, most signal components are concentrated around DC coefficients, u = 0 , v = 0
- coefficients far from u = 0 , v = 0 are less important
- dynamic bit allocation
- zig-zag scanning, run-length coding

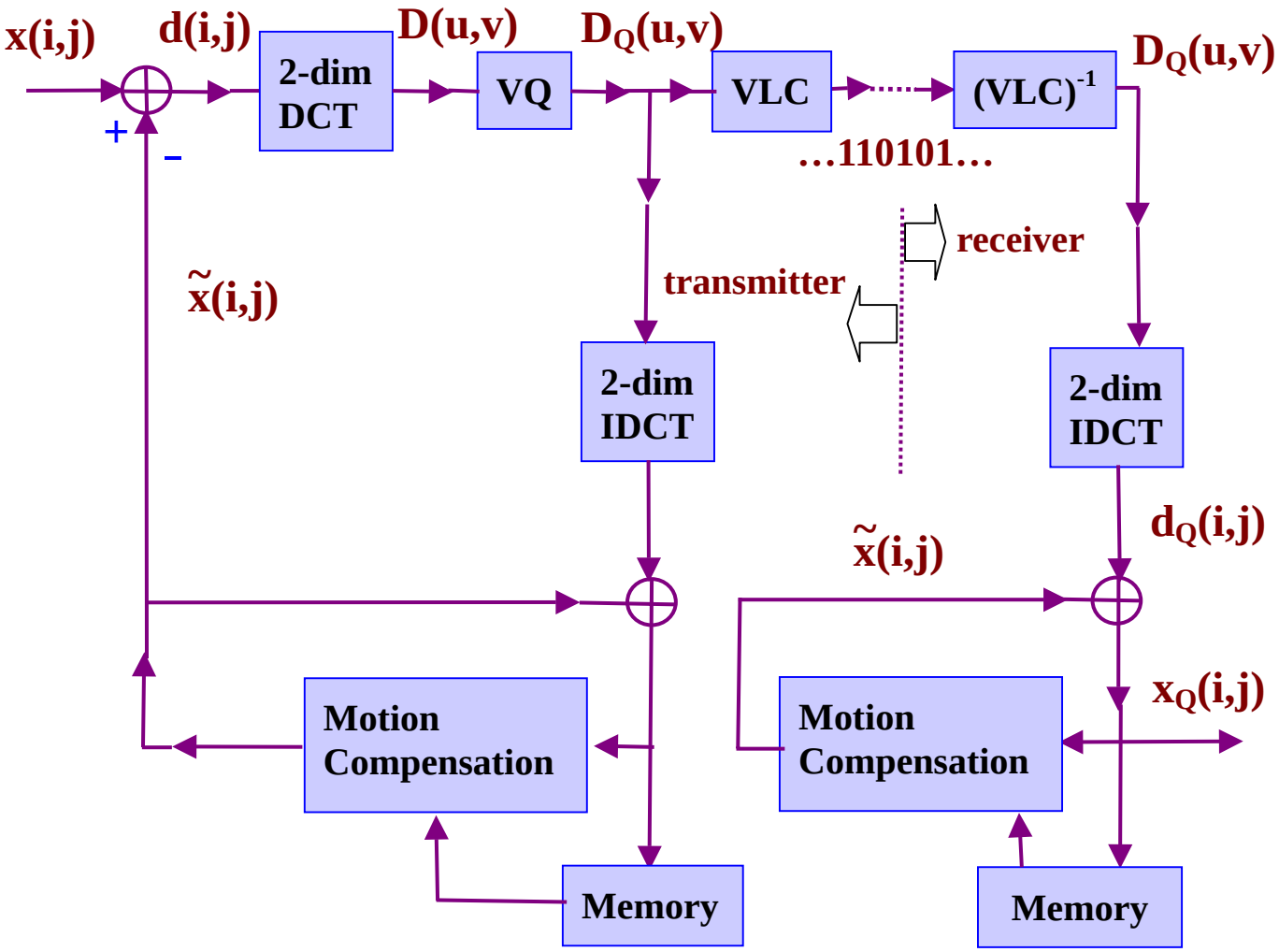
See Fig. 6 , p. 87 of Ref [B]

Variable-length Coding (VLC)

- an example

symbol	prob	fixed length code	VLC
a	1/2(0.9)	00	0
b	1/4(0.05)	01	10
c	1/8(0.03)	10	110
d	1/8(0.02)	11	111
		2 bits/symbol	1.75 bits/symbol (1.15 bits/symbol)

An Example Structure



Sequences of Different Types of Pictures

I B B P B B P B B I B B P

I (intrapictures) – coded without reference to other pictures

P (interframe predicted) – referenced to previous pictures

B (bi-directional interpolated) – referenced to previous and following pictures

Ref [B] : "MPEG Digital Video Coding Standards", IEEE Signal Processing Magazine, Sept. 1997

2.9 Summary

Refs for 2.0

1. *"Perceptual Coding of Digital Audio", Proceedings of IEEE, Apr. 2000*

2. *"Special Issue on Voice Technology in 21st Century", IEEE Journal on Selected Areas in Communications, Jan 1999*

3. *"Special Issue on Standardization and Characterization of G. 729", IEEE Communications Magazine, Sept. 1997*

4. *"Special Issue on MPEG Audio and Video Coding", IEEE Signal Processing Magazine, Sept. 1997*

Exercises

Try the following problems of Haykin
3.31, 3.32, 3.34, 3.36

Computer Problem 1