Video Coding Everywhere ...

- Digital television broadcasting (DVB)
- Digital theater projection
- Digital video/versatile disk (DVD)
- Personal video recorder (PVR)
- Web-based streaming
- Video conferencing
- Mobile video
- ...

Motivation for Compression

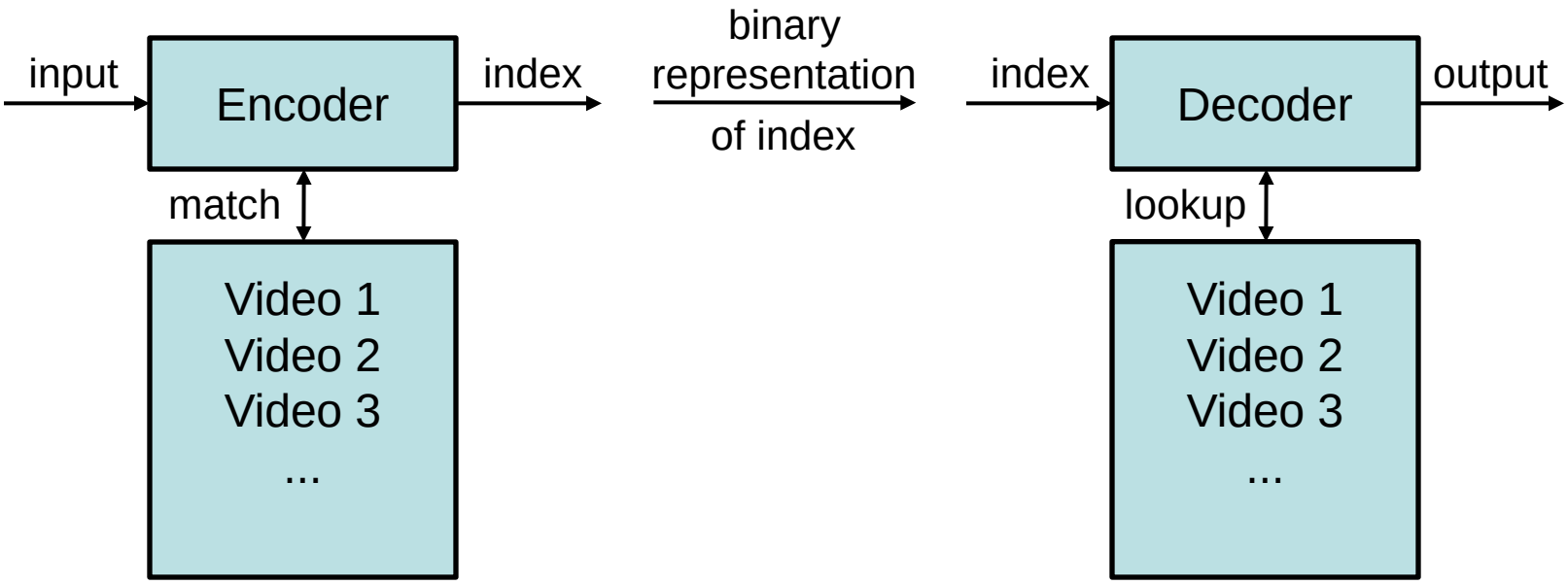
frame size	1280x960
bit-depth	12 bpp
frame rate	30 fps

uncompressed data rate:
442 Mbps

Some interesting bit-rates

– Terrestrial TV broadcasting channel	~20 Mbps
– DVD (4.7…17 GB/length of movie)	5...20 Mbps
– Ethernet/Fast Ethernet	<10/100/1000 Mbps
– DSL downlink	1…10 Mbps
– Mobile broadband	1...7.2 Mbps

Using a Codebook of Videos



n bits label 2^n video sequences

Problem: Decoder has to know all possible video sequences

Similarity of Successive Pictures

. . . is exploited by inter-frame coding

And at the Beginning of a Sequence?

- To be able to exploit inter-frame similarities, a reference frame is required.
- The first reference is processed by intra-frame coding.
- But how to code intra frames?

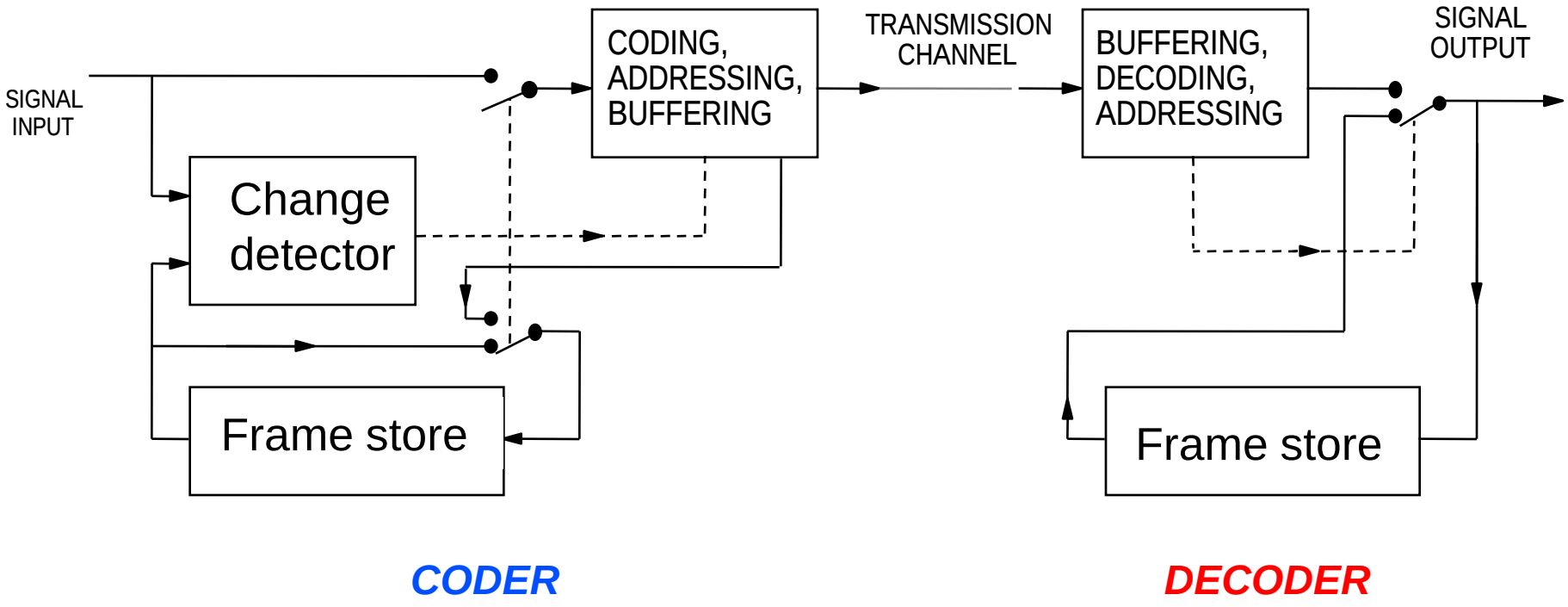
Intra-Frame Coding

. . . exploits the similarity among pixel values.

Interframe Coding

- Conditional replenishment
- Rate-distortion optimized mode selection
- Motion-compensated prediction
- Hybrid coding (interframe prediction + intraframe coding)

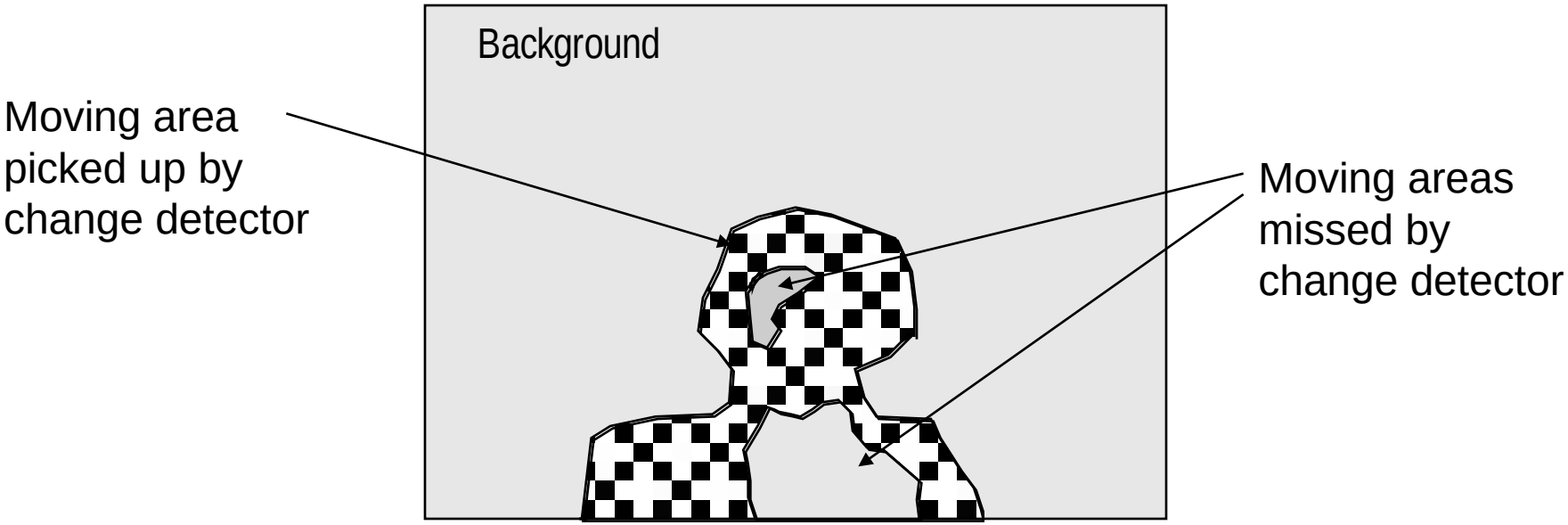
Conditional Replenishment



- Still areas: repeat from frame store
- Moving areas: encode and transmit address and waveform

The “Dirty Window” Effect

- Conditional replenishment scheme with change detection threshold set too high leads to the subjective impression of looking through a dirty window.



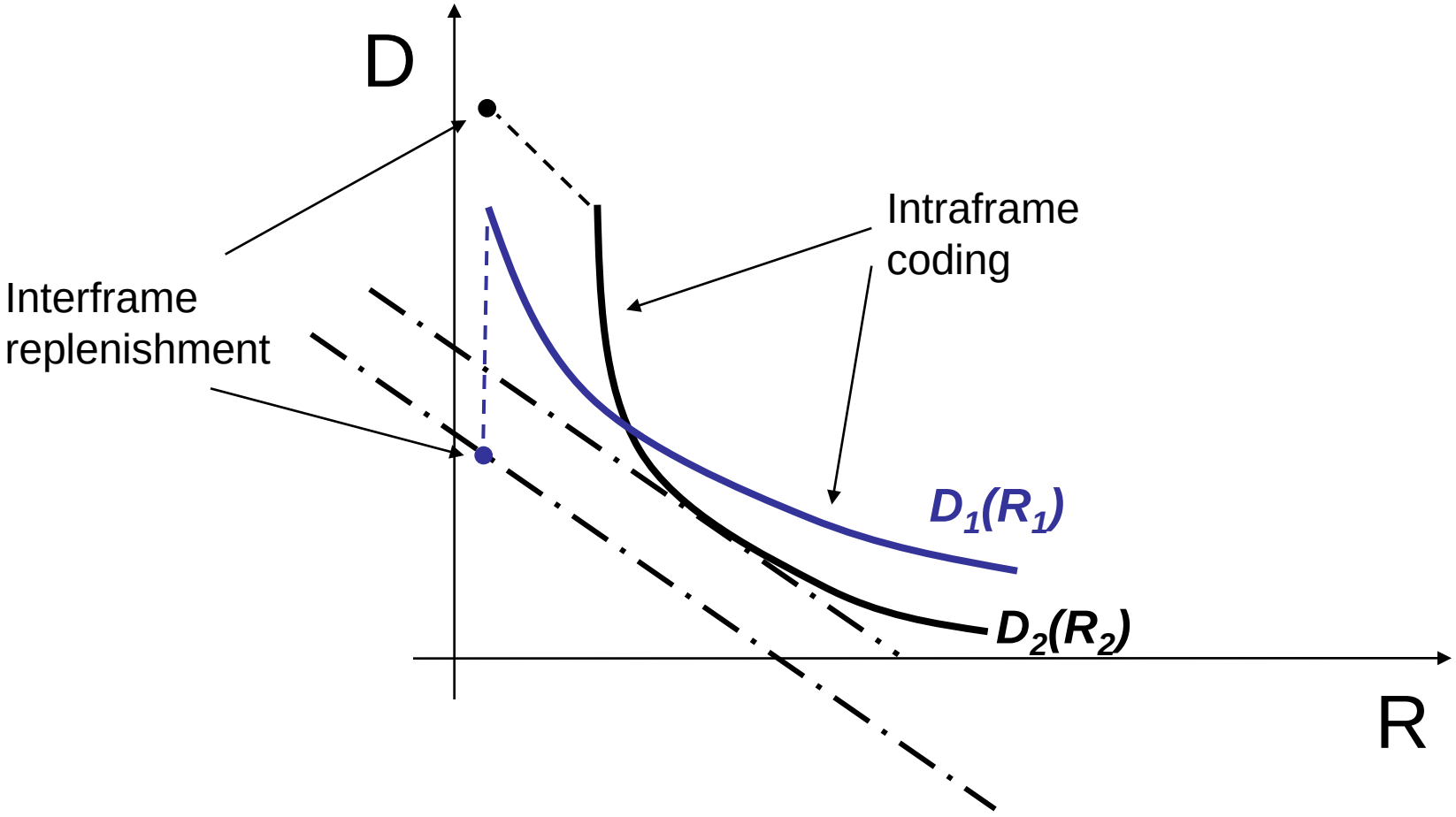
Rate-Distortion Optimized Mode Selection

- How to choose the coding mode, if distortion *D* shall be minimized for a given rate *R*?
- Assumptions
  - Blockwise mode selection, block index *i*
  - Additive overall distortion $D = \sum_i D_i$ and rate $R = \sum_i R_i$
- Lagrangian cost function

$$J = D + \lambda R = \sum_i D_i + \lambda R_i = \sum_i J_i$$

- **Strategy:** Minimize J_i for each block *i* separately, using a common Lagrange multiplier λ

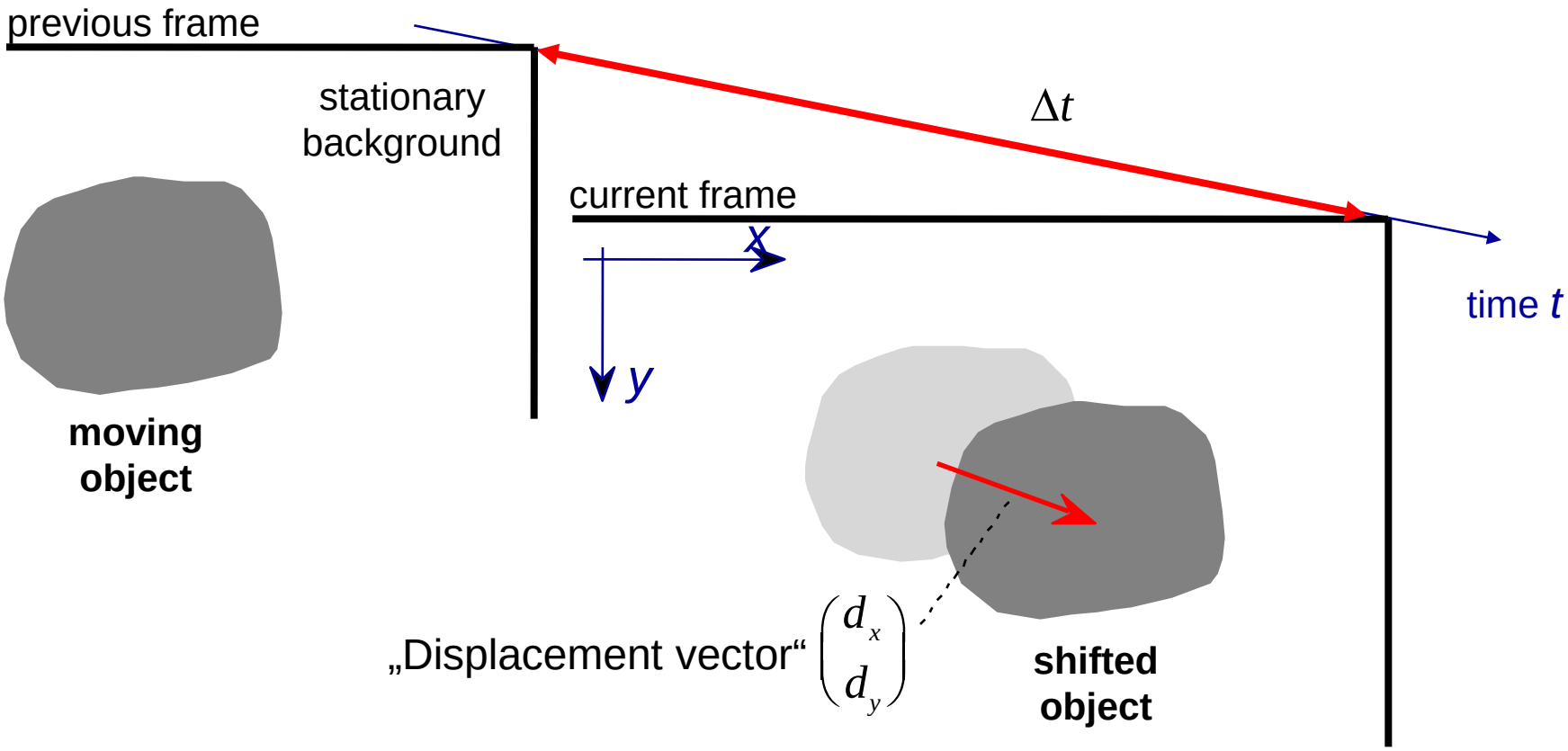
Rate-Distortion Optimized Mode Selection



Successive Pictures

Similar, but objects appear shifted . . .

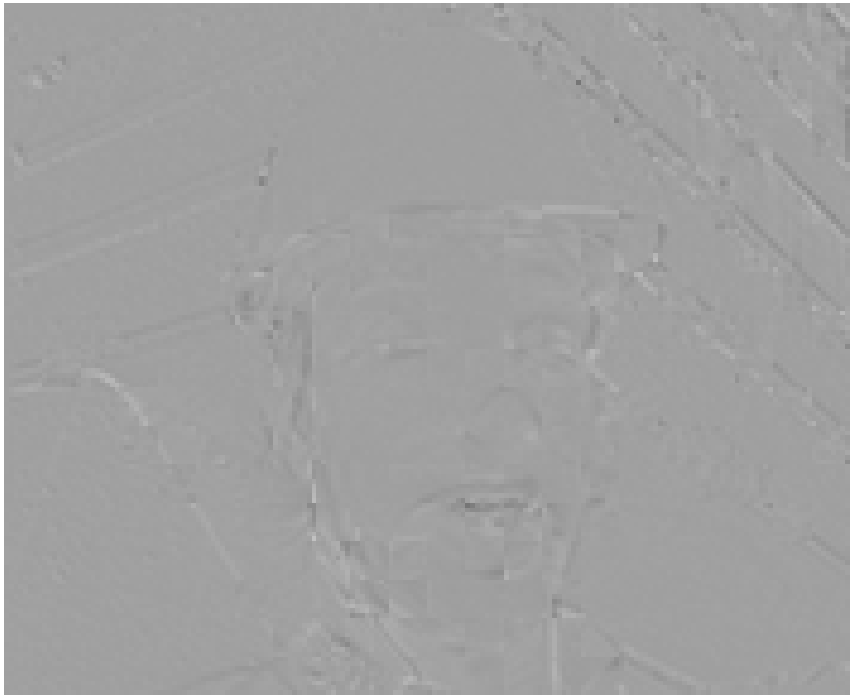
Motion-Compensated Prediction



Prediction for the luminance signal *S(x,y,t)* within the moving object:

$$\hat{S}(x,y,t) = S(x - d_x, y - d_y, t - \Delta t)$$

Example for MC Prediction Error Image



Motion-Compensated Hybrid Coding