Lecture 7 –Video Compression

❑ HW4 – on website
  ❖ Due in one week

JPEG Recap

RGB → YUV

For each 16 × 16 block

    4 - 8×8 Y blocks   8×8 1 U block   8×8 1 V block

  For each block

    DCT

    Quantization ⟵ quality control

    Further transform

      Zig zag reording

      Differentially encode

        first coefficient ⟵ DC coefficient

    Entropy encoding

      Run-length encoding

      Huffman / Arithmetic

    EOB

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Managing quality

24-bits/pixel uncompressed

↓

1 bit/pixel ⤳ 24:1 compression

- Generally speaking, JPEG results in compression ratios of:
  - 0.25 – 0.5 bits per pixel – good quality
  - 0.5 – 0.75 bits per pixel – good to very good quality
  - 0.75 – 1.5 bits per pixel – excellent quality
  - 1.5 – 2.0 bits per pixel – usually indistinguishable from the original

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Video Compression Standards

MP4

   MPEG-1

   MPEG-2

WMV

AVI → compression algos underneath
                   Intel video

MKV   Cinepak
                 Sorenson

FLV

MOV

real player format

All formats (standards) specify the bitstream not how to get there

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Video <u>Standards</u> Organizations

↳ standardize video formats (not algorithms)

International Telecommunications Union   ITU
           Telephony-based

          H.**** video codecs

International Standards Organization (ISO)
          Standardize pretty much everything

          Computers
               └ Disk formats
               ↳ video format for disks

Defacto standards
    formats that are so widely deployed they are thought
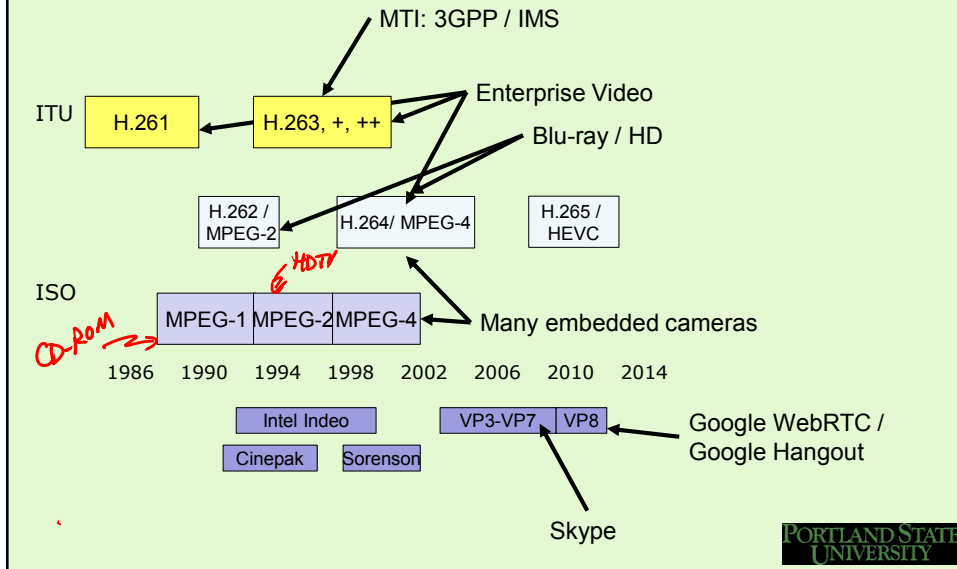   of as standards (typically proprietary)
      Real networks
      Flash
      Skype

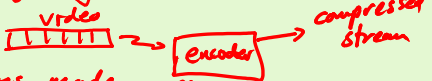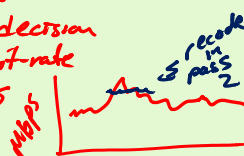**PORTLAND STATE UNIVERSITY**

Video Compression Standards

MTI: 3GPP / IMS

Enterprise Video

Blu-ray / HD

ITU

| H.261 | | H.263, +, ++ |

| H.262 /
MPEG-2 | | H.264/ MPEG-4 | | H.265 /
HEVC |

HDTV

ISO

CD-ROM

| MPEG-1 | MPEG-2 | MPEG-4 |

Many embedded cameras

1986   1990   1994   1998   2002   2006   2010   2014

| Intel Indeo | | VP3-VP7 | VP8 |

Google WebRTC /
Google Hangout

| Cinepak | | Sorenson |

Skype

Video Compression Overview

Redundancy is king

Taking advantage of inter-frame redundancy

❏ Types of Video Compression

Constant-bit-rate video - CBR over a large
time interval
adjust Quant Value (Q) over time
variable-bit-rate video — VBR constant
quality over time

fix Q @ beginning

❏ Types of Compressors

video → encoder → compressed stream

One-pass - all decisions made on fly
+) speedy (one-pass)
-) may not make best decision
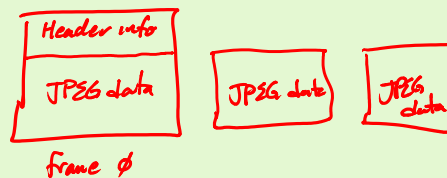Two-pass - get roughly in intended bit-rate
Refine in 2nd ~~step~~ pass

recode in pass 2

MJPEG Compression

JPEG compression repeated on individual frames

Common, but not standardized

Implementation

Header info
JPEG data   JPEG data   JPEG data

frame 0
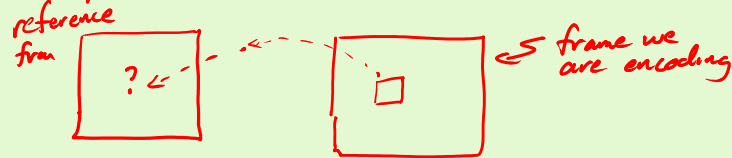
+) Simple, cheap
-) Big files   even though 24:1

Block-based Motion Compensation

Goal: For each MB, find the best visual match in a reference frame

reference
from

? ←

frame we are encoding

Result is:
•) Encode a motion vector and a difference
•) If close enough match, encode just the motion vector

Matching Criteria

MB
• n_1, n_2

candidate motion vector (d_1, d_2)

□ Mean Square Error

$$MSE(d_1, d_2) = \frac{1}{N_1 N_2} \sum_{(n_1, n_2) \in \beta} [s_{current}(n_1, n_2) - s_{reference}(n_1 + d_1, n_2 + d_2)]^2$$

□ Mean Absolute Difference

$$MAD(d_1, d_2) = \frac{1}{N_1 N_2} \sum_{(n_1, n_2) \in \beta} |s_{current}(n_1, n_2) - s_{reference}(n_1 + d_1, n_2 + d_2)|$$

□ Match Count

$$Match(n_1, n_2, d_1, d_2) = \begin{cases} 1 & if \ |s_{current}(n_1, n_2) - s_{reference}(n_1 + d_1, n_2 + d_2)| < T \\ 0 & otherwise \end{cases}$$

$$MPC(d_1, d_2) = \sum_{(n_1, n_2) \in \beta} Match(n_1, n_2, d_1, d_2)$$

Motion Estimation Searching

720

□ Just how expensive is it?
  In class exercise

1 MB search

MSE for one point

$$\text{ONE frame @ pixel aligned} \left(\frac{720}{16} \times \frac{480}{16}\right) \times \left(704 \times 464\right) \times \left(16 \times 16\right) \simeq 1.1 \times 10^{11}$$

45   30

possible motion vectors

calculate MSE

□ How do you speed it up?

Typically $\frac{1}{2}$ + $\frac{1}{4}$ pixel motion vectors allowed

cand

| 1 | 3 | 5 |
| 3 | 3 |

| 0 | 0 | 1 |
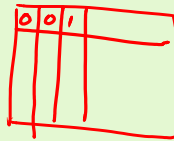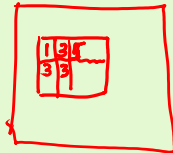
← 1 MB

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Speeding up

Don't compare entire image
  Regions Nearly are good candidates
  limit search range to ± say 32 pixels
Don't search all of the range
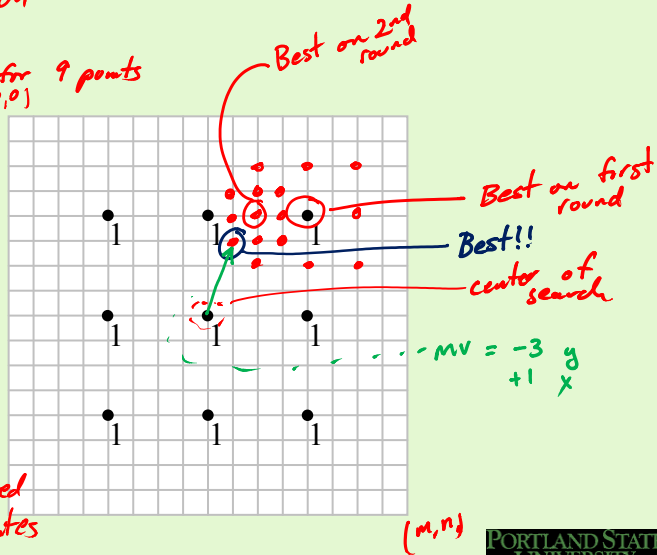 Subsampled search

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