

MPEG: A Video Compression Standard for Multimedia Applications

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Outline

- Introduction
- MPEG Goals
- MPEG Details
- Performance and Such
- Summary



Introduction

- 1980's technology made possible full-motion video over networks
- Needed a standard
 - Often trigger needed volume production
 - *Ala facsimile* (fax)
 - Avoid *de facto* standard by industry
- 1988, Established the Motion Picture Experts Group (MPEG)
 - Worked towards MPEG-1



The Need for Video Compression

- High-Definition Television (HDTV)
 - 1920x1080
 - 30 frames per second (full motion)
 - 8 bits for each three primary colors
 - Total 1.5 Gb/sec!
- Each cable channel is 6 MHz
 - Max data rate of 19.2 Mb/sec
 - Reduced to 18 Mb/sec w/audio + control ...
 - Compression rate must be 83:1!



Compatibility Goals

- CD-ROM and DAT key storage devices
 - 1-2 Mbits/sec for 1x CD-ROM
- Two types of application videos:
 - Asymmetric (encoded once, decoded many)
 - Video games, Video on Demand
 - Symmetric (encoded once, decoded once)
 - Video phone, video mail ...
- (*How do you think the two types might influence design?*)
- Video at about 1.5 Mbits/sec
- Audio at about 64-192 kbits/channel



Requirements

- Random Access, Reverse, Fast Forward, Search
 - At any point in the stream
 - Can reduce quality somewhat during task, if needed
- Audio/Video Synchronization
 - Even when under two different clocks
- Robustness to errors
 - Not catastrophic if bits lost
- Coding/Decoding delay under 150ms
 - For interactive applications
- Editability
 - Modify/Replace frames



Relevant Standards

- Joint picture Experts Group (JPEG)
 - Compress still images only
- Expert Group on Visual Telephony (H.261)
 - Compress sequence of images
 - Over ISDN (64 kbits/sec)
 - Low-delay
- Other high-bandwidth "H" standards:
 - H21 (34 Mbits/sec)
 - H22 (45 Mbits/sec)



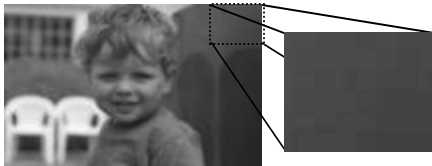
MPEG Compression

- Compression through
 - Spatial
 - Temporal



Spatial Redundancy

- Take advantage of similarity among most neighboring pixels

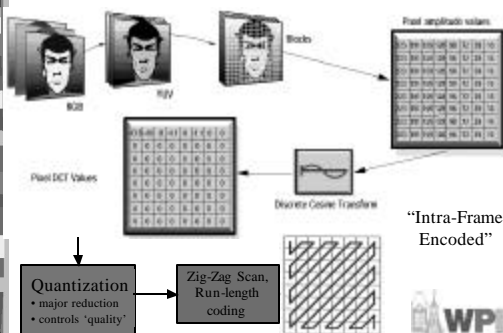


Spatial Redundancy Reduction

- RGB to YUV
 - less information required, same visually
- Macro Blocks
 - Take groups of pixels
- DCT
 - Represent pixels in blocks with fewer numbers
- Quantization
 - Reduce data required for co-efficients
- Entropy coding
 - Compress



Spatial Redundancy Reduction



Groupwork

- When may spatial redundancy reduction be ineffective? What kinds of images/movies?

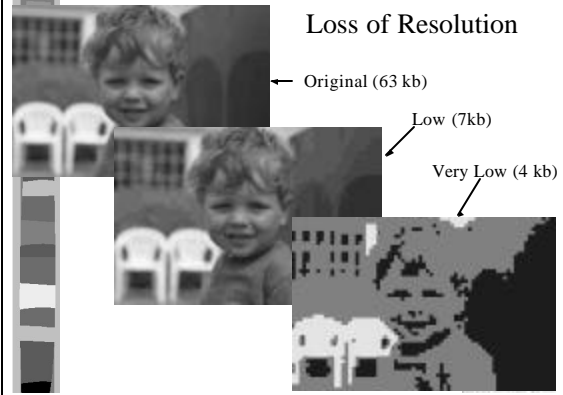


Groupwork

- When may spatial redundancy reduction be ineffective?
 - High-resolution images and displays
 - May appear 'coarse'
 - A varied image or 'busy' scene
 - Many colors, few adjacent



Loss of Resolution



Temporal Redundancy

- Take advantage of similarity between successive frames



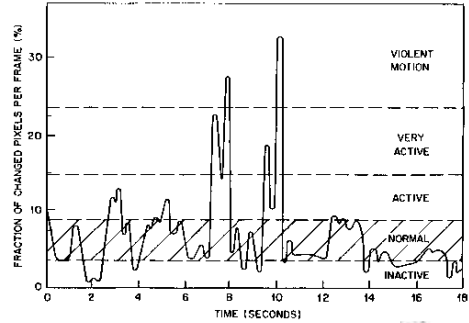
950

951

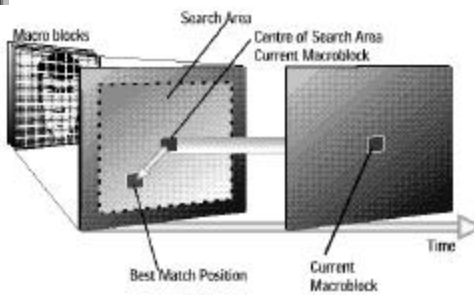
952



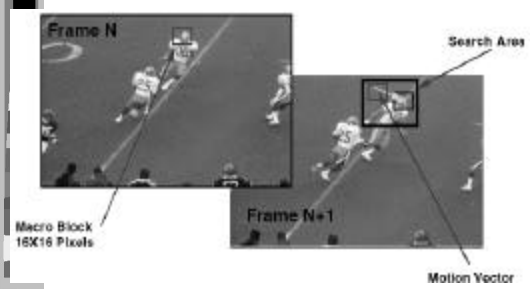
Temporal Activity



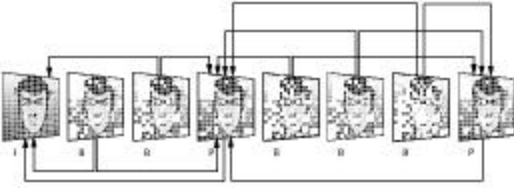
Temporal Redundancy Reduction



Temporal Redundancy Reduction



Temporal Redundancy Reduction



- I frames are independently encoded
- P frames are based on previous I, P frames
- B frames are based on previous and following I and P frames
 - In case something is uncovered

Group of Pictures (GOP)

- Starts with an I-frame
- Ends with frame right before next I-frame
- “Open” ends in B-frame, “Closed” in P-frame
 - (What is the difference?)
- MPEG Encoding parameter, but ‘typical’:
 - I B B P B B P B B I
 - I B B P B B P B B P B B I
- *Why not have all P and B frames?*



Groupwork

- When may temporal redundancy reduction be ineffective?



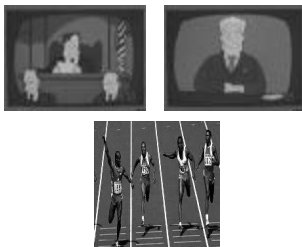
Groupwork

- *When may temporal redundancy reduction be ineffective?*
 - Many scene changes
 - High motion



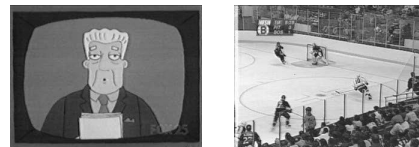
Non-Temporal Redundancy

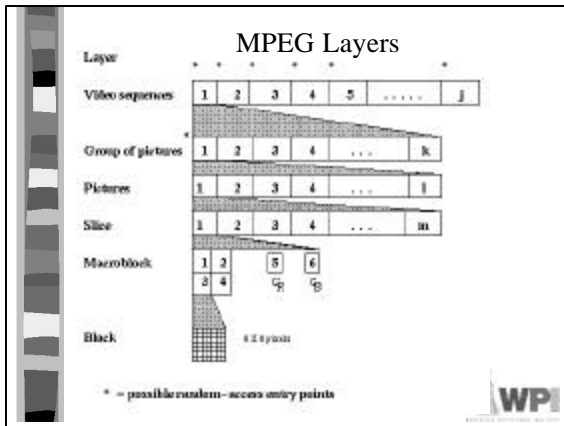
- Many scene changes



Non-Temporal Redundancy

- Sometimes high motion





Typical MPEG Parameters

Parameters	Value
Image resolution	384x 288
Quantization factor	8
Frames between I pictures	5
Frames between P pictures	2
Frames sequence as to be displayed	...IBBPBBI...
Rate control	None

Typical Compression Performance

Type	Size	Compression
I	18 KB	7:1
P	6 KB	20:1
B	2.5 KB	50:1
Avg	4.8 KB	27:1

- Note, results in Variable Bit Rate, even if frame rate is constant

- ### MPEG Today
- MPEG video compression widely used
 - digital television set-top boxes
 - HDTV decoders
 - DVD players
 - video conferencing
 - Internet video
 - ...

- ### MPEG Today
- MPEG-2
 - Super-set of MPEG-1
 - Rates up to 10 Mbps (720x486)
 - Can do HDTV (no MPEG-3)
 - MPEG-4
 - Around *Objects*, not *Frames*
 - Lower bandwidth
 - MPEG-7
 - Not (yet) a standard
 - Allows content-description (ease of searching)
 - MP3
 - For audio
 - MPEG Layer-3

- ### MPEG Tools
- MPEG-1 tools at:
 - <http://www-plateau.cs.berkeley.edu/mpeg/index.html>
 - MPEG-2 tools at:
 - MPEG streaming at:
 - <http://www.comp.lancs.ac.uk/>

Some Interesting Clips: Poltergeist



Wallace and Grommit: Porridge



Wallace and Grommit: Work

