

Scene Adaptive Video Watermarking

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WATERMARKING

- What is Watermarking?**
 - the insertion of a "controlled" amount of distortion is introduced into a multimedia element
- Where are watermarks used?**
 - digital cameras
 - DVD video
 - audio (SDMI)
 - broadcast video (in US - ATSC)
 - "binding" mechanism for multimedia databases
 - key distribution systems
 - preventing forgery of bank notes
- Used as a complementary technique to encryption**
 - for example, when media is converted to an analog representation
- Elements of a watermarking system:**
 - the watermark (what is inserted)
 - embedding technique
 - verification or detection technique
- Important issues**
 - transparency
 - robustness (not necessary for fragile watermarks)
 - capacity (how much data can be hidden)
- Attacks**
 - compression
 - filtering
 - printing and resampling
 - geometric attacks - cropping, resampling, rotation
 - collusion - spatial and temporal
 - conversion to analog

VISUAL MODELS

- Robustness Tradeoff**
 - transparency → weaker embedding
 - detectability → stronger embedding
- How do you satisfy both of these?**
 - use human visual system model - embed the watermark in areas that not "seen" by the observer
 - a visual model predicts how sensitive a region of an image or a video sequence is to distortions
 - there are many human visual properties that have been studied, such as luminance sensitivity, frequency sensitivity, and contrast masking.

IMAGE ADAPTIVE WATERMARKING

- Advantages of employing a visual model:**
 - more information can be embedded for a given level of perceived distortion.
 - the embedded watermark is image dependent, and is more robust against re-watermarking or forged watermark attacks.
 - the embedded watermark is more robust to "normal" signal processing, such as lossy compression.

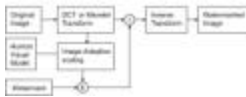
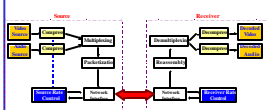


Image Adaptive DCT Watermarking of "Girls"



VIDEO STREAMING



Network

- Limited bandwidth
- May be unreliable - packet loss, delay, and jitter
- May be highly heterogeneous
- Packet loss may arise from the network due to congestion or may be rejected at the receiver due to excess delay or due to the limited capabilities of the "terminal device"
- May use unicast or multicast for transmission

WATERMARKING ISSUES FOR STREAMING VIDEO

- Networking issues** (watermark embedding at the source):
 - How to design watermark to be robust to packet loss?
 - Temporal error propagation may impact watermark detection
 - How to take advantage of feedback within the source, receiver, or from the receiver to the source?
 - How to provide authentication in an error-prone environment? (Semi-fragile watermarking of streaming video?)
 - How does one use error resilient features in the bitstream?
- Synchronization issues for watermark detection**
 - Synchronization may be more challenging because a receiver may obtain the stream at some point other than the "beginning" of the stream
 - Network errors may cause dropped or damaged structures (frames, GOBs), leading to a loss of synchronization
 - Search "window" for resynchronization can be large
 - Many watermarking techniques use correlators. This may be too much computation for real-time resynchronization
- Fingerprinting when using Multicast**
 - Desire different watermark for each receiver but only one multicast stream is sent from source
 - Potential security vulnerabilities with watermark embedding at the receiver
 - Each receiver may receive a different version of the video due to network losses

POSSIBLE SOLUTIONS

- Synchronization:**
 - Include watermark resynchronization information in each video frame
 - Investigate new methods for fast resynchronization
- Semifragile video watermark for authentication**
- Fingerprinting in Multicast**
 - Partial watermark embedding by client
- System Architecture**
 - Embed at source or receiver or combination