Scene Adaptive Video Watermarking

Edward J. Delp
Video and Image Processing Laboratory (VIPER)
School of Electrical and Computer Engineering
Purdue University, West Lafayette, Indiana, U.S.A.
http://www.ece.purdue.edu/~ace

WATERMARKING
What is Watermarking?
- the insertion of a "controlled" amount of distortion into multimedia content

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
- 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 rescanning
- geometric attacks - cropping, resampling, rotation
- collusion - spatial and temporal
- conversion to analog

WATERMARKING ISSUES FOR STREAMING VIDEO

Networking issues
- How to design watermark to be robust to packet loss?
- Temporal error propagation may impair watermark detection
- How to take advantage of "feedback" within the source, receiver, or from the receiver to the source?
- How to provide authentication in error-prone environment?
- More fragile watermarking of streaming video?
- How does one ensure "correct" features in the feedback?

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
- Dynamic error recovery is different in streaming than in non-streaming
- Search "windows" for re-synchronization may be large
- Some watermarking techniques use correlation. This may be too much computation for real-time re-synchronization

Fingerprinting in Multicast
- One can design different watermarks for each receiver but only one multicast stream is sent from source
- Potential security vulnerabilities with watermark embedding at the source
- Each receiver may receive a different version of the video due to network losses

POSSIBLE SOLUTIONS

Fingerprinting
- include automatic re-identification information in each video packet
- Insecure multicast methods for test re-identification

Synchronization
- Partial watermark embedding by client
- System Architecture - "blind" at source or restoration at destination

Visual Models
- robustness: test with human-experiment
- transparency: test with human-experiment
- embedding: test with human-experiment

How do you satisfy both of these?
- use human visual system model - embed the watermark in areas that are 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 sensitivity

Image-Adaptive DCT Watermarking of "Girls"

Original
Watermarked
Difference

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

Packets in WAN

Source Rate
Control
Packetization
Network Interface
Compress
Multiplexing
Reassembly
Demultiplexing
Decompress
Decoded
Audio
Video
Source
Receiver

Fingerprinting when using Multicast
- Desire different watermark for each receiver but only one multicast stream is sent from source
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