Region-of-Interest Intra Prediction for H.264/AVC Error Resilience

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Motivations

- Packet loss affects QoE of video services over IP.

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- Spatial position of the loss in the picture influences perceptual quality[1].

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[1]F. Boulos, D. S. Hands, B. Parrein and P. Le Callet. Perceptual Effects of Packet Loss on H.264/AVC Encoded Videos. In *4th International Workshop on Video Processing and Quality Metrics for Consumer Electronics*, Scottsdale, AZ, January 2009.

Motivations

- Packet loss affects QoE of video services over IP.

- Spatial position of the loss in the picture influences perceptual quality[1].

- Spatio-temporal error propagation heavily distorts video quality.

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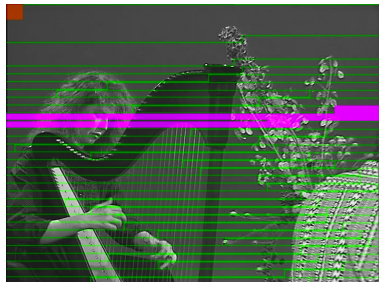
Error Propagation

Lost slice

Intra-prediction from inter-predicted MB

Inter-prediction from lost MB

Prediction order > 1

Error Propagation

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inter-predicted MB

Inter-prediction
from lost MB

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Objectives

1. Study the impact of packet loss in the RoI.
2. Build an attention-based error resilience model against packet loss.

- Determine the RoI which robustness should be enhanced.
- Counter the effect of packet loss, namely spatio-temporal error propagation.

Outline

Introduction
Acquiring Saliency Data
RoI-based Error Resilience
Conclusion

Test Setup
From Eye Tracking to Regions of Interest

Eye Tracking

- Track and record eye movement of observers while watching video sequences.

- Provide reliable information about viewer's visual attention.

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Test Setup
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Test Setup

- Test performed in a standardized environment according to ITU Recommendation BT.500-11[2].

- Video set: SD and HD sequences, 8s or 10s duration.

- JM 14.0 codec, High Profile, IDRBBP... GOP structure of length 24.

- Encoding bitrates chosen such as to obtain good video quality.

- 37 subjects participated in the test.

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[2]ITU-R. Methodology for the subjective assessment of the quality of television pictures, June 2002.

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Some Definitions

- Fixation: the status of a region centered around a pixel position which was stared at for a predefined duration.

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- Saccade: eye movement from one fixation to another.

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- Pursuit: eye movement allowing gaze to follow a moving target.

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Test Setup
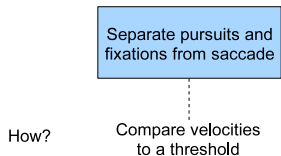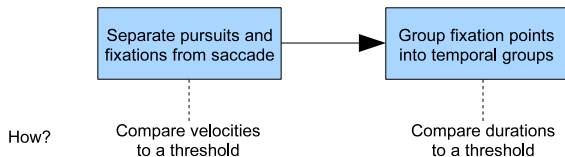From Eye Tracking to Regions of Interest

Some Definitions

- Fixation: the status of a region centered around a pixel position which was stared at for a predefined duration.

- Saccade: eye movement from one fixation to another.

- Pursuit: eye movement allowing gaze to follow a moving target.

- Saliency map: spatial locations of the eye gaze over time.

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From Eye Tracking to Saliency Maps

Separate pursuits and
fixations from saccade

How?   Compare velocities
to a threshold

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From Eye Tracking to Saliency Maps

How?

Separate pursuits and fixations from saccade	Group fixation points into temporal groups	Take into account eye and device accuracy
Compare velocities to a threshold	Compare durations to a threshold	Smooth saliency map with a 2D Gaussian filter

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From Saliency Maps to Regions of Interest

- The encoder needs macroblock level information.

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Test Setup
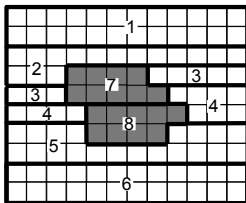From Eye Tracking to Regions of Interest

From Saliency Maps to Regions of Interest

- The encoder needs macroblock level information.

- A pixel belongs to an RoI if its saliency value is higher than a threshold (set empirically).

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RoI-based FMO

- Group RoI macroblocks into one or more slices independently of other slices in the picture using FMO.
- FMO type 6 provides full control over the assignment of macroblocks to slices.
- Different RoI per picture $=>$ 1 PPS NALU per picture in the bitstream.

Slices 1-6: non-RoI.
Slices 7 & 8: RoI.

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Loss Simulation

- Loss simulator[3] operating on a NALU (slice) basis.
- One slice fits in one packet.
- Slice losses in I-pictures to test the robustness of the model against error propagation.
- JM spatial error concealment: weighted sample averaging.

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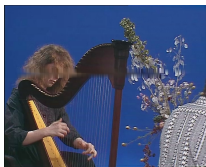
[3] Joint Video Team of ISO/IEC MPEG and ITU-T VCEG. SVC/AVC Loss Simulator. JVT-Q069, October 2005. Available at http://wftp3.itu.int/av-arch/jvt-site/2005_10_Nice/

Introduction
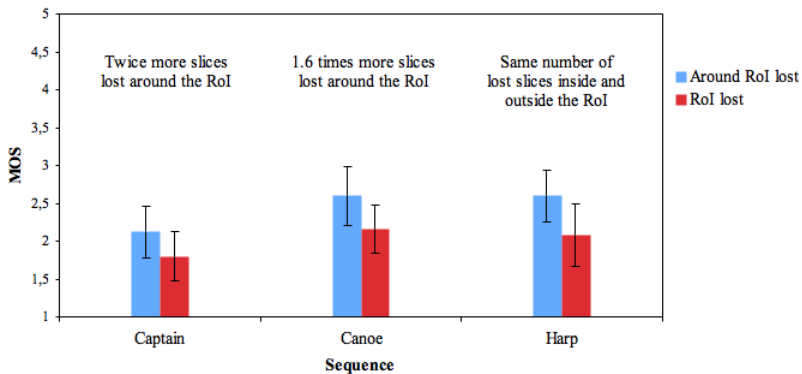Acquiring Saliency Data
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Loss Patterns

RoI lost.

8 slices around the RoI lost.

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Subjective Quality Test

- The most reliable way to assess video quality.
- 25 non-expert subjects rate the quality of video sequences.
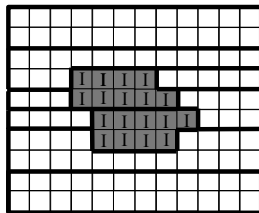- Absolute Category Rating (ACR) with a 5-level scale.

| Excellent |
| Good |
| Fair |
| Poor |
| Bad |

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Perceptual Importance of RoI

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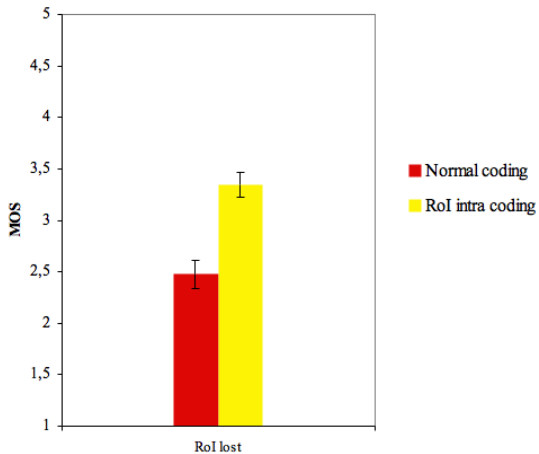Does RoI Matter?
Error Resilience

RoI Intra-Prediction

- Slice lost in a reference picture allows error drift to inter-coded pictures.
- Attenuate the temporal error drift in the RoI by coding all RoI macroblocks of P and B-pictures in intra-prediction mode.
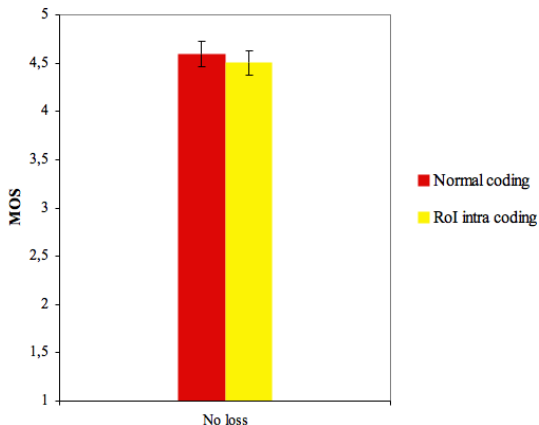- At constant bitrate, the model might incur a quality decrease.

B or P-picture

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RoI Slices Lost

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Overhead of RoI Intra-Prediction

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Does RoI Matter?
Error Resilience

Example

w/o error resilience.

w/ error resilience.

Conclusion and Future Work

- We proposed an error resilient coding based on ground truth visual attention data.
- We created a database of video sequences with visual attention data (publically available soon).

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- We proposed an error resilient coding based on ground truth visual attention data.
- We created a database of video sequences with visual attention data (publically available soon).

- Use an objective saliency model.
- Investigate the tradeoff between RoI size and quality degradation/robustness.

Questions...