



Multidimensional Transcoding for Adaptive Video Streaming

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NOSSDAV 2007, June 4-5



Outline

Introduction

Multidimensional Video Transcoding

Evaluation

Conclusions & Future Work

Adaptive Media Streaming for Mobile Devices



- Mobile devices:
 - Smartphones, PDAs, pocket multimedia players
 - 300 – 600 MHz CPU
 - 64 – 128 MB RAM
 - Small screen resolutions⇒ Great heterogeneity of mobile devices
- Video streams:
 - High data rates
 - Complex to decode
 - Fixed encoding parameters

Video Streaming



- Video adaptation to support different devices
- ⇒ Different versions of video streams
- Traditional approach:
Differently encoded versions of each stream on each server
 - Dynamic approach:
Individual adaptation on each server or in the network

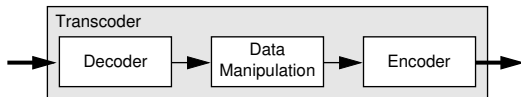
Adaptation Dimensions



- Spatial resolution: reducing the resolution of each frame
- Temporal resolution: reducing the number of frames
- Detail resolution: increasing the quantization level
- Bit stream syntax: changing the syntax of the stream
- Semantic: changing the content of a video
- ...

Decoder - Encoder

- Encoding parameters are defined at encoding time
- Cascaded Pixel Domain Transcoder (CPDT):



- very flexible, but computational intensive
 - Improvements:
 - Minimizing the needed decoding steps
 - Reusing information from the original data
- ⇒ Transcoding = manipulation in the compressed domain

Multidimensional Transcoding

- Different specialized transcoding architectures exist
- A combined architecture is missing
- Multidimensional transcoding by combining existing transcoder architectures
- Focus of this work: resolution reduction in three dimensions
 - Temporal Resolution
 - Spatial Resolution
 - Detail Resolution

Transcoding in Three Dimensions



- Temporal Resolution by
 - B-Frame Skipping
 - P-Frame Skipping
 - ⇒ Motion Vector Refinement
- Spatial Resolution by
 - Macro Block Aggregation
 - ⇒ Motion Vector Refinement
- Detail Resolution by
 - Requantization
 - ⇒ Drift-Error Correction

Transcoding in Three Dimensions



- Temporal Resolution by
 - B-Frame Skipping
 - P-Frame Skipping

⇒ Motion Vector Refinement
- Spatial Resolution by
 - Macro Block Aggregation

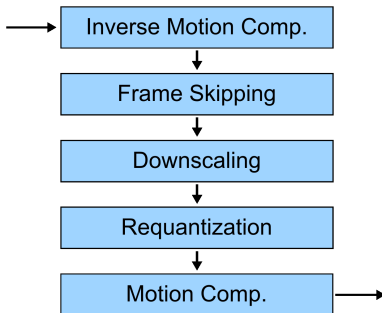
⇒ Motion Vector Refinement
- Detail Resolution by
 - Requantization

⇒ Drift-Error Correction

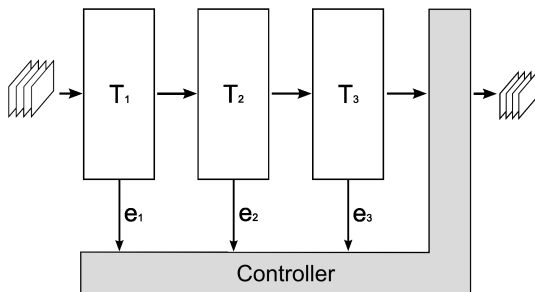


Inverse Motion
Compensation
needed

Transcoder Chain



Processing Architecture

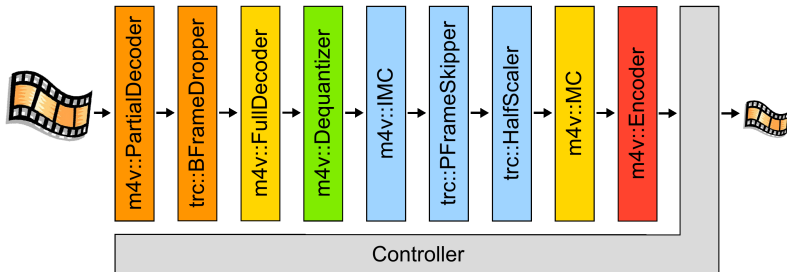


- Pull architecture
- Passive transcoder modules: T_i
- One active component: *Controller*
- Events: e_i

Implementation

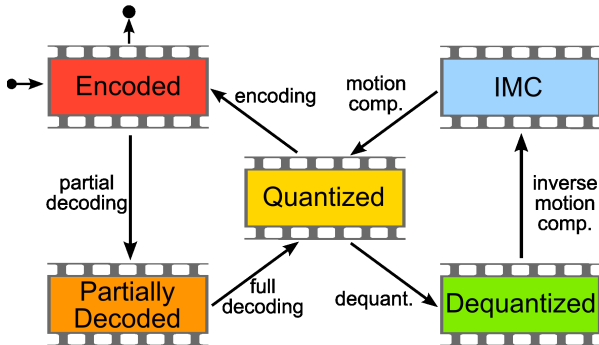
- Prototype implementation in C++
- Transcoding in three dimensions: temporal, spatial, detail
- Features:
 - B-Frame Skipping
 - P-Frame Skipping
 - Downscaling by a factor of 2
 - Requantization
 - Static Controller
 - MPEG-4 Simple Profile

Implemented Transcoder Chain



Data exchanged between transcoders = partially decoded Frames

Frame States



Testvideos

- Source:
 - 12 seconds (300 frames, 25 fps, 30 frames GOV length)
 - CIF (352x288) resolution
 - Encoded by XviD

Akiyo

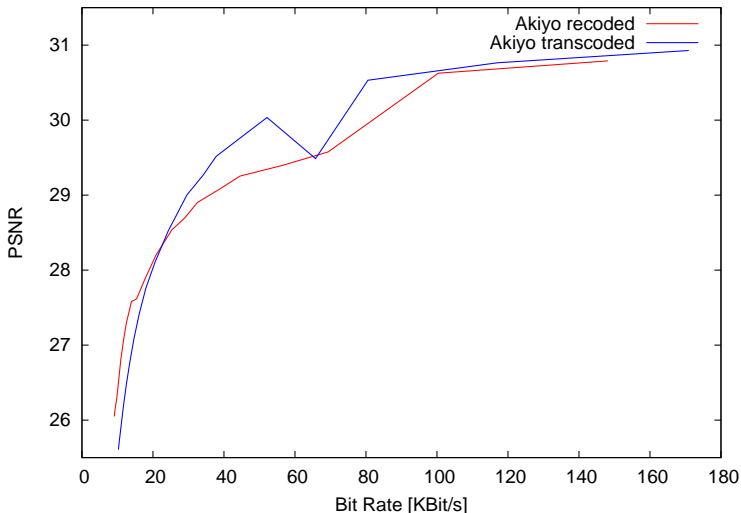


Foreman

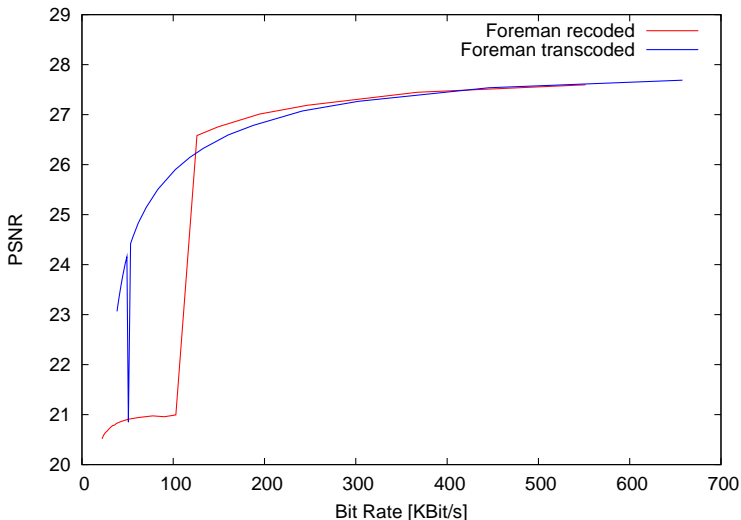


- Transcoded to 150 frames, 12.5 fps, QCIF

Akiyo - Average PSNR Values



Foreman - Average PSNR Values



Runtime Performance

- Intel Pentium 4 CPU 3.20GHz, 512 MB RAM:

Sequence	Processing Time	Processed Frames
Akiyo	4.31 s	34.80 fps
Foreman	10.71 s	14.01 fps

- Transcoded video: 150 frames, 12.5 fps, 12 s

Conclusions & Future Work

- Flexible processing architecture for multidimensional transcoding
- Three transcoding dimensions for fine grain adaptation
- Transcoder implementation for this dimensions
- Promising evaluation results

Future Work

- Optimization to improve runtime
- Further features of MPEG-4 to reduce bit rate
- Dynamic rate control mechanisms
- Quality evaluation by subjective tests



Questions?

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