Frame Rate Up Conversion for H.264 Codec

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What is Frame Rate Up Conversion?

In order to accomplish acceptable coding results at low bit-rates, most video encoders reduce the temporal resolution by skipping frames.

To display the full frame rate after at the decoder, new frames must be interpolated in-between existing ones.

The post-processing unit:
Project Goal

- Implementation of frame rate up-conversion algorithm from 10-15 frames per second up to 25/30 fps
- Algorithmic simulation in Matlab
- Implementation in C under H.264/AVC video codec.

![Diagram showing frame rate conversion process]
Project Goal (cont’)

\[ F_{t-1} \quad F_t \quad F_{t+1} \]
**Algorithms**

The algorithms can be broadly divided into two categories:

I. Linear combination of video fields, without taking object motion into account

II. Advanced up-conversion techniques which employ motion-compensation (MC)
Algorithms in class I

• **Frame repetition**

  The simplest: repeats each frame until a new frame is received

  The image sequence appears jerky, especially in areas of large or complex motion.
Algorithms in class I (cont’)

- **Temporal linear interpolation**
  Another simple algorithm: linearly interpolates between coded frames

The image sequence appears blurry in areas of motion.
Initial algorithm


• Belongs to class II (employs MC)
• The algorithm uses the transmitted true motion vectors (MV) recovered by the decoder to reconstruct the missing frames
• To reconstruct the frame $F_t$ we need information from frames $F_{t-1}$ and $F_{t+1}$ and the relevant motion vectors
**Initial algorithm (cont’)**

For each block $B_i$ (MB or its segment) with non-zero motion vector $v_i$:

$$\tilde{I}\left(\frac{\tilde{p} - v_i}{2}, t\right) = \frac{1}{2}\{I(\tilde{p} - v_i, t-1) + I(\tilde{p}, t+1)\} \quad \forall \tilde{p} \in B_i$$

$\tilde{p}$ – pixel location

$I(\tilde{p}, t)$ – pixel intensity

**Uncovered regions:**

$$\tilde{I}\left(\frac{\tilde{p} - v_i}{2}, t\right) = I(\tilde{p}, t+1) \quad \forall \tilde{p} \in B_i$$

**Occluded regions:**

$$\tilde{I}\left(\frac{\tilde{p} - v_i}{2}, t\right) = I(\tilde{p}, t-1) \quad \forall \tilde{p} \in B_i$$
Initial algorithm (cont’)

Schematic view:

Frame t-1  t  t+1

Bi

vi/2  vi

Uncovered Region

Occluded Region
Implementation

We implemented the discussed algorithm in Matlab, using Nokia’s H.264 codec.
Implementation (cont’)

What’s next?

• Global motion examination
  ▫ Linear MCI for MV that are part of the GM
  ▫ Non-linear MCI for MV that are not part of the GM

• Possible block artifacts correction
  ▫ Examination of several proposed algorithms
  ▫ Post processing using median filter