Parallelized deblocking filter for hybrid video coding

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Outline

- Introduction
- Parallel deblocking filter decisions
- Experiments and results
- Conclusion
Generalized block diagram of an HM2.0 hybrid encoder

HM2.0: Version 2 of test model of the HEVC standardization of ISO/ITU-T
Basic steps of HM2.0 deblocking filter

- Calculation of decision values $d_2$ and $d_5$

  - Required samples

- Deblocking enabled for all 8 lines/columns if $d_2 + d_5 < \beta$

  - Decision $D_i$ for each line/column $i$ to select a filter

  - Filter $F_i$ each line/column $i$

  - Required samples for $i=2$:
Considered implementation

- Maximum degree a parallel processing capabilities exploited
- No unnecessary processing steps are performed
HM 2.0 deblocking for a CU of size 8x8

Previous CUs

Required samples for $d_{5,h}$

Required samples for $d_{2,v}$

Required samples for $d_{5,v}$

Current CU to be deblocked

$d_{2,v}$

$d_{5,v}$

$d_{5,h}$
HM 2.0 deblocking for a CU of size 8x8

Required samples for $D_{0,v}$

Required samples for $D_{7,v}$
HM 2.0 deblocking for a CU of size 8x8

Required samples for $F_{0,v}$

Required samples for $F_{7,v}$

Diagram showing the flow of data:

- $d_{2,v}$ to $D_{0,v}$ to $F_{0,v}$
- $d_{5,v}$ to $D_{1,v}$ to $F_{1,v}$
- $D_{2,v}$ to $F_{2,v}$
- $D_{3,v}$ to $F_{3,v}$
- $\vdots$
- $D_{7,v}$ to $F_{7,v}$

$D_{5,h}$
HM 2.0 deblocking for a CU of size 8x8

Required samples for \( d_{2,h} \)

\[
\begin{align*}
d_{2,v} & \quad D_{0,v} \quad F_{0,v} \quad d_{2,h} \\
d_{5,v} & \quad D_{1,v} \quad F_{1,v} \\
D_{2,v} & \quad F_{2,v} \\
D_{3,v} & \quad F_{3,v} \\
\vdots & \quad \vdots \\
D_{7,v} & \quad F_{7,v}
\end{align*}
\]
HM 2.0 deblocking for a CU of size 8x8

Required samples for $D_{0,h}$ and $D_{7,h}$

- $d_{2,v}$
- $d_{5,v}$
- $D_{0,v}$
- $D_{1,v}$
- $D_{2,v}$
- $D_{3,v}$
- $D_{7,v}$
- $F_{0,v}$
- $F_{1,v}$
- $F_{2,v}$
- $F_{3,v}$
- $F_{7,v}$
- $d_{2,h}$
- $D_{0,h}$
- $D_{1,h}$
- $D_{7,h}$

Panasonic ideas for life

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HM 2.0 deblocking for a CU of size 8x8

Critical path: 44 sequential operations
Motivation

- **Deblocking filter of HM 2.0:**
  The decision and filtering steps for vertical and horizontal edges are performed dependent on each other

- **Problem:**
  Dependencies limit the capabilities for parallel processing

  \[ \Rightarrow \text{Large amount of operations in the critical path} \]

- **Approach:**
  Increase of parallel processing capabilities by performing all decisions based on the unfiltered signal

  \[ \Rightarrow \text{Less operations in the critical path} \]
Parallelized deblocking for a CU of size 8x8

$d_{2,v}$

$d_{5,v}$

$d_{2,h}$

$d_{5,h}$
Parallelized deblocking for a CU of size 8x8

\[ D_{0,v} - D_{7,v} \]

\[ D_{0,h} - D_{7,h} \]
Parallelized deblocking for a CU of size 8x8

\[ F_{4,h} - F_{7,h} \]

\[ F_{0,v} - F_{7,v} \]
Parallelized deblocking for a CU of size 8x8

Critical path: 32 sequential operations (Reduction of 30%)

$F_{0,h} - F_{3,h}$
Experiments

- Implementation into HM 2.0

- Simulation under conditions used in HEVC standardization
Results of experiments

- Same coding efficiency

- Same subjective quality

Conclusion

- Increase of parallel processing capabilities of the deblocking filter by decisions performed based on the unfiltered signal

- Results compared to HM2.0:
  - Reduction of sequential operations in the critical path by 30%
  - Same coding efficiency
  - Same subjective quality

- Application
  - Adopted in HEVC standardization of ISO/ITU-T
  - Further parallelization being evaluated in current core experient CE12