Bring out the Best in Pixels
Video Pipe in Intel® Processor Graphics

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Contents

Intel Processor Graphics

Video Processing Pipe
  - Video Processing Modules
  - Control Panel
  - Adaptive Processing

Summary

Q&A
NEW EXPERIENCES

Media & Display

GPU Architecture Playbook for Media Computing

INNOVATIVE FORM FACTORS

Phones & Tablets

Ultrabooks™

Laptops

Workstations & Servers

Intel is building Media solutions with Great Power and Scalable Performance for Innovative Form Factors and New Experiences
• 4th Generation Intel® Core™ Microprocessor, built on 22 nm process technology

• Next Generation Intel® HD Graphics with Microsoft® DirectX®11.1, OpenGL® 4.0, OpenCL® 1.2 support

• Three Simultaneous Display, HDMI, DisplayPort®, with high-resolution up to 4Kx2K

• Significant 3D and Media performance improvement
Multi-format Codec
Decoded MPEG2 / VC1
AVC SVC MVC
JPEG / MJPEG

VQE
Denoise
Deinterlace
Contrast
Saturation
Skin-tone
Gamut
Color Correction
Stabilization

Media Sampler
Scaling
Sharpness

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Q&A
Introducing Video Quality Engine

**Multi-Format Codec**
- Video Decode and Encode
- High Performance Parallel Engine

**Video Quality Engine**
- Video Processing
- Color Processing

**Video Quality Engine Pipeline**

**Front-End Thread Dispatch/Management**

**Media FrontEnd**

**Media Optimized Execution Units**
- Array of Execution Units
- EU
- Texture Samplers
- Pixel Ops
- Media Samplers

**Media Accelerators**
- $L3$ Cache
Video Processing Pipe

Dedicated video processing on newly designed **Video Quality Engine (VQE)**

Support for an extensive suite of functions for higher quality video at lower power

- Denoise
- Deinterlace
- Skin-tone
- Scalor
- Sharpness
- Image Stabilization
- Compression
- Saturation
- Contrast
- ProcAmp
- Gamut Expansion
- CSC
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Q&A
De-noise

Spatial and Temporal De-noise Filter
- Global noise level measurement
- Content-adaptive spatiotemporal filtering of noise
- Motion history-based blending of spatial and temporal filter results

Block Interface
- Input: YCbCr 420/422
- Output: YCbCr 420/422
De-interlace

Convert interlaced contents to progressive format
- Edge-adaptive Spatial Interpolation result + Motion-compensated Interpolation result
- Motion-adaptive Blending with Temporal Filtering results based on Spatial Temporal Motion Measure (STMM)
- Detection of most common cadences

Chroma Upsampling from 420 to 422
Skin-tone Processing

Per-pixel Enhancement of Skin-tone Pixels
- Reproduce the natural skin colors on the display screen
- Skin Tone Detection identifies pixels with skin-like colors with per-pixel indicator
- Skin Tone Enhancement modifies the Saturation and Hue of the skin-tone pixels

Block Interface
- Input: YCbCr444
- Output: YCbCr444 with modified CbCr components; Per-pixel skin tone indicator
Contrast Enhancement

Automatic Contrast Enhancement: Per-pixel mapping of luma to enhance contrast
1. Histogram of luma Y pixel values is generated for the input video frame
2. Piece-Wise Linear Function (PWLF) is generated from luma histogram
3. Pixel values are modified according to the PWLF

Block Interface
- Input: YCbCr 444
- Output: YCbCr 444 with modified Y
Saturation Enhancement

Per-Pixel Saturation Enhancement
- Utilize 6 basic colors as primaries/anchors (Red, Green, Blue, Magenta, Yellow, Cyan)
- Adjust colorfulness (saturation) of pixels while maintaining their color (hue)

Block Interface
- Input: YCbCr 444
- Output: YCbCr 444 with modified CbCr components
Color Correction

Display proper colors on display screen
1. Inverse gamma correction via PWLF
2. 3x3 matrix multiplication with input/output offset
3. Forward gamma correction via PWLF

Block Interface
- Input: RGB
- Output: RGB
Image Stabilization

Stabilize shaky video contents captured by handheld camera devices

Usage models

- Real-time playback: Watch real-time playback of video streams
- Offline processing: Stabilize shaky video and save/transmit for video sharing

Block Interface

- Input: YCbCr 420
- Output: YCbCr 420
Scaler

Adaptive Video Scaler

- Advanced scaling method for adaptive scaling mode
- Content-adaptive per-pixel blending of polyphase filtering and bilinear filtering reduces ringing
- Programmable coefficient tables available for Y / CbCr channels in horizontal and vertical directions
- Support for up to 16:1 downscaling and max output picture size of 16Kx16K for YUV420/422/444/RGB input picture
Sharpness Enhancement

Enhancement of Image Sharpness and Details

- Content adaptive spatial filtering applied to luma channel
- User control of sharpness enhancement strength = [0, 63]

Adaptive to Skin Tone Pixels

- Skin tone information is utilized
- Enhance detail information without over-sharpening of the skin regions

Interface

- Input: YCbCr 444
- Output: YCbCr 444
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Q&A
Control Panel

- Standard Color Correction
  - Brightness
  - Contrast
  - Hue
  - Saturation
Control Panel

- **Input Range**
  - Limited
  - Full

- **Total Color Correction**
  - Saturation Enhancement
  - Adjustment = [0, 255]
Control Panel

- **Sharpness**
  - Driver Custom Settings = [0, 64]

- **Skin Tone Enhancement**
  - On = [0, 9]
  - Off
Control Panel

- **Noise Reduction**
  - Luma only = [0, 64]
  - Luma and Chroma = [0, 64]
- **Contrast Enhancement**
  - On/Off
- **Film Mode Detection**
  - On/Off
Hardware Statistics

Statistics are gathered on
- Per-block (16x4) basis for encoder stats
- Per-frame basis for other stats

16 bytes of encoder statistics data for per-block statistics is available
- Temporal Variances
- De-noise: Sum of block noise estimates and Number of blocks per frame

A variety of per-frame data is stored in a linear surface
- Skin-tone: Ymax = Max luma value, Ymin = Min luma value, Counter = Number of skin pixels
- Contrast: Luma histogram with 256 bins and 24-bits per bin
- Gamut Compression: Sum of distances of out-of-gamut-range pixels clipped to 32 bits, Number of out-of-gamut-range pixels in 29 bits
Adaptive Processing & Control

The goal of adaptive processing is to deliver optimized video experience.

Hardware statistics and adaptive control logic allow end-to-end optimization and effective sharing of data and information across all processing blocks.
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Intel is building Media Solutions for Quality, Power, and Scalable Performance

Dedicated HW acceleration for codecs, video and image processing, and analytics

Media processing in 4\textsuperscript{th} Generation Processor Graphics delivers:
- VQE: A new feature with a full-set of video processing pipe
- Adaptive Processing & Control for integrated and optimized video pipe behavior
- Ready for various application scenarios and network/mobility environments

Looking Ahead
- Future generations of Intel media processing will address further HW acceleration in video processing, camera image processing, and perceptual computing/machine vision applications
- Improvement in power and performance fitted to exciting new form-factors
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