AVC Intra & Ultra Encoder (v01.00.00) on TMS320C6678 Platform

FEATURES

- **Supports AVC Intra 50 encoding as per SMPTE RP 2027:2011**
- **Supports AVC Intra 100 encoding as per SMPTE RP 2027:2011**
- **Supports Panasonic AVC Intra 50 and AVC Intra 100**
- **Supports H264 High 10 Intra Profile up to level 4.2**
- **Supports H264 High 4:2:2 Intra Profile up to level 4.2**
- **Supports fixed frame size as per the AVC Intra standard**
- **Supports 4:2:0, 4:2:2 and 4:4:4 Chroma formats**
- **Supports both interlace(PAFF & MBAFF) and progressive sequence**
- **Supports customized scaling matrix**
- **Supports 8, 10 and 12 bit input pixel precision**
- **Supports 16x16, 8x8 and 4x4 intra prediction modes**
- **Supports user controllable quantization parameter range**
- **Supports both CABAC and CAVLC entropy coding**
- **Supports arbitrary video resolutions from 64x64 up to 4kx4k which are multiple of 2**
- **Supports 4x4 verses 8x8 transform adaptability at macro block level**
- **Supports algorithm to minimize the flickering artifacts**
- **Supports running on multiple DSP (66x) cores**
- **Supports separate Cb and Cr Quantization parameter control**
- **Supports big endian and little endian input**
- **Supports user configurable parameters like log2_max_frame_num_minus4 and chroma_qp_index_offset**
- **Supports multiple slices encoding based on number of MBs in slice**
- **Graceful exit under error conditions is supported**
- **Supports dynamic slice resize for CABAC enabled AVC Intra 50 streams**
- **Does not support sub frame level data synchronization.**
- **Encoder library validated on TMS320C6678 hardware EVM**

- **The other explicit features that TI's AVC Intra & Ultra Encoder supports are**
  - **eXpressDSP Digital Media (XDM IVIDENC2) interface compliant**
  - **Independent of any operating system (DSP/BIOS, Linux etc)**
  - **Cache aware encoder library Ability to get plugged in any multimedia frameworks (eg. Codec Engine, OpenMax, GStreamer, etc)**

DESCRIPTION

AVC Intra & Ultra, the industry's most advanced compression technology, is a professional intra-frame video codec with bit rates of 50 and 100 Mb/s, Utilizing the High 10 Intra and High 4:2:2 Intra profiles of H.264. AVC Intra & Ultra provides high quality 10 bit and 12 bit intra frame coding. AVC Intra & Ultra, a fully compliant H.264 codec implementation, offers significantly better compression efficiency than old codec families (DVCPro HD). AVC Intra & Ultra is explicitly designed and optimized for broadcast and production use rather than low bandwidth distribution. This project is developed using Code Composer Studio version 5.1.0.09000 and code generation tools version 7.3.5.

PRODUCT PREVIEW

Performance and Memory Summary

This section describes the performance and memory usage of the AVC Intra & Ultra encoder tested on TMS320C6678 EVM

Table 1 Configuration Table

CONFIGURATION	ID
AVC Intra 50 mode, YUV420, 10 bit, 8x8 Intra Pred, CABAC, Single Core	AVCIU_ENC_001
AVC Intra 50 mode, YUV420, 10 bit, 8x8 Intra Pred, CABAC, Multi Core(8 Cores)	AVCIU_ENC_002
AVC Intra 100 mode, YUV422, 10 bit, 8x8 Intra Pred, CAVLC, Single Core	AVCIU_ENC_003
AVC Intra 100 mode, YUV422, 10 bit, 8x8 Intra Pred, CAVLC, Multi Core(8 Cores)	AVCIU_ENC_004
AVC Ultra mode, 200Mbps, YUV444, 12 bit, 8x8 Intra Pred, CAVLC, Single Core	AVCIU_ENC_005
AVC Ultra mode, 200Mbps, YUV444, 12 bit, 8x8 Intra Pred, CAVLC, Multi Core(8 Cores)	AVCIU_ENC_006

Cycles Information - Profiled on TMS320C6678 EVM with Code Generation Tools Version 7.3.5

CONFIGURATION ID	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND) (1)		
	TEST DESCRIPTION	AVERAGE(2)(3)	PEAK(2)(3)
AVCIU_ENC_001	Airshow_p960x720_420p_10bit.yuv @ 30 frames per second	3869	3889
	Airshow_p1440x1080_420p_10bit.yuv @ 30 frames per second	8391	8421
	Fruits_i1440x1080_420p_10bit.yuv @ 60 fields per second	8992	9030
AVCIU_ENC_002	Airshow_p960x720_420p_10bit.yuv @ 30 frames per second	679	685
	Airshow_p1440x1080_420p_10bit.yuv @ 30 frames per second	1199	1345
	Fruits_i1440x1080_420p_10bit.yuv @ 60 fields per second	1650	1672
AVCIU_ENC_003	Airshow_p1280x720_422p_10bit.yuv @ 30 frames per second	3473	3480
	Airshow_p1920x1080_422p_10bit.yuv @ 30 frames per second	7854	7886
	Fruits_i1920x1080_422p_10bit.yuv, @ 60 fields per second	8337	8374
AVCIU_ENC_004	Airshow_p1280x720_422p_10bit.yuv @ 30 frames per second	535	538
	Airshow_p1920x1080_422p_10bit.yuv @ 30 frames per second	1140	1148
	Fruits_i1920x1080_422p_10bit.yuv, @ 60 fields per second	1534	1545
AVCIU_ENC_005	Airshow_p1920x1080_444p_12bit.yuv @ 30 frames per second	10446	10767
	Fruits_i1920x1080_444p_12bit.yuv @ 60 fields per second	11221	11433
AVCIU_ENC_006	Airshow_p1920x1080_444p_12bit.yuv @ 30 frames per second	1512	1543
	Fruits_i1920x1080_444p_12bit.yuv @ 60 fields per second	2035	2080

(1) Measured with C66x DSP 1250MHz clock, DDR2 1333MHZ clock, Program memory in SL2 memory, I/0 buffers in external memory and stack in internal L2 memory with cache configurations: 32KB L1P Program cache, 32KB L1D Data cache and 64KB L2 cache. There could be a variation of approximately 1-2% in the values.
(2) First 30frames have been considered for calculating the average and peak cycle consumption by the encoder library for each of the listed input files.
(3) Performance is measured across the process call after all cores reach same sync point.

Table 3 Memory Statistics of TMS320C6678 with Code Generation Tools Version 7.3.5

CONFIGURATION ID	MEMORY STATISTICS[1][2]					
	PROGRAM MEMORY[4]	DATA MEMORY [3] [5]				TOTAL
		PERSISTENT	CONSTANT	SHARED	SCRATCH	
AVCIU_ENC_001 AVCIU_ENC_003 AVCIU_ENC_005	719	368	20	17360	5209	23676
AVCIU_ENC_002 AVCIU_ENC_004 AVCIU_ENC_006	719	2821	20	17360	41665	62585

(1) All these memory requirements are for AVC Intra & Ultra encoder library only. They do not include any memory requirements from test application side. Stack, heap and code requirements for test-application are extra.
(2) All memory requirements are expressed in kilobytes (1K bytes = 1024 bytes).
(3) The memory requirements given in Table 3 are calculated for1920x1080 resolution and YUV 422 chroma sub sampling.
(4) Program code is stored in SL2 memory.
(5) Typical input and output buffers for 1920x1080 resolutions with yuv planer 4:2:2 formats are as follows.
Input Buffer: 8160KB
Output Buffer: 5120KB

Table 4 Internal Data Memory Split-up

CONFIGURATION ID	DATA MEMORY – INTERNAL[1] [2]					
	LOCAL L2				SHARED L2	TOTAL
	CONSTANTS	PERSISTENT	SCRATCH	STACK		
AVCIU_ENC_001 AVCIU_ENC_002 AVCIU_ENC_003 AVCIU_ENC_004 AVCIU_ENC_005 AVCIU_ENC_006	0	0	256	16	34	306

(1) Internal memory requirements are for each individual cores.
(2) All memory requirements are expressed in kilobytes (1K bytes = 1024 bytes).

Table 5 Cache/SRAM configuration [1]

NAME	AVAILABLE	CACHE	SRAM
L1P (Program Memory)	32KB	32KB	0KB
L1D(Data Memory)	32KB	32KB	0KB
L2	512KB	64KB	256KB

(1) All above mentioned numbers are for all configurations.

Table 6 EDMA Configuration (1) (5)

TC Q	TC 0	TC 1	TC 2	TC 3	TOTAL	MAXIMUM(3)
Usage	R/W to DDR/L2	R/W to DDR/L2	R/W to DDR/L2	R/W to DDR/L2	-	-
Priority(2)	0	1	2	3	-	-
EDMA Channels(6)	-	-	-	-	8(4)	18
QDMA Channels	-	-	0	0	0(4)	32
Num PARAMS	-	-	-	-	32(4)	144

(1) All above mentioned numbers are for all configurations (AVCIU_ENC_001, AVCIU_ENC_002).
(2) Lesser number corresponds to higher TC priority. Default priority is 2. When different TC's have same priority, the arbitration order is TC0 > TC1 > TC2 > TC3.
(3) Max corresponds to the maximum number of EDMA/QDMA channels or maximum number of PARAMS available on the chip. It does NOT indicate the maximum number requested by the codec.
(4) Same EDMA channel is used to copy data to DDR and to L2 memory at different instances.
(5) Above configuration table specifies EDMA hardware usage for each core in multicore scenario.
(6) Resource manager decides TC for each EDMA channel while allocating

Notes

- I/O buffers:
  - Input buffer size = 8160 K-bytes (for 1920x1088 resolution, YUV422)
  - Output buffer size = 5120 K-bytes (for encoding 1920x1088 resolution)
- None of the output buffers are accessed by DSP cores hence the data should be valid in DDR (not in cache).

References

- SMPTE RP 2027:2011: AVC Intra-Frame coding specification for SSM card applications
- eXpressDSP Algorithm Interoperability Standard (TMS320 Algorithm Interface Standard)
- AVC Intra & Ultra Encoder on TMS320C6678 Platform User's Guide

Glossary

Term	Description
Constants	Elements that go into .const memory section
Scratch	Memory space that can be reused across different instances of the algorithm
Shared	Sum of Constants and Scratch
Instance	Persistent-memory that contains persistent information - allocated for each instance of the algorithm

Acronyms

Acronym	Description
DMA	Direct Memory Access
SMPTE	Society of Motion Picture and Television Engineers
EVM	Evaluation Module
AVC	Advanced Video Codec
XDAIS	eXpressDSP Algorithm Interface Standard
XDM	eXpressDSP Digital Media

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