MPEG4 Simple Profile Encoder (v01.00.00) on DM365

FEATURES

- eXpressDSP™ Digital Media (XDM 1.0 IVIDENC1) interface and IRES compliant
- Validated on DM365 EVM with Monta Vista® Linux® 5.0
- MPEG4 simple profile levels 0, 1, 2, 3 compliant. In addition, it can encode 720P (1280x720) and SXVGA (1280x960) formats
- YUV 4:2:2 interleaved data as an input supported
- YUV 4:2:0 semi-planar (NV12 format, that is, Y planar, Cb Cr interleaved) data as an input supported
- Image width as multiple of 16 and height as multiple of 16 supported
- Half Pel Interpolation (HPI) for motion estimation supported
- One motion vector encoding for motion estimation (1MV/MB) with (-32, +31) half pel search range supported
- 21H (Low quality, high performance), 8421H (medium quality, medium performance), 44421H (high quality, medium performance), or 84221H (High quality, low performance) based on meAlgo API parameter supported
- DC prediction supported
- AC prediction when rate control is disabled, that is, fixed Qp mode supported
- Generation of streams with Resync Marker (RM) supported
- MPEG2 Step 2 TM5 rate control algorithm supported
- Variable Bit Rate (IVIDEO_STORAGE), Constant Bit Rate (IVIDEO_LOW_DELAY), and Fixed Qp (IVIDEO_NONE), supported
- Intra–inter decision at 16x16 level (for better speed) or 8x8 block level (for better quality) level based on intraAlgo API parameter supported
- Bonus Skip MB logic (for better quality) or non-Bonus skip MB logic (for better performance) based on skipMBAlgo API parameter supported
- Unrestricted Motion Vectors (UMV) supported
- Access of motion vectors and SAD through MV access API supported. The application should pass the buffer required to write the SAD and motion vector generated. This should be passed as an output buffer parameter. MV access API always provides the motion vectors for the best matching MB.
- VOL header generation at frame-level supported. The application has to pass the buffer required to write the VOL header generated. The encoding process is bypassed and frame count is unaltered when the Header generation API is called.
- Modification of target bit-rate and frame rate (including non-integer) supported
- Setting of separate Quantization Parameter (Qp) for I-frames and P-frames supported
- Changing the size of video packets at create time supported
- Area encode feature supported. The application can provide width, height, sub window width, and sub window height to the algorithm for encoding. The sub-window width and sub-window height should be multiple of 16.
- Rotation (90, 180, and 270 degrees) integrated with the Encoder up to a resolution of 720x576 supported
- Changing the encoding parameters at run-time (dynamic configurability) supported
- Frame level reentrancy supported
- Multi-instance of MPEG4 Encoder and single/multi instance of MPEG4 Encoder with other DM365 codecs supported
- Insertion of user data by application supported
- This encoder does not support the following:
  - 4 MV
  - AC prediction for varying Qp (rateFix = 0)

PRODUCT PREVIEW

- **ME range beyond -32 and +31. Only ME Range = 31 and ME Range = 7 are supported.**
- **DP, RVLC, and HEC**
- **Input width/height, sub-window width/height, rate control algorithm, VBV size, or rotation as dynamically configurable parameters**
- **Arbitrary width and height.**
  - **Supports image width as multiple of 16 and height as multiple of 16.**
  - **Image width below 192 (without UMV) and image width below 224 (with UMV) not supported**
  - **Image width more than 1280 and image height more than 960 not supported**
  - **Area encode feature with horizontal and vertical offsets**
  - **Rotation with width more than 720 and height more than 576 (for instance, 720p (1280x720) or SXVGA (1280x960))**

DESCRIPTION

MPEG4 is the ISO/IEC recommended standard for video compression. This version of the MPEG4 Encoder is compliant with MPEG4 simple profile levels 0,1,2,3. It is validated on the DM365 EVM with Monta Vista Linux 5.0.

Performance Summary

This section describes the performance of the MPEG4 Simple Profile Encoder on DM365 EVM.

Table 1. Configuration Table

CONFIGURATION	ID
MPEG4 simple profile, I/D Cache Enabled encodingPreset = XDM_HIGH_QUALITY inputChromaFormat = XDM_YUV_420SP	MPEG4_ENC_01 (High Quality Low Performance)
MPEG4 simple profile, I/D Cache Enabled encodingPreset = XDM_HIGH_SPEED inputChromaFormat = XDM_YUV_420SP	MPEG4_ENC_02 (Low Quality High Performance)
MPEG4 simple profile, I/D Cache Enabled encodingPreset = XDM_HIGH_QUALITY inputChromaFormat = XDM_YUV_422ILE	MPEG4_ENC_03 (High Quality Low Performance)
MPEG4 simple profile, I/D Cache Enabled encodingPreset = XDM_HIGH_SPEED inputChromaFormat = XDM_YUV_422ILE	MPEG4_ENC_04 (Low Quality High Performance)
MPEG4 simple profile (SVH Mode), I/D Cache Enabled encodingPreset = XDM_USER_DEFINED inputChromaFormat = XDM_YUV_422ILE meAlgo = IMP4VENC_ME_HQ_LP svhMode = 1	MPEG4_ENC_05 (SVH: High Quality Low Performance)
MPEG4 simple profile (SVH Mode), I/D Cache Enabled encodingPreset = XDM_USER_DEFINED inputChromaFormat = XDM_YUV_422ILE meAlgo = IMP4VENC _ME_MQ_MP svhMode = 1	MPEG4_ENC_06 (SVH: Low Quality High Performance)
Common Parameters for all Configuration: rateControlPreset=XDM_DEFAULT, frameRate=30000, numMbRows=0, initQ=0, rcQMax=31, rcQMin=1, intraperiod=30, intraAlgo= IMP4VENC_INTRA_INTER_DECISION_LQ_HP(0), skipMBAlgo = IMP4VENC_SKIP_MB_LQ_HP(0), unrestrictedMV = 0(OFF), rotation=0, VBV_Size=0	

Note: Codec needs to run in extended parameter mode for SVH mode.

Performance Measurement Procedure

- Measured with program memory and I/O buffers in external memory, I/D cache enabled, ARM @297 MHz, MJCP @243 MHz, DDR @243 MHz, Monta Vista Linux 5.0
- DVTB is used to measure the performance numbers in this Datasheet.
- The process time is measured across algActivate/process/algDeactivate function call using gettimeofday() utility of linux.
- NFS File system is used as an environment in performance measurement.
- To avoid the impact of file I/O operation in performance measurement, file write operation is disabled and checksum calculation is included after fread() function to ensure file read is successfully completed before the process call.
- After rebooting the board, codec binary must be executed at least once before start of performance measurement.

Note: Frame encode load can be divided in ARM load and MJCP load. ARM is idle during MJCP processing, and can be utilized to execute any other program in a different thread during this time.

Table 2. Cycles Information for MPEG4_ENC_01

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)(1)					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
BUS	CIF (352x288) @512kbps	0.46	1.52	195.20	0.52	1.59	186.81

(1) Average and peak MCPS values may vary by +/-5%.

Table 2. Cycles Information for MPEG4_ENC_01 (continued)

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)(1)					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Coastguard	VGA (640x480) @3mbps	0.46	3.59	82.80	0.74	3.86	76.91
Football	D1 (720x480) @4mbps	0.47	4.03	73.76	0.67	4.23	70.26
Stockholm	720p (1280x720) @8mbps	0.47	9.73	30.51	0.69	9.96	29.81
Pedestrian	SXVGA (1280x960) @10mbps	0.46	12.84	23.13	0.72	13.10	22.67

Table 3. Cycles Information for MPEG4_ENC_02

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)(1)					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
BUS	CIF (352x288) @512kbps	0.44	1.11	268.53	0.54	1.20	246.73
Coastguard	VGA (640x480) @3mbps	0.46	2.34	126.86	0.63	2.52	117.84
Football	D1 (720x480) @4mbps	0.45	2.57	115.55	0.58	2.70	110.08
Stockholm	720p (1280x720) @8mbps	0.46	6.01	49.44	0.60	6.15	48.31
Pedestrian	SXVGA (1280x960) @10mbps	0.45	7.84	37.89	0.61	8.00	37.14

(1) Average and peak MCPS values may vary by +/-5%.

Table 4. Cycles Information for MPEG4_ENC_03

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)(1)					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
BUS	CIF (352x288) @512kbps	0.43	1.47	202.43	0.49	1.53	193.65
Coastguard	VGA (640x480) @3mbps	0.44	3.50	84.88	0.71	3.77	78.84
Football	D1 (720x480) @4mbps	0.44	3.92	75.79	0.64	4.11	72.20
Stockholm	720p (1280x720) @8mbps	0.45	9.54	31.13	0.67	9.76	30.42
Pedestrian	SXVGA (1280x960) @10mbps	0.44	12.57	23.63	0.70	12.82	23.17

(1) Average and peak MCPS values may vary by +/-5%.

Table 5. Cycles Information for MPEG4_ENC_04

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)(1)					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
BUS	CIF (352x288) @512kbps	0.43	1.09	272.70	0.52	1.19	250.56
Coastguard	VGA (640x480) @3mbps	0.44	2.33	127.29	0.62	2.51	118.25

(1) Average and peak MCPS values may vary by +/-5%.

Table 5. Cycles Information for MPEG4_ENC_04 (continued)

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)(1)					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Football	D1 (720x480) @4mbps	0.44	2.56	116.09	0.56	2.69	110.59
Stockholm	720p (1280x720) @8mbps	0.45	6.01	49.46	0.59	6.15	48.33
Pedestrian	SXVGA (1280x960) @10mbps	0.45	7.84	37.87	0.60	8.00	37.12

Table 6. Cycles Information for MPEG4_ENC_05

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)(1)					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Foreman	CIF (352x288) @512kbps	0.43	1.47	201.78	0.49	1.53	193.91
ICE	4CIF (704x576) @4mbps	0.45	4.46	66.53	0.68	4.70	63.21

(1) Average and peak MCPS values may vary by +/-5%.

Table 7. Cycles Information for MPEG4_ENC_06

INPUT NAME	RESOLUTION	PERFORMANCE STATISTICS (MEGA CYCLES PER SECOND)(1)					
		AVERAGE			PEAK		
		ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS	ARM926 PER FRAME MHz	ENCODE PER FRAME MHz	FPS
Foreman	CIF (352x288) @512kbps	0.43	1.09	271.96	0.50	1.16	256.34
ICE	4CIF (704x576) @4mbps	0.44	2.91	102.10	0.59	3.07	96.87

(1) Average and peak MCPS values may vary by +/-5%.

Note:

- The values in Table 2, 3, 4, 5, 6, and 7 are as measured on the ARM926 side. These are the actual cycles as seen from the host on the DM365 EVM board and will be close to cycles seen on the final system (for average case).
- ARM926 represents mega cycles per frame spend on ARM926.
- Encode frame time is the time seen from ARM926 only. Since most of the processing happens at MJCP, the active load on ARM926 is the value mentioned in ARM926 column. Encode frame time has no connection with MJCP running at 243 MHz.
- All values are collected (both average and peak) at frame-level processing.
- They are measured with Linux without any system traffic.

Table 8. PSNR and Bit-Rate Details (Configuration MPEG4_ENC_01)

TEST SEQUENCE	BIT-RATE / AVERAGE LUMA PSNR (in dB)		
	LOW BIT RATE	MID BIT RATE	HIGH BIT RATE
Foreman CIF (352x288) @30fps VBR	**384 kbps**	**768 kbps**	**1mbps**
	31.87	34.70	35.77
Football D1 (720x480) @30fps VBR	**2 mbps**	**4 mbps**	**6 mbps**
	33.10	36.03	37.94

Table 9. Memory Statistics

RESOLUTION	MEMORY STATISTICS (IN BYTES)					
	PROGRAM MEMORY	DATA MEMORY				TOTAL
		CONSTANT	INTERNAL	EXTERNAL	STACK	
SXVGA (1280x960)	250592	374	0	4296360	8192	4555518
720P (1280x720)	250592	374	0	3319080	8192	3578238
D1 (720x480)	250592	374	0	1416120	8192	1675278
VGA (640x480)	250592	374	0	1283880	8192	1543038
CIF (352x288)	250592	374	0	566088	8192	825246

Table 10. Usage of External Memory (split-up) through CMEM

BUFFER	SIZE (IN BYTES)	
Input Buffer	422ILE: (frameSize*2)(1)(2) , 420SP: (frameSize*1.5)	
Output Buffer(2)	(frameSize*1.5)	
External Data Memory	memTab[0]	14500
	memTab[1]	512
	memTab[2]	(3*frameSize_padded(3)) + 24576
	memTab[3]	Max(Width,Height)*6
	memTab[4]	4
	memTab[5]	81920
	memTab[6]	(frameSize/32)

(1) frameSize = (maxWidth * maxHeight).
(2) Output Buffer size is the theoretical maximum based on 420 format and 1:1 compression ratio. Actual output buffer size requirement will be lower than this.
(3) frameSize_padded = ((maxWidth + 64)*(maxHeight+64))

Notes

- The entire MJCP is a video resource and is used by the codec.
- DMA configuration

Table 11. DMA Configuration

TC Q's	TC 0	TC 1	TC 2	TC 3	TOTAL
Usage	Reserved for system	Used by codec	Not used by codec	Not used by codec	
Priority	0	Not touched by codec (Default – 7)			
EDMA Channels	0	28	0	0	28/64
PaRAM Entries	0	66	0	0	66/256
QDMA Channels	0	0	0	0	0/8

- The MJCP/EDMA resources are acquired using a generic resource manager known as Framework Component. See *MPEG4 Simple Profile Encoder on DM365 User's Guide* for details.
- Code Placement

  All the algorithm code are placed in external memory. The performance quoted is not sensitive to algorithm code placement.

References

- ISO/IEC 14496-2:2004, Information technology -- Coding of audio-visual objects -- Part 2: Visual (Approved in 2004-05-24)
- *MPEG4 Simple Profile Encoder on DM365 User's Guide* (literature number: SPRUEV1)

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
CBR	Constant Bit Rate
CIF	Common Intermediate Format
CVBR	Constrained Variable Bit Rate
DP	Data Partitioning
EVM	Evaluation Module
HPI	Half Pel Interpolation
MJCP	MPEG4 JPEG Co-Processor
MV	Motion Vector
NV12	YUV 420 format with Y plane and CbCr plane
QP	Quantization Parameter
QCIF	Quarter Common Intermediate Format
QVGA	Quarter Video Graphics Array
RVLC	Reversible Variable Length Coding
SQCIF	Sub Quarter Common Intermediate Format
SSE	Sum of Square of Errors
SXVGA	Super eXtended Graphics Array
UMV	Unrestricted Motion Vectors

ACRONYM	DESCRIPTION
VBR	Variable Bit Rate
VGA	Video Graphics Array
VUI	Video Usability Information
XDM	eXpressDSP Digital Media

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