**MFC Reference Software Manual**

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Note: this software manual only contains additional information related to MFC (Multi-resolution Frame Coompatible Stereo Coding). Please refer to JM Reference Software Manual for the details of JM18.3 related information.

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# General Information

1. General Information

## System Overview

This document contains a detailed description of the usage of the MFC software built upon H.264/14496-10 AVC reference software, and more specifically version 18.3. This includes information about the encoder and decoder input parameters, syntax, compilation issues, and additional information with regards to the best usage and configuration of this software.

## Acronyms and Abbreviations

* + 1. **FC**: Frame Compatible
    2. **MFC:** Multi-resolution Frame Compatible Stereo Coding
    3. **OM**: Orthogonal Muxing, technology proposed for MFC standard
    4. **FR**: Full Resolution
    5. **FCFR**: Frame Compatible Full Resolution
    6. **RPU**: Reference Processing Unit
    7. **SbS**: Side-by-Side
    8. **TaB**: Top-and-Bottom

# Installation and Compilation

2. Installation and Compilation.

## Windows using MS Visual Studio .NET

The software package contains a Visual Studio .NET workspace named “jm\_vc10.sln” for .NET 2010 (v10). The workspaces include the following projects:

lencod H.264/AVC reference encoder

ldecod H.264/AVC reference decoder

rtpdump a tool for analyzing contents of RTP packets

rtp\_loss a tool for simulating RTP packet losses

rpu\_sdk a SDK static library which contains functions related to MFC algorithm. The SDK is split into encoder\_layer, rpu\_layer , decoder\_layer and utilities\_layer.

Select the desired project and the appropriate compilation mode, i.e. “Debug” or “Release” and platform i.e. “Win32” or “x64”. Compilation will create the binaries “lencod\_[Mode]\_[Platform].exe” or “ldecod\_[Mode]\_[Platform].exe” in the “bin” directory. “rtpdump.exe” and “rtp\_loss.exe” will be created in the “bin” directory.

For compile time settings and options see section 5.

For faster execution it is recommended to use Release mode in x64 platform.

Note: The software is mostly tested in x64 environment.

## UNIX and Windows using gcc (GNU Compiler Collection)

After unpacking the software package run the “unixprep.sh” shell script. This will remove Windows line break characters for compilation.

In most shell this should work with:

. unixprep.sh

or

chmod u+x unixprep.sh   
./unixprep.sh

For compiling the encoder , decoder type and rpu\_sdk:

make

Binaries named “lencod.exe” and “ldecod.exe” are created in the “bin” directory. For debug mode binaries one can compile the software using the following syntax:

make DBG=1

The above would generate debug binary files named “lencod.dbg.exe” and “ldecod.dbg.exe” in the “bin” directory for the encoder and decoder respectively.

Additional options that can be used during compilation include M32=1 for enforcing generation of 32-bit binary executables on 64-bit architectures, OPT=N for controlling the optimization level, and STC=1 for static linking of libraries.

For compile time settings and options see section 5.

# Using The MFC Encoder Module

3. Using The MFC Encoder Module

This section provides a detailed description of the JM encoder’s usage for MFC.

## Encoder Syntax

lencod [-h] [-d defenc.cfg] {[-f curenc1.cfg]...[-f curencN.cfg]}   
 {[-p EncParam1=EncValue1]...[-p EncParamM=EncValueM]}

|  |  |
| --- | --- |
| ***Options:*** | |
| *-h* | Prints parameter usage. |
| *-d* | Use <encoder\_mfc.cfg> as default file for parameter initializations. If not used then file defaults to “encoder.cfg” in local directory. |
| *-f* | Read <curencM.cfg> for resetting selected encoder parameters. Multiple files could be used that set different parameters. |
| *-p* | Set parameter <EncParamM> to <EncValueM>. The entry for <EncParamM> is case insensitive. |

See section 4 for a description of all parameters.

Supported video file formats:

The software is only tested for planar raw image data of 8 bit sample inputs with concatenated (all video frames in a single file) video data.

Examples of usage:

lencod.exe

lencod.exe -h

lencod.exe -d encoder\_mfc.cfg

lencod.exe -f curenc1.cfg

lencod.exe -f curenc1.cfg –p InputFile="e:\data\container\_qcif\_30.yuv"\   
 -p SourceWidth=176 -p SourceHeight=144

lencod.exe -f curenc1.cfg -p FramesToBeEncoded=30 \   
 -p QPFirstFrame=28 -p QPRemainingFrame=28 -p QPBPicture=30

## Encoder Output

When running the encoder, the encoder will display on screen rate/distortion statistics for every frame coded. Cumulative results will also be presented. The output information generated may look as follows depending on the setting of the Verbose input parameter:

Setting Default Parameters...

Parsing Configfile encoder\_mfc.cfg.........................................

.......................................................................

Parsing Second View Configfile encoder\_mfc\_view1.cfg.......................

.................................

MFC HIGH PROFILE :DefaultGridPosition is set. Default values are being set for the view offsets.

Warning: Hierarchical coding or Referenced B slices used.

Make sure that you have allocated enough references

in reference buffer to achieve best performance.

AdaptiveRounding is disabled when RDO Quantization is used

Warning: Automatic cropping activated: Coded frame Size: 1920x1088

------------------------------------------ JM 18.2 (FRExt) ---------------------

---------------------

Input YUV file : K:\data\2012\_MFC\_source\NewsRoomDolly\_L\_192

0x1080\_24p.yuv

Input YUV file 2 : K:\data\2012\_MFC\_source\NewsRoomDolly\_R\_192

0x1080\_24p.yuv

Output H.264 bitstream : test.264

Output YUV file : test\_rec.yuv

Output YUV file 2 : test\_rec2.yuv

YUV Format : YUV 4:2:0

Frames to be encoded : 2

Freq. for encoded bitstream : 24.00

PicInterlace / MbInterlace : 0/0

Transform8x8Mode : 1

ME Metric for Refinement Level 0 : SAD

ME Metric for Refinement Level 1 : Hadamard SAD

ME Metric for Refinement Level 2 : Hadamard SAD

Mode Decision Metric : Hadamard SAD

Motion Estimation for components : Y

Image format : 1920x1080 (1920x1088)

Error robustness : Off

Search range : 256

Search range (view 1) : 256

Total number of references : 4

References for P slices : 4

References for B slices (L0, L1) : 3, 1

View 1 refs for P slices : 3

View 1 refs for B slices (L0, L1) : 2, 1

Sequence type : Hierarchy (QP: I 19, P 19, B 21)

Entropy coding method : CABAC

Profile/Level IDC : (134,41)

Motion Estimation Scheme : EPZS

EPZS Pattern : Extended Diamond

EPZS Dual Pattern : Extended Diamond

EPZS Fixed Predictors : All P + B

BL EPZS Temporal Predictors : Enabled

EL EPZS Temporal Predictors : Disabled

EPZS Spatial Predictors : Enabled

EPZS Threshold Multipliers : (1 0 2)

EPZS Subpel ME : Enhanced

EPZS Subpel ME BiPred : Enhanced

Motion Estimation Scheme : EPZS

EPZS Pattern : Extended Diamond

EPZS Dual Pattern : Extended Diamond

EPZS Fixed Predictors : All P + B

BL EPZS Temporal Predictors : Enabled

EL EPZS Temporal Predictors : Disabled

EPZS Spatial Predictors : Enabled

EPZS Threshold Multipliers : (1 0 2)

EPZS Subpel ME : Enhanced

EPZS Subpel ME BiPred : Enhanced

Search range restrictions : none

RD-optimized mode decision : used

Data Partitioning Mode : 1 partition

Output File Format : H.264/AVC Annex B Byte Stream Format

--------------------------------------------------------------------------------

-------------------------------

Frame View Bit/pic NVB WP QP QL SnrY SnrU SnrV Time(ms) MET(ms

) Frm/Fld I D L0 L1 RDP Ref

--------------------------------------------------------------------------------

-------------------------------

00000(IDR) 0 2844960 576 0 19 1 45.137 45.759 45.848 7779 0

FRM 8160 0 0 0 0 3 0

00000( B ) 1 733248 0 0 20 2 44.734 47.072 46.771 27893 8956

FRM 31 1 1 1 0 2 8097

00001( B ) 0 663112 0 0 19 2 44.199 45.576 45.642 32638 9125

FRM 565 1 1 1 0 2 0

00001( B ) 1 311040 0 0 20 2 44.560 47.052 46.715 32875 13911

FRM 4 1 2 1 0 2 5982

--------------------------------------------------------------------------------

-----------------------

Total Frames: 4

LeakyBucketRate File does not exist. Using rate calculated from avg. rate

Number Leaky Buckets: 8

Rmin Bmin Fmin

27310704 2844384 2844384

34138368 2844384 2844384

40966032 2844384 2844384

47793696 2844384 2844384

54621360 2844384 2844384

61449024 2844384 2844384

68276688 2844384 2844384

75104352 2844384 2844384

--------------------------------------- Average data all frames --------------

-----------------------

Total encoding time for the seq. : 101.186 sec (0.04 fps)

Total ME time for sequence : 31.993 sec

|-----------|-------------|MFC 3D Encoder PROFLING-------------|------------|

| - | lencode | lencode | RPU |BL Muxing | EL Muxing |

| - |(totaltime) |(jm only) | - | - | - |

| t(s) | 101.19 | 100.68 | 0.03 | 0.12 | 0.35 |

| fps | 0.04 | 0.04 | 0.00 | 0.00 | 0.00 |

| ms/f | 25296.50 | 25171.00 | 0.00 | 0.00 | 0.00 |

| %inc | 0.00 | 0.00 | 0.03 | 0.12 | 0.34 |

|-----------|-------------|-----------|------------|------------|------------|

Y { PSNR (dB), cSNR (dB), MSE } : { 44.658, 44.645, 2.23167 }

U { PSNR (dB), cSNR (dB), MSE } : { 46.365, 46.308, 1.52136 }

V { PSNR (dB), cSNR (dB), MSE } : { 46.244, 46.215, 1.55460 }

View0\_Y { PSNR (dB), cSNR (dB), MSE } : { 44.668, 44.643, 2.23260 }

View0\_U { PSNR (dB), cSNR (dB), MSE } : { 45.668, 45.667, 1.76369 }

View0\_V { PSNR (dB), cSNR (dB), MSE } : { 45.745, 45.744, 1.73264 }

View1\_Y { PSNR (dB), cSNR (dB), MSE } : { 44.647, 44.646, 2.23074 }

View1\_U { PSNR (dB), cSNR (dB), MSE } : { 47.062, 47.062, 1.27902 }

View1\_V { PSNR (dB), cSNR (dB), MSE } : { 46.743, 46.743, 1.37657 }

Total bits : 4552360 (I 2844384, P 0, B 1707400 NVB 576)

View 0 Total-bits : 3507872 (I 2844384, P 0, B 663112 NVB 376)

View 1 Total-bits : 1044488 (I 0, P 0, B 1044288 NVB 200)

Bit rate (kbit/s) @ 24.00 Hz : 54628.32

View 0 BR (kbit/s) @ 24.00 Hz : 42094.46

View 1 BR (kbit/s) @ 24.00 Hz : 12533.86

Bits to avoid Startcode Emulation : 29

Bits for parameter sets : 576

Bits for filler data : 0

--------------------------------------------------------------------------------

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Exit JM 18 (FRExt) encoder ver 18.2

## Encoder Limitations

At this point, the encoder is characterized by certain limitations which may limit its usage. In particular, some items that have been identified as being problematic or not properly supported in the JM18.3 software for MVC setting include:

* The encoder may not perform all level/profile checks as specified in Annex A of the standard which may result in incompatible/non-conforming bitstreams.
* Picture Level RD Optimization does not currently fully support interlace coding modes and may require memory optimizations.
* Adaptive coding structures, i.e. creating Hierarchical groups of pictures of different length and with different coding/type arrangements, are not supported.

# MFC Encoder Parameters

4. MFC encoder Parameters

## MFC coding parameters (main cofiguration file)

MFC coding parameters is based on MVC coding parameters in JM18.3. In this manual, only additional parameters and modified parameters are listed. For other parameters, refer to JM reference software manual.

### ProcessInput

*Class*: Numeric (Integer)

*Description*: For MFC, the value is set to 14.

### ProfileIDC

*Class*: Numeric (Integer)

*Description*: For MFC, the value is set to 134.

### Rpu\_Filter\_Enabled\_Flag

*Class*: Numeric (Integer)

*Description*: Specifies RPU filter enabled or disabled for MFC. Default value is 1.

|  |  |
| --- | --- |
| ***Options:*** | |
| *0* | RPU Filter Disabled. Output of RPU is filled with constant value of 128 |
| *1* | RPU Filter Enabled. |

### Mfc\_Format\_Idc

*Class*: Numeric (Integer)

*Description*: Specifies the FC base layer format for MFC.

|  |  |
| --- | --- |
| ***Options:*** | |
| *0* | SbS |
| *1* | TaB |

### DefaultGridPosition

*Class*: Numeric (Integer)

*Description*: If use the default positions for the FC base layer.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Rpu\_Process\_Format*** | ***View0\_Grid\_Position\_x*** | ***View0\_Grid\_Position\_y*** | ***View1\_Grid\_Position\_x*** | ***View1\_Grid\_Position\_y*** |
| *0* | 4 | 8 | 12 | 8 |
| *1* | 8 | 4 | 8 | 12 |

### View0\_Grid\_Position\_x, View0\_Grid\_Position\_y, View1\_Grid\_Position\_x, View1\_Grid\_Position\_y

*Class*: Numeric (Integer)

*Description*: Specifies the grid positions of the FC base layer. The allowed values are 4, 8 and 12.

### Mux3DBaseFilter

*Class*: Numeric (Integer)

*Description*: Specifies the muxing filter for FC base layer for MFC.Default value is 0.

|  |  |
| --- | --- |
| ***Options:*** | |
| *0* | SVC3D(Fc =0.40) |
| *1* | MFC\_MUX\_FC\_P44(Fc = 0.44) |

### Mux3DEnhFilter

*Class*: Numeric (Integer)

*Description*: Specifies the muxing filter for FC enhancement layer for MFC.Default value is 1.

|  |  |
| --- | --- |
| ***Options:*** | |
| *0* | SVC3D(Fc =0.40) |
| *1* | MFC\_MUX\_FC\_P44(Fc = 0.44) |

### EnableDbgYUVFiles

*Class*: Numeric (Integer)

*Description*: If Generate debug YUV Files. Default value is 0.

### FPASEIPresentFlag

*Class*: Numeric (Integer)

*Description*: If Generate FPA SEI message for the Base view. Default value is 1.

## MVC coding parameters (View 1 cofiguration file)

No additional paramteres are added.

# MFC Hardcoded Encoder Parameters

5. MFC Hard coded Encoder Parameters

For MFC, additional defines are added.

## defines.h

|  |  |  |
| --- | --- | --- |
| *MFC\_ENC\_3D\_FCFR* |  | Enable MFC |
| *MFC\_PROCESS\_INPUT* |  | Set to 14 for MFC |
| *MFC\_INTERLACE\_POC\_MANAGEMENT* |  | allow PocMemeoryManagement for interlace in MVC profile |
| *MFC\_JMCODE\_FIX* |  | Fix JM code issue for interlaced coding |
| *DISPLAY\_LAYERLEVEL\_BITUSAGE* |  | Enable bit usage for each layer |
| *MFC\_ENC\_EL\_CONFIG* |  | Separate RDPictureDecision from Base layer |
| *MFC\_PROFILING* |  | Code for encoder run time profiling |
| *MFC\_FPA\_SEI* |  | Enable FPA SEI message |

## configfile.h

DEFAULTCONFIGFILENAME : Sets default encoder configuration file.

# Using The MFC Decoder Module

6. Using The MFC Decoder Module

This section provides a detailed description of the JM decoder’s usage for MFC. Note that MFC requires a reconstruction process to form the full resolution output image. To decode only both base layer and enhancement layer video, ExportViews in decoder\_mfc.cfg is set to 0. To fully reconstruct left and right view, ExportViews in decoder\_mfc.cfg is set to 1.

## Decoder Syntax

ldecod [-s] [-h] [-d] [decoder\_mfc.cfg]   
 {[-f curenc1.cfg]...[-f curencN.cfg]}   
 [-i bitstream.264] [-o output.yuv] [-r reference.yuv]   
 {[-p DecParam1=DecValue1]...[-p DecParamM=DecValueM]}   
 [-n] Nframes [-mpr] LValue

Examples of usage:

ldecod.exe

ldecod.exe -h

ldecod.exe –d decoder\_mfc.cfg

ldecod.exe –s –i bitstream.264

ldecod.exe –i bitstream.264 –o output.yuv –r reference.yuv

ldecod.exe –i bitstream420.264 -uv

## Example usage of MFC case:

## If only decode the base layer and enhancement layer bitstream: ldecod.exe -d decoder.cfg -p ExportViews=0

## If fully reconstruct left and right view: ldecod.exe -d decoder.cfg -p ExportViews=1

## Decoder Configuration File Format

In this manual, only additional parameters for MFC are listed. For other parameters, refer to JM reference software manual.

### ExportViews

*Class*: Numeric (Integer)

*Description*: If left and right views are reconstructed. Default value is set to 0.

### DeMuxMode

*Class*: Numeric (Integer)

*Description*: specifies the full size reconstruction is from FC base layer or MFC. Default value is set to 1.

|  |  |
| --- | --- |
| ***Options:*** | |
| *0* | FC base layer |
| *1* | MFC |

## Decoder Output

When running the decoder, the decoder will display on screen rate/distortion statistics for every frame coded. Cumulative results will also be presented. The output information generated may look as follows:

Setting Default Parameters...

Parsing Configfile decoder\_mfc.cfg

..................

----------------------------- JM 18.2 (FRExt) -----------------------------

--------------------------------------------------------------------------

Input H.264 bitstream : test.264

Output decoded YUV : test\_dec.yuv

Input reference file : test\_rec.yuv

--------------------------------------------------------------------------

Image Format : 1920x1080 (1920x1088)

Color Format : 4:2:0 (8:8:8)

--------------------------------------------------------------------------

POC must = frame# or field# for SNRs to be correct

--------------------------------------------------------------------------

Frame POC Pic# QP SnrY SnrU SnrV Y:U:V Time(ms)

--------------------------------------------------------------------------

00000(IDR) 0 0 19 0.0000 0.0000 0.0000 4:2:0 183 < 0

| 0| 0>

00000( B ) 0 0 20 11.6937 12.4134 10.8728 4:2:0 103 < 8129

| 0| 0>

00001( B ) 2 1 19 0.0000 0.0000 0.0000 4:2:0 116 < 0

| 0| 0>

00001( B ) 2 1 20 11.6862 12.4200 10.8761 4:2:0 85 < 5982

| 0| 0>

-------------------- Average SNR all frames ------------------------------

SNR Y(dB) : 8.41

SNR U(dB) : 8.92

SNR V(dB) : 7.82

Total decoding time : 0.488 sec (8.197 fps)[4 frm/488 ms]

--------------------------------------------------------------------------

|-----------|-----------|MFC 3D Decoder PROFLING-------|----------|

| - | ldecode | ldecode | RPU |OM-Recon | FC-Recon |

| - |(totaltime)|(jm only)| - | - | - |

| t(s) | 0.488 | 0.453 | 0.035 | 0.000 | 0.000 |

| fps | 8.197 | 8.830 | 0.000 | 0.000 | 0.000 |

| ms/f | 122.000 | 113.250 | 0.000 | 0.000 | 0.000 |

| %inc | 0.000 | 0.000 | 7.726 | 0.000 | 0.000 |

|-----------|-----------|---------|----------|----------|----------|

BaseView Format: 1920x1088x1, x1

DependentView Format: 1920x1088x1

---InterLayer Statistics---

Layer(1), B\_SLICE(2): 86.464%|0.000%|0.000%

Layer(1), TotalFrames(2), Average: 86.464%|0.000%|0.000%, Overall:86.464%

---End InterLayer Statistics---

Exit JM 18 (FRExt) decoder, ver 18.2

Output status file : log.dec

4 frames are decoded.

# MFC Hardcoded Decoder Parameters

7. MFC Hardcoded Decoder Parameters

For MFC, additional defines are added.

## defines.h

|  |  |  |
| --- | --- | --- |
| *MFC\_DEC\_3D\_FCFR* | : | Enable MFC decoder |
| *MFC\_DEC\_3D\_FCFR\_STAT* | : | Print inter-layer stats for MFC |
| *IMGTYPE* | : | Hardcoded to 0. |
| *MFC\_JM\_CODE\_CHANGE* | : | Code changes, mostly bug fixes of JM code |
| *MFC\_PROFILING* | : | Code for decoder run time profiling |