HC – MPEG2 encoder

Release HC021

General information

- ***What is HC***
  HC is a simple to use MPEG2 video encoder and is meant for creating MPEG2 video streams with a strong focus on DVD-compliancy.
  All MPEG2 HD resolutions are supported, maximum resolution: 1920x1152.

- ***Installation***
  Just unzip the archive where you have a few GB free space, the space is needed for the storage of intermediate files.

- ***Hardware requirements***
  The encoder will run on any Intel and AMD processor using Windows XP/2000.
  It will probably run under Linux (using Wine) and Windows Vista.
  HC uses the next CPU extensions if available: MMX/SSE, SSE2, SSE3, at least MMX/ISSE must be present, if SSE2, SSE3 or SSSE3 is present HC will also use it, run time will be 5 - 10% faster with SSE2 and 5 – 30% with SSE3 or SSSE3. The encoder will automatically detect the CPU extensions.
  Memory requirements: HC will run with only 256 MB installed, more is, as always, better.
  On a multi-processor or hyper threaded system, HC will use only one processor or thread.
  It's possible to run multiple instances of Hcenc.

- ***Input***
  Input can be a DGIndex/DGDecode d2v project or input using Avisynth.
  HC expects as input YUV-planes (YV12 color space 4:2:0).
  During the encoding process there are no color plane conversions, the encoder keeps the color planes in YV12 color space.

- ***Versions***
  Two versions are available, a GUI version (HCgui) which is easy to use and the actual encoder (HCenc) which is controlled by a serie of commands in an ini file, it can also take parameters.
  The GUI version will only generate the ini file, it uses HCenc to do the actual encoding.

- ***Output***
  Output is a regular m2v file which can be used directly in your favourite authoring program.

Features

- **Multipass**
  HC is a 2 pass encoder which produces a VBR MPEG2 stream.
  Bitrate control is controlled by an average bitrate value and a maximum bitrate value.

- **Bitrate control**
  Bitrate is controlled by two commands: *BITRATE and *MAXBITRATE.
  Buffer underflows will never occur, while encoding the frames, the VBV (Video Buffer Verifier) is constantly checked for buffer underruns, if buffer underruns occur the bit stream will be adapted so the stream will always be DVD-compliant.

- **Encoding quality**
  Encoding quality is controlled by the encoding profile: FAST, NORMAL, BEST.
  For the *PROFILE command, see the command section.

- **GOP structure**
  User controllable, maximum GOP length is 36, maximum consecutive B-pictures is 2.
  You can for instance give the command *GOP 15 2 or *GOP 12 1, see the command section.
  If the *GOP command is omitted, HC wil run in AUTOGOP mode, this probably is the best way to run the encoder. In AUTOGOP mode HC scans frames to be encoded and measures the activity of the frames. Based on the activity of the frames HC tries to create an optimal GOP structure.
  A sequence header is written for each GOP.

- **Scene change detection**
  HC has a scene change detection algorithm built in, on each scene detection an I-frame is inserted and the GOP will be closed so you can cut the video at each scene change.
  If necessary the frames in the two previous GOP's will be redistributed to maintain a nice general GOP structure.

- **Quantization matrices**
  You can use any matrix you like, some well known matrices are already built in which can be activated by the *MATRIX command. If you want to use your own matrix (intra and non-intra) just give the command *CUSTOMMATRIX and specify the two matrices, see the command section.
  If the *MATRIX command is omitted HC will use the standard "adapted" MPEG matrices, see the matrix section for the matrix specification.

- **Encoding speed**
  Encoding speed is highly dependent of:
  - Complexity and resolution of the video material
  - Speed of your system: CPU, cache size and bus/memory speed
  - Availability of CPU extensions

  Encoding (interlaced) DV video might take longer to encode.
  A fast system will encode a 2 hour movie (DVD backup) in approx. 1.5 hours with *PROFILE BEST.
  Encoding (interlaced) DV video might take longer to encode.

Command section

HCenc is controlled by a serie of commands in the ini file.
It can also use parameters, see the next section.

Commands may be given in any order, they all start with *, commands may be uppercase or lowercase and must start at the first column.

You can simply deactivate a command by putting a space before the command.

The next commands are available:

*ADAPTIVEMATRIX

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*ADAPTIVEMATRIX		

This command activates the code in matrix.dll. Using this command you can change matrices at every GOP. **This is meant for very experienced users only !!**
See the adaptive matrices section in this manual how to create the dll.

*ASPECT

parameter	1:1, 4:3, 16:9, 2.21:1	*type*	character string
Status	not required		
Default	16:9		
Example	*ASPECT 4:3 (3:4 is also allowed)		

This command sets the desired aspect ratio.

*AUTOGOP

parameter	goplength (12 – 18)	*type*	integer
Status	not required		
Default	15 (12 for 23.976 fps)		
Example	*AUTOGOP 12		

This command sets the maximum GOP length to be used by the autogop algorithm.
Running in AUTOGOP mode means the encoder tries to distribute the I, P and B frames in an optimal manner based on the activity of the frames.
Encoding using AUTOGOP will be DVD-compliant if the next values are used:
- For NTSC source to be pulldowned, use values 12 – 14.
- For PAL source a value of 15 should be used.
- For 29.97 NTSC source the maximum of 18 can be used.

*BFF

parameter	-	*type*	-
Status	not required		
Default	NA for progressive, TFF for interlaced		
Example	*BFF		

This command specifies bottom field first, only used for interlaced encoding.

*BIAS

parameter	bias (range 0 – 100)	*type*	integer
Status	not required		
Default	0		
Example	*BIAS 30		

This command tweaks the compression curve, 0 means full VBR (Variable BitRate), 100 tends to CBR (Constant BitRate).

*BITRATE

parameter	bitrate	*type*	integer
Status	required		
Default	-		
Example	*BITRATE 3250		

This command specifies the average bitrate per second in kbits/s. (1 kbit = 1000 bit)

*CHAPTER

parameter	nr. of chapters	*type*	integer
Status	not required		
Default	-		
Example	*CHAPTER 5		
	101		
	1253		
	2763		
	5471		
	8354		

This command sets chapter points at the frames given, this means an I-frame is inserted and the GOP is closed.
There's no limit on the number of chapters, you can even set a chapter on every frame.

*CLOSEDGOPS

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*CLOSEDGOPS		

This command closes all gops.
CLOSEDGOPS is disabled by default.

*CPU

parameters	AUTO, MMX, SSE2, SSE3 ,SSSE3	*type*	character string
Status	not required		
Default	AUTO		
Example	*CPU MMX		

This command can be used to force the cpu to use specific extensions.

*CQ

parameter	quantization	*type*	real
Status	not required		
Default	-		
Example	*CQ 5.8		

This command orders the encoder to do a 1-pass with a constant quantization factor.
The value for quantization is the non-linear scale value.
No database is created, the output file is created in the first pass.
NOTE: this is not the same as CBR encoding, HC doesn't do CBR encoding.

*CQ_BFACTOR

parameter	factor for B-frame quantization	*type*	real
Status	not required		
Default	1.0		
Example	*CQ_BFACTOR 1.4		

Multiplication factor for the quantization of B-frames using constant quantization.
Range: 0.5 – 4.0.
Example: if *CQ or *CQ_MAXBITRATE is set to 5, using *CQ_BFACTOR 1.4 means B-frames will use Q = 7.

*CQ_MAXBITRATE

parameter	quantization	*type*	real
Status	not required		
Default	-		
Example	*CQ_MAXBITRATE 5.8		

This command orders the encoder to do a 1-pass with a constant quantization factor.
If the actual bitrate overshoots the maximum bitrate set by the *MAXBITRATE command the quantizer is temporally raised. Output will be DVD-compliant.
The value for quantization is the non-linear scale value.
No database is created, the output file is created in the first pass.
NOTE: this is not the same as CBR encoding, HC doesn't do CBR encoding.

*CQ_PFACTOR

parameter	factor for P-frame quantization	*type*	real
Status	not required		
Default	1.0		
Example	*CQ_PFACTOR 1.2		

Multiplication factor for the quantization of P-frames using constant quantization.
Range: 0.5 – 4.0.
Example: if *CQ or *CQ_MAXBITRATE is set to 5, using *CQ_PFACTOR 1.2 means P-frames will use Q = 6.

*CUSTOMMATRIX

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*CUSTOMMATRIX		

```
 8  16  19  22  26  27  29  34
16  16  22  24  27  29  34  37
19  22  26  27  29  34  34  38
22  22  26  27  29  34  37  40
22  26  27  29  32  35  40  48
26  27  29  32  35  40  48  58
26  27  29  34  38  46  56  69
27  29  35  38  46  56  69  83

16  17  18  19  20  21  22  23
17  18  19  20  21  22  23  24
18  19  20  21  22  23  24  25
19  20  21  22  23  24  26  27
20  21  22  23  25  26  27  28
21  22  23  24  26  27  28  30
22  23  24  26  27  28  30  31
23  24  25  27  28  30  31  33
```

This command defines custom intra and non-intramatrices to be used and supersedes the default matrix and the *MATRIX command.
The matrices must be supplied as given in the example, 8 values per line.

*DC_PREC

parameter	dc_precision	*type*	integer
Status	not required		
Default	9		
Example	*DC_PREC 8		

This command defines the DC_precision to be used, range 8 - 11.
NOTE: dc_precision 11 is NOT DVD-compliant.

*FRAMES

parameters	startframe endframe	*type*	(2X) integer
Status	not required		
Default	-		
Example	*FRAMES 0 499		

This command specifies the frames to be encoded, if this command is not present all frames will be encoded. The example will encode the first 500 frames.

*GOP

parameters	goplength B-frames	*type*	(2X) integer
Status	not required		
Default	-		
Example	*GOP 12 2		

This command defines the GOP structure.
Max. GOP length is 36, max. B-frames is 2.
If this command is omitted, HC wil run in AUTOGOP mode.

*INFILE

parameter	input file name	*type*	character string
Status	required		
Default	-		
Example	*INFILE D:\movies\ test.avs		

This command defines the input filename. This file should be a d2v project or an Avisynth file, so the extension is d2v or avs.

*INTERLACED

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*INTERLACED		

Use this command if your source is interlaced, it might improve quality.
If this command is used also the alternate scanmethod is set.

*LASTIFRAME

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*LASTIFRAME		

The last frame will be encoded as an I-frame.

*LOGFILE

parameter	log file name	*type*	character string
Status	not required		
Default	-		
Example	*LOGFILE D:\movies\test.log		

This command defines the log filename, if omitted no logfile will be written.
If the logfile already exists the logs will be appended.

*LUMGAIN

parameter	sensitivity (0 - 4)	*type*	integer
Status	not required		
Default	0		
Example	*LUMGAIN 2		

This command adapts the quantization matrices on dark scenes so the bitrate will be raised.
- 0 no change
- 1 mild change
- 2 moderate change
- 3 heavy change
- 4 hit dark scenes real hard

*MASK_SHIFT

parameter	top bottom shift	*type*	3*integer
Status	not required		
Default	0 0 0		
Example	*MASK_SHIFT 16 144 64		

This command masks top and bottom lines, the 3th parameter specifies the shift in lines, positive values will shift the video upwards, negative values will shift it down.
The example will mask 16 top lines and 144 bottom lines, the video is shifted upwards 64 lines.
The shift is done first, after that the top and bottom masking.

*MATRIX

parameter	matrix	*type*	character string
Status	not required		
Default	MPEG matrix		
Example	*MATRIX HClow		

This command defines the intra and non-intra matrix to use.
See the matrix section for available built-in matrices and the default matrix specification.

*MAXBITRATE

parameter	bitrate	*type*	integer
Status	required		
Default	-		
Example	*MAXBITRATE 9000		

This command specifies the maximum bitrate per second in kbits/s. (1 kbit = 1000 bit)

*NOSEQ_ENDCODE

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*NOSEQ_ENDCODE		

This command disables output of the sequence endcode (00 00 01 B7) at the end of the stream.

*NOSCD

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*NOSCD		

This command disables the scene change detection.
Scene change detection is enabled by default, at each scene change an I-frame is inserted and the GOP is closed.

*NOVBV

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*NOVBV		

This command disables the VBV (Video Buffer Verifier) checking.
VBV checking is enabled by default. This command should not be used for DVD creation.

*OUTFILE

parameter	output file name	*type*	character string
Status	required		
Default	-		
Example	*OUTFILE D:\movies\test.m2v		

This command defines the output filename, required.

*PREVIEW

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*PREVIEW		

This command turns on the preview window in the encoder.

*PROFILE

parameter	FAST, NORMAL, BEST	*type*	character string
Status	not required		
Default	NORMAL		
Example	*PROFILE BEST		

This command defines the encoding quality. As usual the best encoding will take the most time.

*PULLDOWN

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*PULLDOWN		

This command sets pulldown flags for 23.976 → 29.97 pulldown.
Interlaced will be turned off, if your source is interlaced, please de-interlace it first.
If the source isn't 23.976 fps this setting will be ignored.

*SCANMETHOD

parameter	ZIGZAG, ALT	*type*	character string
Status	not required		
Default	ZIGZAG		
Example	*SCANMETHOD ALT		

This command defines the scanning method to be used.
If interlaced is flagged it defaults to ALT but can be set to ZIGZAG with this command.

*SCDFILE

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*SCDFILE		

This command writes the frame numbers with a scene change in file <output>_scd.txt.

*SHUTDOWN

parameter	-	*type*	integer
Status	not required		
Default	-		
Example	*SHUTDOWN		

This command will shutdown the system in 300 seconds after finishing encoding.

*SILENT

parameter	-	*type*	-
Status	not required		
Default	-		
Example	*SILENT		

This command disables the encoder GUI, background encode. It might have a marginal speed increase.

*TFF

parameter	-	*type*	-
Status	not required		
Default	NA for progressive, TFF for interlaced		
Example	*TFF		

This command specifies top field first, only used for interlaced encoding.

*TIMECODE

parameters	hour minute second frame	*type*	(4X) integer
Status	not required		
Default	0 0 0 0		
Example	*TIMECODE 1 2 3 4		

This command sets the timecode.

*WAIT

parameter	second	*type*	integer
Status	not required		
Default	5		
Example	*WAIT 0		

This command sets the waiting time before HC exits after an encoding session, range 0 – 99.
If you have a lot of short encodes it's best set to *WAIT 0.

*ZONE

parameter	nr. of zones	*type*	integer
Status	not required		
Default	-		
Example	*ZONE 3		
	1200 1.3		
	1500 1.		
	2700 0.5		

This command raises or lowers the bitrate for parts of the video.
The example will raise the bitrate starting at frame 1200, reset to normal at frame 1500 and lowers
the bitrate starting at frame 2700.
The number of zones is limited to 6400.

Using parameters

The next parameters can be passed:

-i	input file (full path)
-o	output file (full path)
-b	bitrate (kbit/s)
-maxbitrate	max. bitrate (kbit/s)
-frames	startframe endframe
-gop	goplength B-frames
-log	log file (full path)
-chapter	chapter file (full path)
-ini	ini file (full path)
-profile	fast, normal or best
-aspectratio	1:1, 4:3 or 3:4, 16:9 or 9:16, 2.21:1 or 1:2.21 or 2:21
-scene	enable scene change detection
-noscene	disable scene change detection
-interlaced	enable interlaced encoding
-nointerlaced	disable interlaced encoding
-matrix	mpeg, hc, hclow, qlb, notch, jawor1cd, bach1, hvsgood, hvsbetter, hvsbest, avamat6, avamat7,fox1,fox2,fox3,mpegstd
-tff	set to Top Field First (only for interlaced encoding)
-bff	set to Bottom Field First (only for interlaced encoding)
-dc_prec	dc precision (8, 9, 10, 11, *11 is NOT DVD-compliant*)
-bias	bias value (0 – 100)
-cq	constant quantizer, one pass
-cq_maxbitrate	constant quantizer respecting max bitrate and VBV, one pass
-cq_bfactor	CQ factor for b-frames
-cq_pfactor	CQ factor for p-frames
-pulldown	activate pulldown

HC will always look if there's an HC.ini file in the same directory as the exe file and will also read values from it.
Parameters passed have a higher priority than the values supplied in the ini file.

For batch processing you can do something like this:

HCenc_021 –i d:\movies\test1.avs –o d:\movies\test1.m2v –b 4000 –maxbitrate 9000 –ini d:\movies\hc.ini
HCenc_021 –i d:\movies\test2.d2v –o d:\movies\test2.m2v –b 3500 –maxbitrate 8000 –ini d:\movies\hc.ini

Input file, output file, bitrate and maxbitrate are set as parameter, rest of the commands are read from HC.ini.

Reading all from (different) ini files:

HCenc_021 –ini d:\movies\hc1.ini
HCenc_021 –ini d:\movies\hc2.ini

Matrices

The next built-in matrix will be used as default, the MPEG adapted matrix.
The intra matrix is the standard MPEG matrix and will not be written in the MPEG2 stream.
*MATRIX **MPEG**

```
 8 16 19 22 26 27 29 34          16 17 18 19 20 21 22 23
16 16 22 24 27 29 34 37          17 18 19 20 21 22 23 24
19 22 26 27 29 34 34 38          18 19 20 21 22 23 24 25
22 22 26 27 29 34 37 40          19 20 21 22 23 24 26 27
22 26 27 29 32 35 40 48          20 21 22 23 25 26 27 28
26 27 29 32 35 40 48 58          21 22 23 24 26 27 28 30
26 27 29 34 38 46 56 69          22 23 24 26 27 28 30 31
27 29 35 38 46 56 69 83          23 24 25 27 28 30 31 33
```

The next built-in matrix can be used with the *MATRIX command , the MPEG standard matrix.
The intra and inter matrix will not be written in the MPEG2 stream.
*MATRIX **MPEGSTD**

```
 8 16 19 22 26 27 29 34          16 16 16 16 16 16 16 16
16 16 22 24 27 29 34 37          16 16 16 16 16 16 16 16
19 22 26 27 29 34 34 38          16 16 16 16 16 16 16 16
22 22 26 27 29 34 37 40          16 16 16 16 16 16 16 16
22 26 27 29 32 35 40 48          16 16 16 16 16 16 16 16
26 27 29 32 35 40 48 58          16 16 16 16 16 16 16 16
26 27 29 34 38 46 56 69          16 16 16 16 16 16 16 16
27 29 35 38 46 56 69 83          16 16 16 16 16 16 16 16
```

The next built-in matrices can be used with the *MATRIX command:
(some of these matrices are copyrighted by their respective owners)

*MATRIX **QLB**

```
 8 16 19 22 26 27 29 34          16 17 18 19 20 21 22 23
16 16 22 24 27 29 34 37          17 18 19 20 21 22 23 25
19 22 26 27 29 34 37 39          18 19 20 21 22 23 24 26
22 22 26 27 29 34 38 42          19 20 21 22 23 24 26 28
22 26 27 29 32 36 40 50          20 21 22 23 25 26 28 29
26 27 29 32 36 40 50 61          21 22 23 24 26 28 29 31
26 27 29 35 40 50 59 75          22 23 24 26 28 29 31 34
27 29 35 40 50 59 75 89          23 24 25 28 29 31 34 38
```

*MATRIX **NOTCH**

```
 8  9 12 22 26 27 29 34          16 18 20 22 24 26 28 30
 9 10 14 26 27 29 34 37          18 20 22 24 26 28 30 32
12 14 18 27 29 34 37 38          20 22 24 26 28 30 32 34
22 26 27 31 36 37 38 40          22 24 26 30 32 32 34 36
26 27 29 36 39 38 40 48          24 26 28 32 34 34 36 38
27 29 34 37 38 40 48 58          26 28 30 32 34 36 38 40
29 34 37 38 40 48 58 69          28 30 32 34 36 38 42 42
34 37 38 40 48 58 69 79          30 32 34 36 38 40 42 44
```

*MATRIX **BACH1**

```
 8 16 19 22 26 27 29 34          16 18 20 22 24 26 28 30
16 16 22 24 27 29 34 37          18 20 22 24 26 28 30 32
19 22 26 27 29 34 34 38          20 22 24 26 28 30 32 34
22 22 26 27 29 34 37 40          22 24 26 30 32 32 34 36
22 26 27 29 32 35 40 48          24 26 28 32 34 34 36 38
26 27 29 32 35 40 48 58          26 28 30 32 34 36 38 40
26 27 29 34 38 46 56 69          28 30 32 34 36 38 42 42
27 29 35 38 46 56 69 83          30 32 34 36 38 40 42 44
```

*MATRIX **HC**

```
 8   9  13  20  23  27  29  34        16  16  18  20  22  24  27  30
 9  11  16  23  26  29  34  39        16  17  19  22  24  27  30  34
12  16  21  25  28  33  39  45        18  19  22  24  27  30  34  39
15  20  25  28  33  38  44  52        20  22  24  27  30  34  39  45
19  24  28  33  38  43  51  60        22  24  27  30  34  39  45  52
23  27  32  38  42  49  58  68        24  27  30  34  39  45  52  60
27  31  37  42  48  57  67  77        27  30  34  39  45  52  60  69
30  36  41  47  55  65  76  87        30  34  39  45  52  60  69  79
```

*MATRIX **HCLOW**

```
 8  16  17  18  20  22  26   32       16  16  17  18  19  20  22  24
16  16  17  20  22  26  30   36       16  16  17  19  20  22  24  26
17  17  18  22  26  30  36   40       17  17  17  20  22  24  26  30
18  20  22  26  30  36  40   48       18  19  20  22  24  26  30  36
20  22  26  30  36  40  48   56       19  20  22  24  26  30  36  40
22  26  30  36  40  48  56   72       20  22  24  26  30  36  40  48
26  30  36  40  48  56  72   96       22  24  26  30  36  40  48  56
32  36  40  48  56  72  96  108       24  26  30  36  40  48  56  64
```

*MATRIX **JAWOR1CD**

```
 8  16  20  23  27  30  32  34        17  19  21  23  25  27   29   31
16  16  23  24  29  31  34  38        19  21  23  25  27  28   29   33
20  23  27  28  30  35  38  40        21  23  25  27  29  30   32   37
23  24  28  29  35  39  40  44        23  25  27  30  31  34   40   45
27  29  30  35  39  42  45  50        25  27  29  31  38  46   54   60
30  31  35  39  42  46  54  59        27  28  30  34  46  58   72   74
32  34  38  40  45  54  62  72        29  29  32  40  54  72   90  100
34  38  40  44  50  59  72  84        31  33  37  45  60  74  100  124
```

*MATRIX **HVSGOOD**

```
 8  16  16  16  17  18  21   24       20  20  20  20  21  23   26   30
16  16  16  16  17  19  22   25       20  20  20  20  22  24   27   32
16  16  17  18  20  22  25   29       20  20  21  22  24  27   31   36
16  16  18  21  24  27  31   36       20  20  22  26  30  34   38   44
17  17  20  24  30  35  41   47       21  22  24  30  37  44   51   59
18  19  22  27  35  44  54   65       23  24  27  34  44  56   68   81
21  22  25  31  41  54  70   88       26  27  31  38  51  68   88  109
24  25  29  26  47  65  88  115       30  32  36  44  59  81  109  144
```

*MATRIX **HVSBETTER**

```
 8  16  16  16  17  18  21   24       19  19  19  19  20  22   25   29
16  16  16  16  17  19  22   25       19  19  19  19  20  23   26   30
16  16  17  18  20  22  25   29       19  19  20  21  23  26   29   34
16  16  18  21  24  27  31   36       19  19  21  25  28  32   37   42
17  17  20  24  30  35  41   47       20  20  23  28  35  42   48   56
18  19  22  27  35  44  54   65       22  23  26  32  42  53   64   77
21  22  25  31  41  54  70   88       25  25  29  37  48  64   83  104
24  25  29  36  47  65  88  115       29  30  34  42  56  77  104  137
```

*MATRIX **HVSBEST**

```
 8  16  16  16  17  18  21   24       18  18  18  18  19  21  23   27
16  16  16  16  17  19  22   25       18  18  18  18  19  21  24   29
16  16  17  18  20  22  25   29       18  18  19  20  22  24  28   32
16  16  18  21  24  27  31   36       18  18  20  24  27  30  35   40
17  17  20  24  30  35  41   47       19  19  22  27  33  39  46   53
18  19  22  27  35  44  54   65       21  21  24  30  39  50  61   73
21  22  25  31  41  54  70   88       23  24  28  35  46  61  79   98
24  25  29  36  47  65  88  115       27  29  32  40  53  73  98  129
```

*MATRIX **AVAMAT6**

```
 8 16 19 22 26 27 29 34        16 20 24 28 32 36 40 44
16 16 22 24 27 29 35 35        20 24 28 32 36 40 44 48
19 22 26 27 29 34 35 38        24 28 32 36 40 44 48 52
22 22 26 27 29 34 35 40        28 32 36 40 44 48 52 56
22 26 27 29 32 35 40 48        32 36 40 44 48 52 56 58
26 27 29 32 35 40 48 50        36 40 44 48 52 56 58 60
26 27 29 35 40 48 50 60        40 44 48 52 56 58 60 62
27 29 35 40 48 50 60 62        44 48 52 56 58 60 62 62
```

*MATRIX **AVAMAT7**

```
 8 16 19 22 26 28 32 38        16 20 24 28 36 42 46 52
16 16 22 24 28 32 38 44        20 24 28 36 42 46 52 58
19 22 26 28 32 38 44 48        24 28 36 42 46 52 58 62
22 22 26 32 38 44 48 54        28 36 42 46 52 58 62 68
22 26 32 38 44 48 54 64        36 42 46 52 58 62 68 78
26 32 38 44 48 54 64 74        42 46 52 58 62 68 78 88
32 38 44 48 54 64 74 84        46 52 58 62 68 78 88 99
38 44 48 54 64 74 84 94        52 58 62 68 78 88 99 99
```

*MATRIX **FOX1**

```
 8  8  9 11 13 13 14 17         8  8  8  9  9  9  9 10
 8  8 11 12 13 14 17 18         8  8  9  9  9  9 10 10
 9 11 13 13 14 17 17 16         8  9  9  9  9 10 10 10
11 11 13 13 13 17 18 20         9  9  9  9 10 10 10 10
11 13 13 13 16 17 20 24         9  9  9 10 10 10 10 11
13 13 13 16 17 20 24 29         9  9 10 10 10 10 11 11
13 12 13 17 19 23 28 34         9 10 10 10 10 11 11 11
12 13 17 19 23 28 34 41        10 10 10 10 11 11 11 11
```

* MATRIX **FOX2**

```
 8  8  9 11 13 13 14 17         8  8  9 10 11 12 12 12
 8  8 11 12 13 14 17 18         8  9 10 11 12 12 12 13
 9 11 13 13 14 17 17 16         9 10 11 12 12 12 13 14
11 11 13 13 13 17 18 20        10 11 12 12 12 13 14 15
11 13 13 13 16 17 20 24        11 12 12 12 13 14 15 16
13 13 13 16 17 20 24 29        12 12 12 13 14 15 16 16
13 12 13 17 19 23 28 34        12 12 13 14 15 16 16 16
12 13 17 19 23 28 34 41        12 13 14 15 16 16 16 16
```

* MATRIX **FOX3**

```
 8  8  9 11 13 13 14 17        16 16 16 16 16 16 16 16
 8  8 11 12 13 14 17 18        16 16 16 16 16 16 16 16
 9 11 13 13 14 17 17 16        16 16 16 16 16 16 16 16
11 11 13 13 13 17 18 20        16 16 16 16 16 16 16 16
11 13 13 13 16 17 20 24        16 16 16 16 16 16 16 16
13 13 13 16 17 20 24 29        16 16 16 16 16 16 16 16
13 12 13 17 19 23 28 34        16 16 16 16 16 16 16 16
12 13 17 19 23 28 34 41        16 16 16 16 16 16 16 16
```

Adaptive matrices

With HC021 you can change the matrices per GOP.
You have to write your own code to do so and create a DLL which should be named matrix.dll, this DLL
should be in the same directory as the HCenc executable.

The next (Fortran 90) example shows how to create the routine and how it should be called.

```
    subroutine EXTMATRIX(motion,luminance,intra,inter)

! input       - motion    integer*4          value 0 - 32 (0=low, 32=high)
! input       - luminance integer*4          averaged GOP luminance per pixel (0 - 255)
! input/output - intra    integer*2 array    intra matrix (64 values, row order)
! input/output - inter    integer*2 array    inter matrix (64 values, row order)

!DEC$ ATTRIBUTES DLLEXPORT:: EXTMATRIX          ! export routine

    integer*4 motion,luminance
    integer*2 intra(64),inter(64)

!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!                                                    !
! Example code for adaptive matrix DLL creation.     !
!                                                    !
! DLL: matrix.dll, should be in the same directory   !
! as the HCenc executable.                           !
!                                                    !
! This Fortran example adapts the intra and inter    !
! matrices dependent of source motion and luminance. !
! If the *ADAPTIVEMATRIX command is present,         !
! this routine is called at every GOP during the     !
! first pass so the matrices can change at every GOP.!
!                                                    !
! Of course you can create any matrix you want, to be!
! sure matrix values are valid, HCenc will limit all !
! values between 8 and 255 and set intra(1) to 8,    !
! just like the last 3 lines of code in this example.!
!                                                    !
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

! motion stuff
    if (motion <= 5) then
       a=1.-(5.-motion)/50.                 ! interpolate factor a to minimum = 0.9 for low motion
    else
       a=1.+(motion-5.)/270.                ! interpolate factor a to maximum = 1.1 for high motion
    endif

! luminance stuff
    b=1.
    if (luminance < 48) b=0.90              ! lower values for medium dark scenes
    if (luminance < 32) b=0.70              ! lower values for dark scenes

! adapt matrix
    intra=NINT(a*b*intra)                   ! set to nearest integer for whole intra matrix
    inter=NINT(a*b*inter)                   ! set to nearest integer for whole inter matrix

! scale values into "safe values"
    intra=MAX(intra,8); intra=MIN(intra,255)  ! scale intra values, 8 <= intra <= 255
    inter=MAX(inter,8); inter=MIN(inter,255)  ! scale inter values, 8 <= inter <= 255
    intra(1)=8                              ! first intra value should always be 8

    end
```

Note 1:   Entering the routine the matrices intra and inter will have the values as given in the inputfile.

Note 2:   This example code is just what it says, it's only an example how to create the routine, there's no
          guarantee this code will improve your encode.

Note 3:   Using Fortran it's not necessary to declare local variables, variables are declared implicit:
          all variables are real*4 except variables which start with i – n, these are integer*4.