Video Image Processing Technology

© 2007 Altera Corporation—Public

ADERA.

Agenda

- Key trend of "video in FPGA"
- Video image processing basics
 - Color space conversion
 - Chroma sampling
 - Scaling
 - Deinterlacing
 - Image blending
 - Filtering
 - Gamma correction

Conclusion



Key Trend for "Video in FPGA" – 1

High definition (HD) video is ~4x to 6x the size of standard definition (SD) video





Key Trend for "Video in FPGA" – 2

MPEG4-2, at a bit rate of 1.2Mbps Resolution (544 x 368) MPEG4-10, at a bit rate of 1.2Mbps Resolution (544 x 368)



HD → Dramatic Increase in Bits

Image size	Frame size: (Total # of pixels)	Frame size: (Assume 10 bits per pixel)	Data rate: (Assuming 60 frames per second (FPS))
1920 X 1080p	1920 x 1080 = 2.08M pixels	62 Mbits or 7.78 Mbytes	3,732 Mbps
1920 X 1080i	1920 x 1080 x 0.5 = 1.04M pixels	31 Mbits or 3.89 Mbytes	1,866 Mbps
1280 X 720p	1280 x 720 = 921K pixels	27.7 Mbits or 3.46 Mbytes	1,659 Mbps
SD 720 x 480i	720 x 480 x 0.5 = 173K pixels	5.2 Mbits or 0.65 Mbytes	311 Mbps

These numbers will change when we account for HSYNC and VSYNC signals, as well as for chroma downsampling

However, they are correct in a relative sense









Color Space: Basics



- A color space is a method by which we can specify, create, and visualize color
- Computers describe a color stimulus in terms of the excitations of red, green, and blue phosphors on the CRT faceplate
- Printers describe a color stimulus in terms of the reflectance and absorbance of cyan, magenta, yellow, and black inks on the paper



Color Space Conversion: Basics

Y = R*0.299 + G*0.587 + B*0.114 CR = R*(-0.169) + G*(-0.332) + B*0.500 + 128Cb = R*0.500 + G*(-0.419) + B*(-0.0813) + 128



© 2007 Altera Corporation—Public



RGB to YCrCb





Color Space Conversion IP

CSC Version 6.1 Parameter Summary Coefficients Trage Data Format Trage Data Format Trage poted por not Coor plane Configuration Color Plane Configuration Three color planes in sequence Three color planes in sequence Three color planes in sequence Three color planes in parallel Precision Word length Word length consists of an integer part and a fractional part.	🌂 MegaWizard Plug-In Manager - CSC		
Magetion Version 6.1 Parameter Simulation Setings Codeficients Image Data Format Select the size of the image Bits per pixel per color plane : Bits Color Plane Configuration Bits Color Plane in sequence Three color planes in sequence Three color planes in parallel Word length corresponds to the number of bits used by the multiplier. Word length corresponds to the number of bits used by the multiplier. Word length corresponds of an integer part and a fractional part.	CSC CSC	About Documentation	
Settings Model Image Data Format Select the size of the image Image resolution : Image resolution : Image resolution :	Megedore Version 6.1	Abour Bocumentation	
Coefficients Image Data Format Image Pata Format Bits per pixel per color plane : © Three color planes in sequence © Three color planes in parallel Precision Word Length Word length corresponds to the number of bits used by the multiplier. Word length corresponds to the number of bits used by the multiplier.	Settings Model		
Image resolution : Image r	General Coefficients		
Image resolution: Image resolution: Bits per pixel per color plane : Image resolution: Image resolution: Select bits per pixel Three color planes in sequence Three color planes in parallel Precision Word Length Word length corresponds to the number of bits used by the multiplier. Word length corresponds to the number of bits used by the multiplier.			Select the size of the image
Color Plane Configuration Color planes in sequence Three color planes in parallel Precision Word Length Word Length Word length corresponds to the number of bits used by the multiplier. Word length consists of an integer part and a fractional part.			Select bits per pixel Three
COTOT planes are assumed Three color planes in parallel Precision Word Length Word length corresponds to the number of bits used by the multiplier. Word length consists of an integer part and a fractional part.			color planes are assumed
C Three color planes in parallel Precision Word Length Word length corresponds to the number of bits used by the multiplier. Word length consists of an integer part and a fractional part.	O Three color planes in sequence		color planes are assumed
Precision Word Length Word length corresponds to the number of bits used by the multiplier. Word length consists of an integer part and a fractional part.	Three color planes in parallel		
Word Length Word length corresponds to the number of bits used by the multiplier. Word length consists of an integer part and a fractional part.			
Word Length Word length corresponds to the number of bits used by the multiplier. Word length consists of an integer part and a fractional part.	Precision		
Word length Word length corresponds to the number of bits used by the multiplier. Word length consists of an integer part and a fractional part.	-Weyd Longth		
Word length consists of an integer part and a fractional part.	Word length corresponds to the number of bits used by the multiplier.		
	Word length consists of an integer part and a fractional part.		
Please refer to the Video and Image Processing Suite User Guide for details. Select the precision	Please refer to the Video and Image Processing Suite User Guide for details.		Select the precision
Word length : 35 Bits of the multiplier	Word length : 35 Bits		of the multiplier
Integer part of word length : 10 Bits	Integer part of word length : 10 Bits Fractional part of word length : 25 Bits		or the manipher
Overflow behavior : Ignore	Overflow behavior : Ignore		
Underflow Behavior : Ignore	Underflow Behavior : Ignore		
Cancel < Back Next > Einish	Cance	el < <u>Back N</u> ext > <u>F</u> inish	

© 2007 Altera Corporation—Public



Color Space Conversion IP

MegaWizard Plug-In Manager - CSC CSC Version 6.1 Parameter Simulation Settings Coefficients Coorpile Time Coefficients Color model conversion : Custom Din and dout refer to the ir Studio R'G'B' to Y'CbCr: SDTV dout_0 = 0 Studio R'G'B' to Y'CbCr: SDTV VCbCr: HDTV to Studio R'G'B' Computer R'G'B' dout_1 = 0 Computer R'G'B' to Y'LV Gout_2 = 0 Y'LV to Computer R'G'B' Custom v	□× About Documentation * din_2 + 0 * din_2 + 0 * din_2 + 0 * din_2 + 0	Choose the color space conversion	
The core can automatically select the co-efficient, or you can enter custom co-efficient	MegaWizard Plug-In Manager - CSC CSC Version 6.1 1 Parameter Settings 2 Simulation Model 3 Summar General Coefficients - Coordinate Coefficients - - Color model conversion : Studio R'G'B' to Y Din and dout refer to the input and output of dout_0 = 0.299 dout_0 = 0.299 * din_0 + 0. dout_1 = -0.172 * din_0 + -0 dout_2 = 0.511 * din_0 + -0	<pre>//CbCr: SDTV //CbCr: SDTV</pre>	▲bout Documentation * din_2 + 0 * din_2 + 128 * din_2 + 128

© 2007 Altera Corporation—Public









- Per pixel
 - Y (10 bits)
 - Cr (10 bits)
 - Cb (10 bits)
- Total bits
 - 40 bits for Y
 - 40 bits for Cr
 - 40 bits for Cb
- 4:4:4 chroma subsampling
- Bits for 4 pixels: 120
- Bit/pixel = 30





- Per pixel
 - Y (10 bits)
 - Cr (10 bits)
 - Cb (10 bits)
- Drop Cr, Cb for alternate pixels, total bits
 - 40 bits for Y
 - 20 bits for Cr
 - 20 bits for Cb
- 4:2:2 chroma subsampling
- Bits for 4 pixels: 80
- Bit/pixel = 20

© 2007 Altera Corporation—Public





- Per pixel
 - Y (10 bits)
 - Cr (10 bits)
 - Cb (10 bits)
- Drop Cr, Cb for alternate pixels
- Drop Cr and Cb for the second line
- Total bits
 - 40 bits for Y
 - 10 bits for Cr
 - 10 bits for Cb
- 4:2:0 chroma subsampling
- Bits for 4 pixels: 60
- Bit/pixel = 15

© 2007 Altera Corporation—Public



Why Chroma Downsampling?

Image size	Frame size: (Total # of pixels)	Frame size: (Assume 10 bits per pixel and 4:4:4)	Frame size: (Assume 10 bits per pixel and 4:2:2)	Frame size: (Assume 10 bits per pixel and 4:2:0)
1920 X 1080p	1920 x 1080 = 2M pixels	60 Mbits	40 Mbits	30 Mbits
1920 X 1080i	1920 x 1080 x 0.5 = 1M pixels	30 Mbits	20 Mbits	15Mbits
1280 X 720p	1280 x 720 = 900K pixels	27 Mbits	18 Mbits	13.5 Mbits
SD 720 x 480i	720 x 480 x 0.5 = 173K pixels	5.19 Mbits	3.46 Mbits	2.595 Mbits



Chroma Resampling IP

📉 MegaWizard Plug	g-In Manaq	ger - Chroma Resampler	
MegaCore Ch	roma sion 6.1	Resampler	About Documentation
1 Parameter Settings	Simulation Model	3 Summary	
-Image Data Format-			
Image resolution :	:	1920×1080 💌	Pixels
Bits per pixel per (Color Plane Config	color plane : guration : Th	ree color planes in sequence	Conversion Format
Behavior			4:4:4 -> 4:2:2
Conversion format :		4:4:4 to 4:2:0 💌	4:4:4 -> 4:2:0
Horizontal interpolat	tion :	Linear	4:2:2 -> 4:4:4
Vertical interpolation	ר: 	Linear	4:2:0 -> 4:4:4
	Int 2D 2D	erpolation Ty LINEAR NEAREST N	ype IEIGHBOR

© 2007 Altera Corporation—Public



Calculating Data Rates

Image size	Frame size	Chroma sub sample/bits per color plane/FPS	Bit/s transfer rate
1920 x 1080p	2200 x 1125	4:2:2/10/60	2200 x 1125 x 20 x 60 = 2.97 Gbps
1920 x 1080i	2200 x 1125	4:2:2/10/60	2200 x 1125 x 20 x 60 x 0.5 = 1.485 Gbps
1280 x 720p	1650 x 750	4:2:2/10/60	1650 x 750 x 20 x 60 = 1.485 Gbps
720 x 480i	858 x 525	4:2:2/10/60	858 x 525 x 20 x 60 x 0.5 = 270 Mbps ∱
Sync data	Image D	ata 1080p-SDI* rate	e HD-SDI rate HD-SDI rate

SDI = serial digital interface

© 2007 Altera Corporation—Public



Scaling: Basics



D1/SDTV: 720 x 480



HDTV 1080p: 1920 x 1080

- Arbitrary input and output resolutions
- Bicubic, bilinear, and nearest neighbor
- Also with 7.1 \rightarrow multi-tap (polyphase scaling)
- Real-time control of the scaling co-efficiency

© 2007 Altera Corporation—Public



Scaling: Basics

- Nearest neighbor
 - Uses one pixel to generate the new pixel
- Bilinear
 - Uses up to 4 (2x2) pixels to generate the new pixel
- Bicubic
 - Uses up to 16 pixels (4x4) to generate the new pixel
- Multi-tap (polyphase ... coming in 7.1)
 - Uses any arbitrary window size (M x N) to generate the new pixel value



Nearest Neighbor Interpolation





Bilinear Interpolation





Scaling Comparison by Different Methods



Bitubit Scalingsr

© 2007 Altera Corporation—Public



Scaling: Basics

- Nearest neighbor
 - Uses one pixel to generate the new pixel
- Bilinear
 - Uses up to 4 (2x2) pixels to generate the new pixel
- Bicubic
 - Uses up to 16 pixels (4x4) to generate the new pixel
- Multi-tap (polyphase ... coming in 7.1)
 - Uses any arbitrary window size (M x N) to generate the new pixel value
 - Very useful when downscaling





Nearest Neighbor

The quick brown fox jumped over the laxy dog 25 The quick brown fox jumped over the laxy dog 34 The quick brown fox jumped over the laxy dog 32 The quick brown fox jumped over the laxy sog 22 The quick brown fox jumped over the laxy sog 22 The quick brown fox jumped over the laxy sog 18 The quick brown for jumped over the laxy sog 16 The put area to jumped over the laxy sog 16 The put area to jumped over the laxy sog 16 The put area to jumped over the laxy sog 16 The put area to jumped over the laxy sog 16 The put area to jumped over the laxy sog 16 The put area to jumped over the laxy sog 16

The quick brown fox jumped over the lazy dog 36 The quick brown fox jumped over the lazy dog 34 The quick brown fox jumped over the lazy dog 30 The quick brown fox jumped over the lazy dog 30 The quick brown fox jumped over the lazy dog 28 The quick brown fox jumped over the lazy dog 28 The quick brown fox jumped over the lazy dog 28 The quick brown fox jumped over the lazy dog 30 The quick brown fox jumped over the lazy dog 32 The quick brown fox jumped over the lazy dog 32 The quick brown fox jumped over the lazy dog 32 The quick brown fox jumped over the lazy dog 32 The quick brown fox jumped over the lazy dog 32 The quick brown fox jumped over the lazy dog 32 The quick brown fox jumped over the lazy dog 30 The quick brown fox jumped aver 40 The quick brown fox jumped aver 40 The quic





© 2007 Altera Corporation—Public



Bilinear

The quick brown fox jumped over the lazy dog 26 The quick brown fox jumped over the lazy dog 26 The quick brown fox jumped over the lazy dog 24 The quick brown fox jumped over the lazy dog 22 The quick brown for jumped over the lazy dog 20 The quick brown for jumped over the lay dog 10 The quick brown for jumped over the lay dog 10 The quick brown for jumped over the lay dog 10 The quick brown for jumped over the lay dog 10 The quick brown for jumped over the lay dog 10 The quick brown for jumped over the lay dog 10 The quick brown for jumped over the lay dog 10 The quick brown for jumped over the lay dog 10

The quick brown fox jumped over the lazy dog 36 The quick brown fox jumped over the lazy dog 32 The quick brown fox jumped over the lazy dog 30 The quick brown fox jumped over the lazy dog 30 The quick brown fox jumped over the lazy dog 28 The quick brown fox jumped over the lazy dog 26 The quick brown fox jumped over the lazy dog 26 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 20 The quick brown fox jumped over dog 20 The quick brown fox jumped over dog 20





© 2007 Altera Corporation—Public



5-Tap (5 x 5)

The quick brown fox jumped over the lazy dog 28 The quick brown fox jumped over the lazy dog 26 The quick brown fox jumped over the lazy dog 24 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 20 The quick brown fox jumped over the lay dog 10 The quick brown fox jumped over the lay dog 10 The quick brown for

> The quick brown fox jumped over the lazy dog 36 The quick brown fox jumped over the lazy dog 32 The quick brown fox jumped over the lazy dog 30 The quick brown fox jumped over the lazy dog 28 The quick brown fox jumped over the lazy dog 26 The quick brown fox jumped over the lazy dog 26 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 20 The quick brown fox jumped ove





© 2007 Altera Corporation—Public



9-Tap (9 x 9)

The quick brown fox jumped over the lazy dog 28 The quick brown fox jumped over the lazy dog 26 The quick brown fox jumped over the lazy dog 24 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 20 The quick brown fox jumped over the lazy dog 10 The quick brown fox jumped over the lazy dog 10 The quick brown fox jumped over the lazy dog 10 The quick brown fox jumped over the lazy dog 10 The quick brown fox jumped over the lazy dog 10 The quick brown fox jumped over the lazy dog 10 The quick brown fox jumped over the lazy dog 10 The quick brown fox jumped over the lazy dog 10 The quick brown fox jumped over the lazy dog 10 The quick brown fox jumped over the lazy dog 10

> The quick brown fox jumped over the lazy dog 36 The quick brown fox jumped over the lazy dog 32 The quick brown fox jumped over the lazy dog 30 The quick brown fox jumped over the lazy dog 28 The quick brown fox jumped over the lazy dog 26 The quick brown fox jumped over the lazy dog 26 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 22 The quick brown fox jumped over the lazy dog 20 The quick brown fox jumped over the lazy dog 20 The quick brown fox jumped over the lazy dog 30 The quick brown fox jumped aver the lazy dog 30 The quick brown fox jumped ave





© 2007 Altera Corporation—Public



Upscaling

400 x 300 scaled to 800 x 600





Different Upscaling Results





Upscaling: Things to Remember

- Generally you can get very good results with bicubic or 4-tap scaling
- There is not much improvement beyond 4x4



Interlace

First all odd lines scanned (1/60sec)



...then all even lines (1/60sec)



...presenting a full picture (1/30sec)



Progressive

All lines scanned in single pass ... presenting a full picture (1/60sec)









- Because of the time intermix (1 frame = field @time 't' + field @time 't+1/60') it is impossible to:
 - Deinterlace a frame AND
 - Keep 60 frames/second AND
 - Keep the full quality (=all information for a picture)
- You will have to alter at least one of those points
 - Except, when there is no motion

© 2007 Altera Corporation—Public



How do we deinterlace video?

- 'Bob' deinterlacing
- One field of the video is made into a complete frame
- Because each field has only half the lines of a full frame, additional scan lines have to be added to create a frame



© 2007 Altera Corporation—Public



Generating the additional scan line

- Duplication
- Interpolation





- How do we deinterlace video?
 - 'Weave' deinterlacing
 - This method simply combines the two fields into one frame
 - This methodology is good when there is not much motion between two successive fields
 - Weave leads to artifacts when there is motion





Deinterlacing: With Motion





Deinterlacing: Without Motion





Deinterlacing Applications

- Deinterlacing is used whenever you want to
 - Grab still image from video
 - Play video on a noninterlaced display
 - Compress video
- Applications
 - Video surveillance before compression/storage
 - Video conferencing to display on a non-interlaced screen
 - Broadcast before compression and video switching

💐 MegaWizard Plug-In Manager - Deinterlacer			<u>_ ×</u>
MegesCere Version 6.1	About	Documenta	ation
1 Parameter 2 Simulation 3 Summary Settings Model			
-Image Data Format]
Image resolution : 1920×1080) 🔻	Pixels	
Bits per pixel per color plane : 8	•	Bits	
Number of color planes in sequence : 3	•	Planes	
Behavior]
Deinterlacing method : Bob - Scanline D	uplication	-	
Base address of frame buffers : Bob - Scanline Du Bob - Scanline In	uplication Interpolation		
weave			
Cancel	< <u>B</u> ack	<u>N</u> ext >	<u>F</u> inish



Image Blending: For Onscreen Display (OSD) and Picture-in-Picture (PiP)





Alpha Image Blending: Basics

- Alpha image blending is the process of digitally assembling multiple images to make a final image
- The basic operation used is known as 'alpha blending', where an opacity value, 'α', is used to control the proportions of two input <u>pixel</u> values that end up a single output pixel
- Consider three pixels:
 - Foreground pixel, f
 - Background pixel, b
 - Composited pixel, c
- Also alpha (α) is the opacity value of the foreground pixel
 - α =1 for opaque foreground, α =0 for a completely transparent foreground



Alpha Blending: Basics

191	191	191	191	191	R
63	63	63	63	63	G
255	255	255	255	255	в

- The color is RGB (191, 63, 255)
- The alpha values go from 255 (fully opaque) to 0 (fully transparent)
- The actual resulting merged color is computed this way:
 - (image color × alpha) + (background color × (100% - alpha))





Alpha Image Blending: Basics

Composite RGB image can be calculated by





Alpha Blending IP Core

🗙 MegaWizard Plug-In Manager -	Alpha Blending Mix	er		
Alpha Blen Version 6.1	ding Mixe	r	About Documen	tation
1 Parameter Settings				
Image Data Format			_	
Number of lavers being mixed :	8	-		
_ Input Resolutions	р -			
Background image recolution:	1920×1080	Divels		
Laver 2 resolution :	64×64	Divela		
Layer 3 resolution :	128×128	Pivels		
Layer & resolution :	256×256	Divels		
Layer 5 resolution :	640×480	Divels		
Layer 6 resolution :	720×486	Divels		
Layer 7 resolution :	1280×720	Divels		
Eaver 7 resolution .	1920×1080	Divola		
r oreground image resolution .	192021000	FIXOIS		
Bits per pixel per color plane :	8	Bits		
Number of color planes in sequence :	3	✓ Planes		
	1-			
3ehavior				
🔽 Enable alpha blending				
Alpha bits per pixel : 2	*			
			Cancel	Einish

- In PIP, background video is played in the center of the screen, while smaller square video clips are played in corners of the screen
- Multi-layer mixing (2 to 8 layers)
- Every foreground layer can use a different alpha value to control its transparency, resulting in true image blending effects

© 2007 Altera Corporation—Public



Filtering in Video Image Processing (VIP)

- Various video image processing signal chains have to filter the input signals to
 - Remove noise
 - Smooth the image
 - Sharpen the image
 - Implement custom processing
- Altera[®] VIP solutions provide options to implement this filtering



2D Filtering to Enhance Images





2D Filtering to Enhance Images





2D Median Filter

- Noise gets introduced into video data set via any electrical system used for storage, transmission, and/or processing
- Median filtering is a simple and very effective noise removal filtering process
- Median filtering:
 - Each pixel is determined by the median value of all pixels in a selected neighborhood (mask, template, window)
 - The median value m of a population (set of pixels in a neighborhood) is that value in which half of the population has smaller values than m, and the other half has larger values than m



2D Filtering

- 2D finite impulse response (FIR) filter and 2D median filter
 - -3x3, 5x5, or 7x7 filter sizes

 Useful for noise reduction, smoothing, and edge enhancement

	FIR Filter	· 2D			About Degumentatio
MegaCore'	Version 6.1		_		
Settings	2 Simulation Model				
General	Coefficients				
-Image Data Fo	ormat				
Image resolution	on :	1024×768 • P	ixels		
Number of cold	or planes in sequence	: 3 💌 P	lanes		
Input			Output		
Bits per pixel	per color plane :	8	Bits Bits per pix	el per color plane :	8 -
Data type :		Unsigned 💌	Data type :		Unsigned 💌
🗌 🔲 Guard ba	ands	Max : 1 🔄	Guard	bands	Max: 1
		Min : 1	i i		Min : 1
		, –			, _
Precision					
The result of the	he FIR calculation is u ted coefficient cet re	nsigned binary fixed-point of sults will be in the range 0.0	lata with 8 magnitude 10 to 255 50 (to 2 daci	oits and 9 fraction t wal places)	oits.
with the select	ted coernicient sec, re	saits will be in the range o.c	a a a	nai piaces)	
The selected o	utput format is 8 bit u	insigned integers. No under	flow or overflow will oc	cur	
Discard fraction	n bits by :	Round values to neare:	st integer	Y	
Convert from s		: Replacing negative value	ues with zero	Y	
				_	
Constrain to ra	ange by :	Saturating to min and n	nax values	_	
izard Plug-In I FIR F	Manager - FIR Fil	lter 2D			
izard Plug-In I FIR F Version	Manager - FIR Fil Filter 2D 6.1	lter 2D			<u>A</u> bout <u>D</u> ocumentation
izard Plug-In I FIR F Version ter 2 Simul Mode	Manager - FIR Fil Filter 2D 6.1 lation 3 Summa	lter 2D			About Documentation
izard Plug-In FIR F Version ter 2 Simul Mode	Manager - FIR Fil Filter 2D 6.1 lation 3 Summa s	iter 2D ary			About Documentation
Example 2 Simulation Control Statement of Control S	Manager - FIR Fil Filter 2D 6.1 ation 3 Summ s	iter 2D ary			About Documentation
Izard Plug-In I FIR F Version Version Coefficient 3x3	Manager - FIR Fil Filter 2D 6.1 lation 3 Summers	ary	_		About Documentatio
Example 2 Coefficient	Manager - FIR Fil Filter 2D 6.1 Iation 3 Summ IS S	Iter 2D	_		About Documentatio
Example 2 Coefficient State 2	Manager - FIR Fil Filter 2D 6.1 Iaton 3 Summa S Simple Smoot	Iter 2D			About Documentation
Example 2 Coefficient State 2	Manager - FIR Fil Filter 2D 6.1 aton 3 Summe S S Simple Smoot Simple Shares	tter 2D			About Documentation
Example 2 Coefficient 3x3 Time Coefficient ent set : le symmetric mo	Manager - FIR Fil Filter 2D 6.1 1 1 5 5 5 5 5 5 5 5 5 5 5 5 5	tter 2D		_	Lebout Documentation
Example 2 Coefficient Sample 2 Coefficient	Manager - FIR Fil Filter 2D 6.1 atom ③ Summi Simple Smoot Simple Smoot Simple Smoot O.111328125	hing v hing v hing (1111)			About Documentation
izard Plug-In FIR F Version er Coefficient 3x3 Time Coefficient ert set : le symmetric mo 1111 3125	Manager - FIR Fil Filter 2D 6.1 atom ③ Surma S S S S S S S S S S S S S	ter 2D			About Documentation
Izard Plug-In FIR F Version er Smil Goefficient int act : le symmetric mo lilli 3125	Manager - FIR Fil Filter 2D 6.1 atom 3 Summ 5 5 5 5 5 5 5 5 5 5 5 5 5	ter 2D ary hing oj 1132812 oj 11128812 oj 11128812			About Documentation
Izard Plug-In FIR F Version Coefficient 3x3 Time Coefficient at set : le symmetric mo 1111 3125 1111 1125 1111	Manager - FIR Fil Filter 2D 6.1 atom 3 Summ 5 5 5 5 5 5 5 5 5 5 5 5 5	tter 2D ary hing ning 0.111280122 0.111280122 0.11128112 0.11128112			Legendreficient
izard Plug-In FIR F Version er 3x3 Time Coefficient int set : e symmetric mo 1111 3125	Manager - FIR Fil	ter 2D ary thing bing o)11526122 o)111526122 o)111526122 o)111526122 o)111526122			Lebout Documentation
izard Plug-In FIR F Version er 3x3 3x3 ime Coefficient int set : le symmetric mo 1111 1125	Manager - FIR Fil	ter 2D			Leventeen Levent
izard Plug-In FIR F Version Coefficient 3x3 Time Coefficient int set : le symmetric mo 1111 3125 1115 3125	Manager - FIR Fil	ter 2D			About Documentation
izard Plug-In FIR F Version and Coefficient Mode Coefficient ass ass ass ass ass ass ass ass ass as	Manager - FIR Fil Filter 2D 6.1 atom 3 Summ 5 5 5 5 5 6 5 5 5 6 5 5 5 5 5 5 5 5 5 5 5 5 5	ter 2D			About Documentation
Izard Plug-In FIR F Version er Smid 3x3 Time Coefficient ax3 Time Coeffi	Manager - FIR Fil	ter 2D ary hing of 111288122 of 111288122 of 111288122 of 111288122 of 111288122 of 111288122			About Documentation
Izard Plug-In FIR F Version er Coefficient 3x3 Time Coefficient int set : le symmetric mo 1111 3125 1111 1125 1111 1125 1111 1125 1111 1125 1111 1125 1111 1125 1111 1125	Manager - FIR Fil	ter 2D ary ting ing oillisation oillisation		tion bits :	▲bout Documentation
izard Plug-In FIR F Version er 3x3 Time Coefficient int set : le symmetric mo 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125	Manager - FIR Fil	ter 2D ary hing ning 0.11528122 0.11528122 0.11528122 0.11528122 0.11528122 0.11528122 0.11528122 0.11528122 0.11528122 0.11528122 0.11528122 0.11528122 0.11528122	1 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	tion bits :	Lever Desired Coefficient
Izard Plug-In FIR F Version er 3x3 ime Coefficient at set : le symmetric mo 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125 1111 3125	Manager - FIR Fil	ter 2D		tion bits :	Lever Desired Coefficient
izard Plug-In FIR F Version er 3x3 3x3 ime Coefficient int set : le symmetric mo 1111 125 1111 125 nt Precision — d word length of r	Manager - FIR Fil	ter 2D	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	tion bits :	Labout Documentation About Decimentation Key Desired Coefficient Actual Coefficient 9 ∰ Bits



2D Median Filter IP

- The 2D Median Filter MegaCore[®] function provides a means to perform 2D median filtering operations using matrices of 3×3, 5×5, or 7×7 kernels
- Each output pixel is the median of the input pixels found in a 3x3, 5x5, or 7×7 kernel centered on the corresponding input pixel
- Where this kernel runs over the edge of the input image, zeros are filled in

🌂 MegaWizard Plug-In Manager - Median Filter 2D
Median Filter 2D Version 6.1 <u>About</u> <u>Documentation</u>
1 Parameter 2 Simulation 3 Summary Settings Model
Image Data Format
Image resolution : 1920×1080 Pixels
Bits per pixel per color plane : 8 💽 Bits
Number of color planes in sequence : 3 Planes
Behavior Filter size : 3x3 Pixels 3x3 5x5 7x7
Cancel < Back Next > Finish



Gamma Correction: Basics

- There is a nonlinear relationship between pixel value and its displayed intensity on a monitor
- This nonlinear relationship is roughly a power function displayed_intensity (L) = pixel_value (V)^gamma





Gamma Correction: Basics

To correct this annoying little problem, the input signal to the monitor (the voltage) must be "gamma corrected"





Gamma Correction: Basics







VIP Basics – Summary

Core	Function
Color space converter	Converts image data between a variety of different color spaces
Chroma resampler	Changes the sampling rate of the chroma data for image frames
Scalar	Resizes and clips image frames
Deinterlacer	Converts interlaced video formats to progressive video format
Alpha blending mixer	Mixes and blends multiple image streams, including PIP
2D filter	Implements a 3x3, 5x5, or 7x7 FIR filter on an image data stream to smooth or sharpen images
Gamma corrector	Performs gamma correction on a color space



DSP Total Solutions





Summary

Key trend of "video in FPGA"

- SD transitions to HD
- MPEG4-2 moves to MPEG4-10
- Video image processing technology consists of:
 - Color space conversion
 - Chroma sampling
 - Scaling
 - Deinterlacing
 - Image blending
 - Filtering
 - Gamma correction

Altera provides total solution for video image processing technology

