Chroma Key Compositing with FPGA

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Daniel H. Moon
Thipok (Ben) Rak-amnouykit
Chroma Key Compositing

A special effects technique

The “Green Screen” technique

Replaces a specific “color” in a video feed with an image or another video feed
Traditional Method for CKC

Editing happens after video is taken

Use software to process the video
How about with hardware?

Replicate Chroma Key Compositing on an FPGA

Process video feeds in **real-time**
Overview

Receive a video feed with Chroma Key background

Identify the Chroma Key pixels

Replace the pixels with a static image or another video
I – Camera Selection

NTSC camera:

- Low resolution
- Auto-gain to adjust saturation
- Output data in YCbCr format
II – Memory Management with DDR RAM

- External Flash Memory – to store image data
- Image FSM – to load image at startup
- External DDR RAM – to store video data

- Memory Arbiter Module
  1. Coordinate data storage of the video feed and image
  2. Assign storage address to each video pixel
  3. Interface with the RAMs
III – Compositing Selector

Selector Module:

• Basic – compare and replace selected pixel
• Advanced – implement morphological processing
IV – Zooming In and Out

Zero-order Hold Interpolation
The Block Diagram

Video System

Video Feed with Chroma Key

NTSC

YCbCr[15:0]

NTSC CLK

Memory

Within FPGA

Memory Arbiter

Flash Memory

HSV[15:0]

Addr[18:0]

Zoom

Image FSM

Addr[18:0]

Flash CLK

DDR

DDR CLK

Selector

FIFO

RGB[23:0]

HSV to RGB

sel_out[15:0]

Selector Mix

data_in[15:0]

data_out[15:0]

data_reg

FIFO

RGB[23:0]

VGA Display

VGA CLK
Module I – Video System
Module II - Memory

Within FPGA:
- YCbCr to HSV
- Addr. Counter
- Button_Up, Button_Down
- Zoom
- Addr[18:0], HSV[15:0]
- Memory Arbiter
- addr_write[18:0], data_in[15:0], addr_read[18:0], data_out[15:0]
- DDR
- DDR CLK
- Selector Mux
- HSV to RGB
- feed_out[15:0]
- data_req
- Feed_out[15:0]
Module III - Selector
Testing

Test and debug each module separately

1. Video System Module
   - HSV pixel streaming with logic analyzer

2. Memory Module
   - Data storage and retrieval

3. Selector Module
   - Output resulting composite video on VGA monitor
Testing

Integrate all modules and test with:

1. Video feed with Chroma Key screen + Static Image

2. Video feed with Zoom – in/out
Testing

Integrate all modules and test with:

3. Video feed with Chroma Key screen + Zoom – in/out + Morphological image processing
# Timeline

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Conclusion

Chroma Key Compositing using the FPGA:
Eliminating the need for post-processing

Features
Chroma Key selection, Zooming, and Morphological processing

Hardware
Chroma Key Screen, NTSC, DDR RAM, and Flash memory.

Modules
Video System, Memory Arbiter, and Selector
Image Sources

Slide 3: http://www.aimersoft.com/blog/wp-content/uploads/2014/05/chroma-key.jpg
Slide 6: http://www.intertest.com/media/images/Wat-250D2-cameras.jpg
Slide 7: http://www.bechtle.co.uk/medias/HTULxBTRBTG57M5NkJYV58-30.jpg
Slide 8: http://images2.memedroid.com/images/UPLOADED24/518849d96e228.jpeg
Slide 15: http://www.hdwallpapers.in/walls/windows_xp_bliss-wide.jpg