ROSE-HULMAN INSTITUTE OF TECHNOLOGY

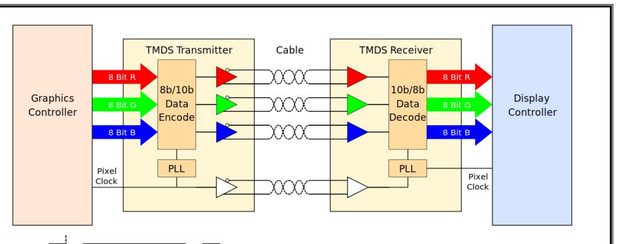
ECE Department

Real Time Image Process

Ryunosuke Murakami
murakar@rose-hulman.edu
Kuangyi Lu
luk@rose-hulman.edu
Rose- Hulman Institute of Technology

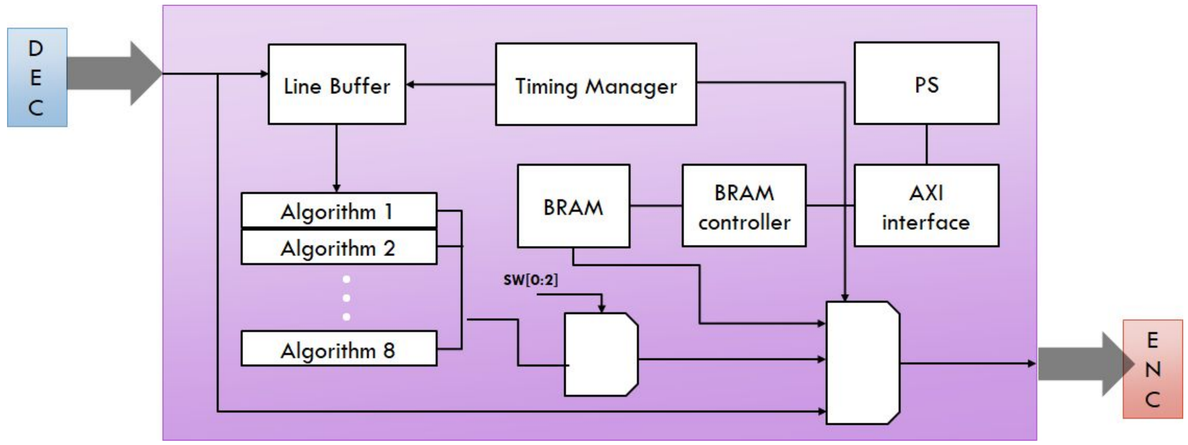
ECE530
Software and Hardware Co-Design with Zybo
Instructor: Jianjian Song

TMDS Video Format



- Data output is controlled with video active signal
- Hsync indicate line end
- Vsync indicate frame end

Overview of System

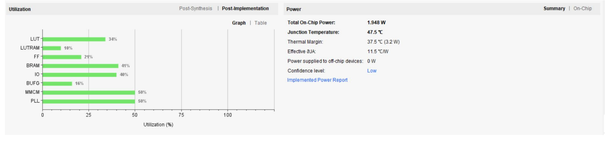


Line Buffer

- Store pixel data into memory cell
  - memory cell size 1280
- 4 lines of memory module is used
  - 3 lines for img process algorithm
  - 1 line for storing ongoind pixel
- Each line buffer rotates when its memory cell is full stored.

PL Design

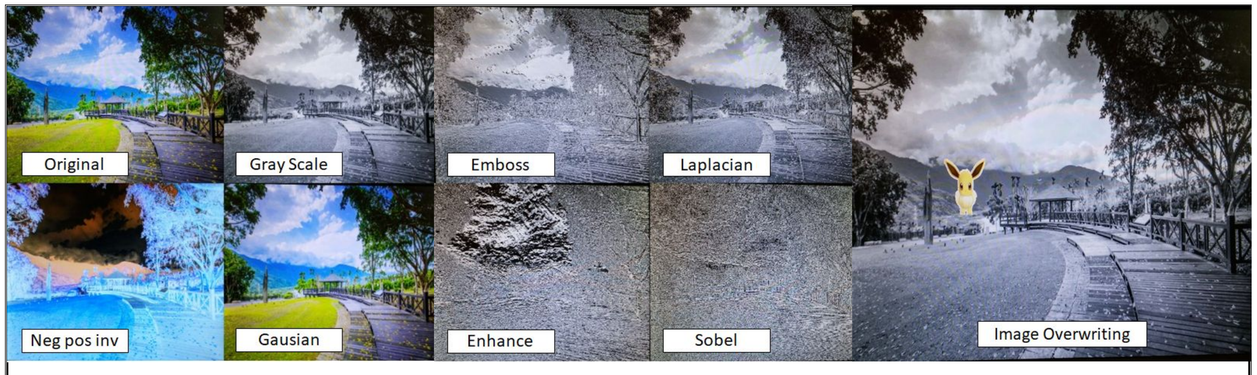
- TMDS image processing system was designed with verilog HDL with
  - 4 line line Buffer
  - Image Processing algorithm
  - TMDS Timing Manager



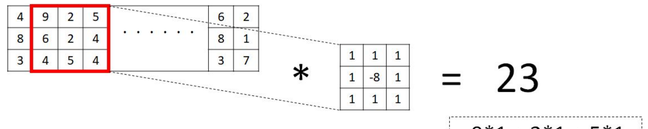
PS Function

- Image overwrite function was implemented, which display image data stored in BRAM
- Zynq PS write image data into BRAM via SDK
- AXI 4 interface is used to connect Zynq PS and BRAM via BRAM controller module

Image Process Algorithms



- Pixel wise and Window wise algorithms were implemented
- 3x3 filter (Convolution operation) was applied



3x3 window size Laplacian filter operation

- Applied Algorithms
  - Gray Scale:
    - Color to balck and white
  - Neg Pos Inv:
    - Invert luminance
  - Gausian filter:
    - smoothing effect (σ=1.3)
  - Emboss filter:
    - emphasize emboss outline
  - Laplacian filter:
    - Edge detection
  - Sobel filter:
    - Edge detection + emboss

TMDS Timing Manager

- Manage current position of output
  - count Horizontal address with pixel clock from TMDS
  - count Verical address with active of Horizontal Synchronization pulse
  - Current position will be reser with Vertical Synchronization pulse

BRAM

- Image data is stored from SDK
  - can change contents without synthesizing
- Connected with both PS and PL module
  - PS connection: via AXI interface
  - PL connection: Image Process