A Study on Real-time Retinex Video Image Enhancement

- Adaptive image enhancement
  - Since each pixel value is adjusted based on the surrounding pixels' value, each region in an image can be properly corrected.
- Drawbacks in its hardware implementation
  - High computational cost and iterative procedures

Input image

A result of non-adaptive image enhancement

A result of adaptive image enhancement

- This work

  focuses on an efficient hardware architecture for real-time adaptive video enhancement based on the Retinex theory and its QP (quadratic programming) model.

Image Enhancement based on the Retinex theory

- Retinex theory – by Land and McCann

Input image $I(x,y)$ = Illumination image $L(x,y)$ × Reflectance image $R(x,y)$

(Output of enhancement)

<Reflectance Image $R(x,y)$>
Illumination-independent “Original” image

Procedure
1. Estimate illumination image L from input image
2. Obtain R by subtract L component from input image I

$$R(x,y) = \exp\{\log(I(x,y)) - \log(L(x,y))\}$$

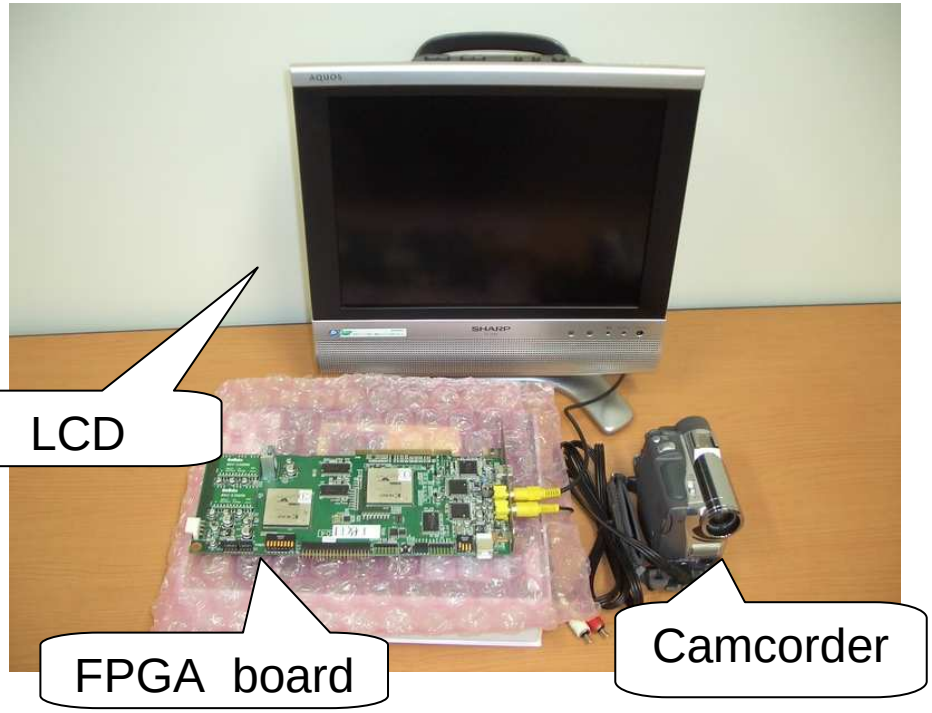
- QP (quadratic programming) model
  - One of the schemes to estimate illumination image.
  - The following cost function is minimized, assuming the smoothnes of illumination image.

$$F[l] = \int_{\Omega} (|\nabla l|^2 + \alpha(l-i)^2 + \beta|\nabla(l-i)|^2)dxdy$$

i : log I , l : log L

FPGA Implementation result

- FPGA: Xilinx Virtex2
- Maximum frequency：54MHz
- Memory usage: 342kbits
- I/O: NTSC (720x480, 30fps) YCbCr 4:2:2



Input image

Output image