Image Processing

CSCI 4239/5239
Advanced Computer Graphics
Spring 2014

Types of Image Processing

- Sample texture to generate image
  - Texture can be read from file
  - Generate texture on pass 1, process on pass 2
- Combing values from different textures
  - Differencing/merging images
- Combining surrounding values from one texture
  - Sharpen, blur, erosion, dilation, ...
  - Edge detection
  - Anti-aliasing

Image Processing by Shader

- Pixel value based on the pixels in the vicinity
  - Weighted average of group of pixels
    - Sum of weights should be one
    - Weights may be negative
  - Edge detection
    - Sum of weights should be zero
    - Some weights must be negative
- Fragment processing can get values from a texture by sampling
  - Need the image in a texture
  - For interactive graphics, need image -> texture

OpenGL Implementation

- Draw the scene
- Copy scene to texture
  - glCopyTexImage2D
  - Set pixel spacing
- Apply processing to texture
  - Identity projection
  - Draw quad size of window
  - Sample pixel from texture
- Can do multiple iterations

Framebuffer Implementation

- Procedure remains the same
  - Draw the scene to texture framebuffer
  - Apply processing to (framebuffer) texture
- Very efficient
  - No need to move buffers to and from video card
- Simple to implement
  - Allocate and size buffer
  - Switch destination with glBindFrameBuffer

Image Filters

- Sharpen (sum of weights=1)

```
-1  -1  -1
-1   9  -1
-1  -1  -1
```

- Blur (sum of weights=1)

```
1  2  1
2  1  2   /  13
1  2  1
```

- Erosion (minimum)
- Dilation (maximum)

Edge Detection

- Laplacian (sum of weights=0)

$$\begin{matrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{matrix}$$

- Prewitt $\sqrt{H^2+V^2}$

$$H = \begin{matrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{matrix} \qquad V = \begin{matrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{matrix}$$

- Sobel $\sqrt{H^2+V^2}$

$$H = \begin{matrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{matrix} \qquad V = \begin{matrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{matrix}$$

Anti-Aliasing

- Draw image at higher resolution to FBO
  - FBO dimensions integer multiple of screen
  - 1024x768 => 2048x1536 or 4068x3072
- Use shader to average FBO pixels
  - 2x2 (1/4 each) or 4x4 (1/16 each)
- Lines need to be drawn thicker, text and raster operations enlarged

Real Time Image Processing

- Same shaders as post-processing
- Use OpenCV to capture camera images
  - cvCreateCameraCapture()
  - cvQueryFrame()
  - glTexImage2D()
- Set frame rate with glutTimerFunc()

Inter-image processing

- Often used to detect differences
  - Image registration is critical
- Can be used to merge images
  - Monochrome images to color
  - Image enhancement

Assignment 7: Image Processing

- Use a shader to do image processing
  - Spatial transformation (sharpen, ...)
  - Color transformation
  - Resampling (e.g. anti-aliasing)
  - Multi-image operations
  - Special effects (lens flare)
- Can be on a generated scene or existing image (e.g. video feed)