Climb
A Generic and Dynamic Approach to Image Processing

Christopher Chedeau

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Introduction

- Climb: Common Lisp image processing
- Same Genericity as Olena\(^1\)
- With more Interactivity

\(^1\)olena.lrde.epita.fr
Erosion
  Definition
  Naive Version
  Genericity Issues
  Final Version

Morpher
  Morpher Definition
  Content Morpher
  Combination

Demonstration

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Erosion Definition

"All the pixels are replaced by the minimum value of the pixels around."
Erosion Example

Dilation Example

Naive Boolean 2D Version

```c
// Loop through all the valid image pixels
for (x = 0; x < img_width; ++x)
    for (y = 0; y < img_height; ++y)

    // Initialize the output image
    new_image[x][y] = TRUE;

// Loop through all the neighborhood pixels
neighborhood:
    for (i = -neighb_width; i <= neighb_width; ++i)
        for (j = -neighb_height; j <= neighb_height; ++j)
            if ((x + i >= 0 && x + i < img_width) &&
                (y + j >= 0 && y + j < img_height))

            /* Algorithm */
            if (old_image[x + i][y + j] == FALSE)
                new_image[x][y] = FALSE;
                break neighborhood;
```

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Genericity Issues

- Image Structure
- Neighborhood

![Image Structure](8-connexity 4-connexity Custom)

- Algorithm
  - Difference between erosion and dilation? Min / Max
  - Accumulator
  - Black Box: Many inputs, Compute a result

- Value Type
  - Bool, Gray, RGB, ...
  - Specialize the Accumulator
Final Version

```lisp
(defun erosion (img neighb)
  (image-map img
    (accu-reduce neighb
      (min-accu))))
```

- Readable Algorithm
- Small Functions: Easily Unit Testable
- Extensible
- Write Once, Support Everything
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Definition

- Alter communication protocol
- Non intrusive, Transparent, Memory Free
- Glue between Objects
RGB to Gray Implementation

(make-direct-value-morpher-image
  (lambda (gray) (vector gray gray gray gray gray))
  (lambda (rgb) (/ (reduce #'+ rgb) 3)))
Content Morpher

- Work on Sets
- Restriction

- Custom-shaped Site Set
- Cropped Image

- Addition
  - Image Border
- Ordering
Possibilities: Combination of ...

- Concrete Objects
- Value Morpher
- Content Morpher
- Repetition
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(defparameter lena (load-image "lena.png" :magick))

(defparameter gray
  (make-direct-value-morpher-image lena
    (lambda (gray) (vector gray gray gray))
    (lambda (rgb) (/ (reduce #'+ rgb) 3))))

(defparameter c8 (make-box (make-point -1 -1) (make-point 1 1)))
(defparameter c4 (site-set-mask c8 #*[010111010])

(defparameter ero (erosion gray c4))
(defparameter dil (dilation gray c4))
(defparameter diff (image-combine-values #'- dil ero))

(defparameter final (image-combine-values
  (lambda (rgb edge)
    (if (> edge 50) (vector 255 0 0) rgb))
  lena diff))

(save-image final "final.png" :png)
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- Personal Additions:
  - Fusion of Olena Concepts with Functional and Dynamic Programming
  - Developer Friendly
- Current
  - Basic Morphological Operators
  - Morpher System
- Future
  - Genericity on Value Types
  - More Algorithms and Image Types
  - Performance
Questions

Questions?
Bibliography