

Computer graphics

Image Arithmetic

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Overview

- 1 Introduction
 - Objectives
- 2 Pixel multiplication
 - Definition
 - Examples
- 3 Pixel division
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 - Change detection
 - Change detection
- 4 Blending
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Objectives

- Understand about the arithmetic between images.

Objectives

- Understand about the arithmetic between images.
- Learn addition, subtraction, multiplication, division and blending between images.

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Pixel multiplication

Definition

The first form takes two input images and produces an output image in which the pixel values are just those of the first image, multiplied by the values of the corresponding values in the second image. The second form takes a single input image and produces output in which each pixel value is multiplied by a specified constant.

Pixel multiplication

Definition

$$Q(i, j) = P_1(i, j) * P_2(i, j) \quad (1)$$

Pixel multiplication

Definition

$$Q(i, j) = P_1(i, j) * P_2(i, j) \quad (1)$$

$$Q(i, j) = P_1(i, j) * C \quad (2)$$

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Pixel multiplication

Examples



Figure: Original image.



Figure: Original image * 3.

Pixel multiplication

Examples



Figure: Original image.

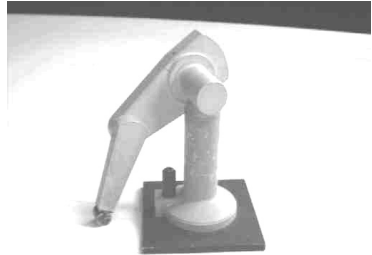


Figure: Original image * 3.

Pixel multiplication

Examples



Figure: Original image.



Figure: Original image * 3.

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Pixel division

Definition

The image division operator normally takes two images as input and produces a third whose pixel values are just the pixel values of the first image divided by the corresponding pixel values of the second image.

Pixel division

Definition

$$Q(i, j) = P_1(i, j) / P_2(i, j) \quad (3)$$

Pixel division

Definition

$$Q(i, j) = P_1(i, j) / P_2(i, j) \quad (3)$$

$$Q(i, j) = P_1(i, j) / C \quad (4)$$

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Pixel division

Change detection

We could use division to detect changes between frames.



Figure: Frame 1.



Figure: Frame 2.

Pixel division

Change detection

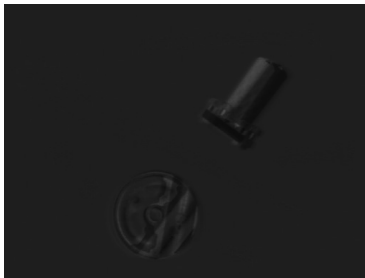


Figure: (Frame 1 / Frame 2)*30.

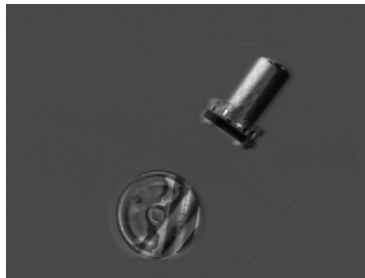


Figure: After contrast stretching.

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Pixel division

Segmentation of Characters

Suppose we want to segment the characters, the result will be:

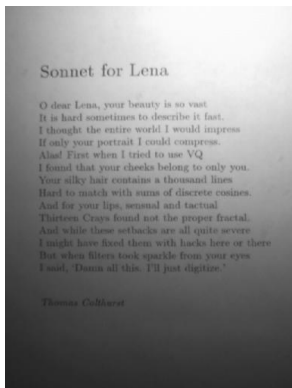


Figure: Photo.

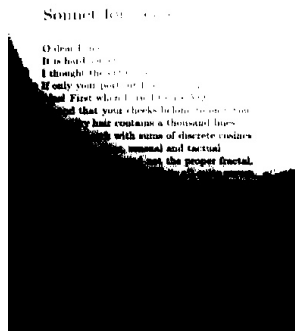


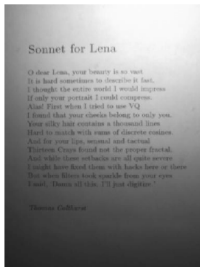
Figure: Thresholding ($\theta = 127$).

Pixel division

Segmentation of Characters

$$I' = (I - \min) \frac{\text{newMax} - \text{newMin}}{\text{max} - \min} + \text{newMin}$$

Photo



White paper



Result

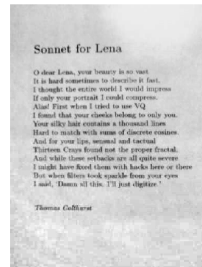


Figure: Division and scaling to [0-255]

Pixel division

Segmentation of Characters

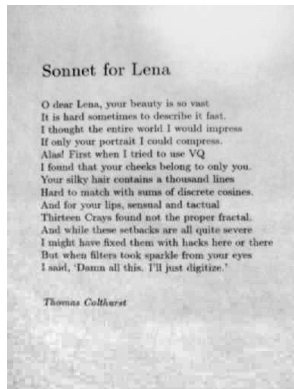


Figure: Division.

Sonnet for Lena

O dear Lena, your beauty is so vast
 It is hard sometimes to describe it fast.
 I thought the entire world I would impress
 If only your portrait I could compress.
 Alas! First when I tried to use VQ
 I found that your cheeks belong to only you.
 Your silky hair contains a thousand lines
 Hard to match with sums of discrete cosines.
 And for your lips, sensual and tactual
 Thirteen Crays found not the proper fractal.
 And while these setbacks are all quite severe
 I might have fixed them with hacks here or there
 But when filters took sparkle from your eyes
 I said, 'Damn all this. I'll just digitize.'

Thomas Colthurst

Figure: Thresholding ($\theta = 170$).

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Blending

Definition

This operator forms a blend of two input images of the same size. Similar to pixel addition, the value of each pixel in the output image is a linear combination of the corresponding pixel values in the input images. The coefficients of the linear combination are user-specified.

$$Q(i, j) = X * P_1(i, j) + (1 - X) * P_2(i, j) \quad (5)$$

Blending

Examples



Figure: The images for blending

Blending

Examples



Figure: Blending with $X = 0.25$.

Blending

Examples



Figure: Blending with $X = 0.5$.

Blending

Examples



Figure: Blending with $X = 0.75$.

Blending

Examples



Figure: Blending.

Questions?

