

# Computer graphics

## Image Arithmetic

MSc. Vicente Machaca Arceda

Universidad Nacional de San Agustín de Arequipa

May 16, 2020

# Overview

- 1 Introduction
  - Objectives
- 2 Pixel addition
  - Definition
  - Examples
  - Colors
- 3 Pixel Subtraction
  - Definition
  - Characters segmentation
  - Change detection

# Table of Contents

- 1 Introduction
  - Objectives
- 2 Pixel addition
  - Definition
  - Examples
  - Colors
- 3 Pixel Subtraction
  - Definition
  - Characters segmentation
  - Change detection

# Objectives

- Understand about the arithmetic between images.

# Objectives

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

# Table of Contents

- 1 Introduction
  - Objectives
- 2 Pixel addition
  - **Definition**
  - Examples
  - Colors
- 3 Pixel Subtraction
  - Definition
  - Characters segmentation
  - Change detection

# Pixel addition

## Definition

This operator takes as input two identically sized images and produces as output a third image of the same size as the first two. Each pixel value is the sum of the values of the corresponding pixel from each of the two input images.

# Pixel addition

## Definition

Normal addition :

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



# Pixel addition

## Definition

Normal addition :

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

Almost always, we need to scale the image:

$$Q(i, j) = P_1(i, j)/2 + P_2(i, j)/2 \quad (2)$$

# Pixel addition

## Definition

Normal addition :

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

Almost always, we need to scale the image:

$$Q(i, j) = P_1(i, j)/2 + P_2(i, j)/2 \quad (2)$$

Also, we could add a constant value:

$$Q(i, j) = P_1(i, j) + C \quad (3)$$

# Table of Contents

- 1 Introduction
  - Objectives
- 2 Pixel addition
  - Definition
  - **Examples**
  - Colors
- 3 Pixel Subtraction
  - Definition
  - Characters segmentation
  - Change detection

# Pixel addition

## Example with scaling



Figure: Example of pixel addition using Equation 5. OpenCV limits the values to [0-255] (int8).

# Pixel addition

Example without scaling



Figure: Example of pixel addition using Equation 5. We cast the image to int, before the adding operation.

# Pixel addition

## Example with scaling

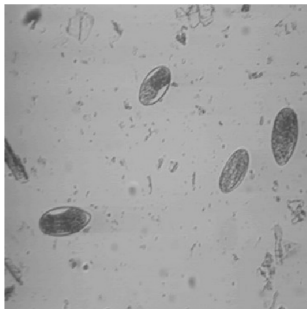


Figure: Example of pixel addition using Equation 2.

# Pixel addition

Image plus constant

Original



Original + 50

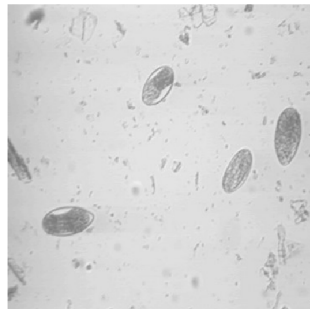
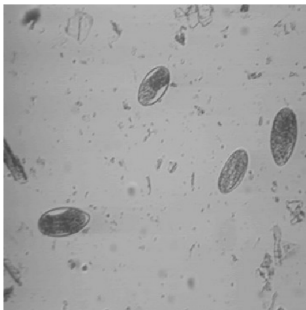


Figure: Adding a constant to a image.

# Pixel addition

Image plus constant

Original



Original + 100 (OpenCV)

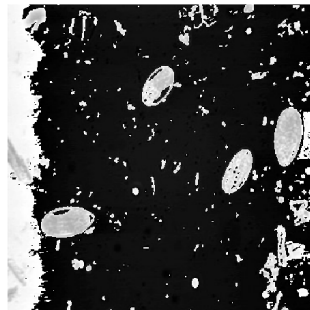


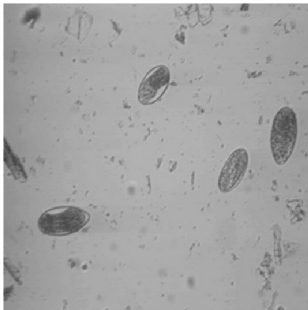
Figure: If you use OpenCV, this problem could occurs. It is because OpenCV limits the pixel values to [0-255].



# Pixel addition

Image plus constant

Original



Original + 100

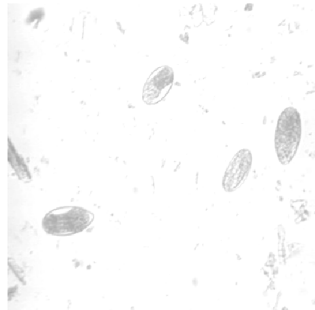
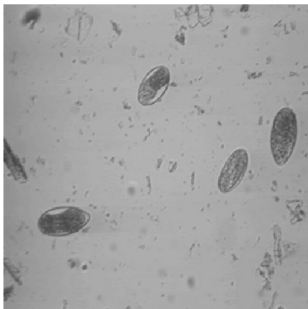


Figure: Before add a constant, cast the image type to int (`img = img.astype(int)`).

# Pixel addition

Image plus constant

Original



Original\*0.8 + 100

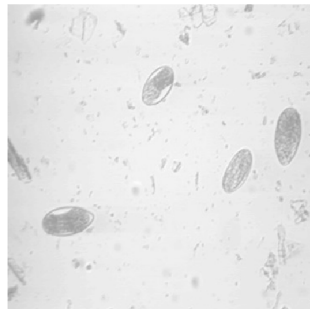


Figure: We scale the image before adding a constant.

# Pixel addition

Image addition with colors



Figure: Two images for addition.

# Table of Contents

- 1 Introduction
  - Objectives
- 2 Pixel addition
  - Definition
  - Examples
  - **Colors**
- 3 Pixel Subtraction
  - Definition
  - Characters segmentation
  - Change detection

# Pixel addition

Image addition with colors



Figure: Addition of two images with colors.

# Table of Contents

- 1 Introduction
  - Objectives
- 2 Pixel addition
  - Definition
  - Examples
  - Colors
- 3 Pixel Subtraction
  - **Definition**
  - Characters segmentation
  - Change detection

# Pixel subtraction

## Definition

The pixel subtraction operator takes two images as input and produces as output a third image whose pixel values are simply those of the first image minus the corresponding pixel values from the second image.

# Pixel subtraction

## Definition

$$Q(i, j) = |P_1(i, j) - P_2(i, j)| \quad (4)$$

$$Q(i, j) = |P_1(i, j) - C| \quad (5)$$



# Pixel subtraction

## Example

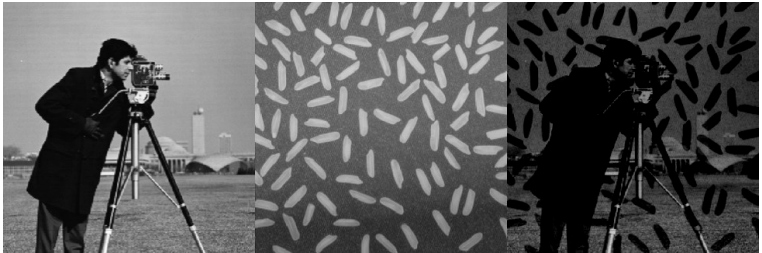


Figure: Example of subtraction operator.

# Table of Contents

- 1 Introduction
  - Objectives
- 2 Pixel addition
  - Definition
  - Examples
  - Colors
- 3 Pixel Subtraction
  - Definition
  - **Characters segmentation**
  - Change detection

# Pixel subtraction

## Applications - Segmentation of Characters

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

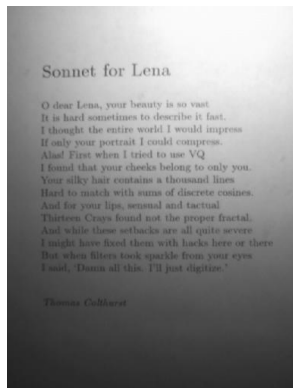


Figure: Photo.

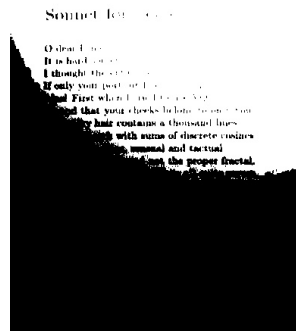


Figure: Thresholding ( $\theta = 127$ ).

# Pixel subtraction

## Applications - Segmentation of Characters

We could take a photo of a white paper to apply subtraction:

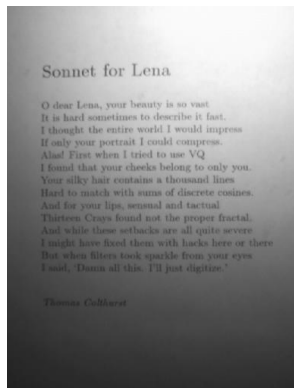


Figure: Photo.

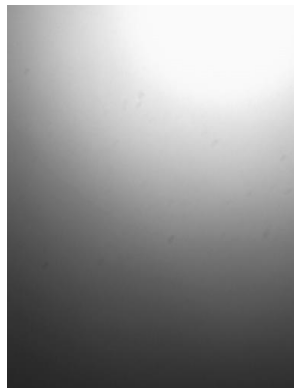


Figure: Photo of white paper.

# Pixel subtraction

## Applications - Segmentation of Characters

We take the normal photo and subtracts the white paper photo to get a new image:

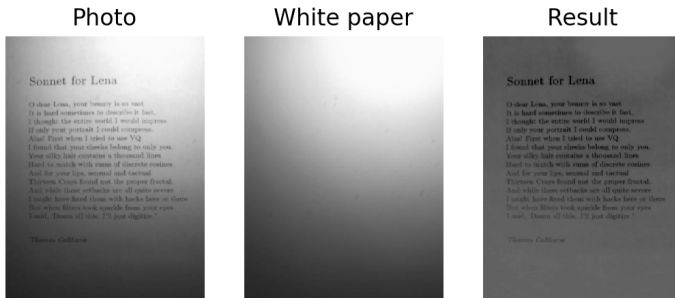


Figure: Result after applying subtraction and an addition of 100 to avoid negative values.

# Pixel subtraction

## Applications - Segmentation of Characters

Then we apply thresholding with  $\theta = 80$

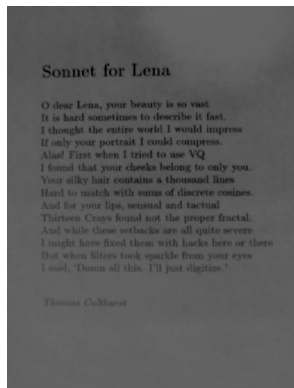


Figure: Difference

### 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 Callagret

Figure: Thresholding ( $\theta = 80$ ).

# Pixel subtraction

## Applications - Segmentation of Characters

### Comparison:

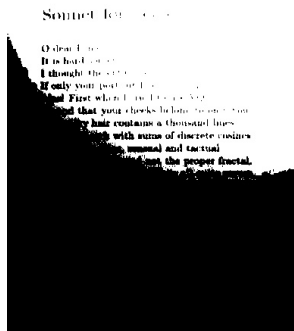


Figure: Without subtraction.

### Sonnet for Leda

O dear Leda, 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 possess.  
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, unusual and tactual  
Thirteen Crays found not the proper fractal.  
And while these aesthete 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'd just digitize."

E. E. Cummings

Figure: With subtraction.

# Table of Contents

- 1 Introduction
  - Objectives
- 2 Pixel addition
  - Definition
  - Examples
  - Colors
- 3 Pixel Subtraction
  - Definition
  - Characters segmentation
  - **Change detection**



# Pixel subtraction

Applications - Change detection

We could use subtraction to detect changes between frames.



Figure: Frame 1.



Figure: Frame 2.

# Pixel subtraction

Applications - Change detection



Figure:  $|\text{Frame 1} - \text{Frame 2}|$  and contrast stretching.

# Questions?

