Computer Vision

Enhancement techniques Segmentation

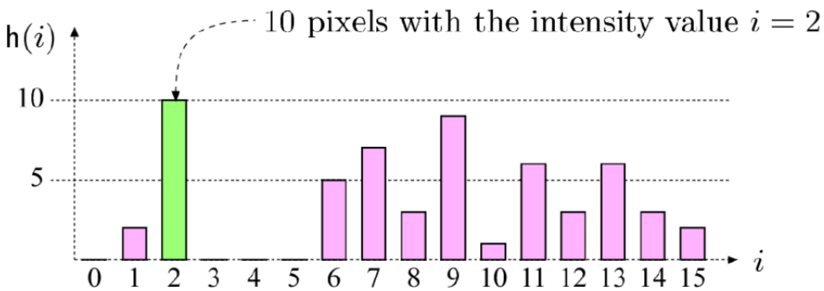
Fátima Leal

DCT DEPARTAMENTO CIÊNCIA E TECNOLOGIA

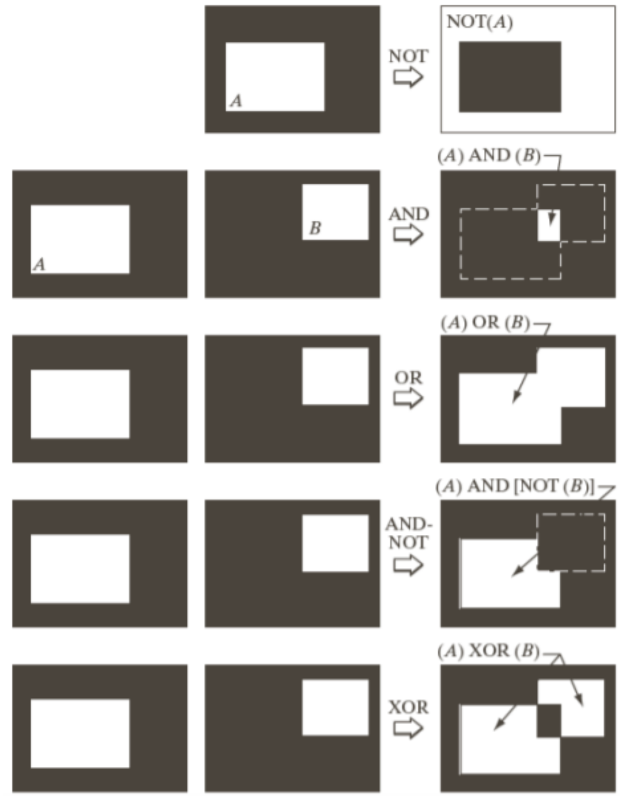
UPT UNIVERSIDADE PORTUCALENSE

What we have learnt

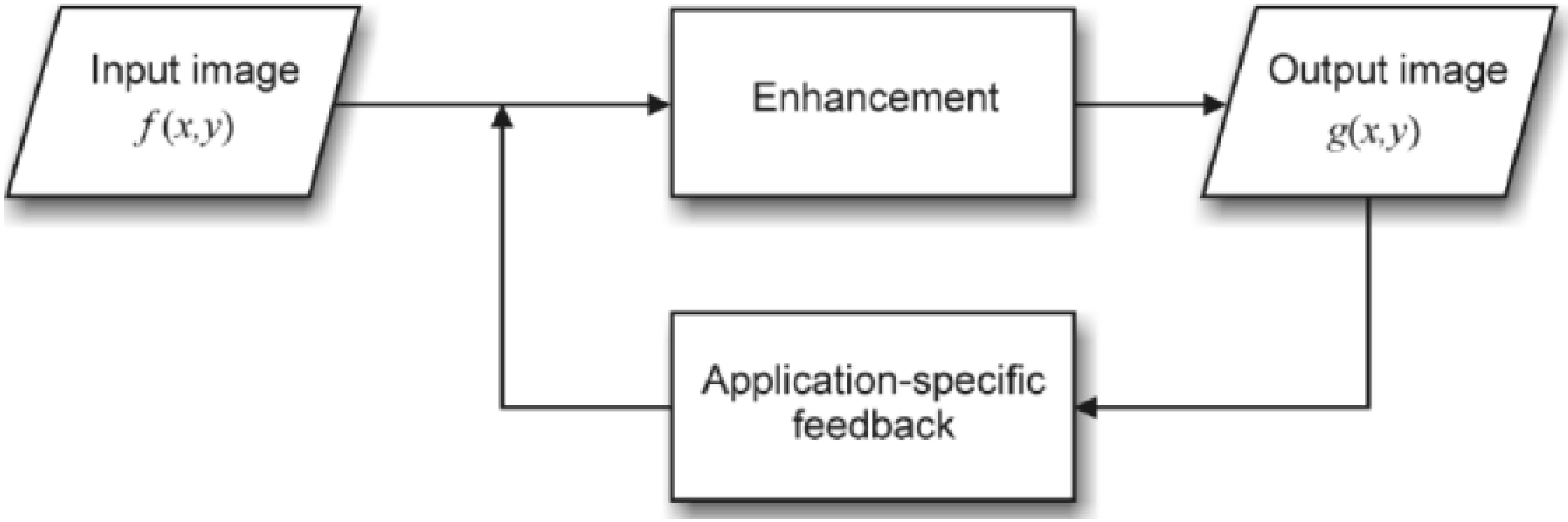
- Arithmetic and Logic operations
- Histograms



h(i)	0	2	10	0	0	0	5	7	3	9	1	6	3	6	3	2
i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15



What we have learnt



Content

- Enhancement Techniques
- Segmentation
- Low Pass Filters
- High Pass Filters

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Image Enhancement Techniques

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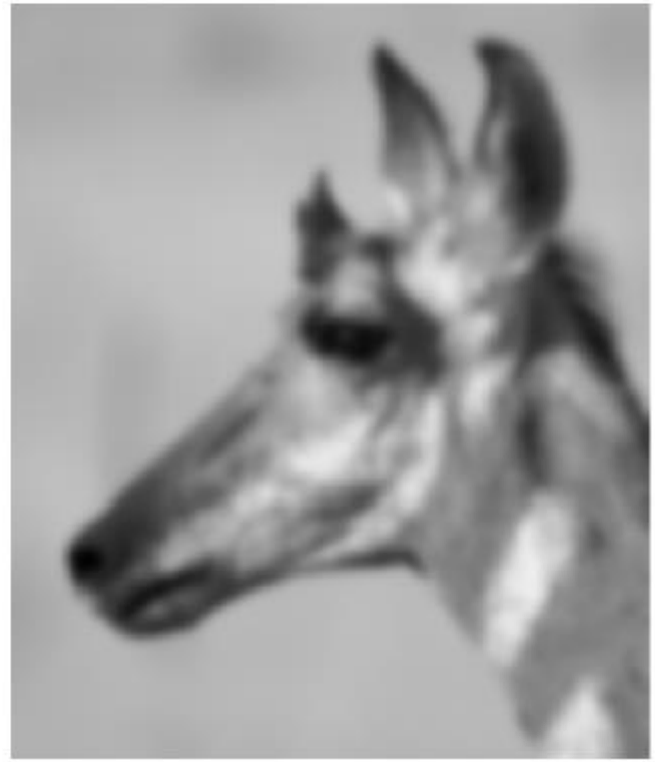


Image Enhancement Techniques

- **A blurring image** happens when the camera takes a picture out of focus.
- Sharper regions in the image lose their detail, normally as a disc/circular shape. Then each pixel in the image is mixed in with its surrounding pixel intensities.
- **Image enhancement** techniques are very important not only to improve the subjective quality of an image for human viewing, but also to modify the image in such a way as to make it more suitable to further analysis and automatic extraction of its contents.

Image Enhancement Techniques

- We have different types of enhancement techniques:

  - Low pass Filters
    - Average Filtering
    - Gaussian filter
    - Nonlinear filtering

  - High Pass filters
    - Laplacian filter

LOW PASS FILTER

Average Filtering

- In this technique it is calculates the average of the neighbourhood pixels
- This box is named as kernel box.

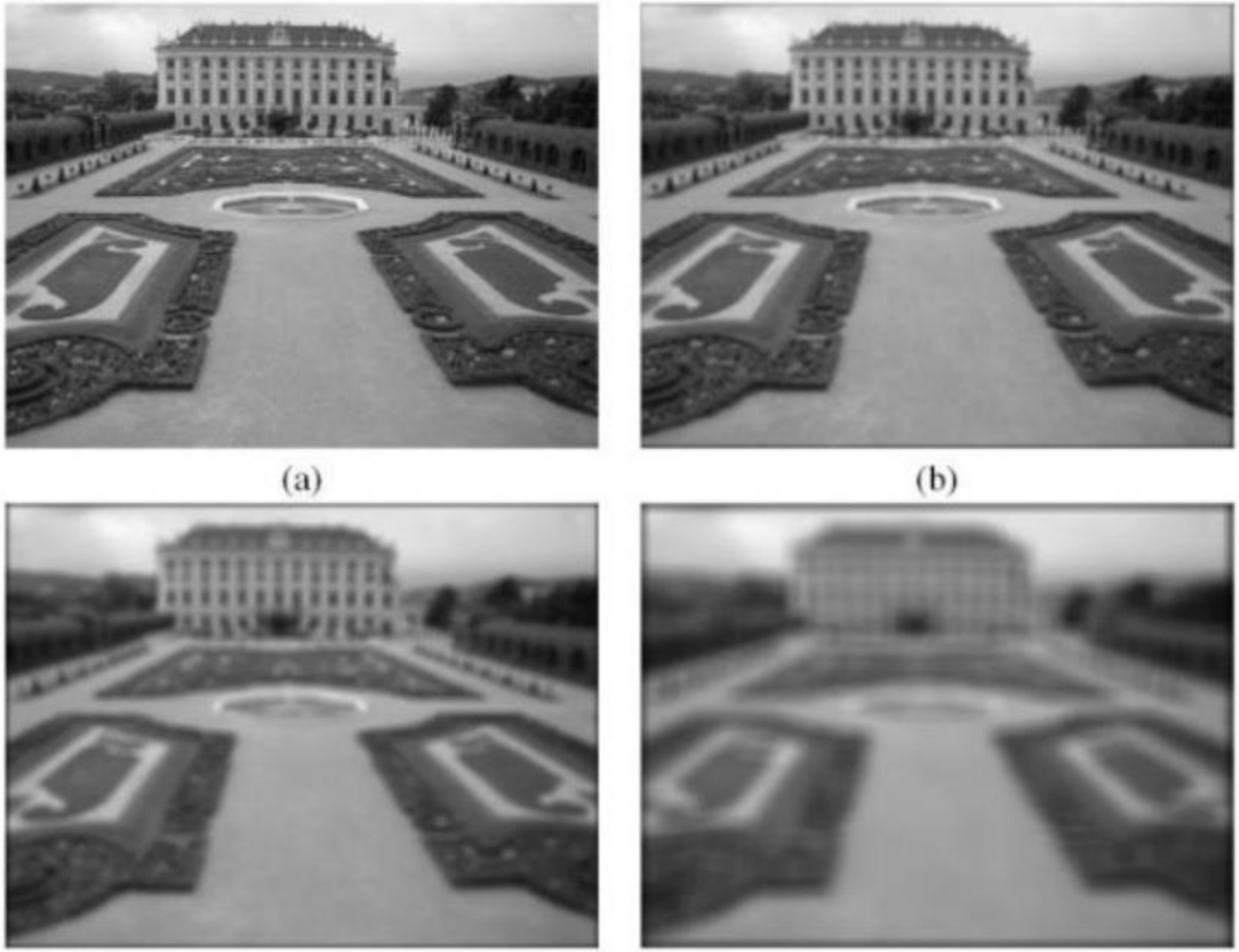
30	100	130
130	Pixel	160
50	100	210

- No OpenCV it is used the blur method for this technique.

Average Filtering

Low Pass Filter

Average Filter



(a) (b) (c) (d)

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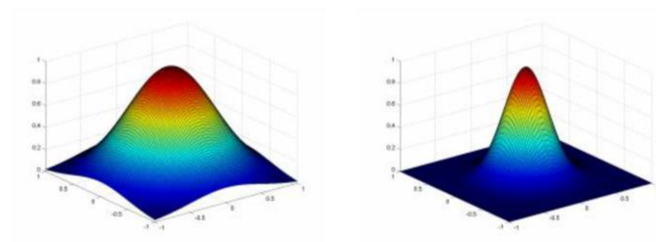
Gaussian Filter

- It is used a kernel gaussian
- This is calculated using the `cv2.GaussianBlur`.
- The function requires the specification of a width and height with odd numbers
- Optionally, it is possible to specify the number of standard deviations on the X and Y axis (horizontal and vertical).

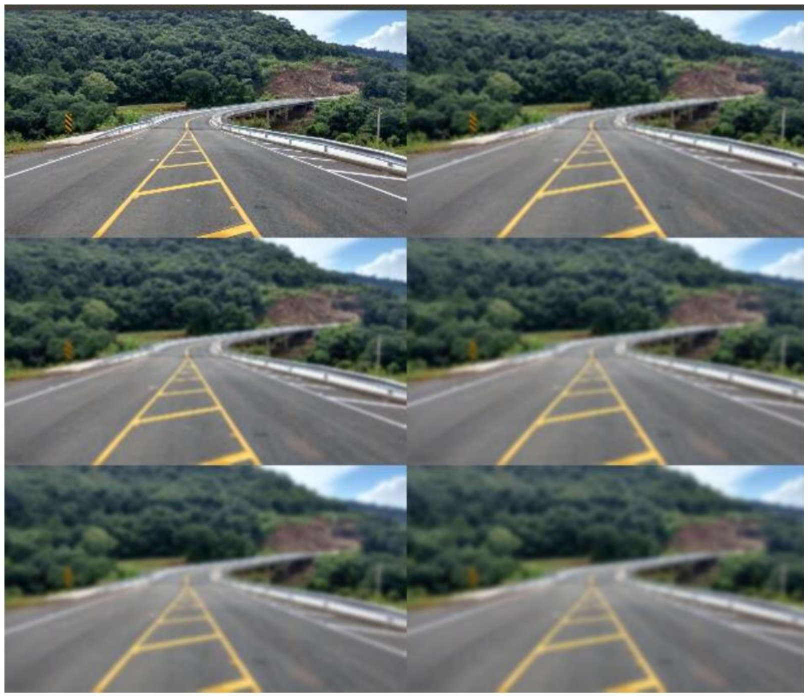
A 2D Gaussian is just the product of 1D Gaussians:

$$g(x,y;\sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} = \frac{1}{\sqrt{2\pi}\sigma} \exp^{-\frac{x^2}{2\sigma^2}} . \frac{1}{\sqrt{2\pi}\sigma} \exp^{-\frac{y^2}{2\sigma^2}} = g_\sigma(x).g_\sigma(y)$$

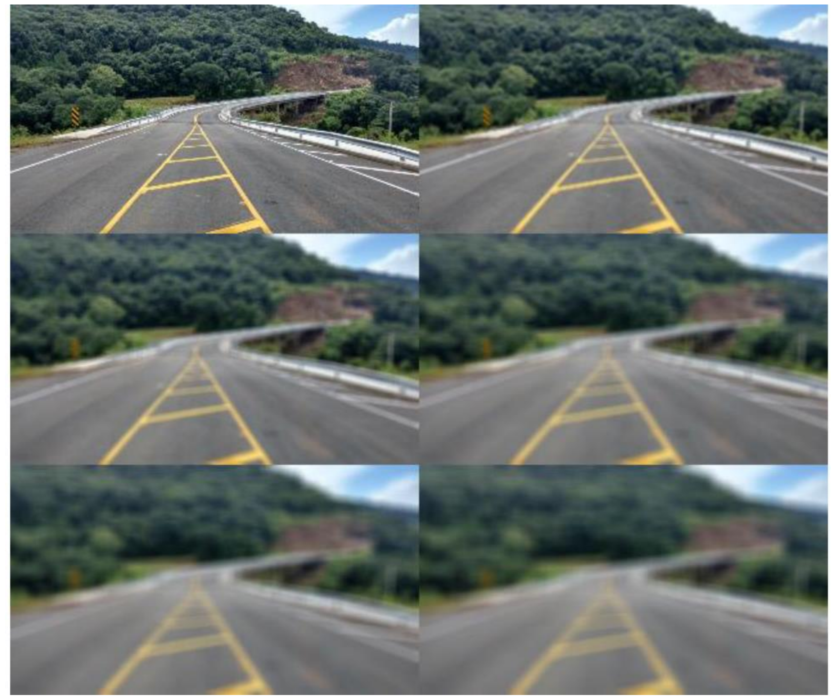


(a) $\sigma = 0.5$ (b) $\sigma = 0.25$

Gaussian Filter vs Neighbourhood



Gaussian



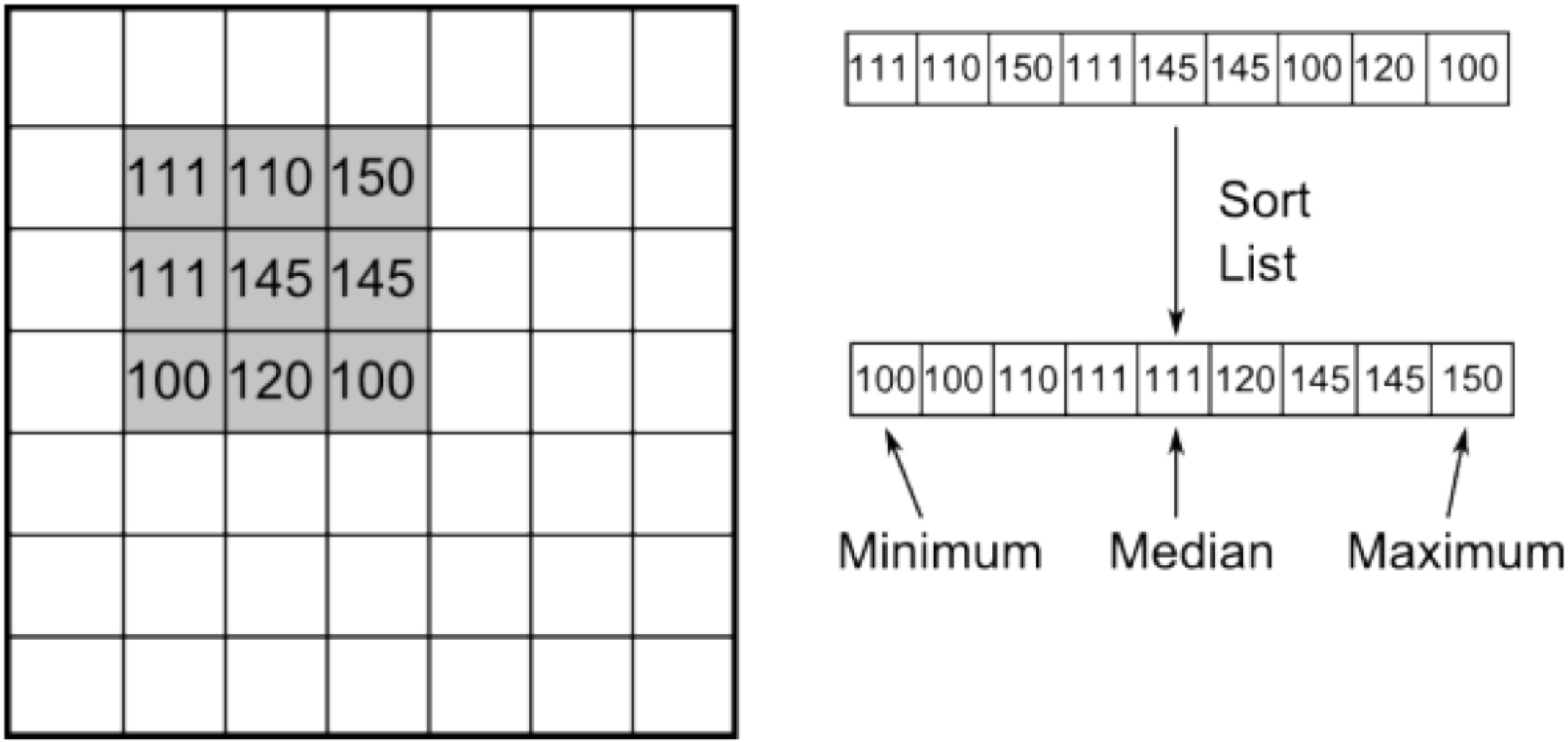
Average

Nonlinear Filtering

- In linear filtering each output pixel is a weighted summation of some number of input pixels;
- Easier to compose and are amenable to frequency response analysis. In nonlinear filtering a combination of neighbouring pixels is performed.
- They are also known as **rank-order filters**.
- Median Filter consists in finding the median value on a neighbourhood with a given size. It is more effective in not blurring edges.

Nonlinear Filtering

Nonlinear Filter



Nonlinear Filtering

- When applying a median blur, we first define our **kernel size k**.
- Then, as in the averaging blurring method, we consider all pixels in the neighbourhood of size kxk.
- Instead of replacing the central pixel with the average of the neighbourhood, we **replace the central pixel with the median** of the neighbourhood.
- Median blurring is more effective
- Averaging and Gaussian methods can compute means or weighted means for the neighbourhood
- By replacing our central pixel with a median rather than an average, we can substantially reduce noise.

Nonlinear Filtering

High PASS FILTER

Laplacian Filter

- Laplacian filter is a **High-Pass Filter** (HPF) whose effect on the output image is equivalent to preserving or emphasizing its **high-frequency components** (*e.g.*, fine details, points, lines, and edges), i.e., to highlight transitions in intensity within the image.

- Linear HPFs can be implemented using **2D convolution** masks with positive and negative coefficients, which correspond to a digital approximation of the Laplacian, a simple, isotropic (i.e., rotation invariant) second-order derivative that can respond to intensity transitions in any direction.

Laplacian Filter

Image Segmentation

- Extract symbolic information as regions of interest
- Finding groups of pixels

- Image segmentation techniques can vary widely according to:
  - **type of image** (*e.g.*, binary, gray, color).
  - **choice of mathematical framework** (e.g., morphology, image statistics, graph theory).
  - **type of features** (e.g., intensity, color, texture, motion) and
  - **approach** (e.g., top-down, bottom-up, graph-based).

- Three categories:
  - **Intensity-based** (non-contextual) methods: work based on pixel distributions (i.e., histograms).
  - **Region-based** (contextual) methods: rely on adjacency and connectivity criteria between a pixel and its neighbours.
  - **Other methods**: segmentation based on texture, edges, and motion

Image Segmentation: Simple Thresholding

- A simple thresholding example would be selecting a pixel value T, and then setting all pixel intensities less than T to zero, and all pixel values greater than T to 255. In this way, we can create a binary representation of the image.

$$g(x,y) = \begin{cases} 255 & if \quad f(x,y) \geq T \\ 0 & if \quad f(x,y) < T \end{cases}$$

Image Segmentation: Simple Thresholding

- For autonomous vehicle this is one of the techniques used to identify the road
- The same technique is used to identify objects

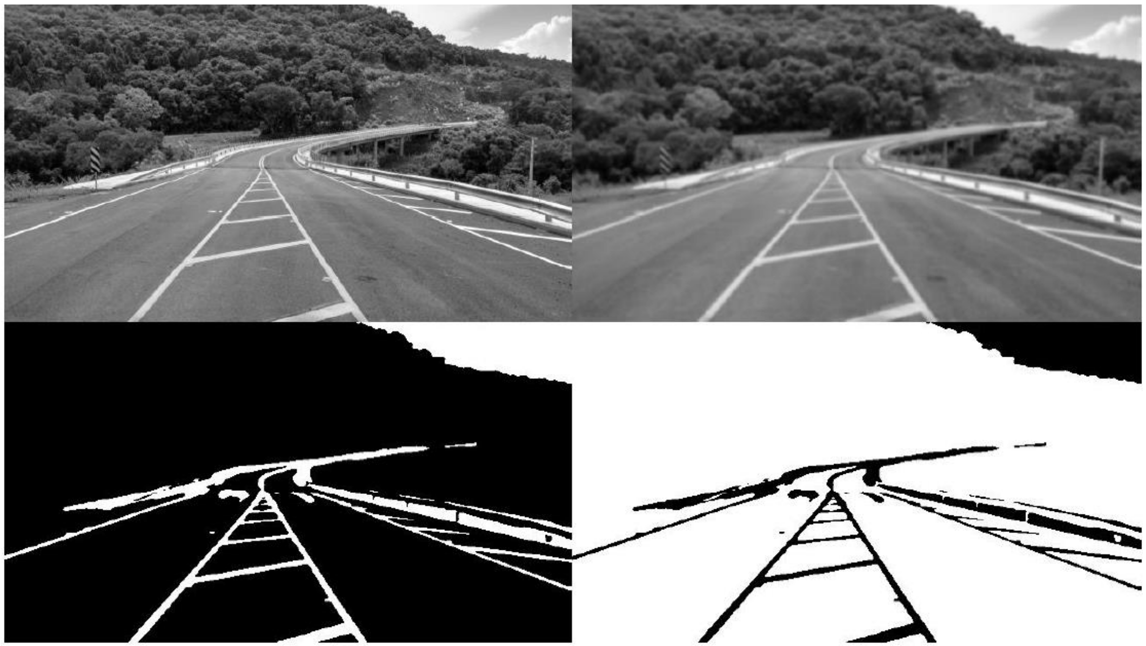


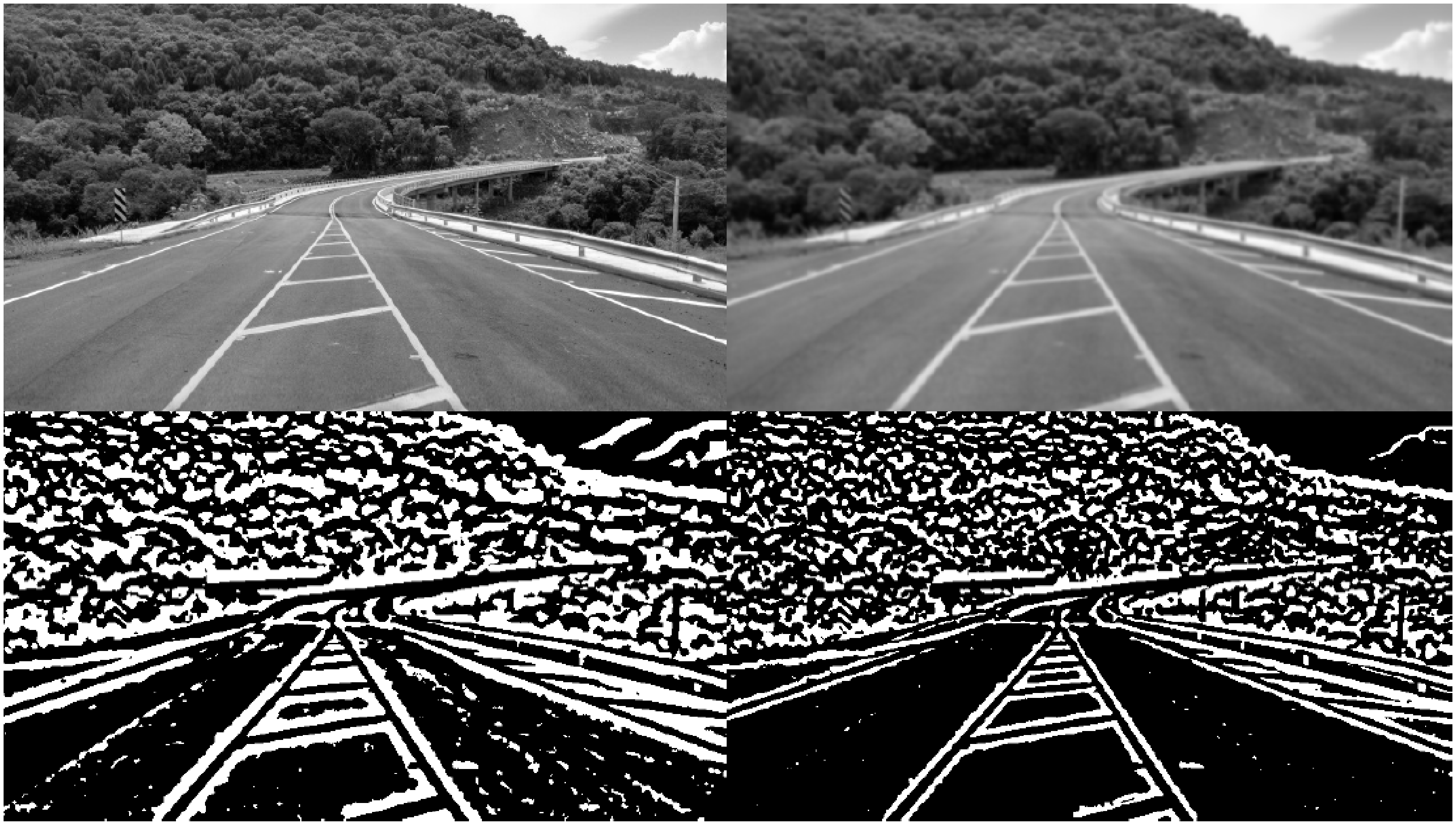
Image Segmentation: Adaptative Thresholding

- T value used in the previous example was arbitrary. However, there are math techniques to optimise. This is proposed by adaptative thresholding

- We need:

  - A window value where the threshold is calculated using pixels next to the image.
  - A parameter which is subtracted to the average calculated and generate the final threshold.

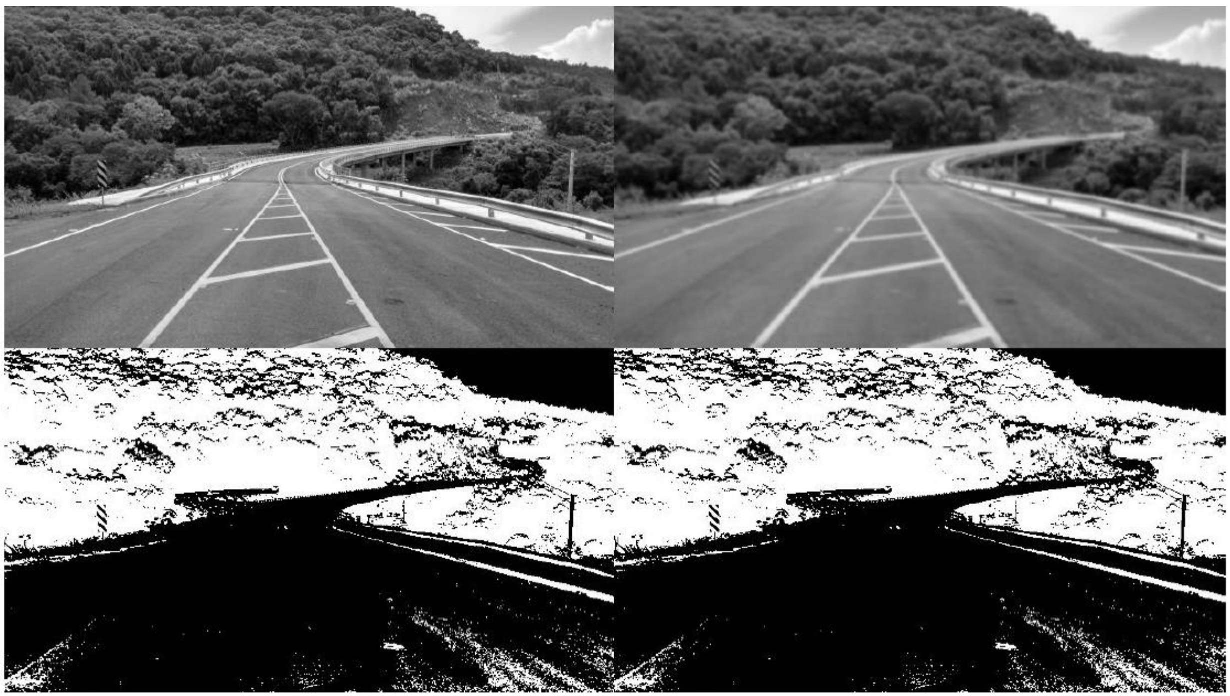
Image Segmentation: Adaptative Thresholding



Otsu

- Otsu's method assumes there are two peaks in the grayscale histogram of the image and then tries to find an optimal value to separate those

- Otsu is common seen as a global thresholding method.



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Let's play with images!

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Do conhecimento à prática.