

# Prelucrarea Imaginilor

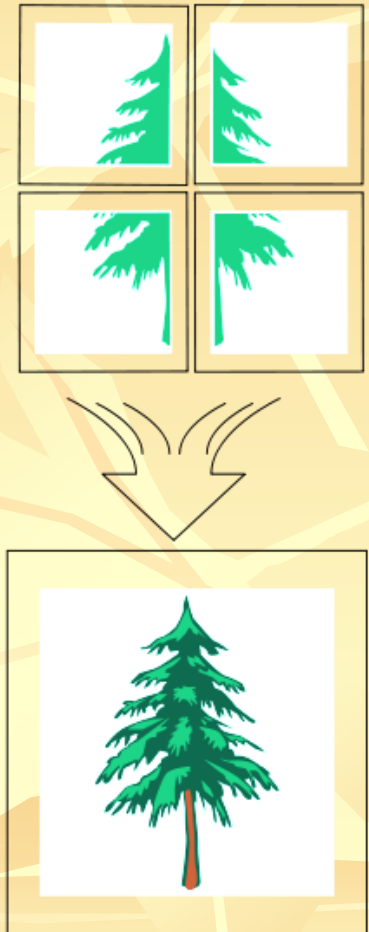
## Curs 10

### *Concatenarea Imaginilor*

# Concatenarea imaginilor

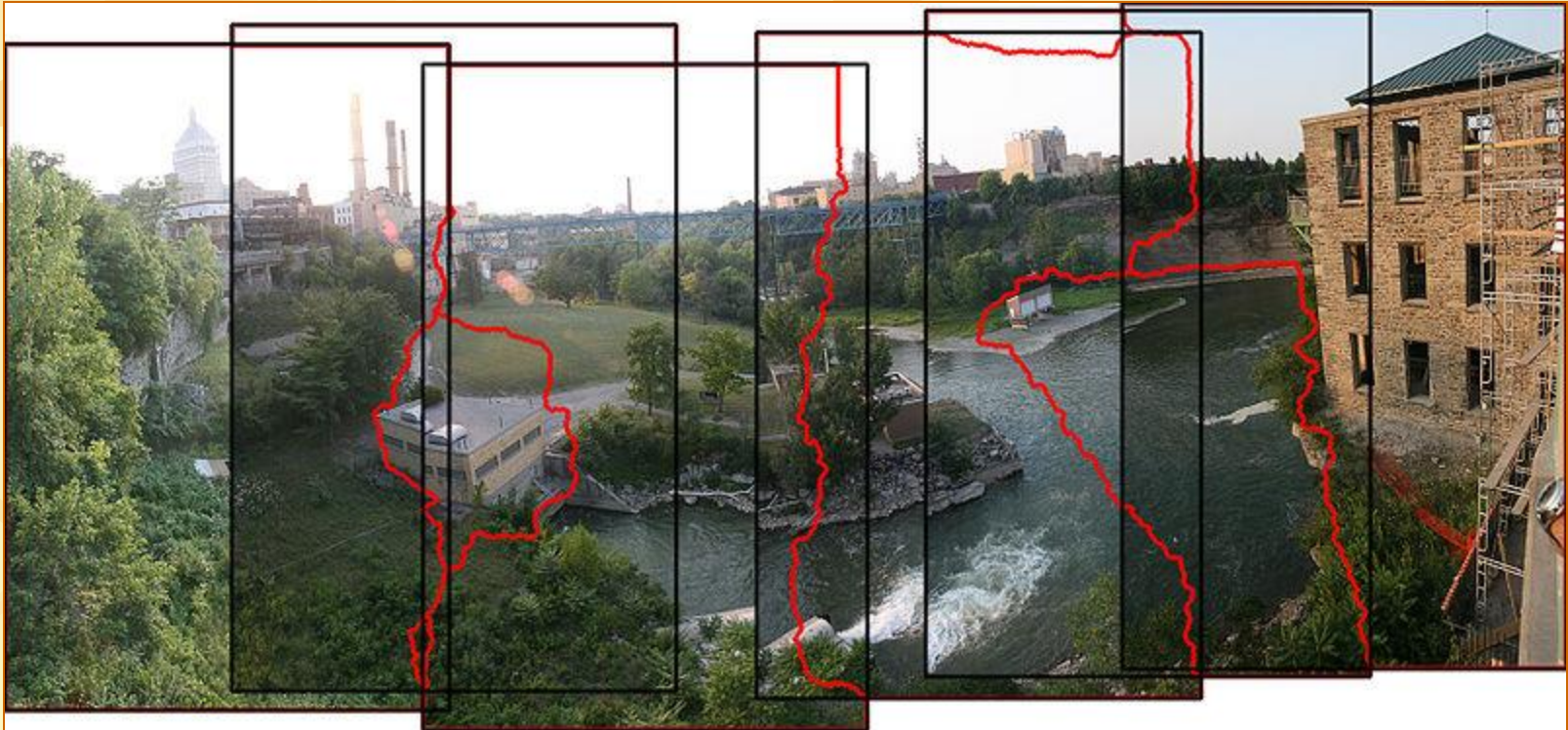
## Image stitching.

**Image stitching** or **photo stitching** is the process of combining multiple photographic images with overlapping fields of view to produce a segmented panorama or high-resolution image. Commonly performed through the use of computer software, most approaches to image stitching require nearly exact overlaps between images and identical exposures to produce seamless results.[\[1\]](#)



... Concatenarea imaginilor

... Stages of the stitching process.



Example for geometrical registration and stitch line in panorama creation.

- **Projection geometry.**

1. For image segments that have been taken from the same point in space, stitched images can be arranged using one of these graphical projections:

- Rectilinear projection, where the stitched image is viewed on a 2D plane.
- Cylindrical projection, where the stitched image shows a  $360^\circ$  horizontal field of view and a limited vertical field of view. Panoramas in this projection are meant to be viewed as though the image is wrapped into a cylinder and viewed from within. When viewed on a 2D plane, horizontal lines appear curved while vertical lines remain straight.<sup>[4]</sup>
- Spherical projection, where the stitched image shows a  $360^\circ$  horizontal by  $180^\circ$  vertical field of view. Panoramas in this projection are meant to be viewed as though the image is wrapped into a sphere and viewed from within. When viewed on a 2D plane, horizontal lines appear curved as in a cylindrical projection, while vertical lines curve as they get closer to the poles of the sphere.<sup>[4]</sup>





- **Challenges of image stitching.**

1. The use of images not taken from the same place (on a pivot about the entrance pupil of the camera<sup>[5]</sup>) can lead to parallax errors in the final product. When the captured scene features rapid movement or dynamic motion, artifacts may occur as a result of time differences between the image segments. "Blind stitching" through feature-based alignment methods (see autostitch), as opposed to manual selection and stitching, can cause imperfections in the assembly of the panorama.



Alcatraz Island, seen in an example of a panorama created by image stitching

- **Image stitching software.**

1. Dedicated programs include [Autopano](#), [Autostitch](#), [Hugin](#), [Ptgui](#), [Panorama Tools](#), [Photostitch](#), [Microsoft Research Image Composite Editor](#), and [CleVR](#).
2. Many other programs can also stitch multiple images. A popular example is [Adobe Photoshop](#), which includes a tool known as "Photomerge" and the new "Auto-Blend" in CS3. Also, Photoshop has a "Nudge" option, which makes it easy to manually stitch two pictures if there is enough contrast along their edges.

- **References.**

1. Ward, Greg (2006). "Hiding seams in high dynamic range panoramas". *Proceedings of the 3rd symposium on Applied perception in graphics and visualization*. ACM International Conference Proceeding Series. **153**. ACM.[doi:10.1145/1140491.1140527](#). ISBN 1-59593-429-4.
2. S. Suen; E. Lam, and K. Wong (2007). "[Photographic stitching with optimized object and color matching based on image derivatives](#)". *Optics Express* **15**: 7689–7696. [doi:10.1364/OE.15.007689](#).
3. Szeliski, Richard (2005) (PDF). [Image Alignment and Stitching](#). Retrieved 2008-06-01.
4. <sup>a</sup> <sup>b</sup> Wells, Sarah et al. (2007). [IATH Best Practices Guide to Digital Panoramic Photography](#). Retrieved 2008-06-01.
5. Littlefield, Rik (2006-02-06) (PDF). [Theory of the "No-Parallax" Point in Panorama Photography](#). ver. 1.0. Retrieved 2008-06-01.

## Panoramic photography.

**Panoramic photography** is a technique of photography, using specialized equipment or software, that captures images with elongated fields of view. It is sometimes known as *wide format photography*. The term has also been applied to a photograph that is cropped to a relatively wide aspect ratio. While there is no formal division between "wide-angle" and "panoramic" photography, "wide angle" normally refers to a type of lens, but this lens type does not necessarily image a panorama. An image made with an ultra wide angle fisheye lens covering the normal film frame of 1:1.33 is not automatically considered to be a panorama. An image showing a field of view approximating, or greater than, that of the human eye – about 160° by 75° – may be termed panoramic. This generally means it has an aspect ratio of 2:1 or larger, the image being at least twice as wide as its height. The resulting images take the form of a wide strip. Some panoramic images have aspect ratios of 4:1 and sometimes 10:1, covering fields of view of up to 360 degrees. Both the aspect ratio and coverage of field are important factors in defining a true panoramic image. [citation needed]



## ... Panoramic photography.

## Concatenarea imaginilor

Photo-finishers and manufacturers of Advanced Photo System (APS) cameras use the word "panoramic" to define any print format with a wide aspect ratio, not necessarily photos that encompass a large field of view. In fact, a typical APS camera in its panoramic mode, where its zoom lens is at its shortest focal length of around 24 mm, has a field of view of only 65°, which many photographers<sup>[who?]</sup> would only classify as wide angle, not panoramic.<sup>[citation needed]</sup>



A panorama of Sydney featuring (from left) the Sydney Opera House, the business district skyline, and the Sydney Harbour Bridge.

The photograph is a *segmented* panoramic, meaning that it is an assembled collection of numerous overlapping images, as opposed to one continuous exposure (Panoramic cameras and methods).



## Panoramic cameras and methods.

### Short rotation (or swing-lens).

*Short rotation* is a term used to define cameras that have a lens that rotates around the camera's rear nodal point (the optical point from which the focal length is measured) opposite a curved film plane.<sup>[1]</sup> As the photograph is taken, the lens pivots around its nodal point while a slit exposes the vertical strip of film that is aligned with the axis of the lens. The entire exposure usually takes a fraction of a second and the camera's functions similarly to the method of viewing a scene by turning one's head from side to side on a steady level. It is also referred to as *rotating lens* or *swing lens*. Typically, these cameras capture a field of view between 110° to 140° and an aspect ratio of 2:1 to 4:1. The images produced commonly take up 1.5 to 3 times as much space on the negative as the exposure made by traditional 35 mm cameras.

# Concatenarea imaginilor

... Panoramic cameras and methods.

... Short rotation (or swing-lens).

Short rotation cameras have a number of limitations. They usually offer relatively few shutter speeds and have poor focusing ability, with most models having a fixed focus, set to the hyperfocal distance of the maximum aperture of the lens, often at 10 meters (30 ft) or more.

Thus, panoramic photographers wishing to photograph closer subjects must use a small aperture to bring the foreground into focus, limiting the camera's use in low-light situations. For these reasons, cameras of this type are most often used outside, specifically for landscape or kite photography, where there is usually plenty of available light and there is less requirement for short focusing depths.



A negative from a 35 mm swing lens camera

## Concatenarea imaginilor ... Panoramic cameras and methods.

... Short rotation (or swing-lens).

Rotating lens cameras also produce a notable and odd distortion of straight lines. If the horizon, for instance, is placed even slightly off-center, the horizon line will bow slightly in the opposite direction. This 'distortion' looks unusual to the viewer because the image, which was originally viewed and captured from a sweeping, curved perspective, is being viewed flat. To view the resulting image correctly, the viewer would have to produce a sufficiently large print and curve it identically to the curve of the film plane in the camera. This type of 'distortion' can be reduced by using a swing-lens camera with a 'normal' focal length lens [the FT-2 has a 50 mm while most other 35 mm swing lens cameras use a wide-angle lens, often 28 mm], and by photographing buildings from a corner location, not from the center of a flat surface.[citation needed]

Swing lens panoramic cameras have also been built - in small to very large sizes - for use while suspended by kites [or helicopters, in the modern era].



The distortion of architectural subjects is severe when using a rotating lens camera

### Full rotation.

Rotating panoramic cameras (also referred to as slit scan or scanning cameras) are similar to swing-lens or short rotation cameras, but are capable of  $360^\circ$  of rotation or more. The whole camera rotates. A clockwork or motorized mechanism rotates the camera continuously and evenly and simultaneously pulls the film through the camera so the motion of the film matches the motion of the image movement across the image plane. Exposure is made through a narrow slit. Using the central part of the image field produces a very sharp picture that is consistent across the frame. These cameras are widely used for group pictures, particularly of athletic teams. Digital rotating line cameras image a  $360^\circ$  panorama line by line. A linear sensor has 10,000 sensor elements that use charge-coupled device technology. A  $360^\circ$  panorama is composed of approximately 120,000 individual 'line images'. For this example, the final image has approximately 1,200 million pixels. Digital rotating line cameras are used for documenting historic buildings or sites.[citation needed]

Notable digital cameras in this style are the Panoscan and Eyescan. Analogue cameras include the Cirkut, Hulcherama, Leme, Roundshot and Globuscope, all of which are capable of  $360^\circ$  of rotation.[citation needed]

Panoramic photography is commonly used in theatre to photograph the entire cast. Traditionally, the cast will have a "runner" who will appear on both sides of the photograph by running to the other after the camera has moved past them.



**Segmented.**



Example of a segmented panorama. Taken with a Nikon Coolpix 5000 and stitched with PTgui.



Upper Falls on the Genesee River, downtown Rochester, New York. Taken with a Sony A700.  
2 rows of 5 images per row, stitched as a mosaic using PTGui.

Segmented panoramas, also called stitched panoramas, are made by joining multiple photographs with slightly overlapping fields of view to create a panoramic image. Stitching software is used to combine multiple images.

In order to correctly stitch images together without parallax error, the camera must be rotated about the center of its entrance pupil.



The Giza Pyramids in Cairo, Egypt.

### **Catadioptric cameras.**

Lens and mirror based (catadioptric) cameras consist of lenses and curved mirrors that reflect a 360 degree field of view into the lens' optics. The mirror shape and lens used are specifically chosen and arranged so that the camera maintains a single viewpoint. The single viewpoint means the complete panorama is effectively imaged or viewed from a single point in space. One can simply warp the acquired image into a cylindrical or spherical panorama. Even perspective views of smaller fields of view can be accurately computed.

The biggest advantage of catadioptric systems is that because one uses mirrors to bend the light rays instead of lenses (like fish eye), the image has almost no chromatic aberrations or distortions. Because the complete panorama is imaged at once, dynamic scenes can be captured without problems. Panoramic video can be captured and has found applications in robotics and journalism.



### References.

1. [a b](#) Littlefield, Rik (2006-02-06) (pdf). [Theory of the "No-Parallax" Point in Panorama Photography](#). ver. 1.0. Retrieved 2007-01-14.
2. Kerr, Douglas A. (2005). ["The Proper Pivot Point for Panoramic Photography"](#) (PDF). *The Pumpkin*. Retrieved 2007-01-14.
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Arno, Florence: May 2001



# The Stitching of Images

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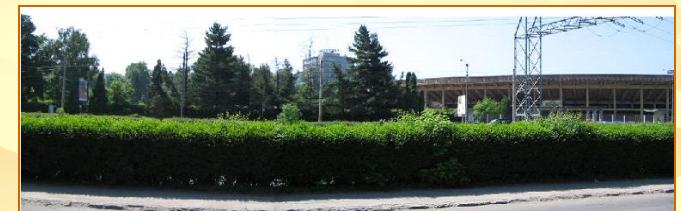
Faculty of Mathematics and Computer Science

## Abstract-

The paper focuses on some methods that allow the merging of images.

The equalizing of the brightness and the modification of color are two issues which are taken into consideration. Problems that occur when stitching images are also dealt with.

For solving stitching problem a genetic algorithm is proposed.



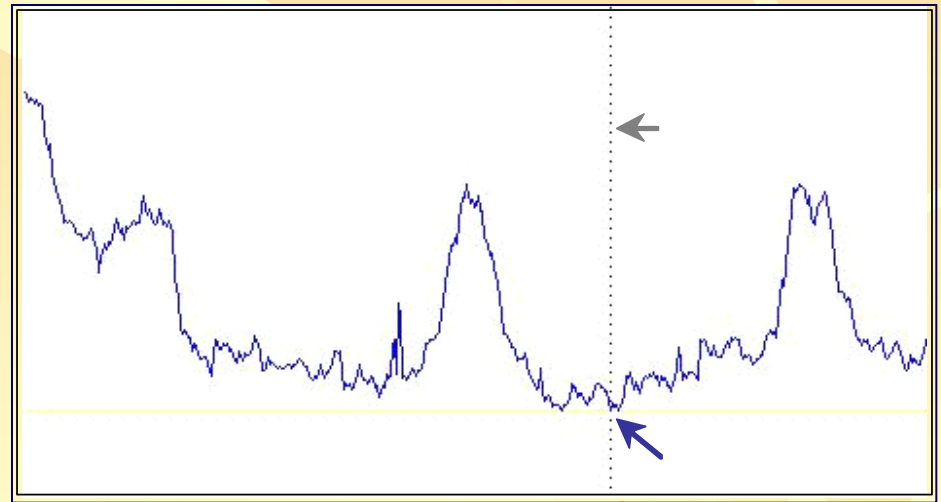
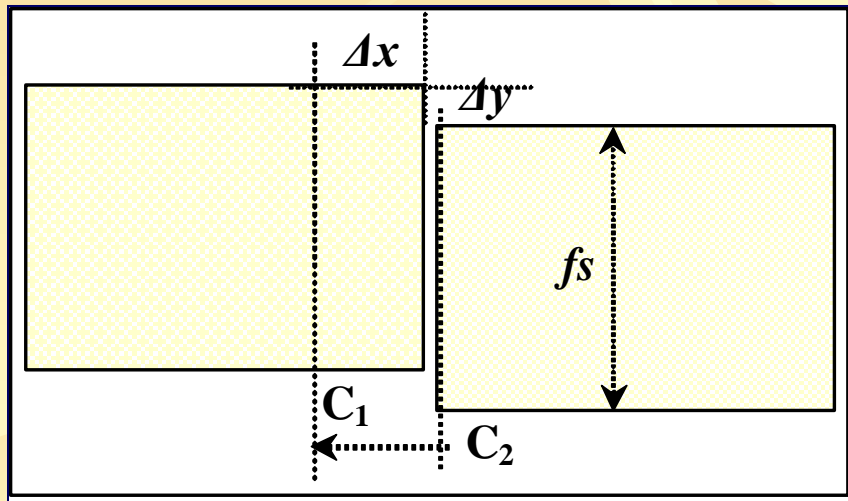
# *Scaling*

- for the *left* image 90%
- for the *right* image 90%



# *The Cut Determination*

- $C1(\Delta x)$ , the cut of the left image (I1),
- $T(\Delta y)$  the vertical translation of the image on the right (I2),
- $S(fs)$ , the scaling of the image on the right (I2) .



The optimum stitch is the one for which the distance  $\partial(C1, C2, \Delta y)$  is minimum.

# *The genetic algorithm*

- A chromosome is a vector  $X = (\Delta x, \Delta y, fs)$ .
- The chromosome evaluation (*fitness function*):  $eval(X) = \delta(C1, C2, \Delta y)$
- Recombination (crossover operator) :  $rec(X, Y) = \alpha X + (1 - \alpha)Y$ ,
- The chromosome mutation:  $mut(X) = X + \sigma \cdot N(0, 1)$



The image from obtained by the chromosome  $X = (168, 10, 0.95)$  .



