

# Non-photorealistic line-based rendering: A perceptual approach

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# NON-PHOTOREALISTIC LINE-BASED RENDERING: A PERCEPTUAL APPROACH

Audrey Legeai, Gwenola Thomas and Joëlle Thollot

We aim at rendering large 3D objects on mobile devices by means of strokes.

Since mobile devices have small screens and limited resources, we should :

- prefer **view-independent** strokes to lower the C.P.U. load and to ensure temporal coherence.
- use a **minimal set of relevant** strokes to provide a legible depiction of the object.

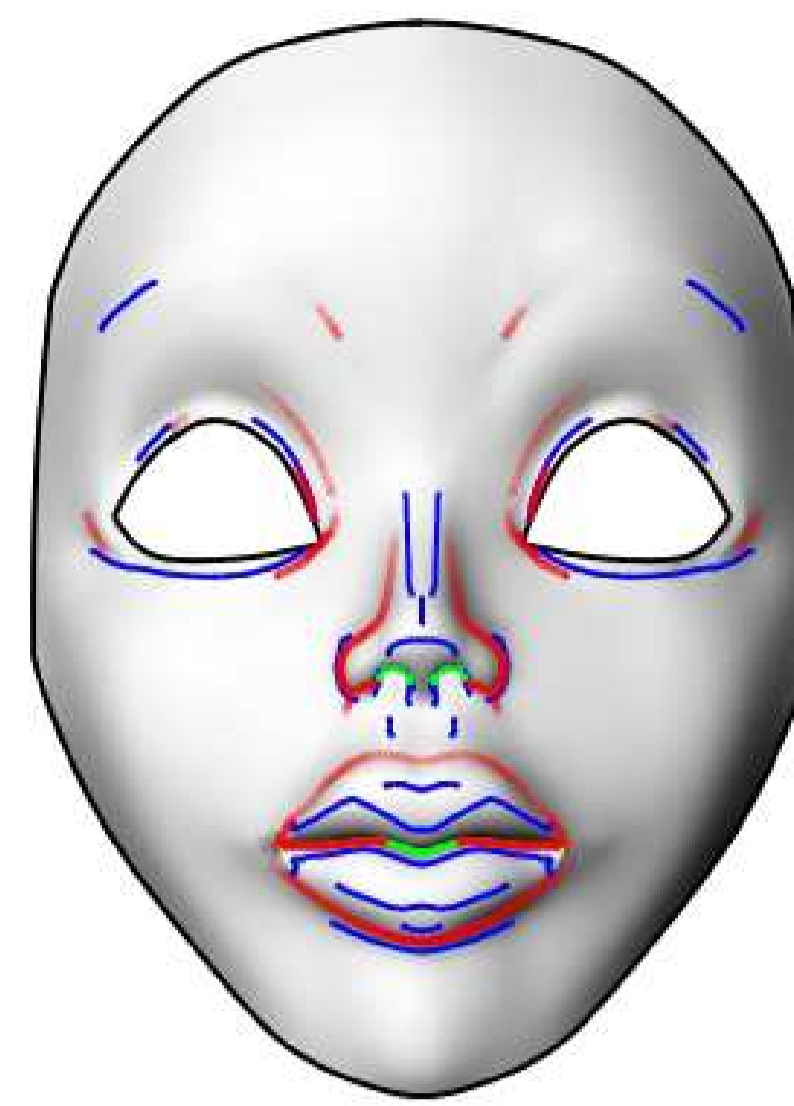
## 1. WHAT KIND OF FEATURE LINES CAN WE EXTRACT FROM A 3D MODEL?

### SILHOUETTES [Hertzmann 99, Markosian 97, etc.]

- ✓ Allow distinguishing the object from its environment.
- ✗ View-dependant.
- ✗ Additional lines are needed.

### SUGGESTIVE CONTOURS [Decarlo 03, Decarlo 04]

- ✓ Convey complementary information.
- ✗ View-dependant.
- ✗ Computation sensitive to noise.



### BOUNDARIES

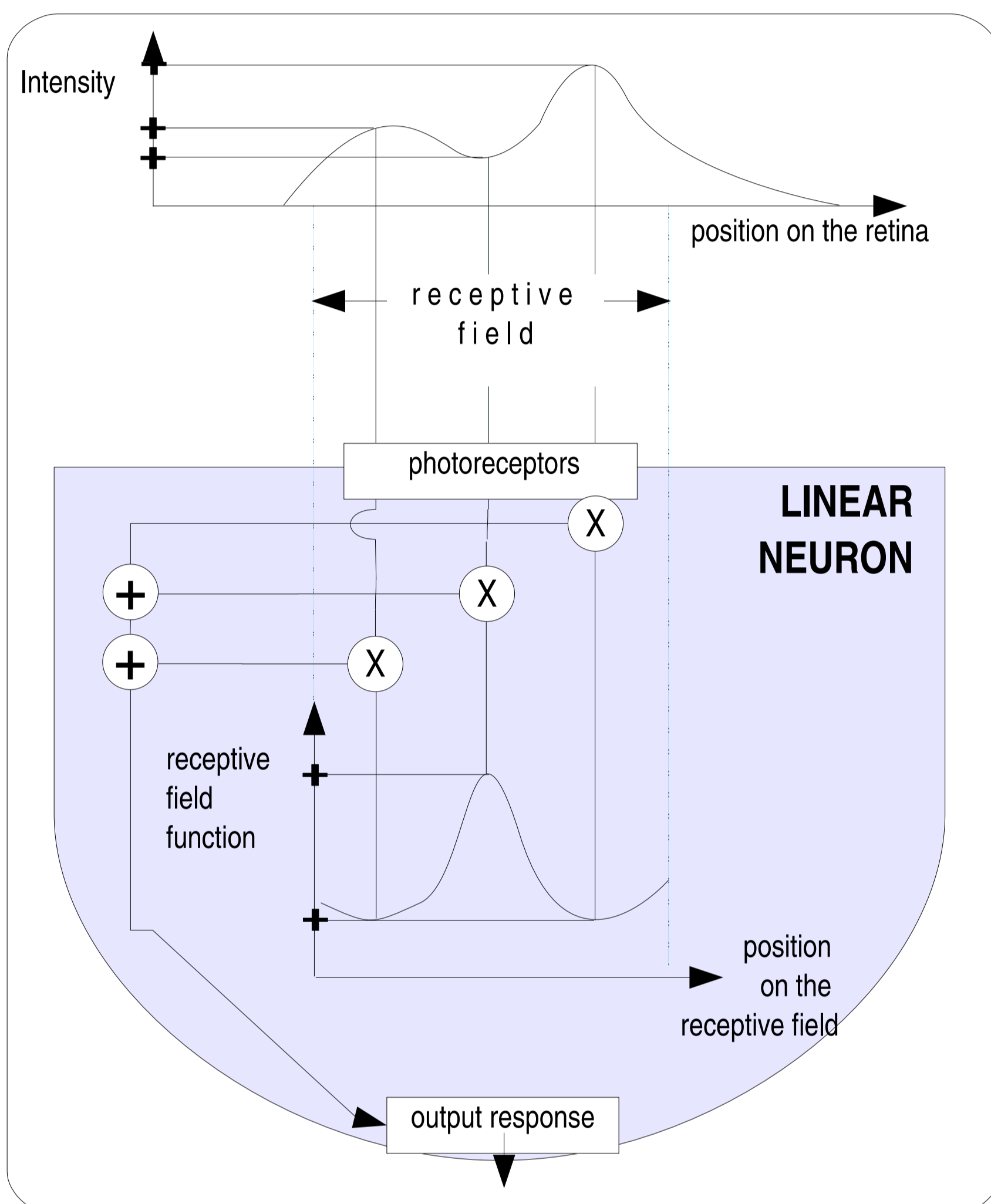
- ✓ Allow distinguishing the object from its environment.
- ✓ View-independent.
- ✗ Additional lines are needed.

### CREST LINES [Yoshizawa 04, Hildebrandt 05, etc.]

- ✓ Convey complementary information.
- ✓ View-independent.
- ✗ Computation sensitive to noise.

Features conveyed by suggestive contours and crest lines are either redundant or complementary.  
➤ We want to select among those lines the ones that are the most relevant.

## 2. WHAT DO WE PERCEIVE FROM SHAPES?

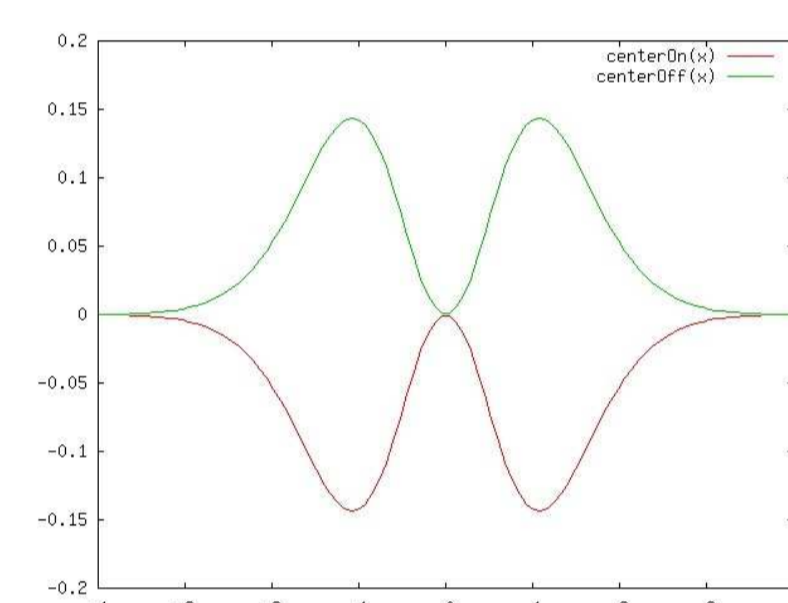


The response of linear neurons in early visual system may be modeled as the linear spatial summation of the intensity of light falling on their receptive field. [Petkov 97]

We can draw an analogy between the function of intensity on the receptive field and the intensities of a set of neighbour pixels within an image. Then, **simulating the response of a grid of identical linear neurons to an image consists into convolving the receptive field function and the image function**. The result is a response map. Response map resulting from different neurons simulation can be combined.

### GANGLION CELLS

Location:  
Retina.  
Function:  
Local contrast analysis.  
Receptive field function:  
Difference of gaussians.



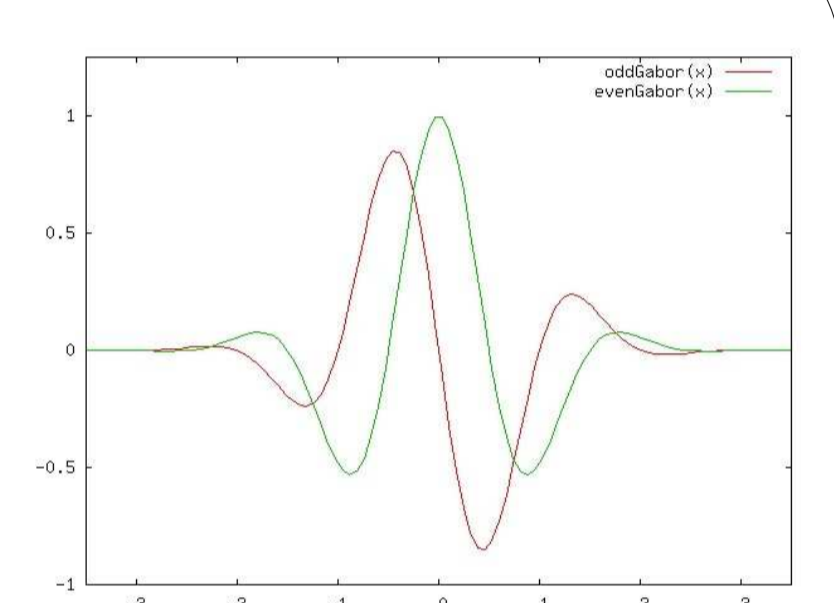
### MULTISCALE DIFFERENCE OF GAUSSIANS [Blommaert 90]

Combination of the response maps of ganglionar cells with different receptive fields' size.



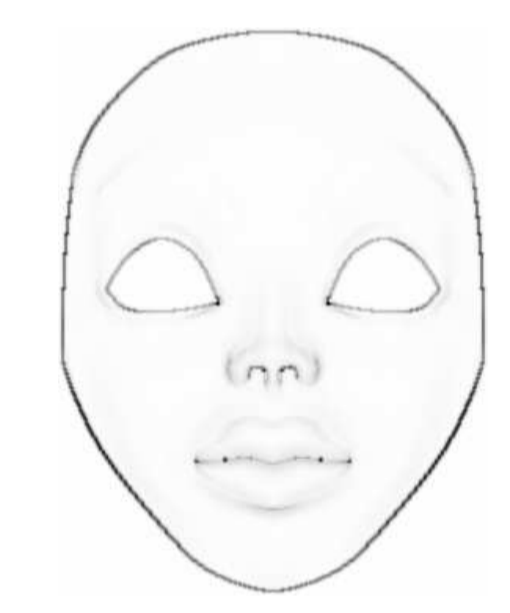
### SIMPLE CELLS

Location:  
Visual cortex.  
Function:  
Edges and bars detection.  
Receptive field function:  
Gabor function.



### GABOR ENERGY MAP [Daugman 85]

Combination of the response maps of simple cells with odd and even receptive fields functions.

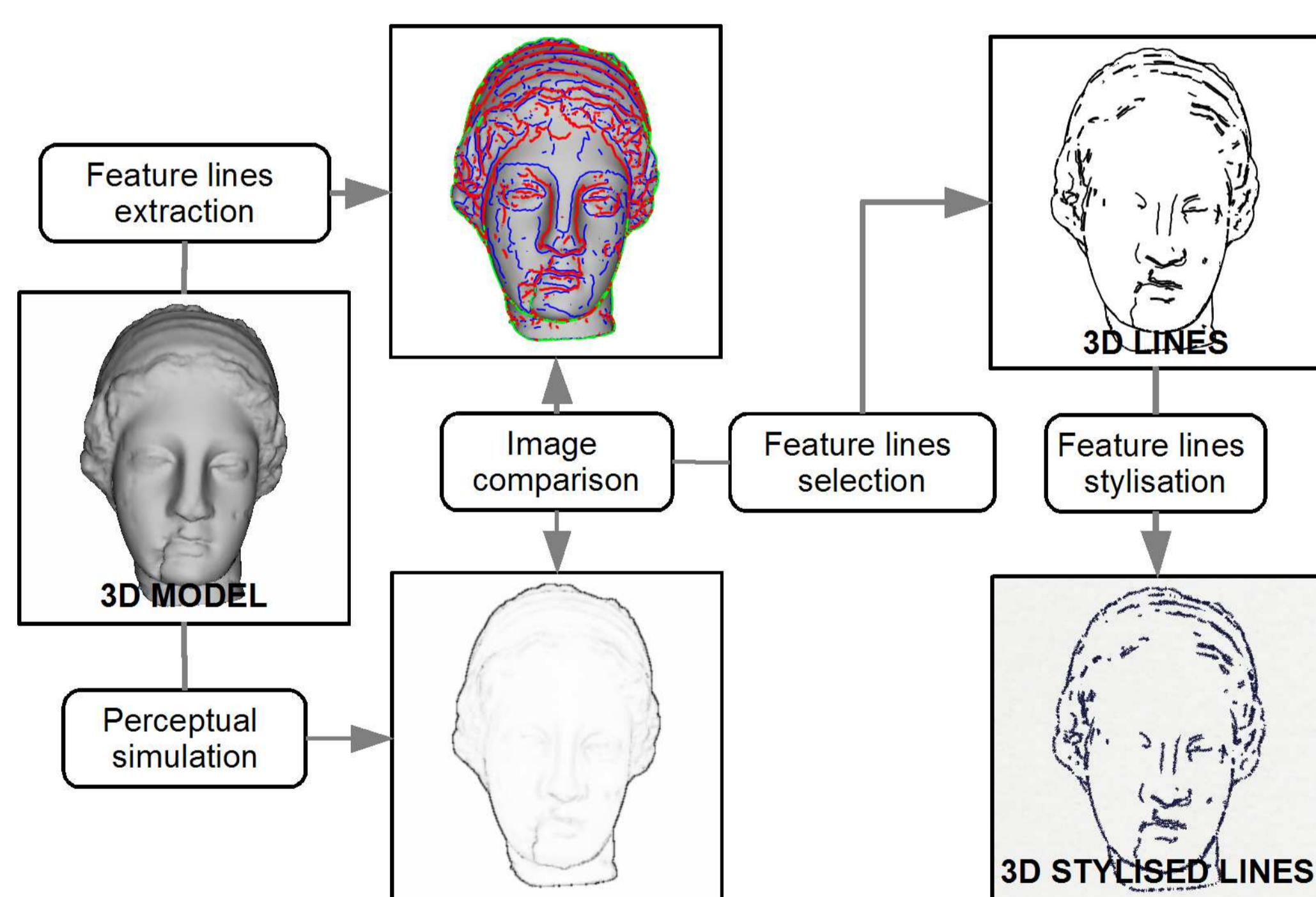


## 3. APPLICATIONS

We suggest to select the 3D lines whose location in image plane corresponds to the best perceived areas location. Our selection scheme :

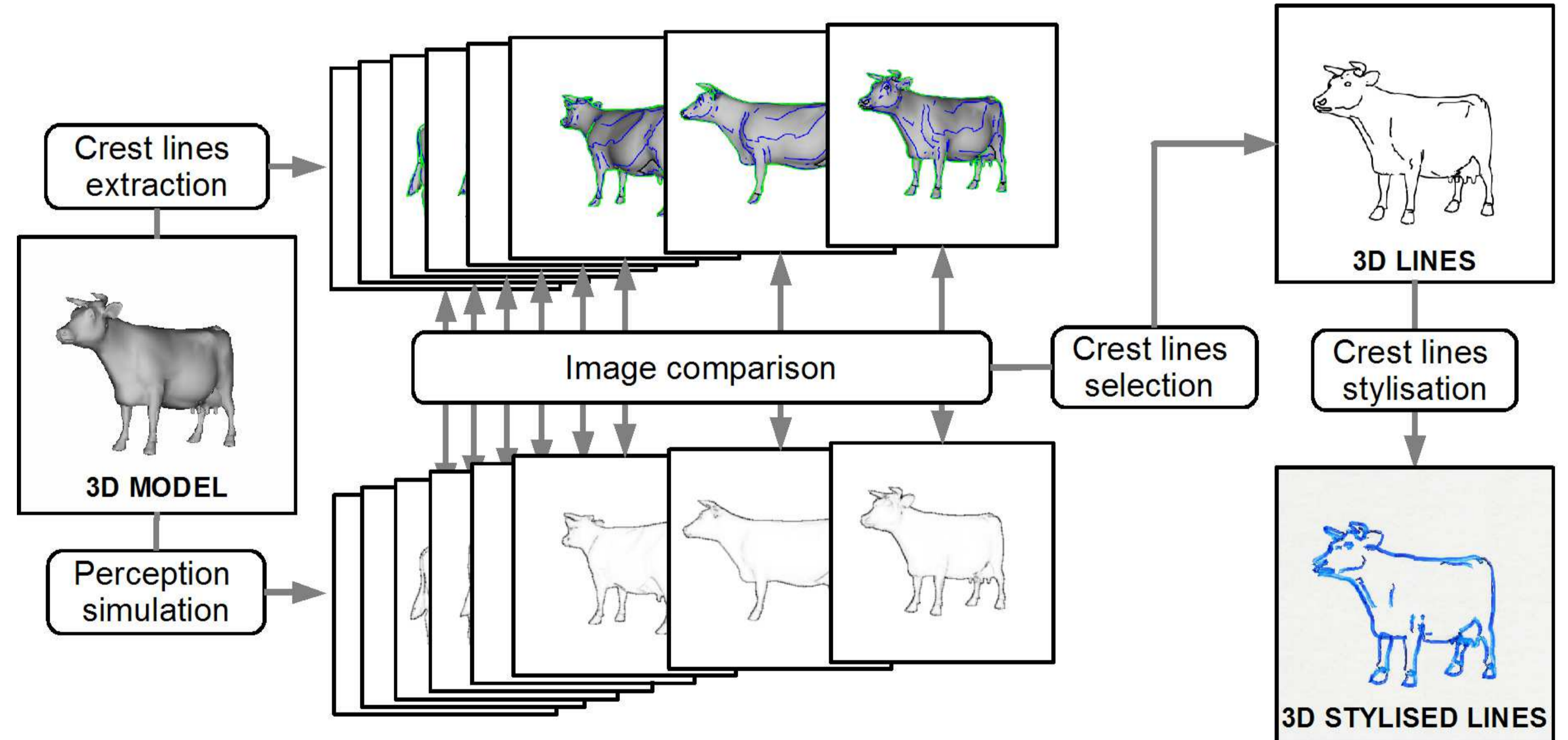
- ✓ is independant on the type of lines and model representation,
- ✓ relies on very intuitive thresholds,
- ✓ allows preserving the 3D lines' connexity, which makes stylisation straightforward.

### Suggestive contours and crest lines combination



- ✗ Selected suggestive contours and crest lines may be redundant.
- ✗ Selection process has to be run again every time the viewpoint changes.

### Crest line selection



- ✓ Selection can be preprocessed.
- ✗ Selected lines may still look crooked depending on the extraction scheme we used.

## 4. LIMITATIONS AND WORK IN PROGRESS

It is not clear yet what viewpoint, light model, or perception model we should use to proceed to the selection.

In the future, we will investigate perceptual invariants under viewpoint change and light change so as to extract view-independent feature lines in accordance with perception.