Reconstructing Flowers from Sketches

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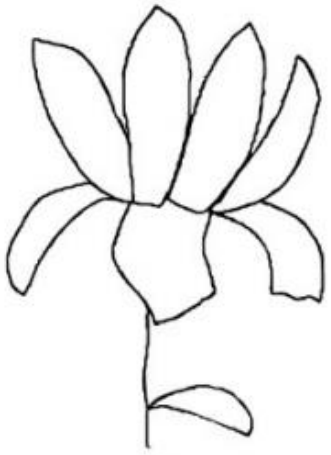
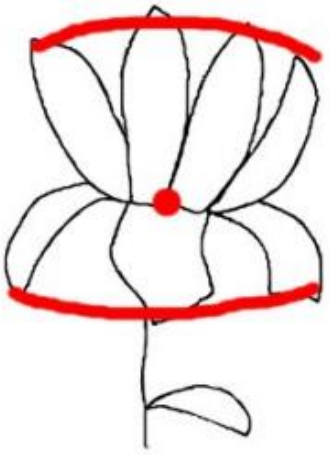
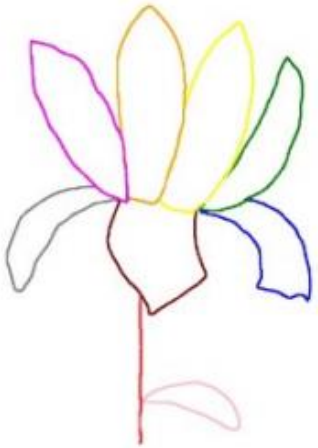




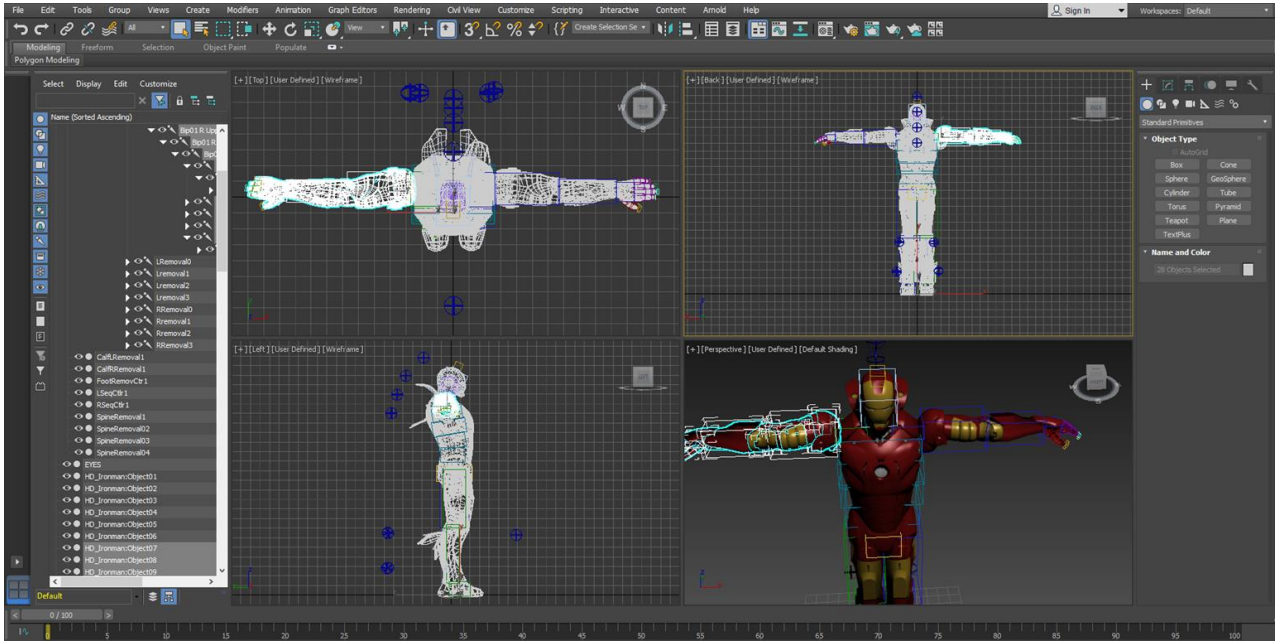


Summary

Sketches

- Most commonly used tool in the early stages of design

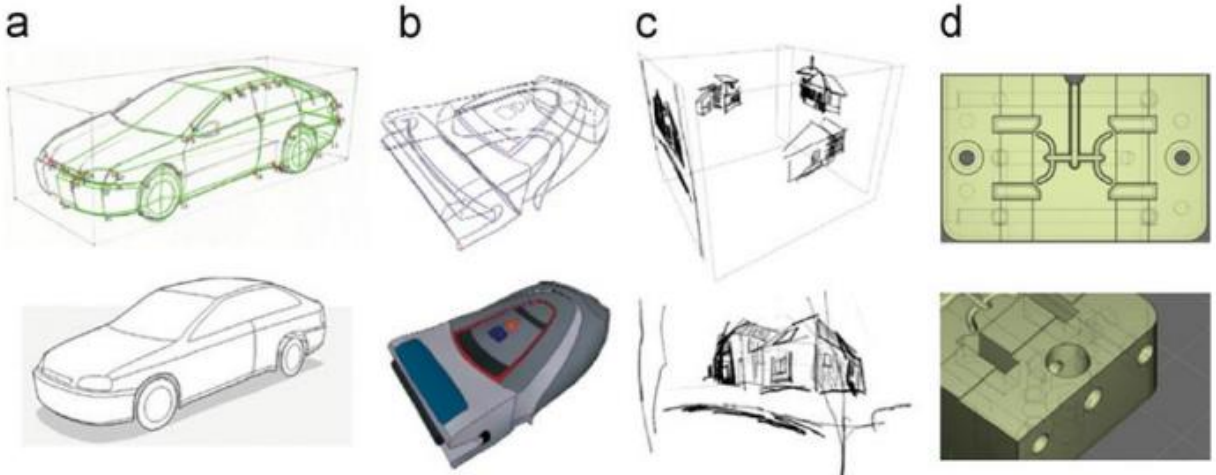
- Everybody is able to draw sketches
- 3D modeling requires skills



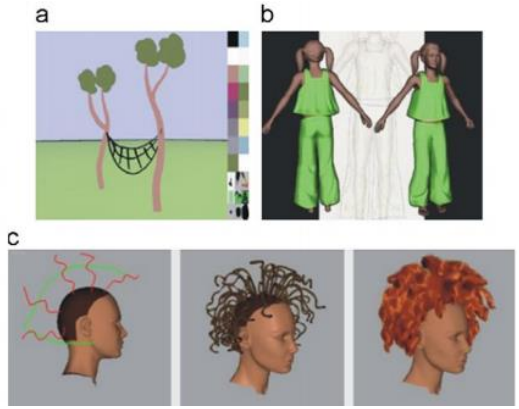
- Ability to create 3D shapes from 2D drawings → 3D for everybody

Sketches

- Computer Aided Design (CAD)



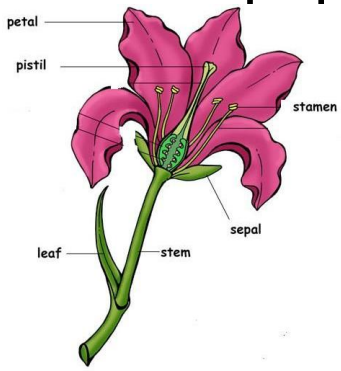
- Content creation (games, animations, virtual reality,...)



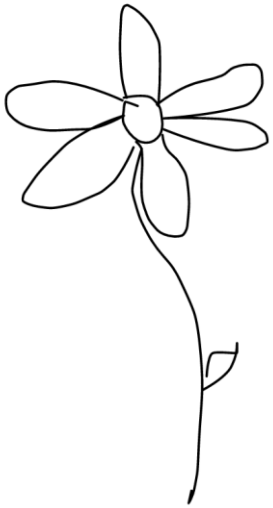
Sketch-based modeling: A survey, Computers & Graphics, 2009, Olsen and al.

Why flowers ?

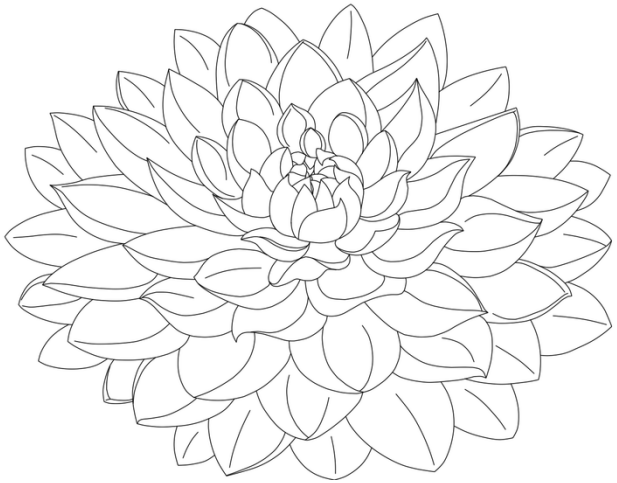
- Symbol of beauty, one of the most popular subjects of artistic drawing



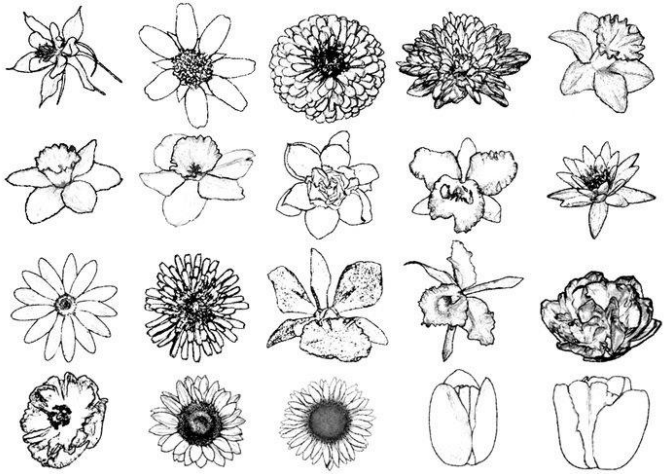
- Well-defined structure
- Simplicity



complexity



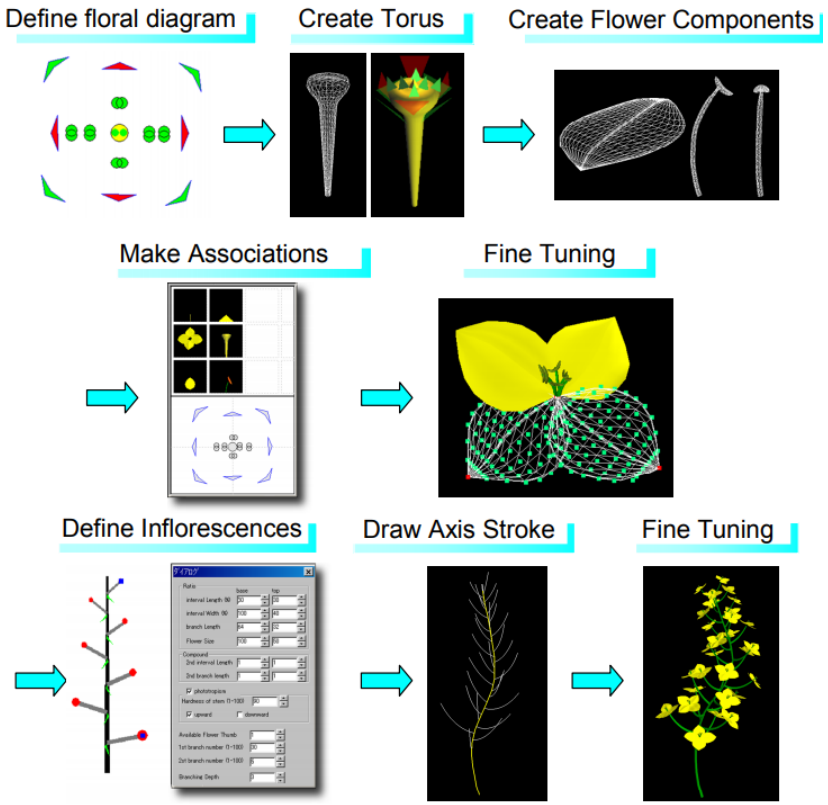
large variety



Interactive systems

- Floral diagrams and inflorescences (2005)

Use different sketch to specify the overall appearance,and interact with the user to refine the details of the desired final model



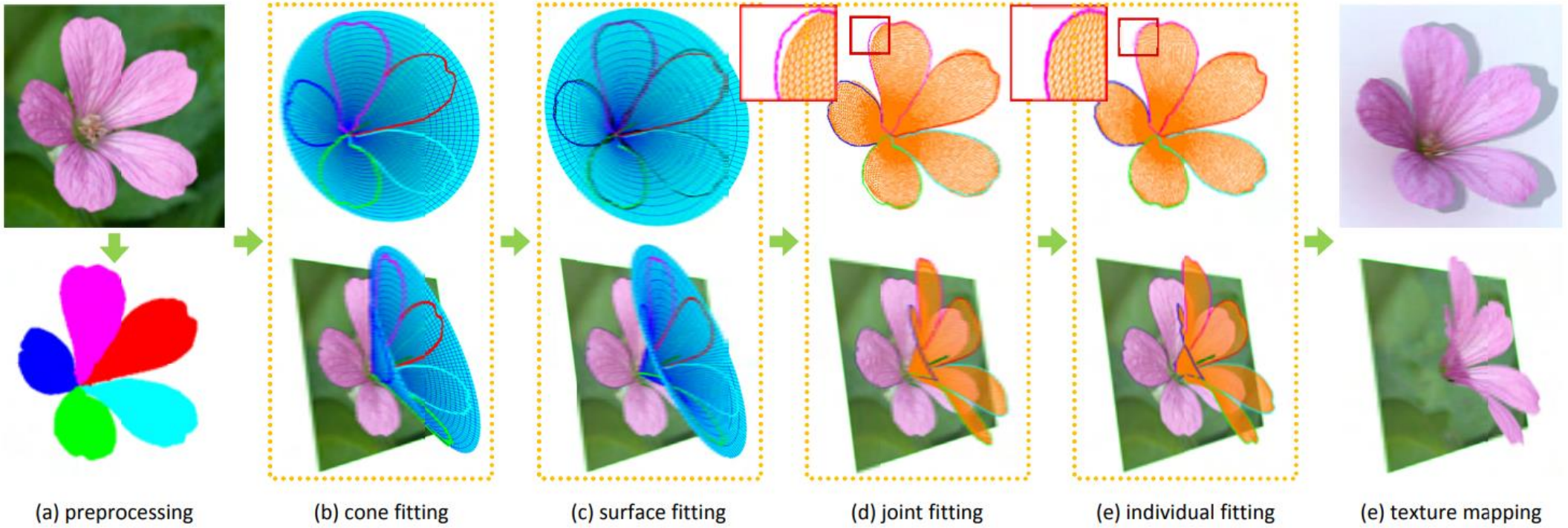
Ijiri, Takashi and Owada, Shigeru and Okabe, Makoto and Igarashi, Takeo,Floral Diagrams and Inflorescences: Interactive Flower Modeling Using Botanical Structural Constraints,ACM Trans. Graph.,July 2005

Reconstruction methods

Fast reconstruction, low effort required

- Flower reconstruction from a single photo (2014)

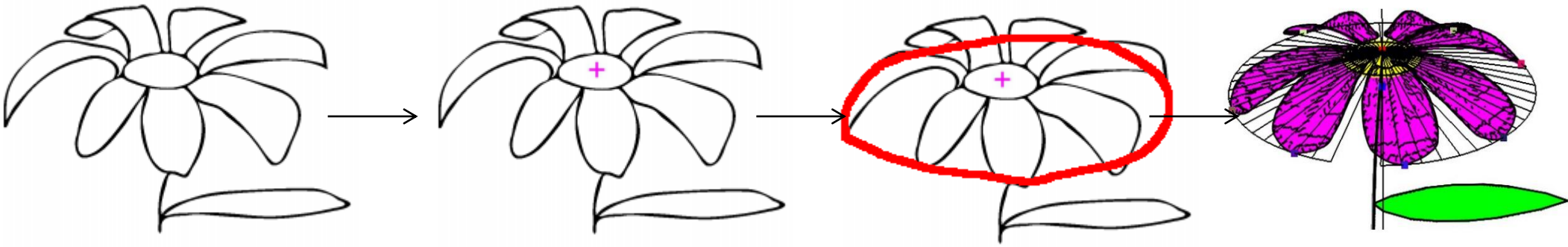
Reconstruction of the 3D model with texture based on a photo



Flower reconstruction from a single photo, computer graphics forum 2014,Feilong Yan,Minglun Gong,Daniel Cohen-Or,Oliver Deussen,Baoquan Chen

Sommaire

Method : user view



2D Sketch input

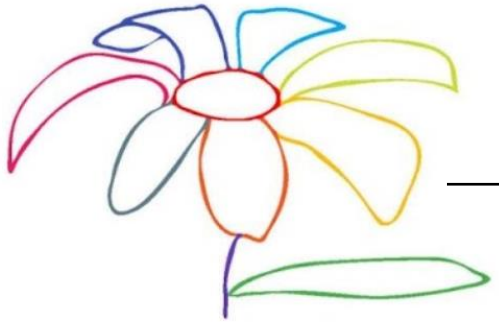
-silhouette Sketch
-moderate abstraction
-stem

One click :
Base point

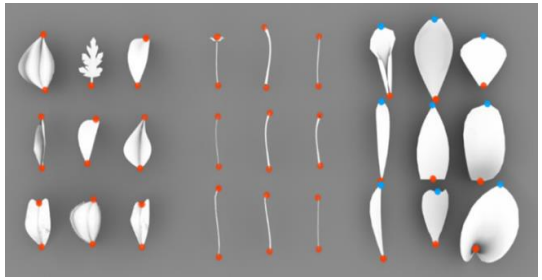
Quick line :
Petal-tip curve

3D Model

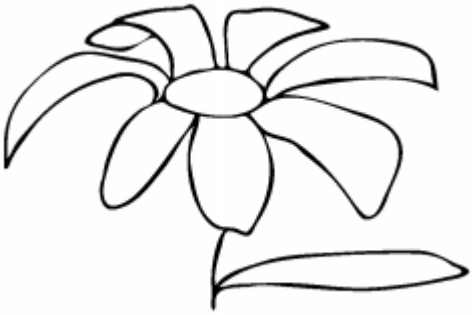
Method



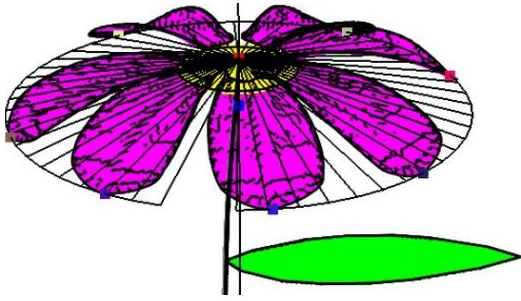
2D Segmentation



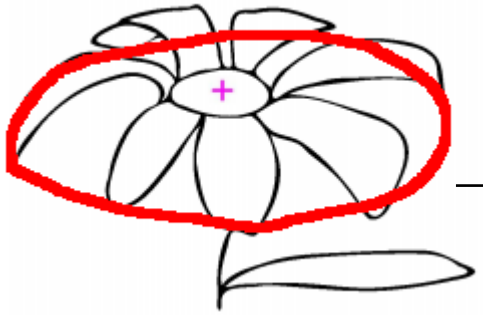
Sketch-based retrieval



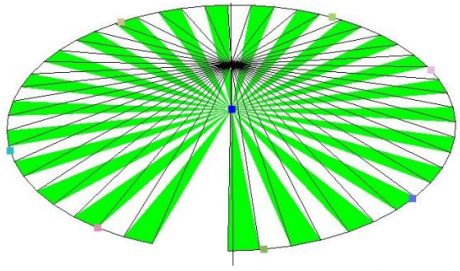
Part selection



3D reconstruction

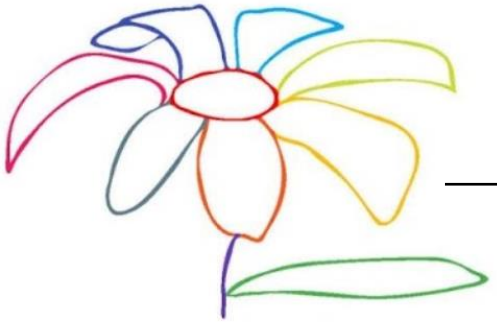


2D cone drawn by user

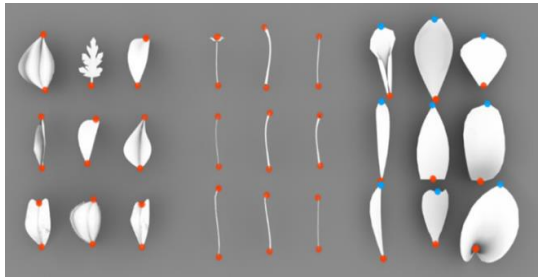


3D cone reconstruction

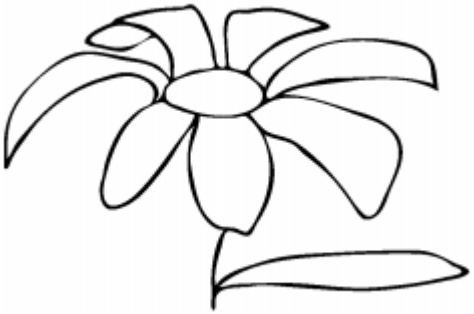
Method



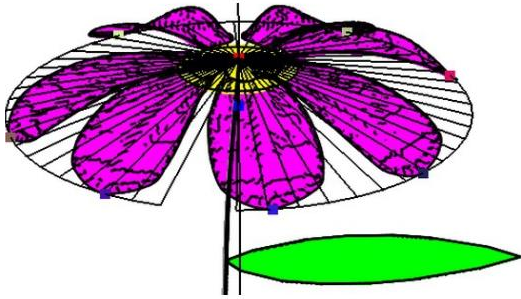
2D Segmentation



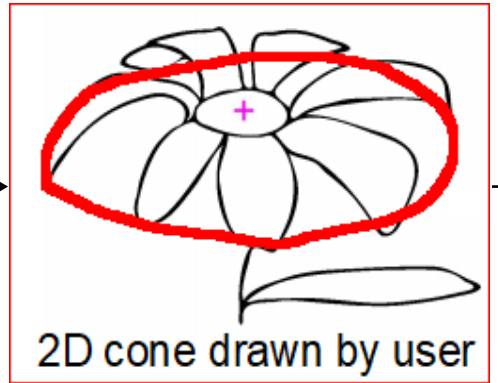
Sketch-based retrieval

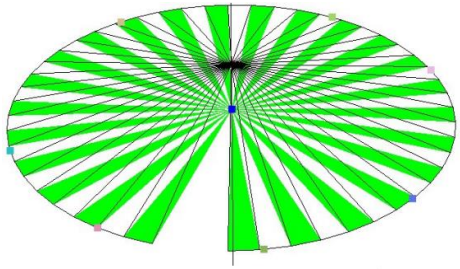


Part selection



3D reconstruction



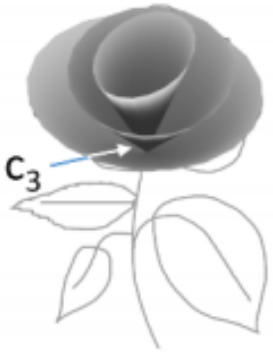


3D cone reconstruction

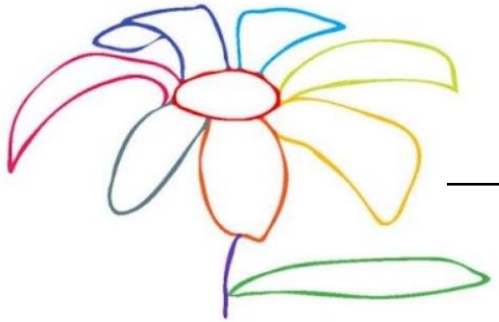
Guide strokes

The user provides the following informations:

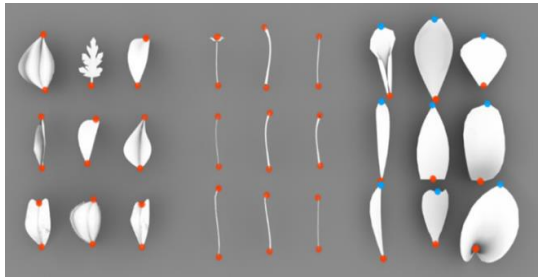
- Petal-tip curve : curve passing through the tips of drawn petals of the same layer
- Base point : junction between the stem and the corolla



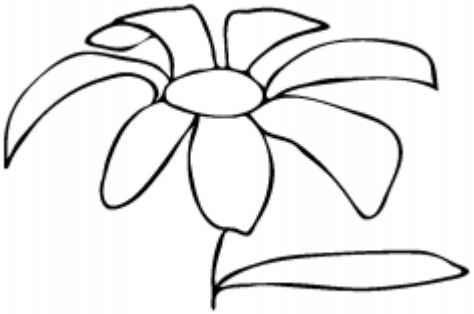
Method



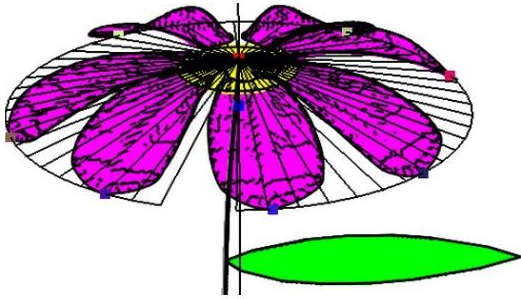
2D Segmentation



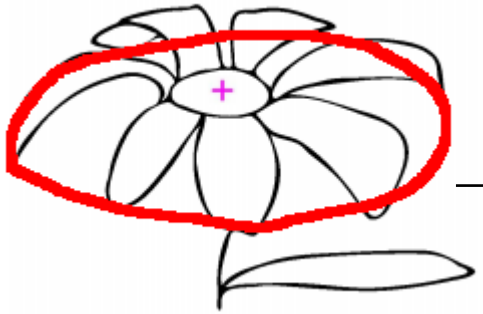
Sketch-based retrieval



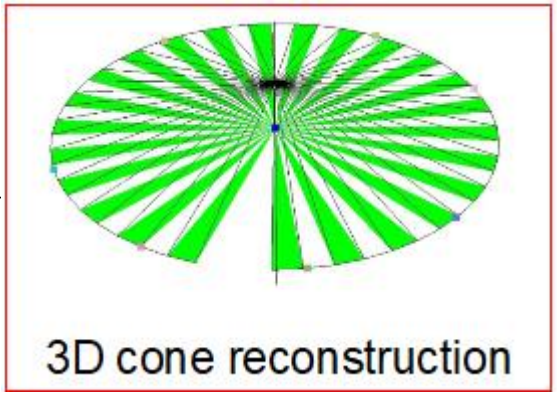
Part selection



3D reconstruction



2D cone drawn by user

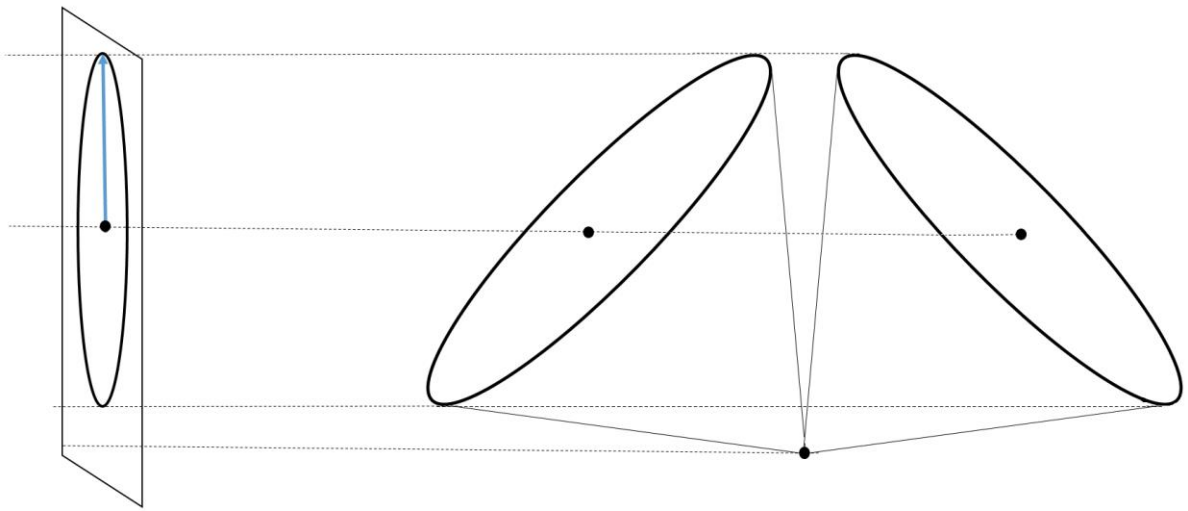


3D cone reconstruction

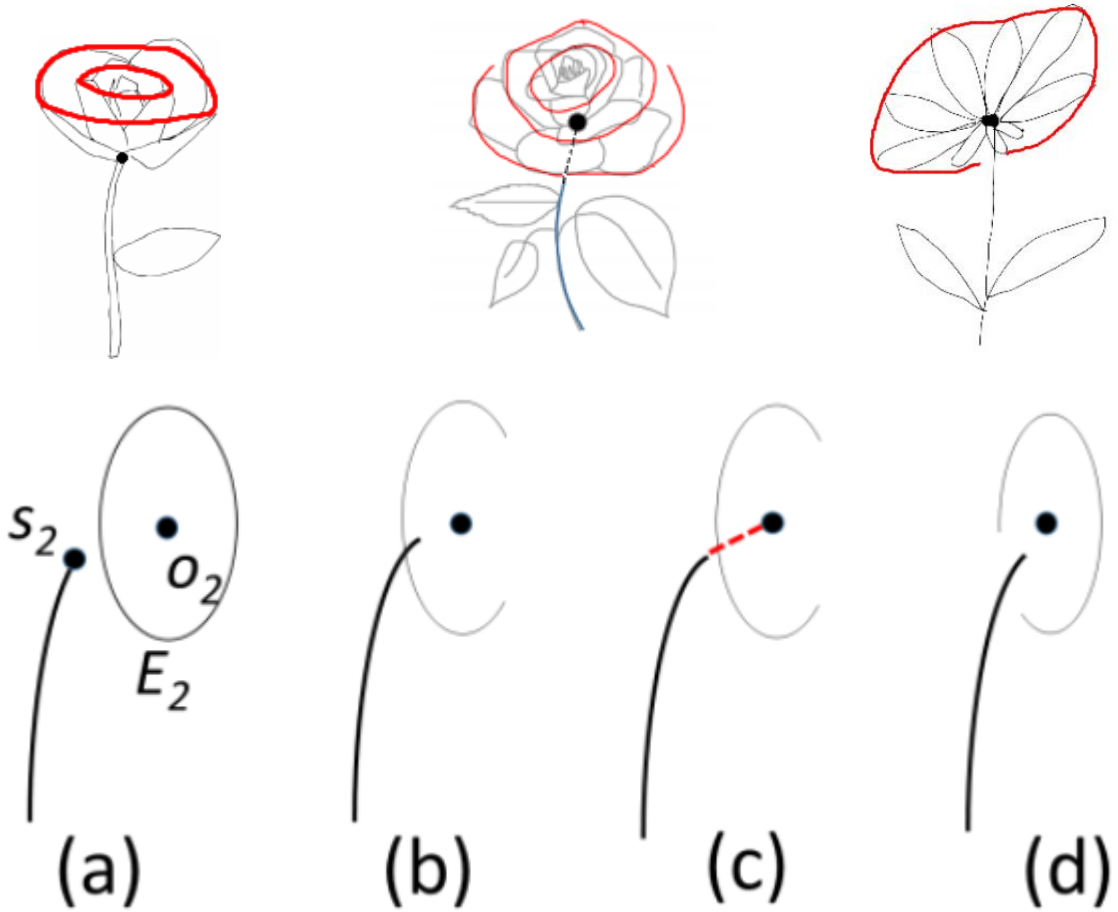
Orientation of the corolla

- Define the ellipse based on the user curves

- Use the 2D ellipse in order to compute the 3D cone

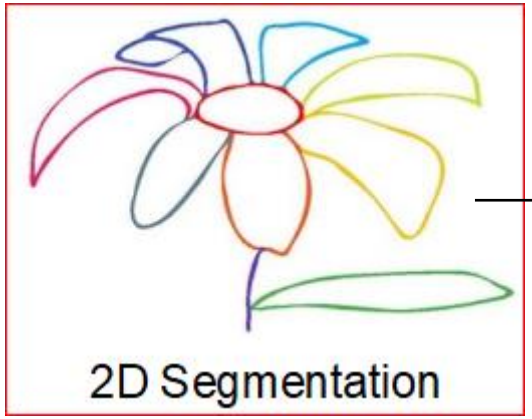


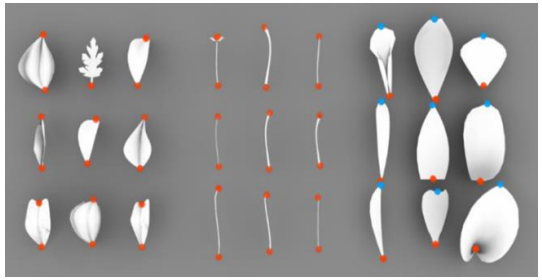
Orientation of the corolla



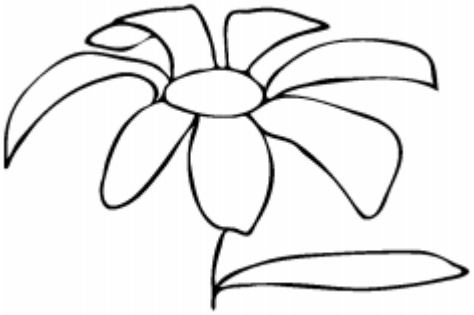
The flower is oriented towards the observer if the curves of the petal is closed (a) or if the stem (b) or the segment [s2, o2] (c) intersects it. Otherwise, the flower is oriented away from the observer (d).

Method

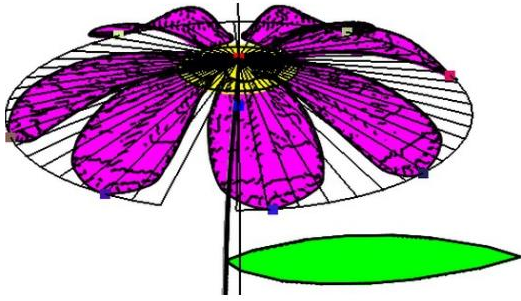




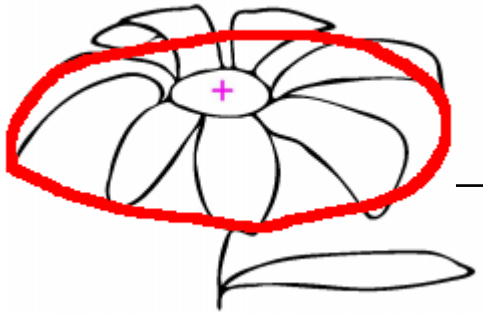
Sketch-based retrieval



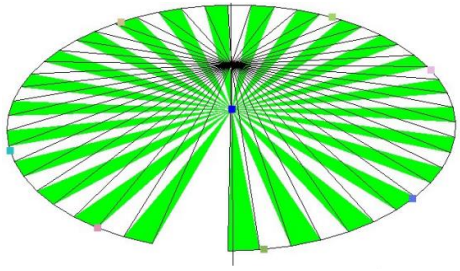
Part selection



3D reconstruction

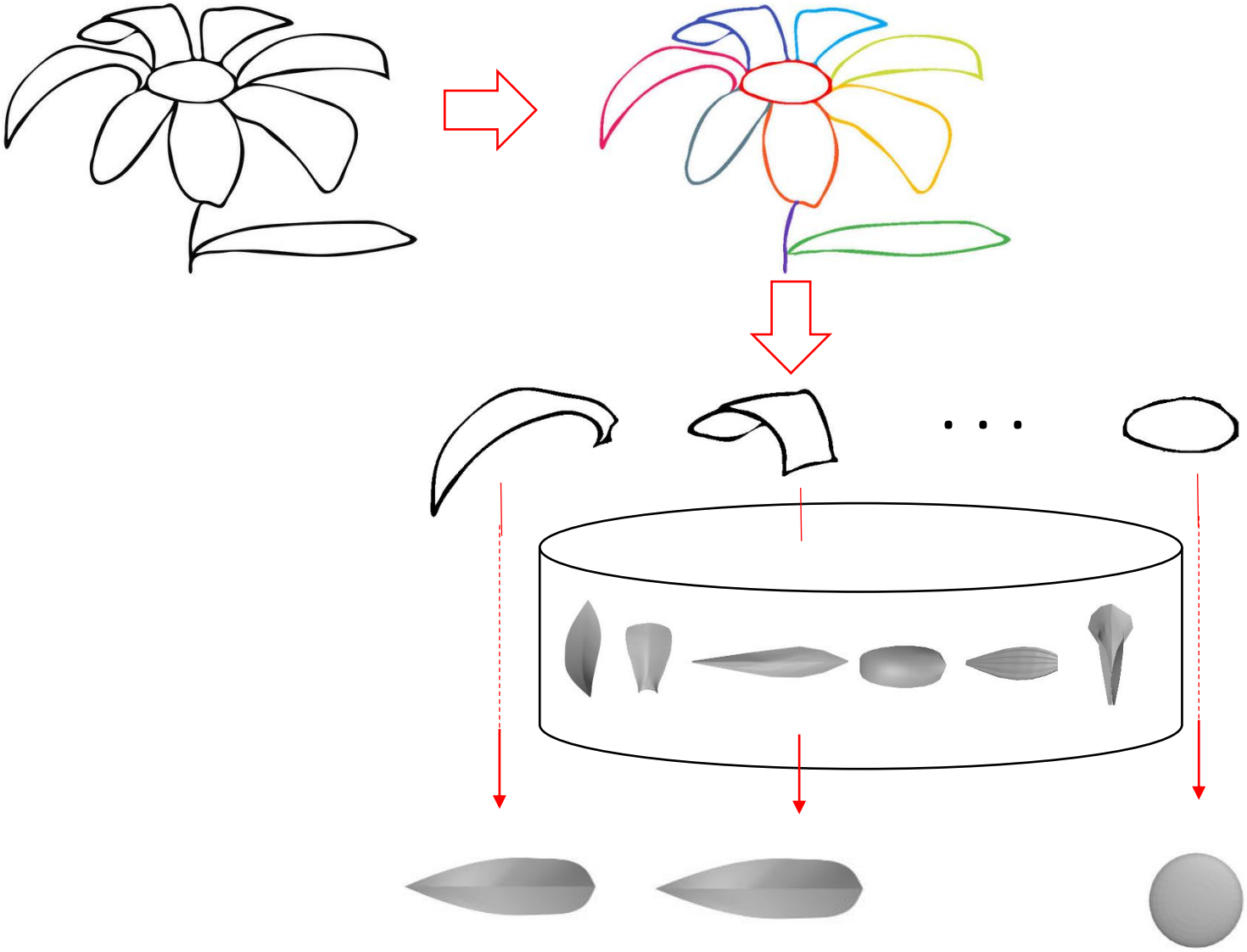


2D cone drawn by user

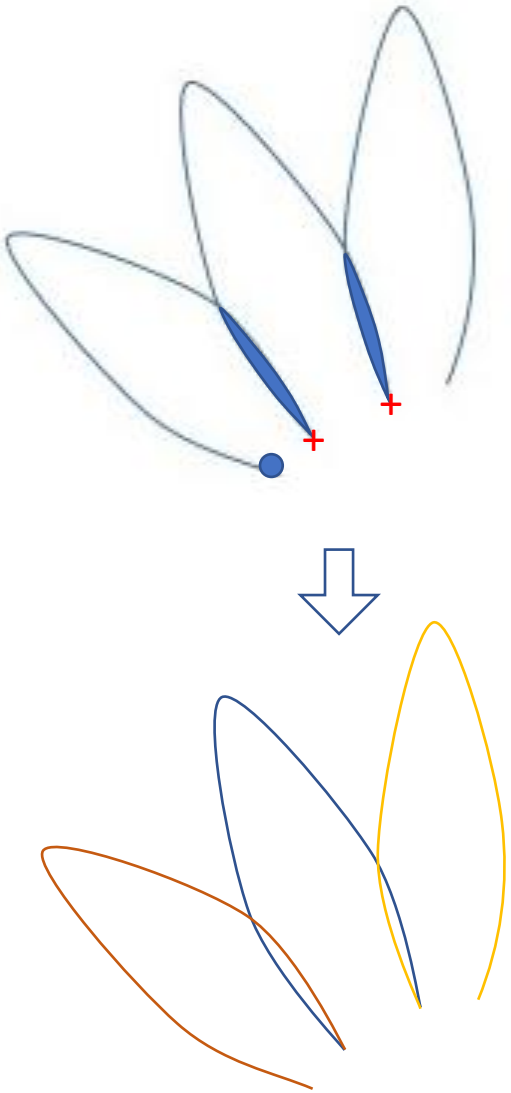


3D cone reconstruction

Segmentation



Segmentation



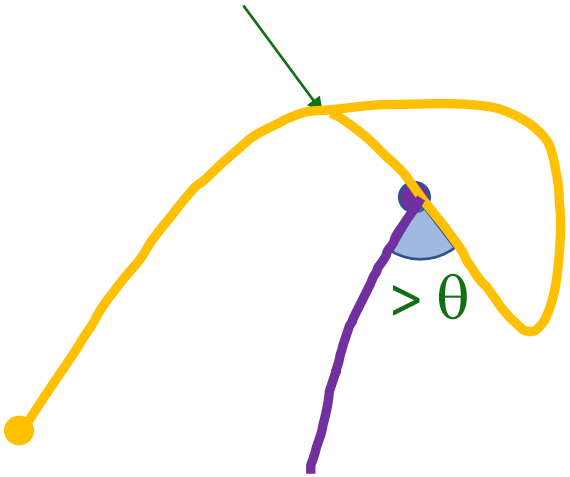
If area inside the loop is small,
we segment the stroke at the point
of maximal curvature in the loop

c.f.

Segmentation

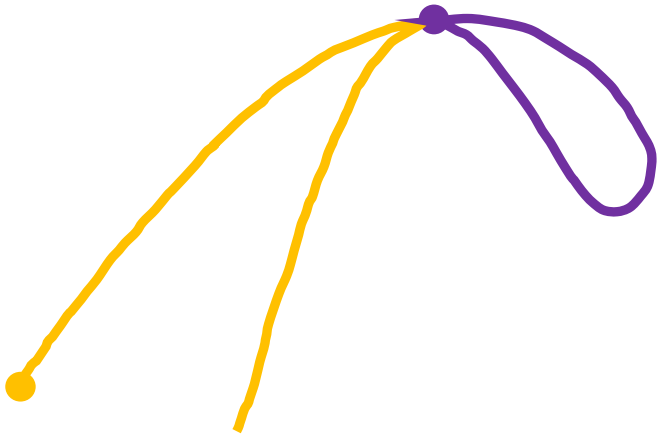
2 subsequent strokes meet at 1 junction point:

The stroke ends at a T-junction with itself



=> Assign a same label

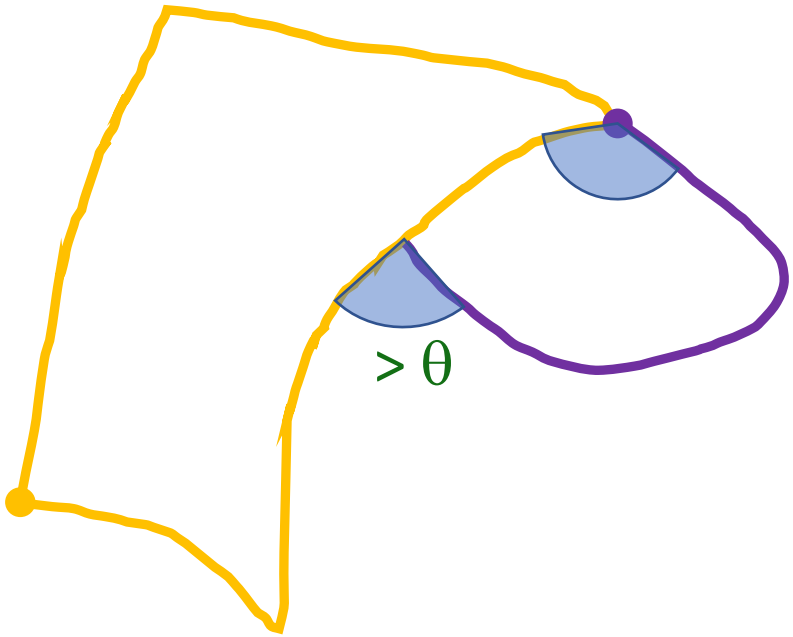
Pairs of coinciding tangent directions are found



=> Assign a same label

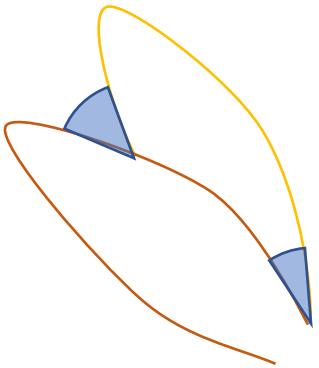
Segmentation

2 subsequent strokes meet at 2 junction points:



=> Assign a same label

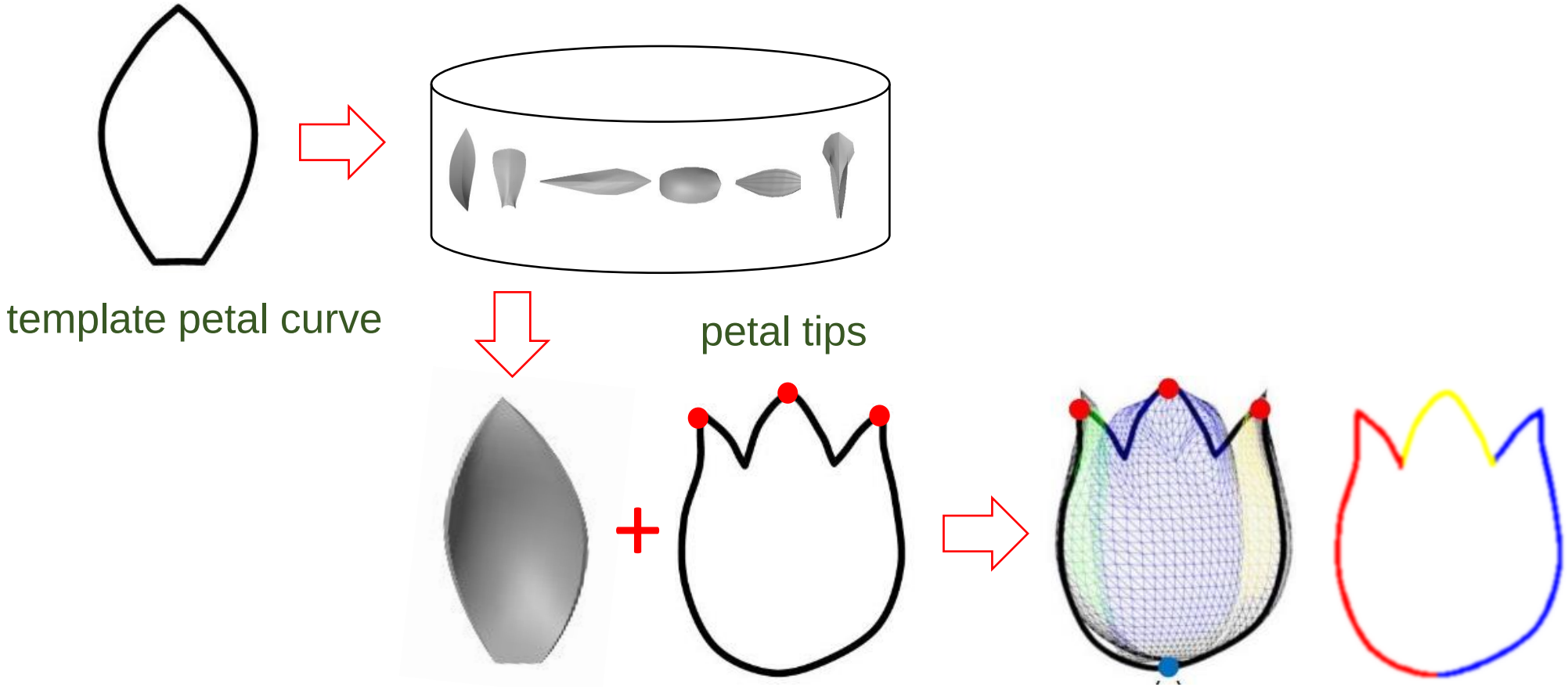
c.f.



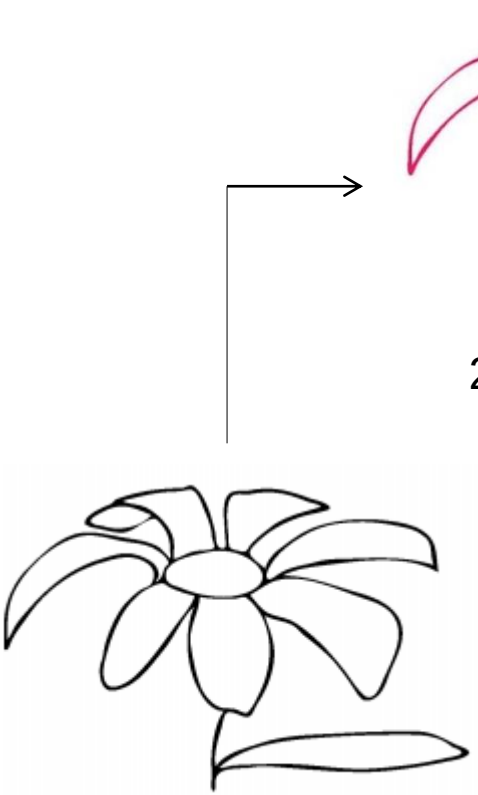
Segmentation

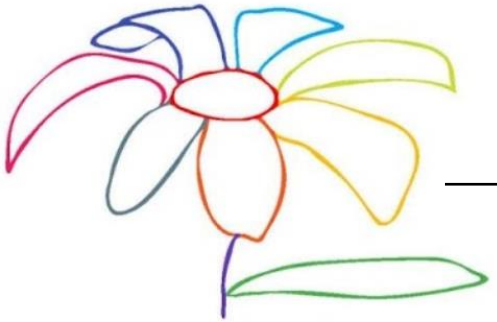
Sketch with high level of abstraction :

- Segmentation fails, and therefore, retrieval of shape elements
- Solution:

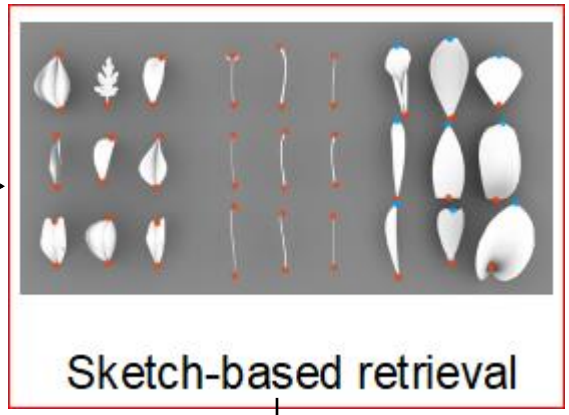


Method

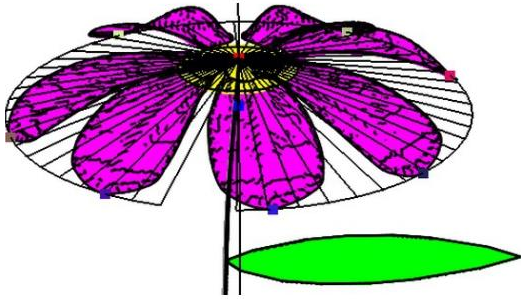




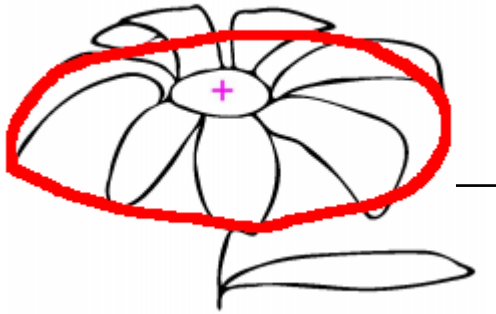
2D Segmentation



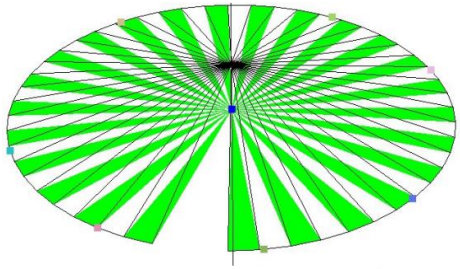
Part selection



3D reconstruction

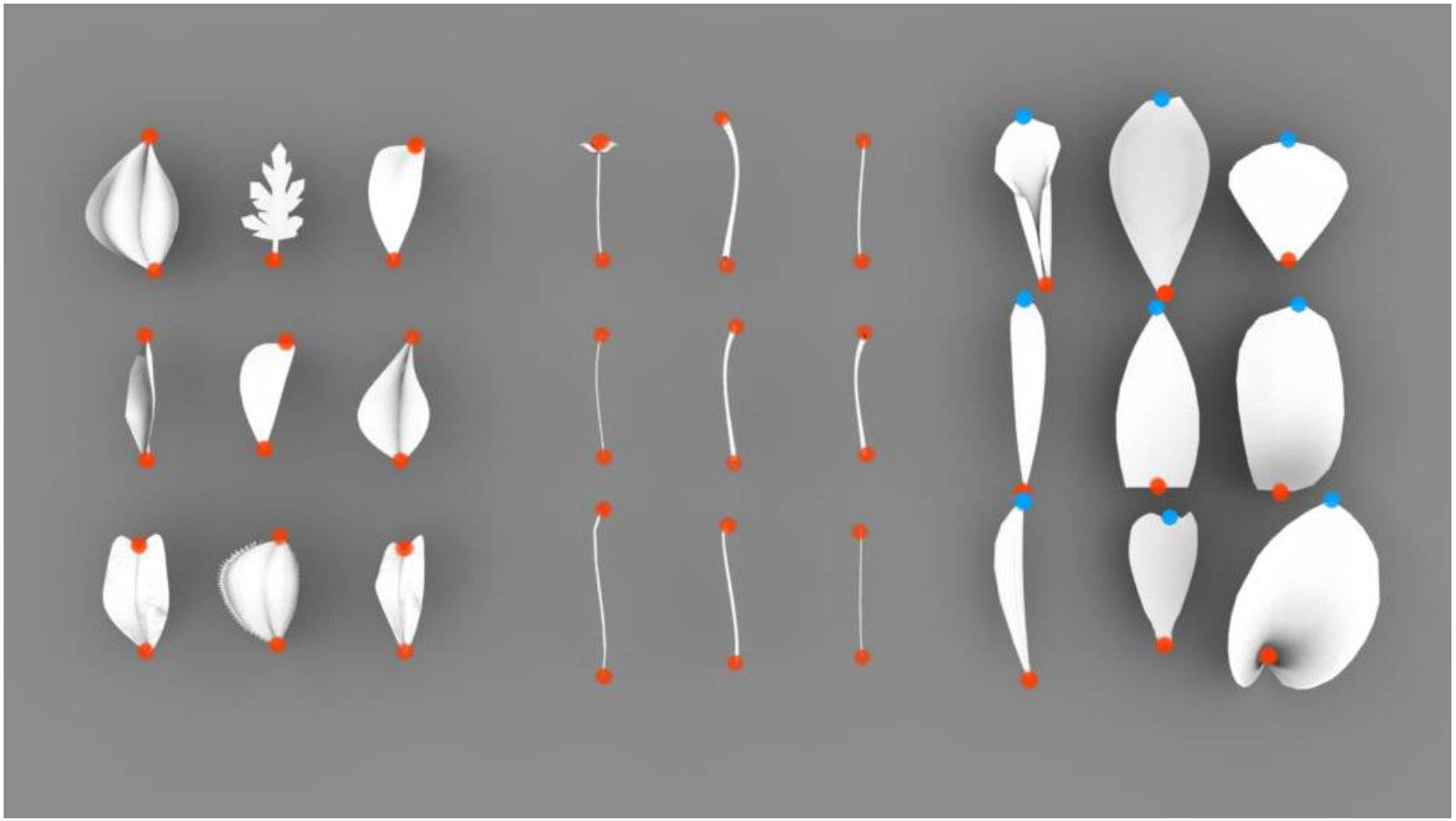


2D cone drawn by user



3D cone reconstruction

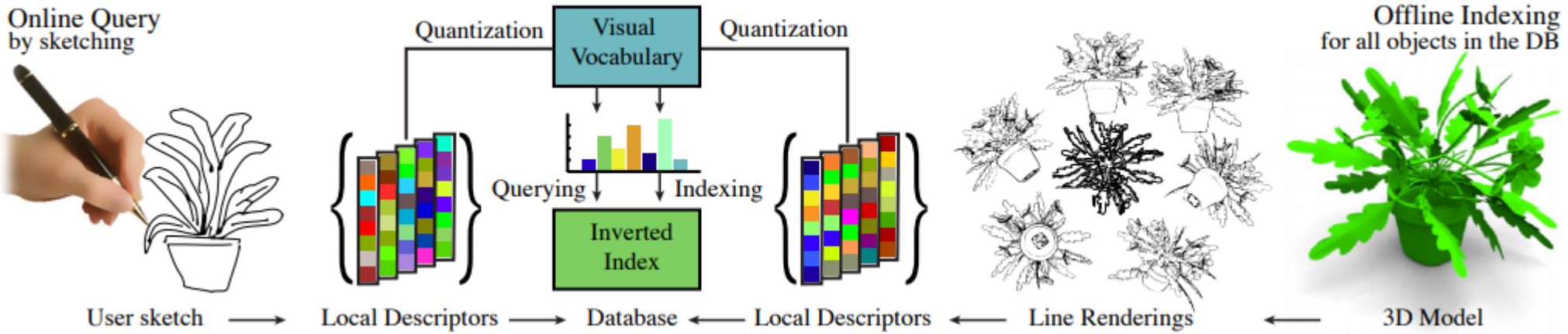
Floral Model Database



Examples of elementary models in our database. Attachment areas are shown in red and the petal tips in blue.

Floral Model Database

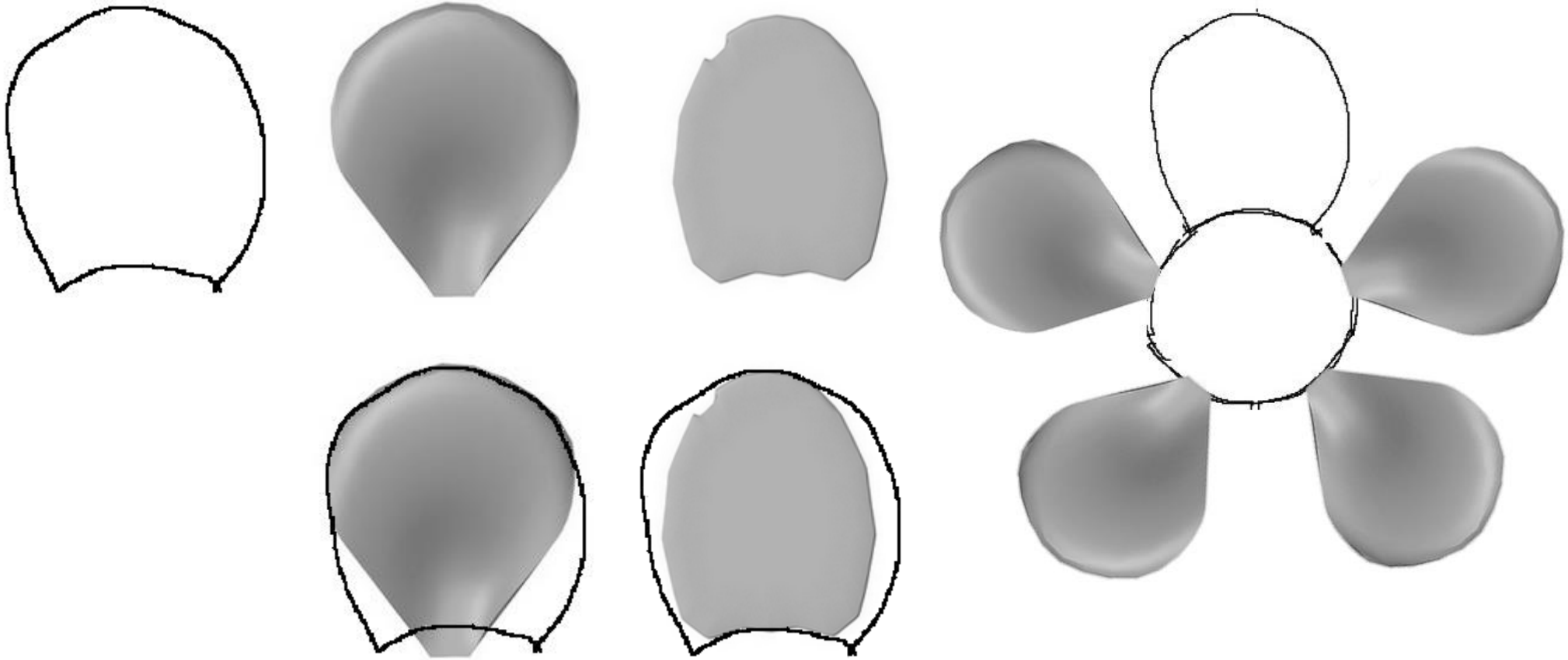
Based on the work of Eitz and others



Eitz, Mathias and Richter, Ronald and Boubekeur, Tamy and Hildebrand, Kristian and Alexa, Marc,Sketch-Based Shape Retrieval,ACM Trans. Graph. (Proc. SIGGRAPH),2012

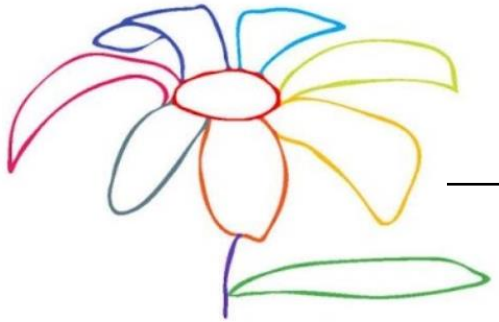
Nature of the drawing

Difficulty in selecting goog candidate

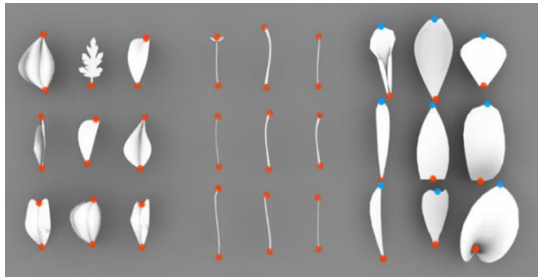


Which one ? Why ?

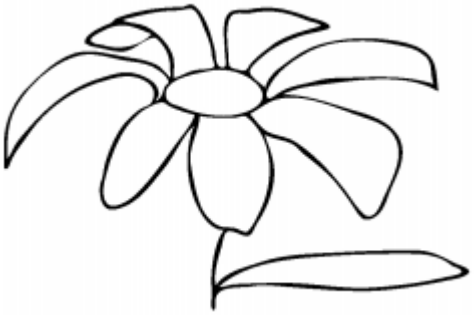
Method



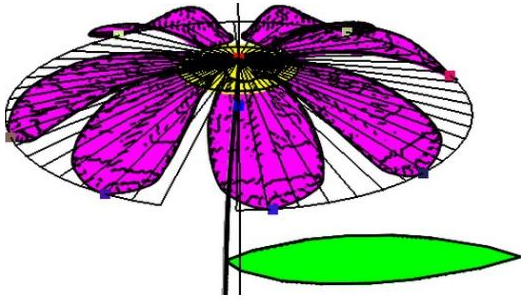
2D Segmentation



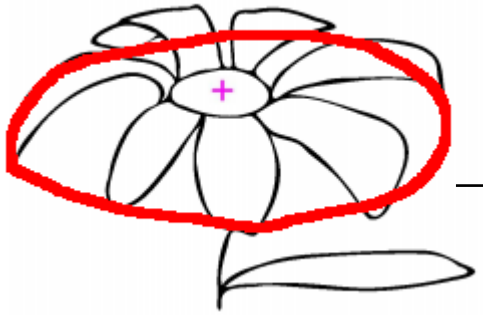
Sketch-based retrieval



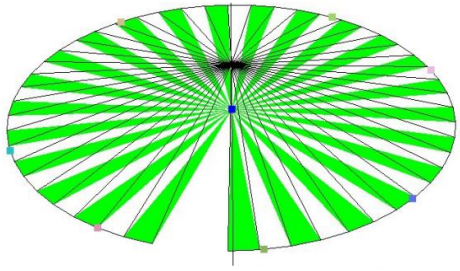
Part selection



3D reconstruction



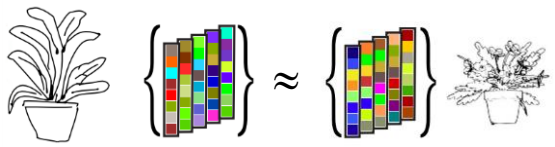
2D cone drawn by user

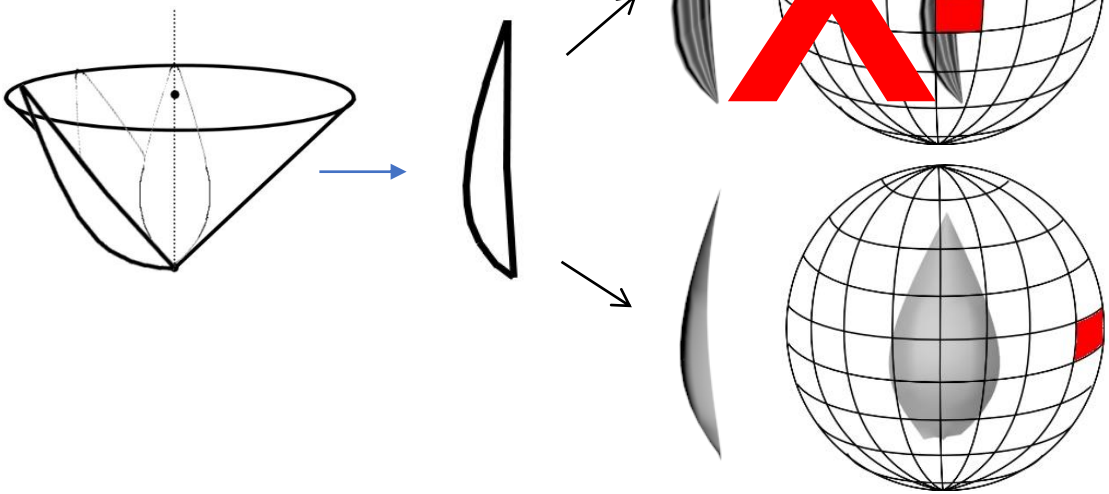


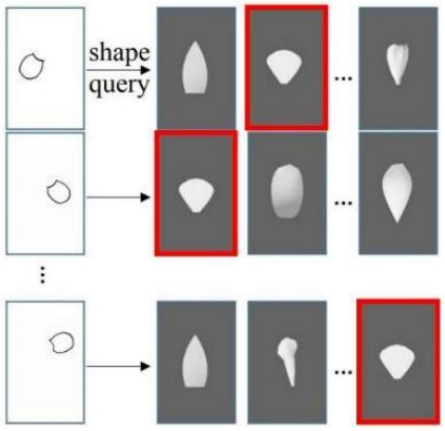
3D cone reconstruction

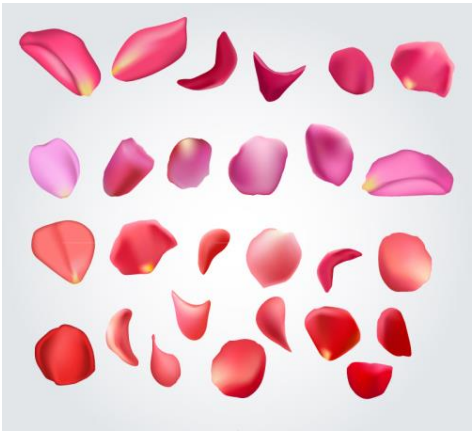
Selection of the good candidates

$$S = S_{similarity} + \alpha \cdot S_{view} + \beta \cdot S_{model} + \gamma \cdot S_{ftype}$$

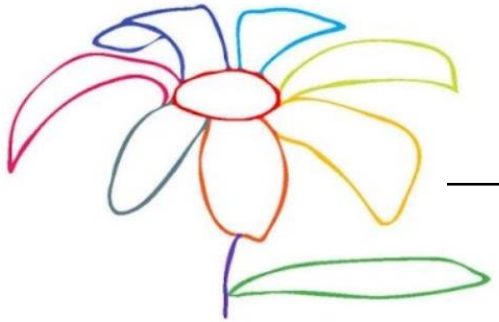




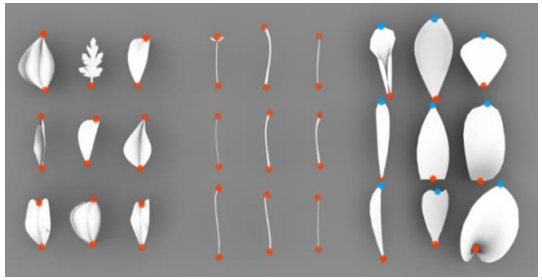




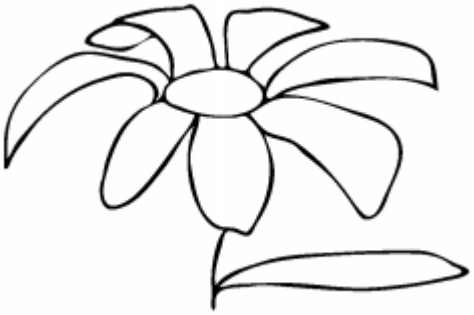
Method



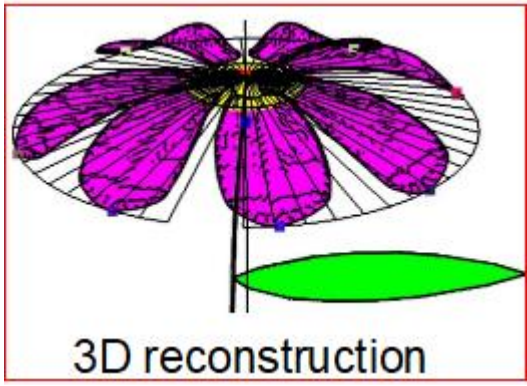
2D Segmentation



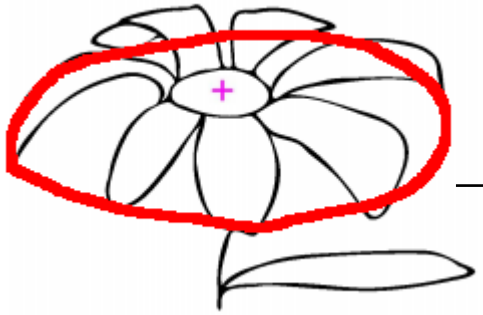
Sketch-based retrieval



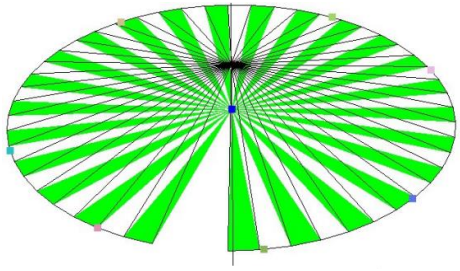
Part selection



3D reconstruction



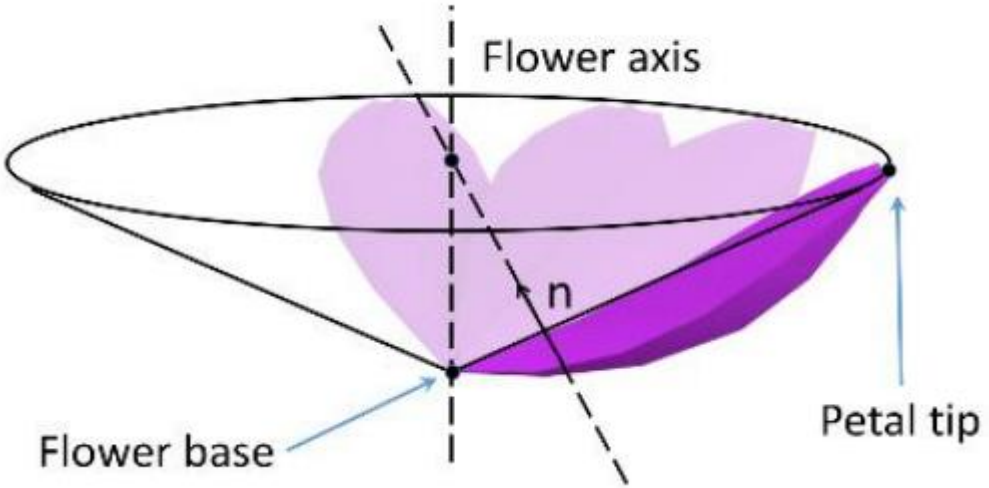
2D cone drawn by user



3D cone reconstruction

Placement

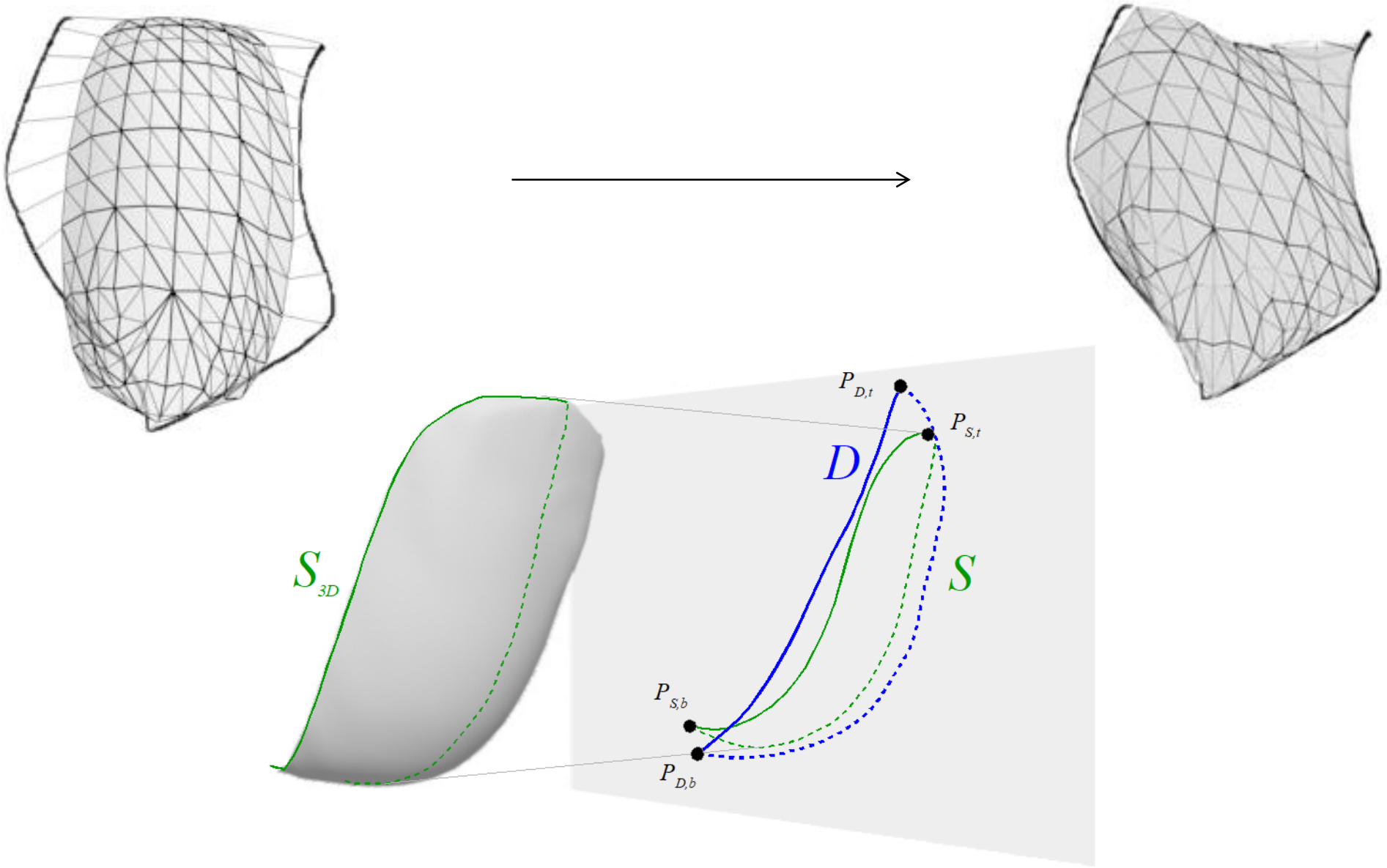
- Placement of the petals through the cone.



- Then placement of the stem and the leafs

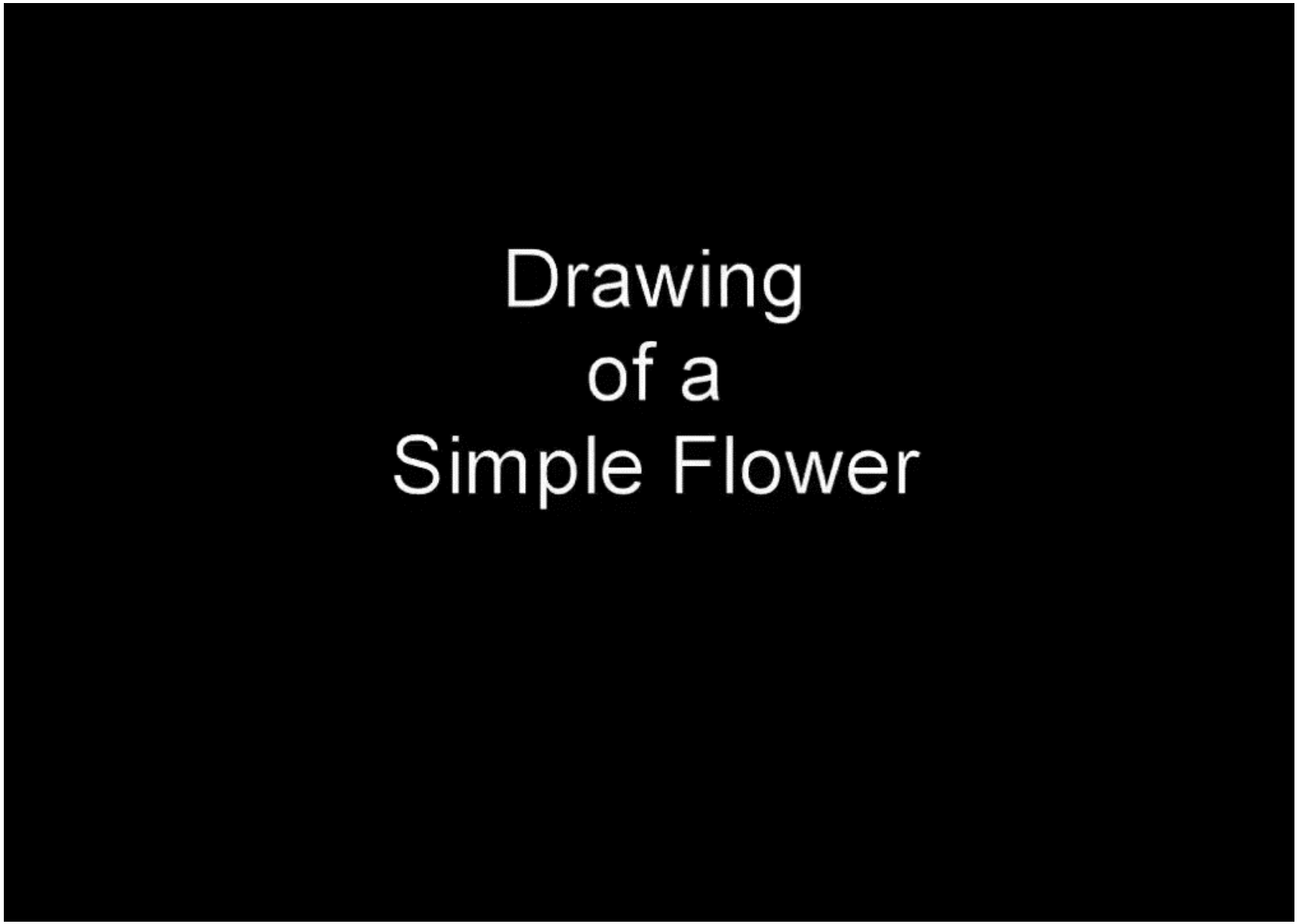
Flower Reconstruction and Refinement

Laplacian deformation

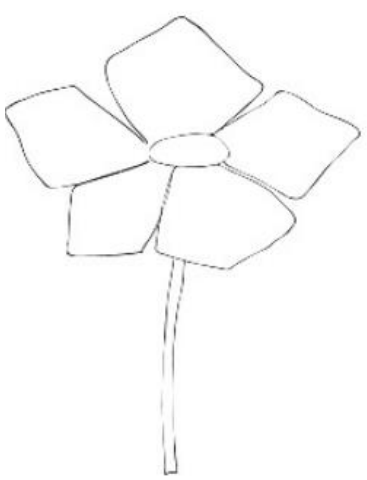


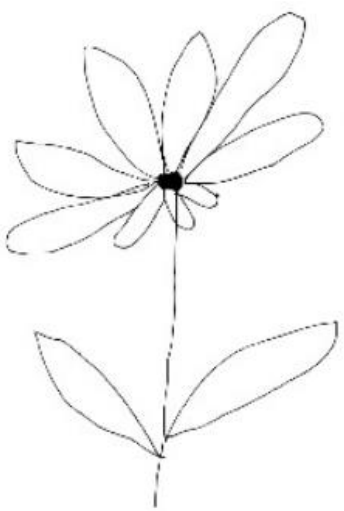
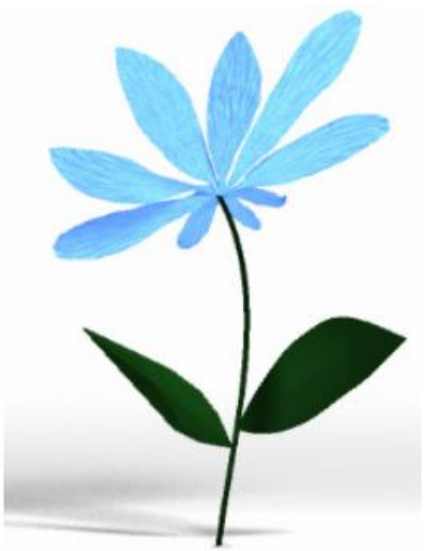
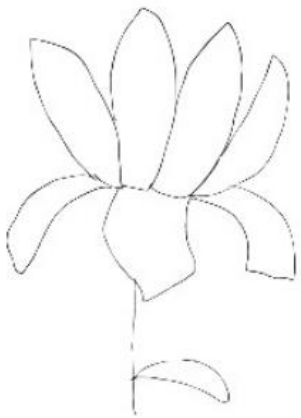
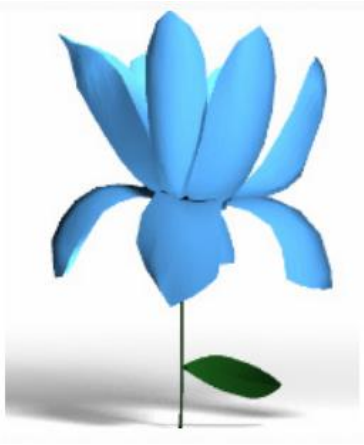
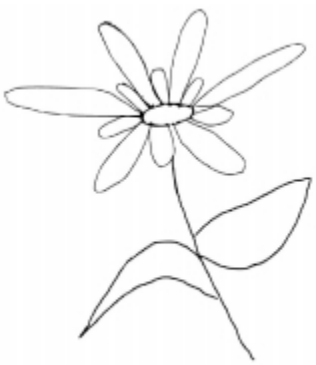
Sommaire

Results

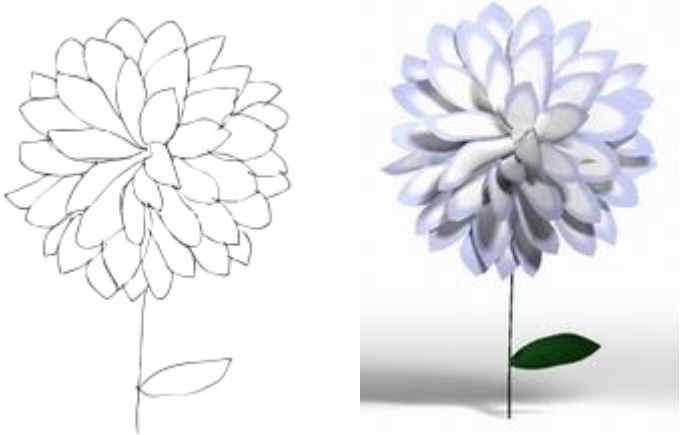


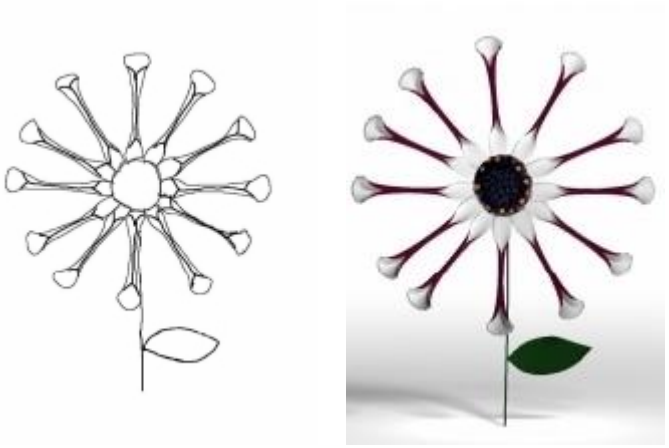
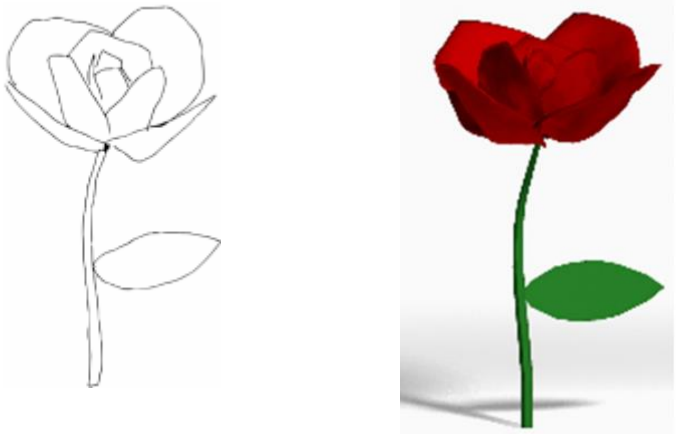
Results




Results



Limitations

- The presence of the flower stem in the sketch is mandatory
- The expressibility of the reconstructed geometry that depends on the variability of the model database
- Strictly frontal view : the segmented curves of the drawing do not represent well the 3D curvature of the petals

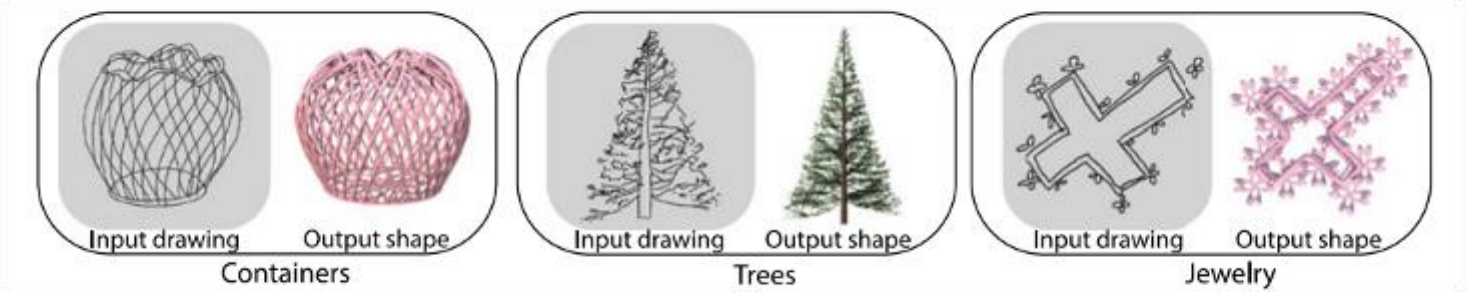
Conclusion

- System requiring minimum interaction with the user
- Reconstruction of flowers of all kinds (simple and complex)
- 3D reconstruction of the flower regardless of the point of view used for drawing

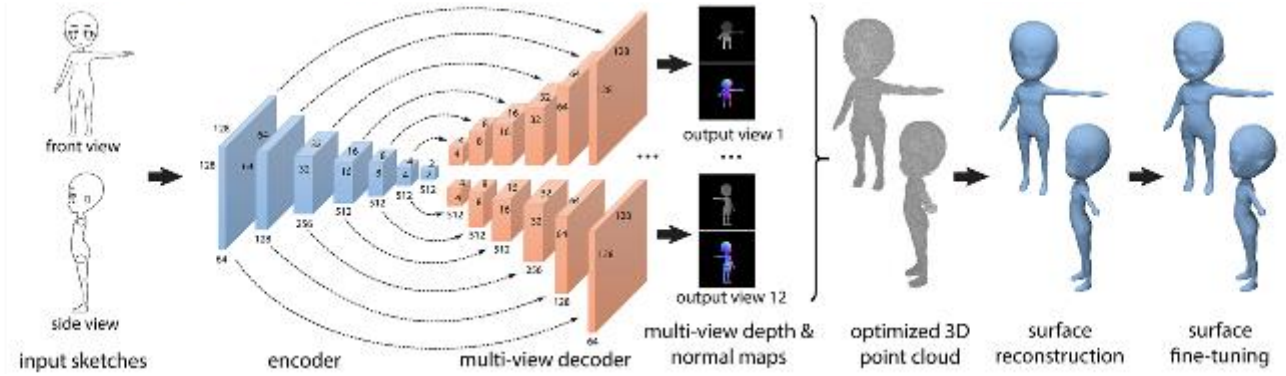
Thanks for your attention. Any questions ?

CNN

- Shape Synthesis from Sketches via Procedural Models and Convolutional Networks (2017) [1]

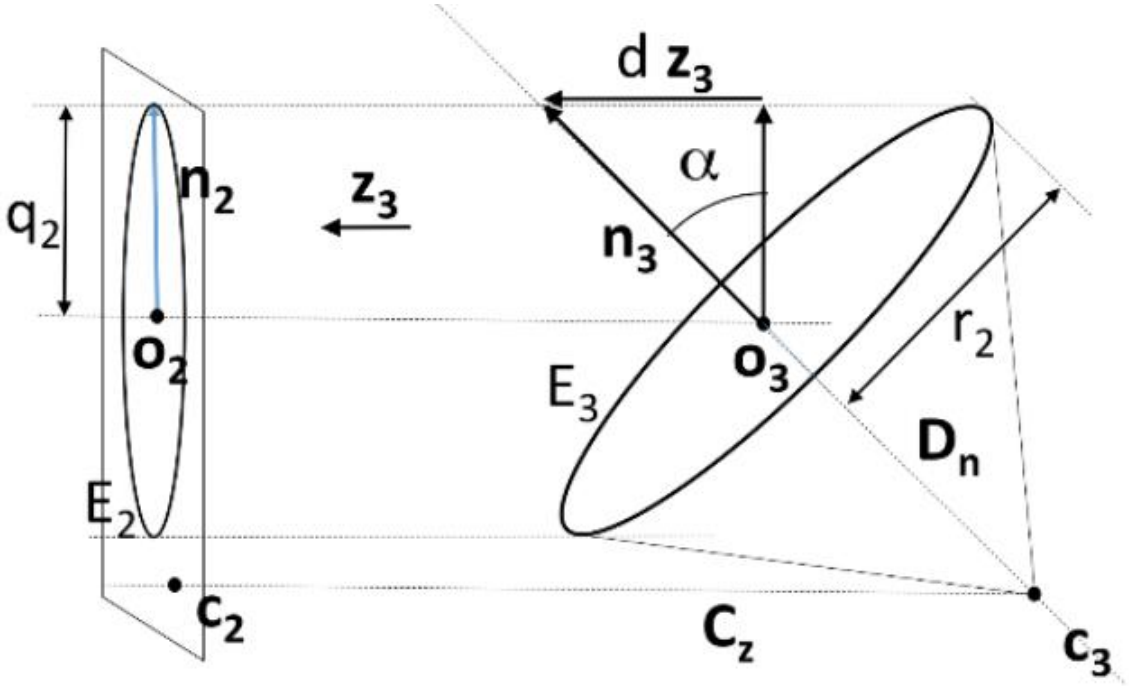


- 3D shape reconstruction from sketches via Multi-view convolutional networks (2017) [2]



[1] : H. Huang, E. Kalogerakis, E. Yumer and R. Mech, "Shape Synthesis from Sketches via Procedural Models and Convolutional Networks," Transactions on Visualization and Computer Graphics, 2017
[2] : Zhaoliang Lun, Matheus Gadelha, Evangelos Kalogerakis, Subhransu Maji, Rui Wang"3D Shape Reconstruction from Sketches via Multi-view Convolutional Networks" Proceedings of the International Conference on 3D Vision (3DV) 2017

3D cone



$$\sin\alpha = \|\boldsymbol{n_2}\|/\mathrm{r} \qquad \tan\alpha = d/\|\boldsymbol{n_2}\|$$

$$d = \|\boldsymbol{n_2}\|^2/\sqrt{r^2 - \|\boldsymbol{n_2}\|^2}$$

Selection criteria

$$S_{view} = \exp(-\|\Delta\varphi\|^2/\sigma_\varphi{}^2) + \exp(-\|\Delta\theta\|^2/\sigma_\theta{}^2),$$

$$\text{where } \sigma_\varphi = \pi/8 \text{ and } \sigma_\theta = \pi/4$$

S_{model} = 0.2 * nb of Occurences

S_{ftype} = 0.3 * nb of Occurences