TOWARDS DEVELOPABLE PRODUCTS FROM A SKETCH

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MOTIVATION

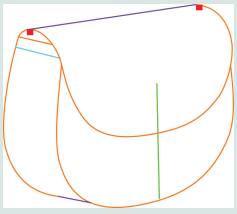
Objective: Generate the 3D shape of a piecewise developable object from a single annotated sketch

Hypothesis:
- piecewise cylindrical surfaces
- global mirror-symmetry

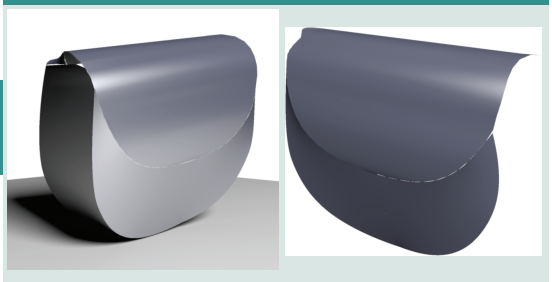
Approach :
We use a geometric approach were pairs of symmetric points and rulings are extracted from the 2D input, and enforced in the 3D reconstruction.

RESULTS

INPUT : ANNOTATED SKETCH



OUTPUT : 3D PIECEWISE DEVELOPABLE SURFACES



CONCLUSION

- satisfying results for photo not significantly affected by perspective
- future work
  - extension to generalized cones
  - automatic detection of symmetry orientation [1]

REFERENCES

[1] : Cordier, F., Seo, H., Melkemi, M., & Sapidis, N. S. (2013). Inferring mirror symmetric 3D shapes from sketches. Computer-Aided Design, 45(2), 301-311.

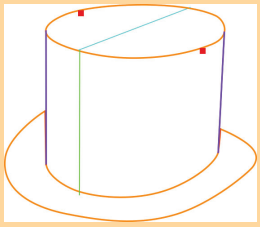
[2] : Xu, B., Chang, W., Sheffer, A., Bousseau, A., McCrae, J., & Singh, K. (2014). True2Form: 3D curve networks from 2D sketches via selective regularization. ACM Transactions on Graphics, 33(4).

[3] : Stanko, T., Hahmann, S., Bonneau, G. P., & Saguin-Sprynski, N. (2016). Surfacing curve networks with normal control. Computers & Graphics, 60, 1-8.

OUR METHOD

Assumptions :
- orthographic projection
- generic 3/4 viewpoint
- piece-wise cylindrical surface

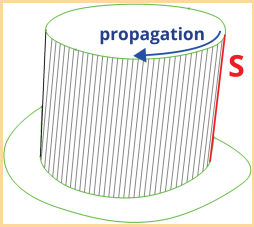
INPUT : ANNOTATED SKETCH



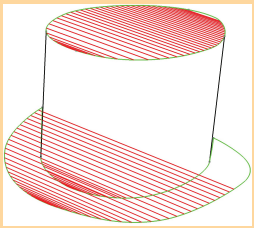
Annotations :
- borders/seams as Bezier curves (*orange curves*)
- silhouettes *(purple straight lines)*
- symmetry features *(red squares and cyan/green lines)*
- pairs of symmetrical borders/seams.

We then compute :
- **n** : 3D normal vector of the symmetry plane
- **cycles** : set of minimal closed contours

2D INTERPRETATION

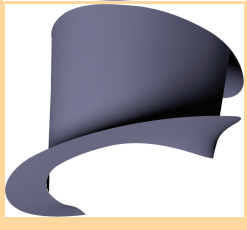


Rulings : *(blue lines)*
For each cycle with a silhouette **s** :
- **s** is the 2D projection of a 3D ruling
- parallel lines are propagated



Pairs of symmetrical points : *(red lines)*
Within two symmetric curves :
- pairs colinears to projection of **n**
- 3D position constrained by mirror-symmetry

OUTPUT : 3D PIECEWISE DEVELOPABLE SURFACES



Lifting the 2D Bezier curves in 3D :
Minimize

mirror-symmetry (inspired by [1]) — *compliance to the projection*

$$E = \omega_0 E_{\text{devel}} + \omega_1 E_{\text{sym}} + \omega_2 E_{\text{minvar}} + \omega_3 E_{\text{proj}}$$

developability term : constant tangent plane along each ruling — *minimal variation (as in [2])*

Triangulation of each 3d curve cycle :
- triangulation of rulings
- surfacing remaining patch boundaries [3]