Surface Reconstruction from Unstructured 3D Curves

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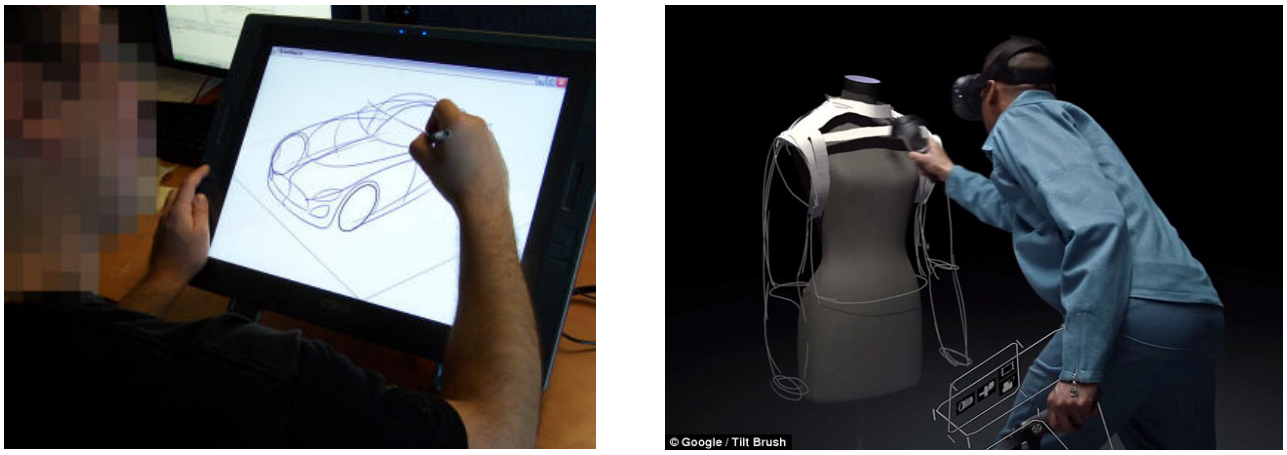
Context and Research Goal

Designers draw extensively to externalize their ideas and communicate with others. While design drawings are traditionally created with pen and paper, novel user interfaces allow designers to create sketches in 3D using pen tablets [1] or virtual reality devices [2] (Figure 1). However, most of these tools produce 3D curves rather than surfaced 3D models. The goal of this PhD is to develop methods capable of reconstructing 3D surfaces from unstructured "curve clouds" produced with 3D sketching tools.



(a) ILoveSketch [1] (b) TiltBrush [2]

Figure1: Novel user interfaces (a) and virtual reality devices (b) allow designers to draw 3D sketches. Our goal is to reconstruct 3D surfaces from the drawn curves.

Approach

The problem of surfacing a curve network has been long studied in the Computer-Aided-Design community, including methods that leverage specific properties of design sketches, such as surface curvature alignment with the drawn curves [3]. However, such methods assume that the input curve network is well connected, forming well-defined cycles that bound surface patches. Unfortunately, the strength of freehand sketching tools like ILoveSketch [1] and TiltBrush [2] is that they give complete freedom to designers to create *unstructured* 3D curves, which as a result do not form clean networks. While simple heuristics such as curve snapping have been used to connect unstructured curves, they are often prone to errors.

In contrast, researchers in geometry processing have proposed a number of approaches to robustly surface noisy *point* clouds [4]. We plan to take inspiration from this family of work to

derive robust methods to handle noisy *curve* clouds. In particular, we will study the use of volumetric implicit functions extrapolated from the curves, as commonly done to generate iso-surfaces from point sets [5].

Location

The PhD will take place at Inria Sophia Antipolis, on the beautiful French riviera. The research will be conducted in the GraphDeco group (https://team.inria.fr/graphdeco/). The group does research on image synthesis and computer-aided design.
The work will be done in collaboration with David Bommes, who is an expert in geometry processing and numerical optimization (https://www.aices.rwth-aachen.de/people/bommes).

Requirements

The successful candidate should have taken courses in numerical optimization, computer graphics, geometry processing. The candidate must have experience in C++ programming.

References

[1] ILoveSketch: As-natural-as-possible sketching system for creating 3D curve models
Seok-Hyung Bae, Ravin Balakrishnan, and Karan Singh – ACM UIST 2008
http://www.ilovesketch.com/

[2] TiltBrush by Google – 2017
https://www.tiltbrush.com/

[3] Flow Aligned Surfacing of Curve Networks
Hao Pan, Yang Liu, Alla Sheffer, Nicholas Vining, Changjian Li, Wenping Wang
ACM SIGGRAPH 2015
http://haopan.github.io/curvenet_surfacing.html

[4] State of the Art in Surface Reconstruction from Point Clouds
Matthew Berger, Andrea Tagliasacchi, Lee Seversky, Pierre Alliez, Joshua Levine, Andrei Sharf, Claudio Silva - Eurographics 2014
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[5] Poisson surface reconstruction
Michael Kazhdan, Matthew Bolitho, Hugues Hoppe – SGP 2006
http://hhoppe.com/proj/poissonrecon/