

Sketch-based 3D Modeling in Virtual Reality

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Introduction

- VR for interactive 3D content
- Intuitive sketch-based 3D modeling
- Easy to use for beginners

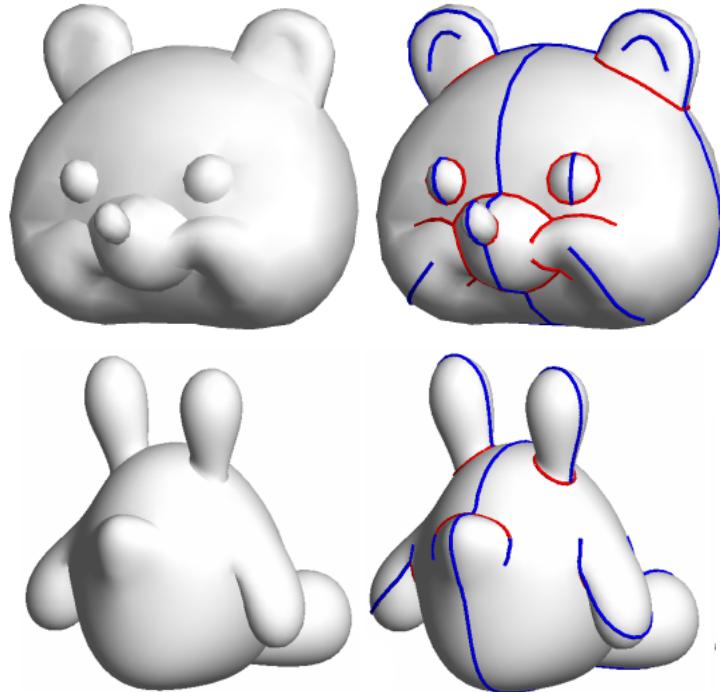


Related Work

FiberMesh

Nealen A., Igarashi T., Sorkine O., and Alexa M., 2007

- Sketch-based 3D modeling
- Functional optimization
- Drawn curves serve as handles and functional constraints
- Curve deformation & surface optimization



Google Tilt Brush

- 3D art in virtual reality
- No exporting to 3D model formats



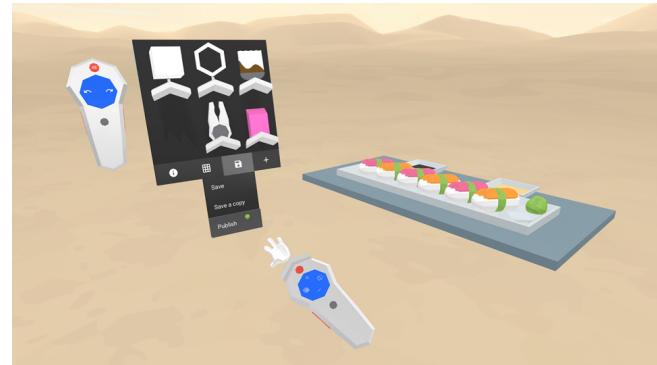
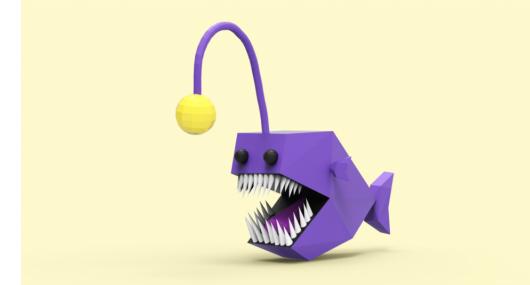
Oculus Medium

- Intuitive clay-like modeling
- Exporting models in .obj format



Google Blocks

- Provides predefined base shapes (spheres, cubes, cones)
- Low-level editing
- Low-poly meshes
- Exporting models in .obj format



Motivation

- Transfer pen-and-paper drawing skills
- Intuitive editing
- Utilizing 3D space
- Real time to avoid motion sickness

SketchMeshVR

System components

- Oculus Rift + Touch controllers
- FiberMesh (Nealen et al. 2007)
- Libigl
- Multithreaded rendering + linear solving

FiberMesh algorithm

- Curve deformation
 - Differential coordinates with co-rotational methods

$$\arg \min_{\mathbf{v}, \mathbf{r}} \left\{ \sum_i \| \mathbf{L}(\mathbf{v}_i) - \mathbf{r}_i \mathbf{R}_i \delta_i \|^2 + \sum_{i \in C_1} \left\| \mathbf{v}_i - \mathbf{v}'_i \right\|^2 + \sum_{i,j \in E} \| \mathbf{r}_i \mathbf{R}_i - \mathbf{r}_j \mathbf{R}_j \|^2_F + \sum_{i \in C_2} \left\| \mathbf{r}_i \mathbf{R}_i - \mathbf{R}'_i \right\|_F^2 \right\}$$

FiberMesh algorithm

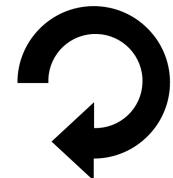
- Surface optimization
 - Geometry-independent linear systems

$$\arg \min_c \left\{ \sum_i \|\mathbf{L}(c_i)\|^2 + \sum_i \|c_i - c'_i\|^2 \right\}$$

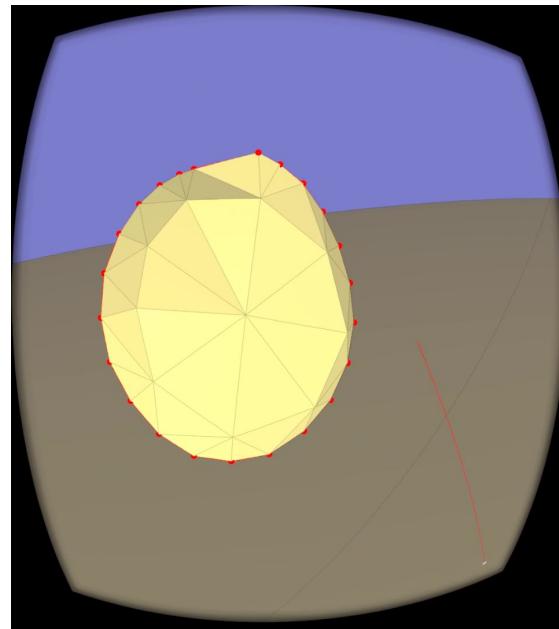
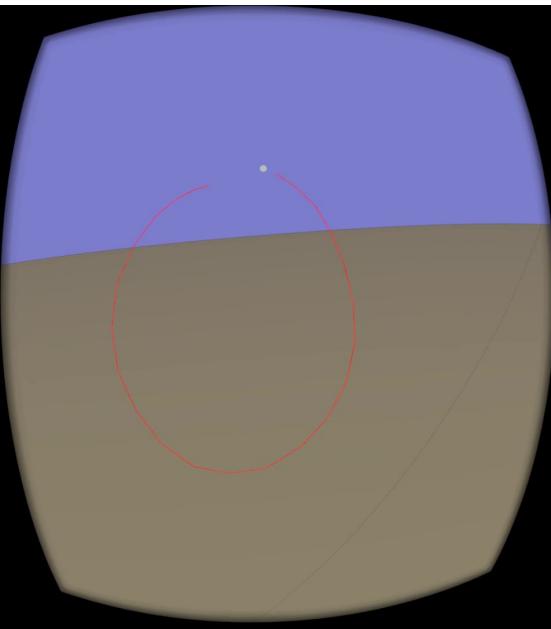
$$\arg \min_e \left\{ \sum_i \|\mathbf{L}(e_i)\|^2 + \sum_i \|e_i - e'_i\|^2 \right\}$$

$$\eta_{ij} = (e_i + e_j) / 2 \cdot (\mathbf{v}_i - \mathbf{v}_j) / \|\mathbf{v}_i - \mathbf{v}_j\|$$

$$\arg \min_{\mathbf{v}} \left\{ \sum_i \|\mathbf{L}(\mathbf{v}_i) - \delta_i\|^2 + \sum_{i \in C} \|\mathbf{v}_i - \mathbf{v}'_i\|^2 + \sum_{(i,j) \in B} \|\mathbf{v}_i - \mathbf{v}_j - \eta_{ij}\|^2 \right\}$$



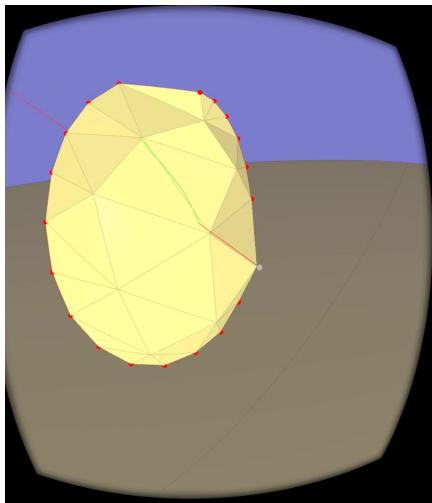
Drawing



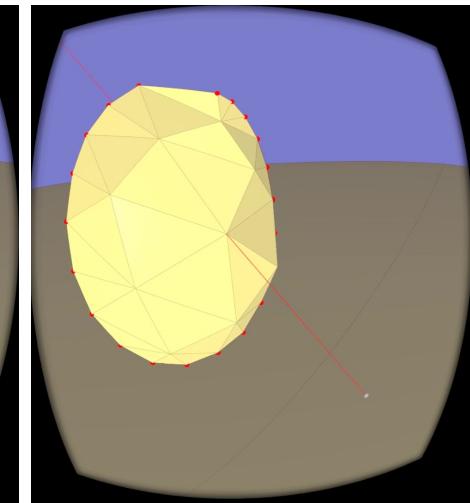
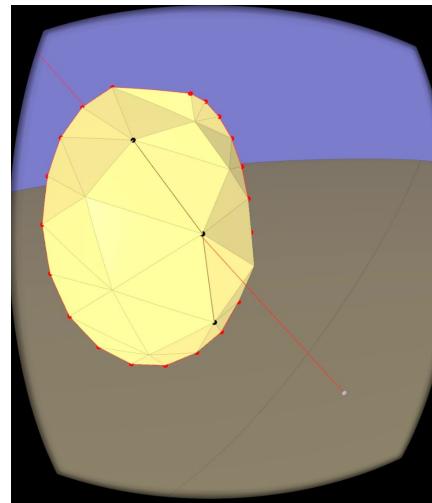
Uses hand position

Adding and removing curves

Adding

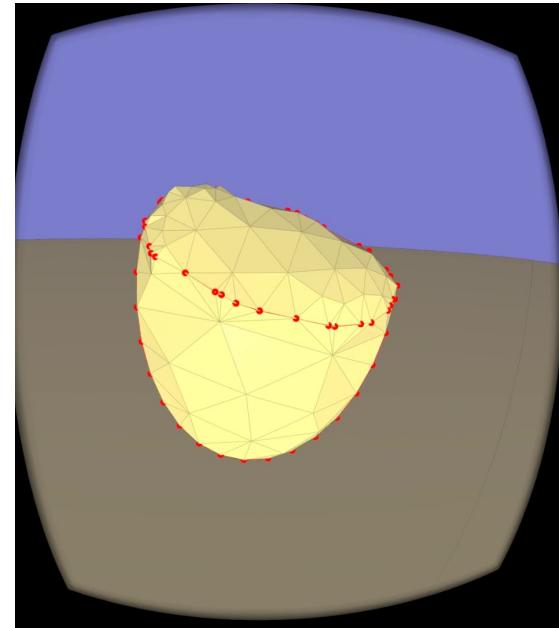
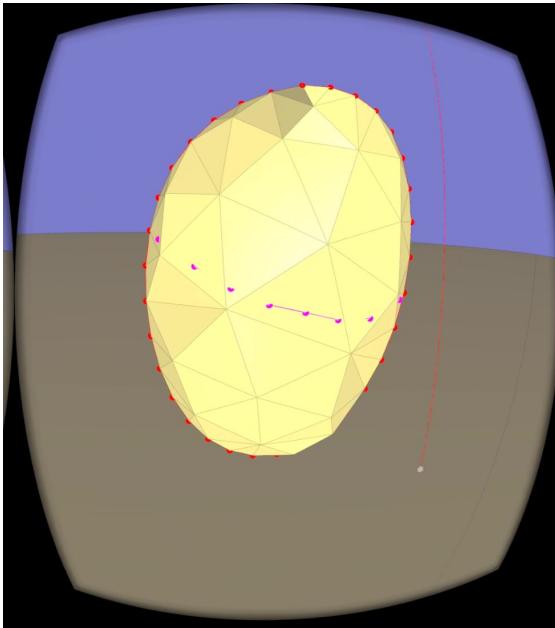


Removing



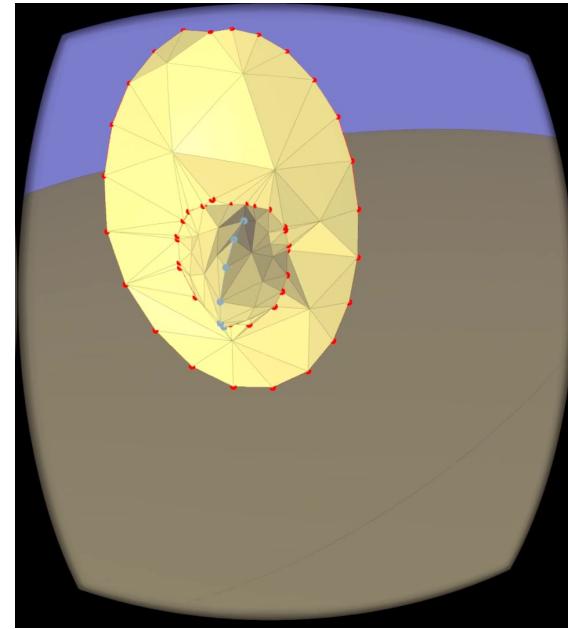
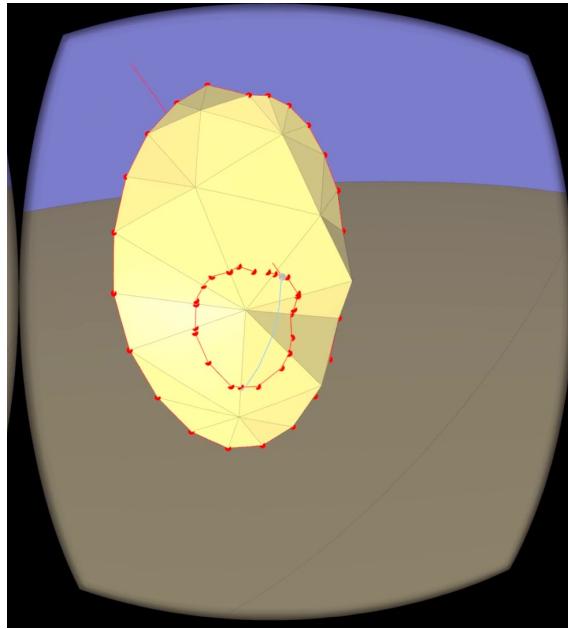
Uses ray-mesh intersection

Cutting



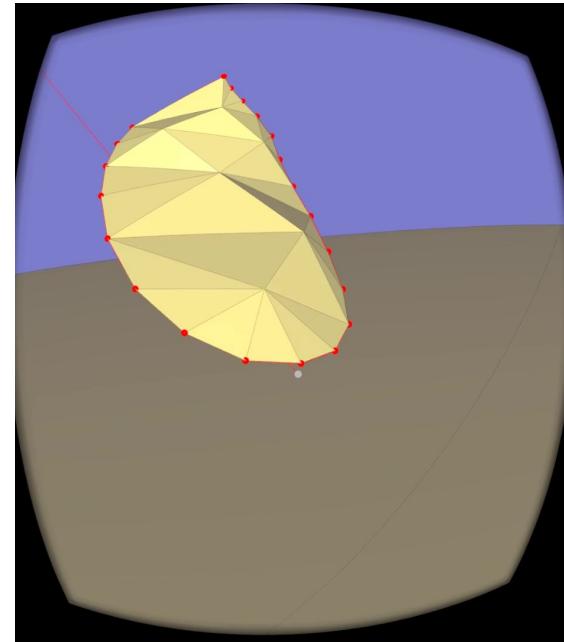
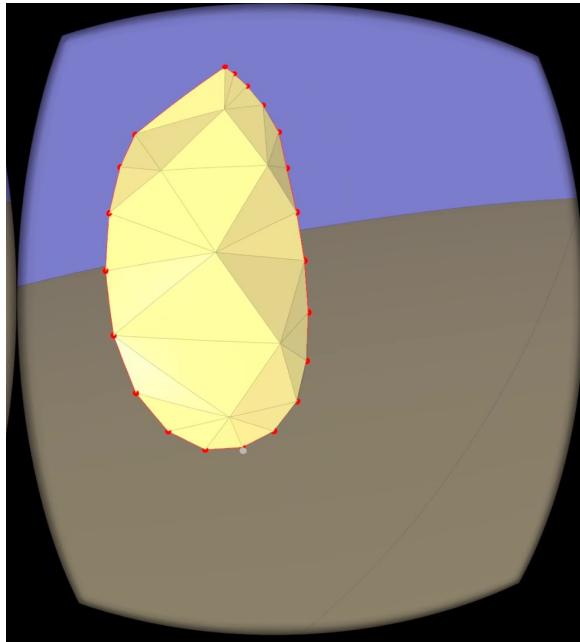
Uses ray-mesh intersection

Extrusion



Uses ray-mesh intersection for base and hand position for silhouette

Curve deformation

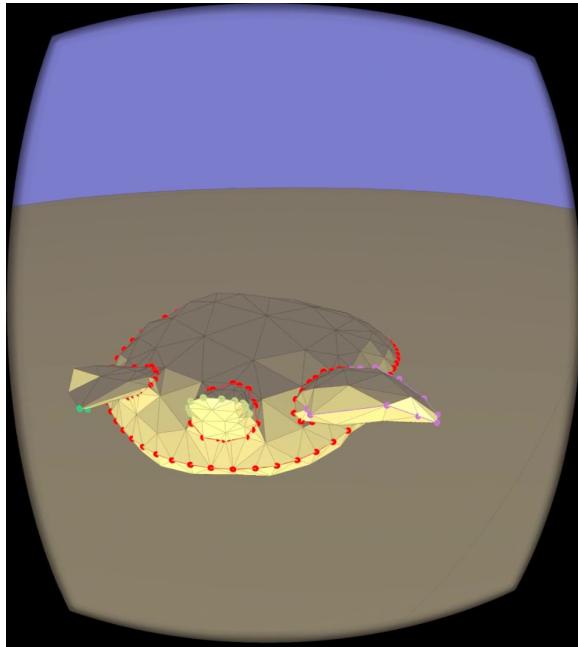


Uses hand position

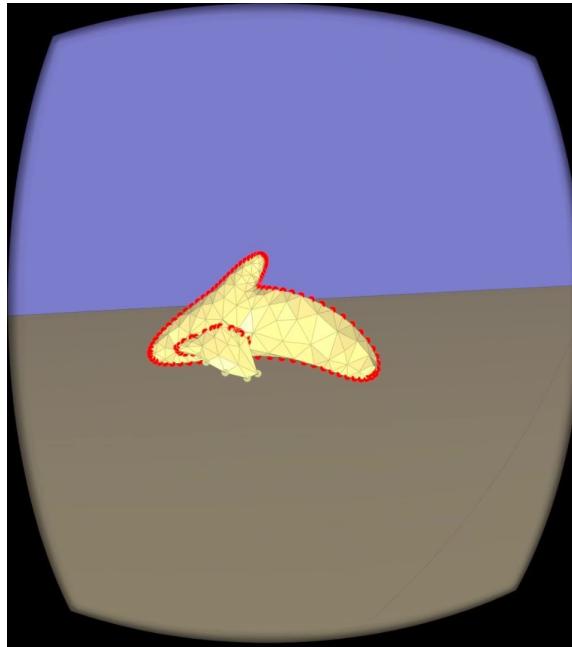
Novel contributions

- First silhouette sketch-based method in VR
- Out-of-plane editing
 - Curve deformation
 - Diagonal cuts
 - Extrusions

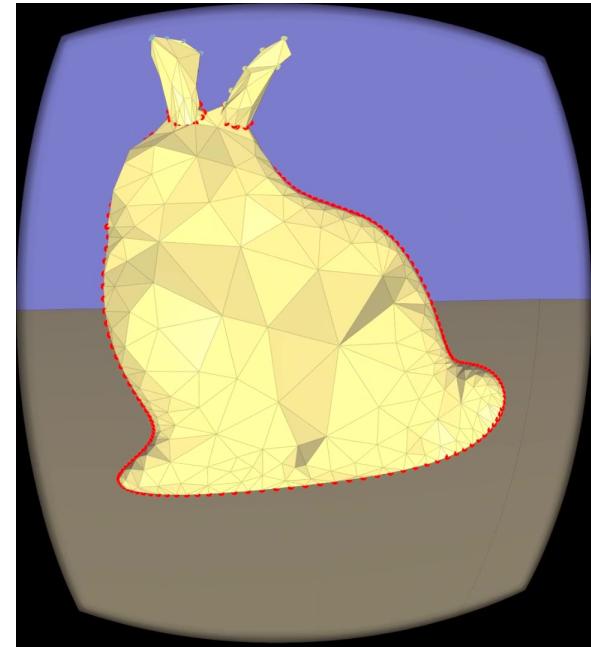
Some results



5 minutes



7 minutes



9 minutes

Evaluation

Advantages

- Out-of-plane editing
- Tactile 3D feedback
- Sense of scale

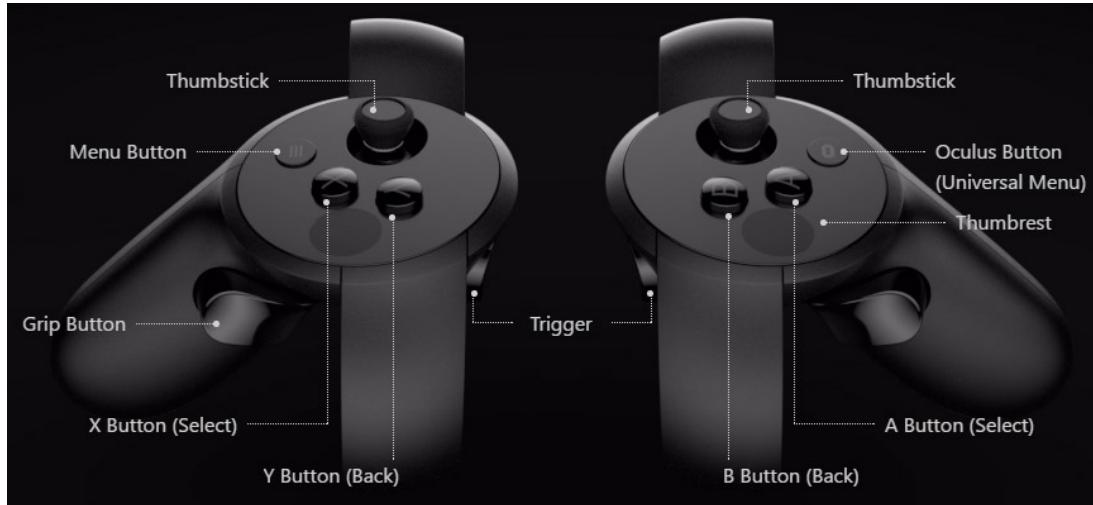
Disadvantages

- Less precise
- Quicker fatigue
- Requires more space

Current limitations

- No feedback on selected mode
- Mesh navigation in small space
- Sharp curve deformation
- Undo button

Demo



Action button	Toggle button	Actions
Grip	A button	Cut & extrude
Trigger	B button	Add & remove curves
Grip + Trigger	Thumbstick	Draw & pull

Thank You



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