Viewpoint Selection for Liquid Animations

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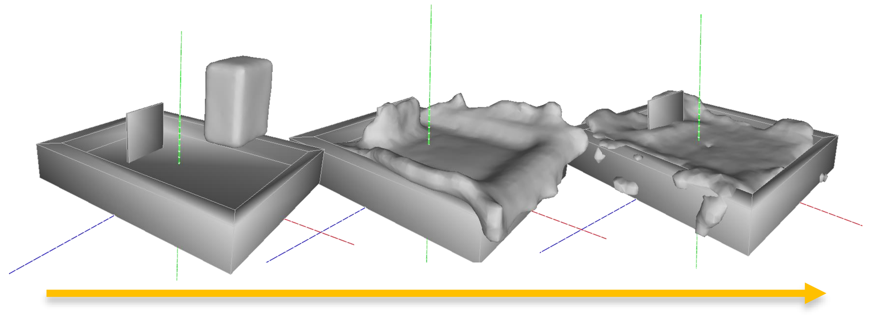
We propose a viewpoint selection method for time-varying liquid shapes in order to select the best viewpoint for liquid animations. First, viewpoint evaluation is performed by a combination of three evaluation terms; occlusion term, spatial feature term, and temporal feature term, and the viewpoint having the maximum evaluation value is selected as the ``best viewpoint''. Through various experiments, it was confirmed that the results of this method is consistent with human intuition and that it can select viewpoints independent of the resolution of liquid meshes.

References
[1] JUDD T., DURAND F., ADELSON E. H.: Apparent ridges for line drawing. ACM Transaction on Graphics 26, 3 (July 2007) 19.
[2] LEE C. H., VARSHNEY A., JACOBS D. W.: Mesh saliency. ACM Transaction on Graphics 24, 3 (July 2005), 659–666.
[3] YAMAUCHI H., SALEEM W., YOSHIZAWA S., KARNI Z., BELYAEV A., SEIDEL H.-P.: Towards stable and salient multi-view representation of 3D shapes. In Proc. SMI'06 (2006), pp. 265–270.

Our Method

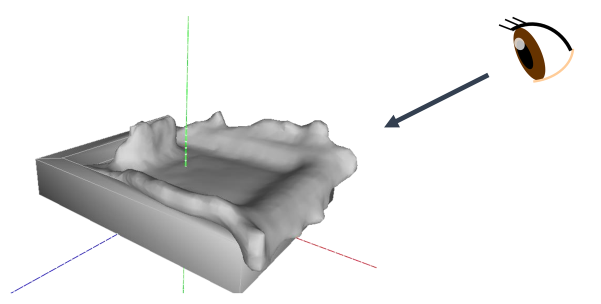
Input

Time-series 3D polygonal mesh Sequences with different number of vertices and faces.



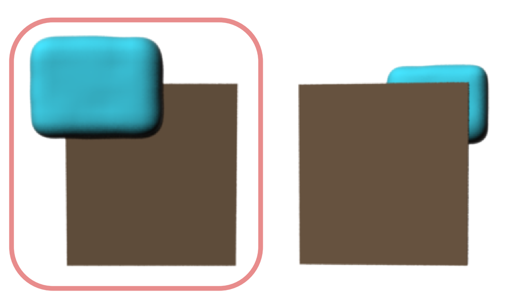
Output

- Best viewpoint $\boldsymbol{p}_{best}$
- Worst viewpoint $\boldsymbol{p}_{worst}$

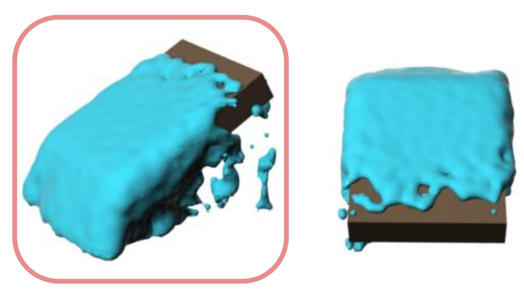


Ease of Perception

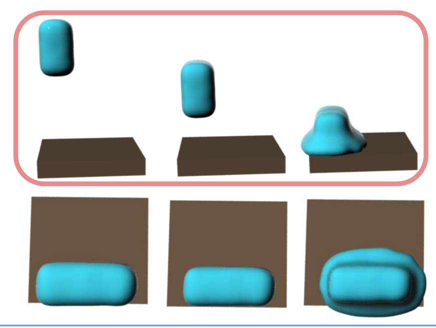
Occlusion
Less occluded objects



Spatial Feature
Visible geometric features (e.g. wave tip, splash)



Temporal Feature
Viewing the movement of objects from the side



Occlusion Term

Evaluates the size of visible vertices

C_i: A set of visible vertices in i-th frame

$$Occ(\boldsymbol{p}) = \sum_{i}^{frame} |C_i|$$

Spatial Feature Term

Evaluates the size of geometric features perceptible from the viewpoint

$$Sf(\boldsymbol{p}) = \sum_{i}^{frame} \sum_{v_j \in C_i} \gamma(v_j) \qquad \gamma(v_j) = \begin{cases} 1 & if\ \ threshold \leq q_1(v_j) \\ 0 & else \end{cases}$$

$q_1(v_j)$: Maximum view-dependent curvature [1]

Mean curvature / Mesh saliency [2] / Maximum view-dependent curvature [1]

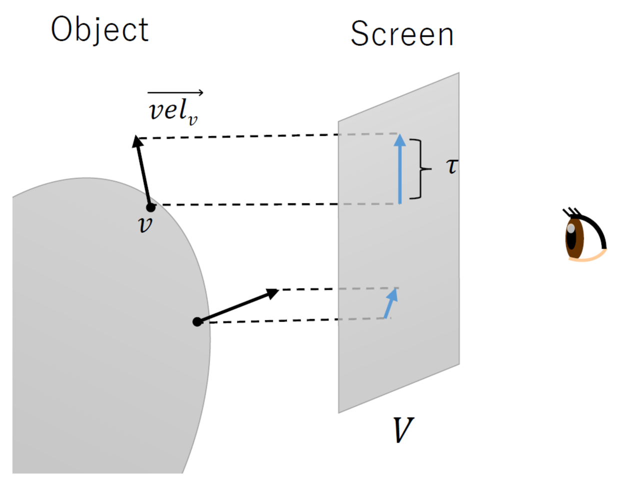
Temporal Feature Term

Evaluates the magnitude of movements perceptible from the viewpoint

$$Tf(\boldsymbol{p}) = \frac{\sum_{i}^{frame} \sum_{v_j \in C_i} \tau(v_j)}{\sum_{i}^{frame} |C_i|}$$

$$\tau(v_j) = \left|\mathrm{proj}_V \overrightarrow{vel_v}\right|$$

The magnitude of projected velocity of a vertex to the screen



Viewpoint Evaluation Function

Takes the product of normalized evaluation values: $\overline{Occ}, \overline{Sf}, \overline{Tf}$

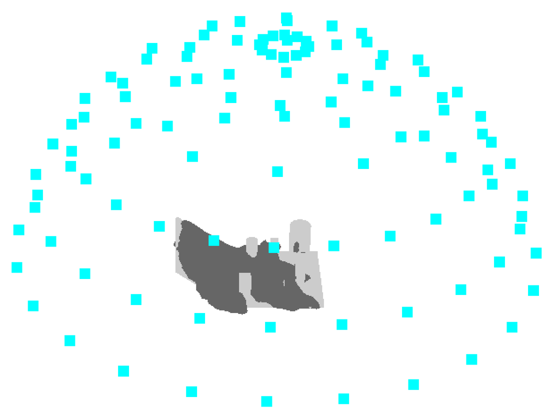
$$F(\boldsymbol{p}) = \overline{Occ}\,(\boldsymbol{p}) \cdot \overline{Sf}\,(\boldsymbol{p}) \cdot \overline{Tf}\,(\boldsymbol{p})$$

Experiment: Candidate Viewpoints

Viewpoint sphere [3]

- All viewpoints are directed to the center of a sphere
- Center: the center of entire scene
- Radius: twice the length of BB of entire scene

Sample 108 viewpoints uniformly on its hemisphere



Results

Scene 1

Best view / Worst view / Distribution map of evaluation values
Yellow: high, black: low

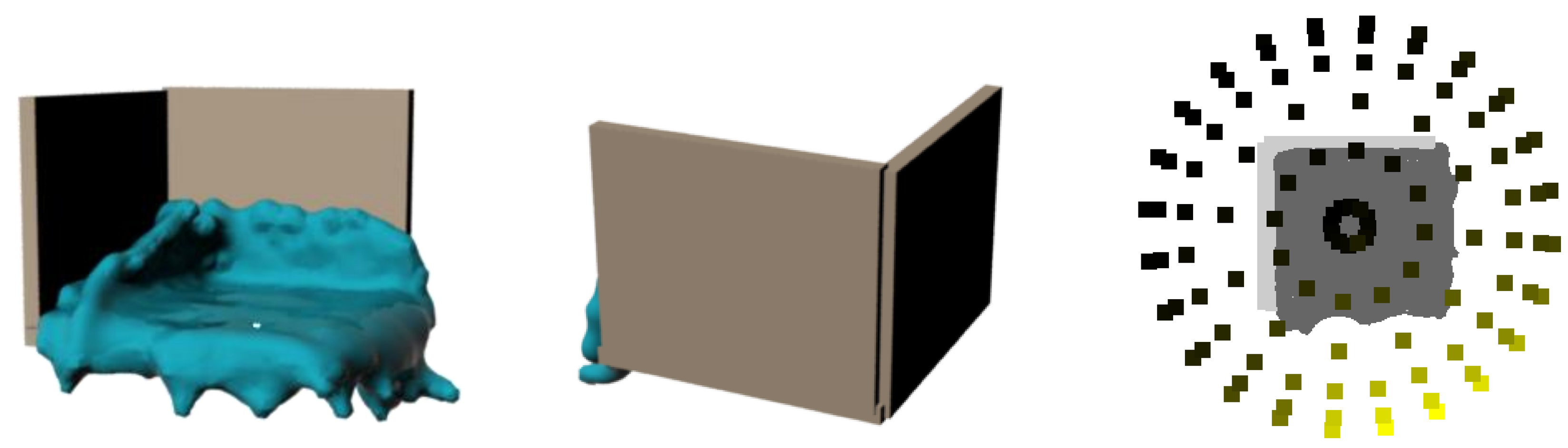
Scene 2

Best view / Worst view

Scene 3

Best view / Worst view

Scene 4



Best view / Worst view