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Poster

Viewpoint Selection for Liquid Animations

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Abstract

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.

CCS Concepts

•***Computing methodologies*** → ***Physical simulation;*** *Scientific visualization;*

1. Introduction

In this paper, we consider the issue: Which viewpoint can effectively display the characteristics of liquid animations? This issue is usually called *viewpoint selection*. Viewpoint selection is a topic that has attracted wide attention in the field of Computer Graphics and can be applied to areas such as film production and scientific visualization. Viewpoint selection methods for various types of objects such as three-dimensional static polygon mesh [YSY*06], human body animation [RZM12], and volume data [JS06] have been proposed in the past.

In the case of liquid animations, however, no effective method for viewpoint selection has been studied so far. For the dynamic shape of liquids, the following features different from other types of objects have been reported.

- The number of vertices and faces in the mesh of liquid are not constant for each frame due to accompanying dynamic shape changes such as splash.
- The direction and speed of motion of liquid shape are different for each area.
- Self-occlusion or external occlusion by other obstacles occurs.

We propose a novel viewpoint selection method which takes into consideration these features for time-varying liquid shapes.

2. Proposed Method

Our method focuses on the following three terms affecting the "goodness" of viewpoints for dynamic liquid shapes; occlusions, spatial features, and temporal features.

Occlusion term. Term for evaluating occlusion, and it is the total number of vertices on liquid shapes that can be seen from the viewpoint. With this term, the smaller the occlusion, the larger is the total value. Since the number of visible vertices decreases when both self-occlusion and external occlusion occur, it is possible to evaluate how much the liquid shape has occluded.

Spatial feature term. Term for evaluating the geometric features of liquid shapes. We adopt here the maximum view-dependent curvature [JDA07] which can extract visually important features such as wave tips and splashes more than saliency values proposed by [LVJ05]. We then count visible vertices having a large curvature exceeding the threshold value. The larger the number of counts, the larger is the evaluation value.

Temporal feature term. Term for evaluating the temporal features related to the movement of liquid shapes. Intuitively, regions with higher speeds are more noticeable than those with lower speeds on liquid shapes. This is also justified by the fact that human visual attention is attracted to large motion [Joh73]. We think that the higher the speed of a movement in the direction perpendicular to the view direction, the more easily it can be perceived. For this reason, the magnitude of the velocity perpendicular to the view direction is evaluated.

Viewpoint evaluation function. We evaluate each candidate viewpoint using a comprehensive evaluation function including the above three terms, and select a viewpoint by the maximum evaluation value. In order to select a viewpoint that has large values for all three terms, the product of the three values is taken as the final evaluation value of that viewpoint.

3. Results

We follow [YSY*06] as the experiment method in this study. Specifically, we set a sphere centered on the scene object. On its upper hemisphere, we uniformly sample 108 candidate viewpoints.

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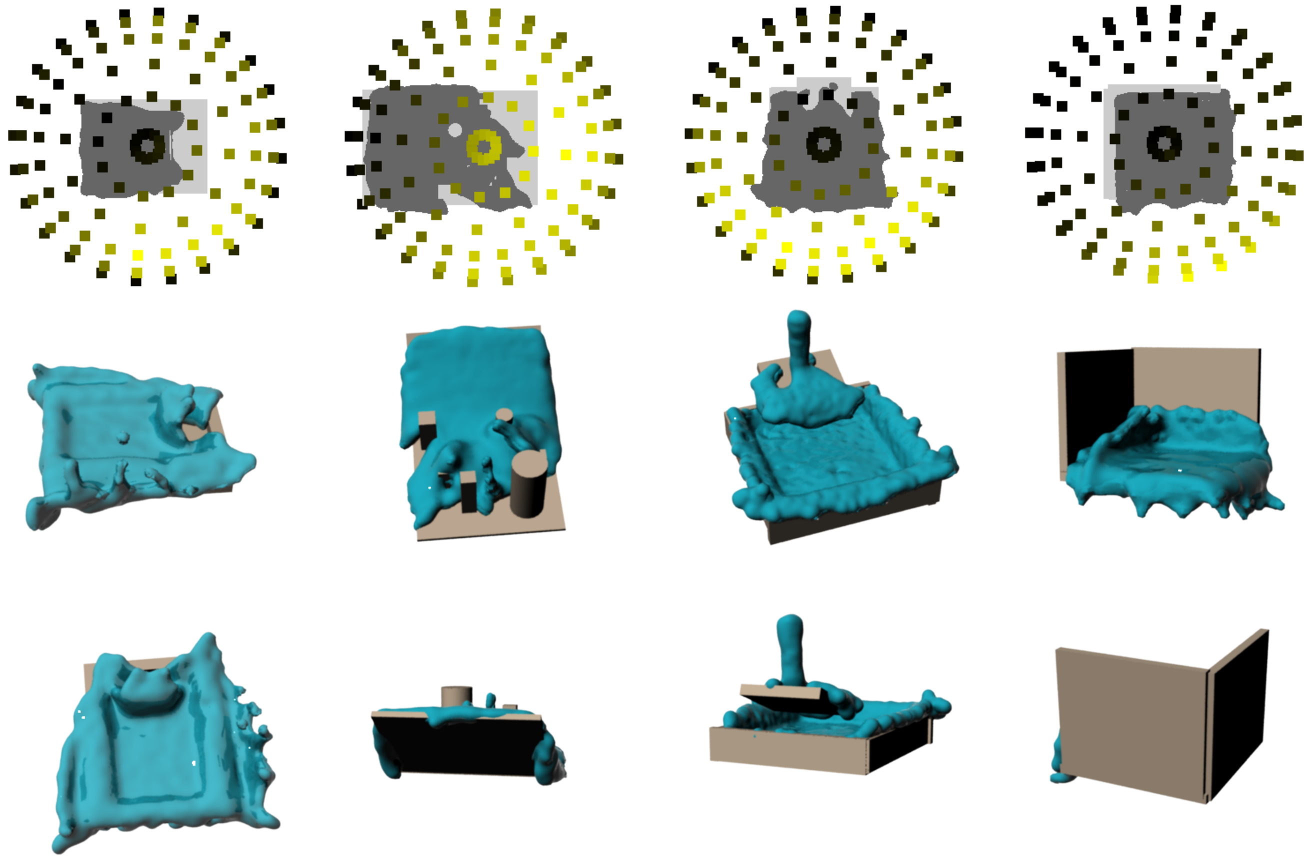

Figure 1: *Viewpoint selection results for four scenes. Top: Distribution map of the evaluation values for 108 viewpoints on the hemisphere. Color interpolation is performed between yellow (maximum value) and black (minimum value). Middle: Results for the viewpoint with the largest evaluation value (50th frame). Bottom: Results for the viewpoint with the smallest evaluation value (50th frame).*

The radius of the sphere is set twice the diagonal length of the bounding box of the entire scene. We use four scenes with different shapes of external occlusions and initial liquid positions. Each scene has 120 frames of polygonal meshes with different number of vertices and faces.

Figure 1 shows the results of the viewpoint selection. As seen from the distribution map of the evaluation values, the values change smoothly on the hemisphere, and a spatially-consistent evaluation value distribution is obtained. For the middle and bottom parts, it was confirmed that the viewpoints at which the movements and shapes of liquids are easy to perceive and with less occlusions have larger evaluation values. We can conclude that these results are consistent with human intuition to some extent.

4. Conclusions and Future Work

We proposed a method for selecting viewpoints from time-varying liquid shapes using our evaluation values. Experimental results confirmed that it is possible to select viewpoints with which it is easy to perceive the shapes and movement of liquids.

Future work includes the evaluation of the proposed method by user test and the automatic generation of liquid animations by smoothly interpolating several selected viewpoints.

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