Estimating Fluid Simulation Parameters from Videos

Naoya Iwamoto*  Ryusuke Sagawa†  Shoji Kuniomo*  Shigeo Morishima**

*Waseda University  †AIST

Figure 1: Fluid simulator optimization result based on camera captured fluid motion.
(a): Capturing 3D fluid motion by single camera with patterns projection, (b): Reconstructed depth of fluid surface when a ball is swinging, (c): Result of particle simulation with optimized parameters. (d): Result of retargeting another action.

1 Introduction

Recently, a video-based high quality 3D shape and motion modeling methods for fluid are proposed. [Huamin et al. 2009] However, this approach only aims to capture and generate original fluid action as it is.

Therefore, we propose a new method to capture and retarget an original liquid feature to generate another action for fluid by optimizing particle simulation parameters. Even if the correct physical parameters of a target liquid is known, sometimes the impression of liquid action reconstructed by simulator is not so real as original depending on a simulator performance. In this paper, we treat a simulator as a blackbox and try to optimize parameters to make an impression as close as original action captured by video camera. Especially, in case of an unidentified liquid, the parameters are also optimized to make a look as same as original.

2 Liquid Motion Capturing

Liquid motion is captured by single video camera (30 fps) looking down upon a liquid surface in aquarium. The liquid is whitened by water base paint to make the structured light pattern reflect sharper. Then based on the calculated distance between liquid and camera, the liquid surface is estimated with about 1,200,000 vertices [Sagawa 2009]. A reconstructed liquid surface is shown in Fig.1-(b).

3 Correspondence in Real and Virtual World

To unify the coordinates of real world and simulator, and then get the correspondence, we divide both real and virtual world as same number and size of small voxels considering the scale and the origin position located on the center of water tank. To make resampling the surface of liquid, the vertex and particles located close to the center of the voxels in the liquid surface are chosen to be compared and minimize cost function. The sampling points are situated with equal intervals in x-y coordinate parallelizing with resting state water surface. By this process, it was chosen 215 particles from total of 60,000 particles.

In fig1-(c), yellow ball is the trigger controlled by hand to ruffle the water surface. The shape and location are estimated liquid surface vertices by Hough transformation of depth data. And then the original captured motion is reflected in the liquid simulator to generate a copy action.

4 Cost Function

By considering a factor that the motion of simulated fluid impressed correctly assembled, a cost function is defined as the difference of 3D shapes of fluid surface. Cost function can be defined as a sum of an averaged absolute correspondence of norm per scene between real and virtual.

5 Optimization Parameters

NVIDIA® PhysX is selected as a fluid simulator. In PhysX, four parameters: stiffness, viscosity, rest density, damping are selected to be optimized. If we gave only those values of random parameters in simulator, the values of those parameters are estimated by minimizing cost function by iterative calculation with Simulated Annealing. This process was repeated 1174 times and took 15 hours 24 minutes. The process is Simulator independent.

6 Result and Conclusion

Fig1 (b) and (c) are real motion and simulation result of water when yellow ball is swinging. Initial parameters give an impression of sticky liquid like honey, but after optimization it becomes more fluently very close to real water. Fig1 (d) is the retargeting result for ball dropping to water with same parameters. Then, POV-RAY is selected as rendering software. The result of optimized parameters is splashed the liquid like water on surface.

The quantitative evaluation for open retargeting test is next subject. Furthermore, we need to try other simulators and also other simulation except swinging the ball.

References