Soap film flow and thickness for soap bubble rendering

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ABSTRACT

In practice, it is not easy to find a study of soap bubbles rendering by measuring the speed and thickness of soap bubbles flow. In this study, we have carried out to measure the change in the flow and thickness of a soap film to realistically render soap bubbles.

CCS CONCEPTS

• Computing methodologies → Virtual reality • Modeling and simulation • Real-time simulation

KEYWORDS

Soap bubble rendering, Soap film, Thickness, Fluid flow, VR, AR, XR

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1 INTRODUCTION

For soap bubbles rendering, the speed and thickness of the soap film over time are important parameters. However, research using measured data is rarely found. Therefore, in this study, we calculate the speed of fluid flow in a soap film for realistic soap bubble rendering and measure the thickness of soap film over time.

2 Bubble flow and thickness

2.1 Flow Tracking of Soap Film

Soap bubbles flow down by gravity over time. In order to determine the thickness of soap bubbles according to the movement of the soap film, the soap film video photographed was used from [Harvard Uninversity]. Using this video as input, the Lucas-Kanade [Lucas and Anade, 1981] optical flow algorithm was used to measure the moving distance of the soap film by one frame, and the velocity value of the soap film was extracted for each frame. Since the soap film needs the distance data value (X, Y value) moved every fram, the existing algorithm was modified to suit the research.

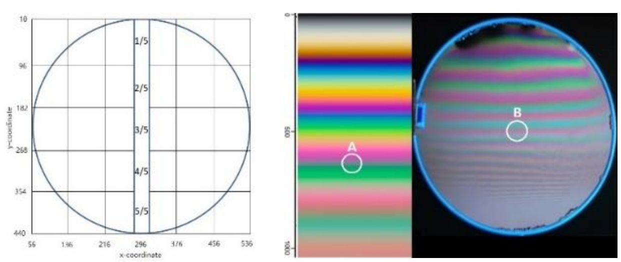

Figure 1: Soap bubble section (left) and thickness matching (right)

2.2 Soap Bubble Speed

As shown in Figure 1, the soap bubbles except the blanks were divided into 5 parts and the distance of soap film flow was obtained for each equal part. The sampled speed for each section was curve-fitted and expressed as polynomial equations. The bubble flow, which is 1/5 in Figure 2 shows rapid movement at the beginning and gradually stabilizes and accelerates. It's just a few moments from the start, so it might not show a lot of motion, so there were not many speed changes. At 2/5, speed

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was not stabilized by continuous movement. At section 3/5, the film of soap gradually flows down, showing a stable appearance. The flow of the soap film increases with time. At section 4/5, the movement shows the speed begins to increase at the center at the sample index of 145 shown in Figure 3. The soap film was just before bursting at the 5/5 section, and from the sample index of 52, the speed decreased rapidly and then disappeared. Figure 2 and 3 show samples of speed and curve fitting of 1/5 and 4/5 sections respectively.

2.3 Thickness measurement

The thickness was measured by comparing the appearance of soap bubbles in the image using aforementioned Figure 1 (right) showing the color corresponding to the thickness of soap bubbles.

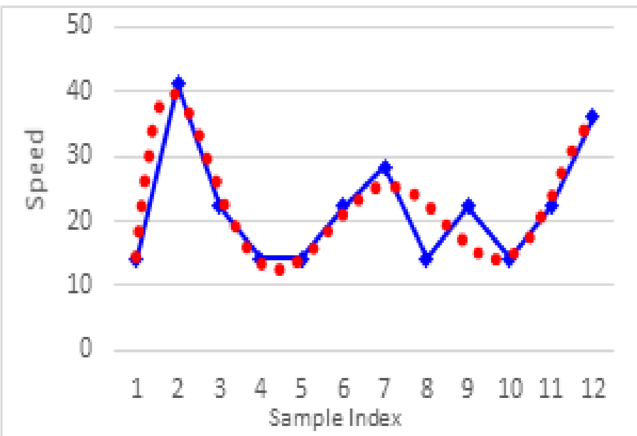

Figure 2 : Samples of speed and curve fitting of section of 1/5

We analyzed and compared the RGB and HSL present in the color and used the matching color thickness. For example, A's RGB is Red: 157, Green: 142. Blue: 163, and B's RGB is Red: 152, Green: 164, and Blue: 155. Since the error was within 10, the desired value could be obtained. Section 1/5 is the top of the soap bubble so it is not thick and the oil film disappears completely in 123 seconds. Section 5/5 is at the bottom and the thickest soap film is maintained. It also disappears last at 237 seconds.

3 Rendering Results and Discussion

Bubble rendering uses texute-based algorithm. Parameters for rendering soap bubbles include total opacity, rim light, texture partition and flow velocity and thickness measured in the experiment. Of these, the overall transparency (Opacity) expresses the change in the concentration of soap bubbles by the surfactant as a visual effect and can confirm the change of color according to the position of light [Morris, 2003]. Rim light must express the spectrum of soap bubbles according to the viewing angle, light position, and light intensity. For example, the edge becomes thinner when you see soap bubbles and when the direction of light is straight. The method we used to implement the rendering of the soap bubbles in the Unity Engine was Shader Forge.

As shown in Figure 4, *A* is the overall rendering and *B ~ F* is the result of applying the process of changing the color of each section according to the speed and thickness over time to the rendering. By using the texture source that was made by authors, the shape of the upper and lower sides was repeated to avoid the overlapping part.

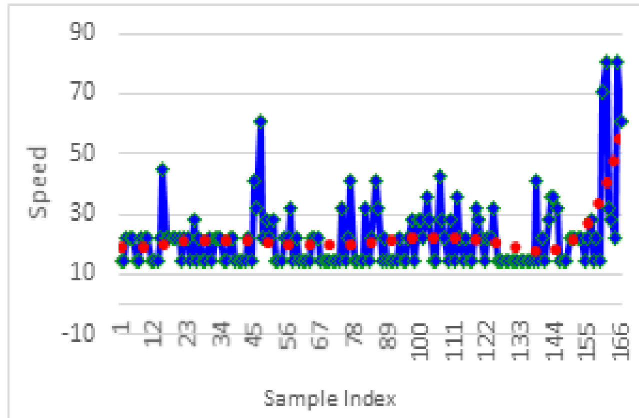

Figure 3 : Samples of speed and curve fitting of section 4/5

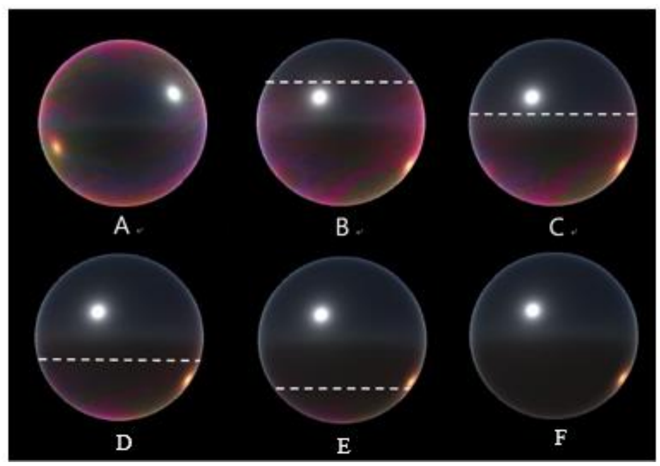

Figure 4 : The flow of rendering over time of soap bubbles

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REFERENCES

Harvard University. Harvard Natural Sciences Lecture Demonstrations.https://sciencedemonstrations.fas.harvard.edu/presentations/thin-film-interference

B.D. Lucas and T. K. Anade (1981). An iterative image registration technique with an application to stereo vision.. *In Proceedings DARPA Image Understanding Workshop*, April 1981, 121-130

N. Morris. (2003) Capturing the Reflectance Model of Soap Bubbles. University of Toronto (2003).