Abstract

In this paper we will present some simulative techniques when two and more bubbles meet. We will discuss the possible geometry arrangements and mostly the methods for calculating the geometry of common surfaces in bubble clusters. At the end we will present our own proposal how to improve one of these methods and we will prove it’s rightness on some special arrangements of soap bubbles.

Keywords: bubble clusters, geometry of soap bubbles, common surfaces

Introduction

Soap bubbles are fragile and beautiful natural phenomena. They are prominent in everyday life, can be found in many places in real world such as carbonated beverages, on the ground of waterfalls, while washing up... Their geometry is as clean and elegant as anything in nature, which makes them particularly suited to computer graphics.

Proposed method

There are several works that dealt with common surfaces in bubble clusters. Our proposed method is based on Dynamic common surfaces. [Ďurikovič 2001]. First, we use this dynamic calculation to find the geometry arrangement of soap bubbles and then perform SCG operations on these bubbles. The results will be very realistic.

We store the positions of all spherical bubbles and also the calculated positions and radii of the curvature spheres that cut them up into a multidimensional array. At the end we perform CSG operations on each two intersecting spheres. There is a rule that small bubble always intrudes into the larger bubble, because has a higher pressure.

So it is clear that we need to subtract the bubble that forms on common wall from the larger bubble in each intersecting pair of bubbles. Figure 1 presents bubble cluster of 5 bubbles. Bubble A is the biggest bubble and has common intersection with bubbles B, D, F and H. We get desired borders (blue area) after cutting off all helping bubbles (green circles) from bubble A.

Figure 1: CSG operations on bubble A

Then we take the next sphere. If this sphere is in bubble pair in position of smaller bubble we take the intersection of this bubble with the helping bubble that forms on common wall.

Figure 2: CSG operations on bubble F. Subtraction is represented by green color, intersection by yellow color and purple symbolized the subtraction of the same sized bubble.

If this bubble is larger one from couple of bubbles we always subtract the helping bubble from it. If the two bubbles are equal the border is flat plane that goes through the intersection points and you can make either intersection or subtraction in this situation. If two bubbles have no intersection we never do the CSG operations on these two bubbles.

Figure 3: Complete bubble cluster

Conclusion and future work

We presented some new method how to simulate soap bubbles. As our future work we would like to simulate it in POV-Ray

Some examples

Here we present some examples of proposed method by simulation of double-bubble, 5 and 7-bubble cluster in POV-Ray and also pictures drawn in interactive geometry software Carbi Geometre. For better imagination you can see each bubble cluster as 3D model and in 3 different 2D-views: front view, side view and ground plan. The drawings in Carbi Geometre are not completely perfect, but enough illustrative and good for explanation and understanding proposed method.