Fast and Stable Blob Physics

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In this tutorial, we are going to explore how to create a blob similar to the main character Gish in the video game Gish. I'll also detail a simple collision handling system for multiple blobs that is both fast and stable.

Usually blobs are simulated with a combination of edge springs and internal springs to keep their shape. In most of these setups, there will be a point where the blob has deformed so much that the mesh will invert and get stuck. I'm going to show you how you can get rid those internal springs, and actually end up with something way more stable.

Here is the formula for calculating the area of a polygon:

$$A = \frac{1}{2}\sum_{i=0}^{n-1}(x_i y_{i+1} - x_{i+1} y_i)$$

We want our blobs to behave as if they're filled with some kind of incompressible fluid. The area of the polygon should stay the same even if the vertices move around. I am going to make the assumption that the pressure force is going to move each vertex the same distance *h* along its normal if the current area of the polygon is not equal to the target area.

$$x_{i,n+1} = x_i + hp_i$$

$$y_{i,n+1} = y_i + hq_i$$

When I plug those terms into the polygon area formula and set it up so that it will equal the starting area, I will get this equation:

$$A_0 = \frac{1}{2}\sum_{i=0}^{n-1}[(x_i + hp_i)(y_{i+1} + hq_{i+1}) - (x_{i+1} + hp_{i+1})(y_i + hq_i)]$$

So right now, we have a quadratic equation for *h* but in its current format it's a bit awkward to work with. In the next steps, we'll shuffle things around a bit so that we will be able to solve for *h* using the quadratic formula. If we expand the equation, we'll get this:

$$A_0 = \frac{1}{2}\sum_{i=0}^{n-1} \begin{matrix}[(x_i y_{i+1} + x_i h q_{i+1} + h p_i y_{i+1} + h^2 p_i q_{i+1}) - \\ (x_{i+1} y_i + x_{i+1} h q_i + h p_{i+1} y_i + h^2 p_{i+1} q_i)]\end{matrix}$$

Our next step is to split this equation into workable parts. First I'll move out the terms without the *h* multiplier:

$$A_0 = \frac{1}{2}\sum_{i=0}^{n-1}(x_i y_{i+1} - x_{i+1} y_i) + \frac{1}{2}\sum_{i=0}^{n-1} \begin{matrix}[(\cancel{x_i y_{i+1}} + x_i h q_{i+1} + h p_i y_{i+1} + h^2 p_i q_{i+1}) - \\ (\cancel{x_{i+1} y_i} + x_{i+1} h q_i + h p_{i+1} y_i + h^2 p_{i+1} q_i)]\end{matrix}$$

Now I'm going to split the second summation depending on whether they are multiplied by *h* or *h*². At the same time, I'm going to move the multipliers to the outside of the summations since they stay constant.

$$A_0 = \frac{1}{2}\sum_{i=0}^{n-1}(x_i y_{i+1} - x_{i+1} y_i) + \frac{1}{2}h\sum_{i=0}^{n-1} \begin{matrix}[(x_i q_{i+1} + p_i y_{i+1}) - \\ (x_{i+1} q_i + p_{i+1} y_i)]\end{matrix} + \frac{1}{2}h^2\sum_{i=0}^{n-1} \begin{matrix}[(p_i q_{i+1}) - \\ (p_{i+1} q_i)]\end{matrix}$$

At this point, things are starting to shape up and we have the variables that we can plug into the quadratic formula! All three of them can be calculated using a simple for loop.

$$0 = ah^2 + bh + c$$

$$a = \sum_{i=0}^{n-1}(p_i q_{i+1} - p_{i+1} q_i)$$

$$b = \sum_{i=0}^{n-1}[(x_i q_{i+1} + p_i y_{i+1}) - (x_{i+1} q_i + p_{i+1} y_i)]$$

$$c = \sum_{i=0}^{n-1}(x_i y_{i+1} - x_{i+1} y_i) - 2A_0$$

$$h = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

Once you've calculated the value for *h*, you can go ahead and offset those vertices.

Collisions (Incomplete)

Two blobs, A and B

Calculate the center of mass for both blobs. Don't use the polygon centroid formula. That gets screwed up when the polygon self-intersects.

$$\boldsymbol{c} = \frac{1}{n}\sum_{i}^{n}\boldsymbol{x}_i$$

Now that you have the centers, you have the option of doing an early exit if the distance between the centers is too large. This would probably be between 1.5 and 2x the sum of the radii of the two blobs.