Metaballs
Annotated Reference

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Key References

Blinn, J., 1982. A Generalization of Algebraic Surface Drawing. ACM Transactions on Graphics (TOG) 1, 3, 235–256.

In this paper, Blinn presents a model and rendering technique for *blobs*. *Blobs* generally are the same as metaballs. Here, *blobs* are used to display molecular structures. For the density field a summation of a Gaussian density distribution is used and for rendering a type of ray-casting.
This paper is almost always referenced in other papers related to metaballs. As it is the first one that dealt with this kind of object it was important for me to see how these objects were first introduced and what differences further research brought compared to the descriptions in this paper. I included the mentioned Gaussian function in my implementation and compared it to other appropriate field functions used in other models.

Lorensen, W. E., and Cline, H. E., 1987. Marching Cubes: A High Resolution 3D Surface Construction Algorithm. In ACM Siggraph Computer Graphics, Vol. 21, ACM, 163–169.

This is one of the most cited papers in the field of computer graphics. It describes an algorithm to create three dimensional surfaces by polygonisation. Originally, the algorithm was used for medical data, for instance from computer tomography or magnetic resonance imaging. 2D slices of information are processed to determine an approximated mesh of triangles. The paper explains the basic process of the algorithm and mentions some enhancements. Basically, in the algorithm space is divided into cubes, and triangles within these cubes are calculated to approximate the surface.
The marching cubes algorithm is a common choice for rendering metaballs. I chose an algorithm based on it for my implementation in this research. As different lookup tables have to be used, I selected the next reference as base for my implementation.

Bourke, P., 1994. Polygonising a scalar field (Marching Cubes) [online]. Australia: Paul Bourke. Available from: http://paulbourke.net/geometry/polygonise/ [Accessed 25 May 2015].

This web site contains an overview of the marching cubes algorithm and provides some pseudo code and useful lookup tables for determining triangles. This information was a great starting point for my implementation. The descriptions are well-structured and focus on the important steps in the algorithm. My implementation uses the lookup tables found on this web site and adaptations of some functions for the basic polygonisation process. Bourke's web site in general contains further interesting articles about calculating and visualising geometry, this also includes an article about metaballs in general.

Further References

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Nishita, T., Iwasaki, H., Dobashi, Y., and Nakamae, E., 1997. A Modeling and Rendering Method for Snow by using Metaballs. In Computer Graphics Forum, vol. 16, Wiley Online Library, C357–C364.

Takayama, J., and Genda, E., 2005. Artworks using Metaball Representation with Stepwise Approach. In ACM SIGGRAPH 2005 Sketches, ACM, 100.

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Wyvill, G., and McPheeters, C., and Wyvill, B., 1986. Data Structure for Soft Objects. The Visual Computer 2, 4, 227–234.