Implicit surfaces and FRep

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Traditionally implicit surfaces include algebraic and skeleton-based surfaces. Advantages of using implicit surfaces in computer graphics and solid modeling are well known: ease of point classification and ray-tracing, natural blending. However, the application was limited by organically looking blobby shapes (metaballs, soft objects). FRep is a generalization of traditional implicit surfaces and constructive solid geometry (CSG). In FRep, an object is represented by a tree structure, where leaves are arbitrary "black box" primitives and nodes are arbitrary operations.

Function evaluation procedures traverse the tree and evaluate the function value in any given point. This model makes it possible to represent by a single continuous function such different objects as traditional skeleton-based implicit surfaces, convolution surfaces, constructive (CSG) solids (using so-called R-functions in the nodes of the tree), swept objects, and volumetric objects. Many operations are closed on this representation, i.e., generate an object (defined by a continuous function), which again can be a subject for further transformations. In this sense, in FRep there is no difference between soft objects, CSG solids, and volumetric (voxel) objects, which are processed in the same manner. This allowed researchers to solve such long standing problems as metamorphosis between objects of different topology, sweeping by a moving solid, controlled blending for all types of set-theoretic operations, collision detection and hypertexturing for arbitrary solids, direct modeling of space-time and multidimensional objects. This topics will be covered in the tutorial.