Volumetric and Multidimensional Modeling Using HyperFun

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Abstract

This invited talk describes basics and current developments of an approach to modeling volumetric and multidimensional objects using HyperFun language and associated software [1]. HyperFun is a modeling language designed to be a high-level tool suitable for specifying functionally based (F-rep) models [2]. While being minimalist, it supports all main notions of F-rep. HyperFun is also intended to serve as a lightweight exchange protocol to support platform independence and Internet-based collaborative modeling.

Software tools for HyperFun are being developed in an open source project manner by the team of collaborators from several countries. Application software deals with HyperFun models through the language interpreter or using the compiler to C/C++/Java and a set of utilities of the HyperFun API. The project description and current application tools (HyperFun polygonizer and plug-in to POVRay) are available at the devoted Web site

`http://www.hyperfun.org`.

A volume can be thought as a subset of 3D space with additional scalar value given in each its point. Scalar values can be given in the nodes of a regular space grid (voxel data) or by a continuous function of three variables. In this sense volumetric models are included in the F-rep concept. However, there are advantages in a hybrid volume modeling system based on both F-rep and voxel data. We describe the hybrid system architecture and give details of its implementation [3]. We describe the tools under development: volume sculpting with 4D spline volumes [4], interactive modeling using convolution surfaces [5], and real-time volumetric fly-through [3].

F-rep naturally allows for multidimensional modeling using functions of several variables. Practical multidimensional modeling is supported by HyperFun. Approaches and tools for interpretation of multidimensional models in terms of multimedia and animation are described [6].

Main current application areas of the presented approach include education (geometry, computer graphics, programming languages), animation and multimedia, and computer art [7]. We are also planning to develop an advanced computer-aided design system based on several geometric representations including F-rep and voxels.

Keywords: *shape modeling, volume modeling, multidimensional modeling, F-rep, implicit surface, voxel, animation, multimedia.*

REFERENCES

[1] V. Adzhiev, R. Cartwright, E. Fausett, A. Ossipov, A. Pasko, V. Savchenko "HyperFun project: a framework for collaborative multidimensional F-rep modeling", Implicit Surfaces '99, Eurographics/ACM SIGGRAPH Workshop (Bordeaux, France, September 13-15 1999), J. Hughes and C. Schlick (Eds.), pp. 59-69, URL http://www.hyperfun.org/

[2] A. Pasko, V. Adzhiev, A. Sourin, V. Savchenko "Function representation in geometric modeling: concepts, implementation and applications", The Visual Computer, vol.11, No.8, 1995, pp.429-446, URL http://wwwcis.k.hosei.ac.jp/~F-rep/

In Russian: В. Аджиев, А. Пасько, В. Савченко, А. Сурин "Моделирование форм с использованием вещественных функций", Открытые Системы, 5, 1996, с.14-18. URL

http://www.osp.ru/os/1996/05/14.htm

[3] V. Adzhiev, M. Kazakov, A. Pasko, V. Savchenko "Hybrid system architecture for volume modeling", Computers & Graphics, Pergamon Press, vol. 24, No. 1, 2000, pp. 67-78.

[4] B. Schmitt, A. Pasko, V. Savchenko "Extended space mapping with Bezier patches and volumes", Implicit Surfaces '99, Eurographics/ACM SIGGRAPH Workshop, Bordeaux, France, September 13-15, 1999, J. Hughes and C. Schlick (Eds.), pp. 25-31.

[5] Y. Goto, A. Pasko "Interactive modeling of convolution surfaces with an extendable user interface", EUROGRAPHICS 2000, Short Papers, Interlaken, Switzerland, 21-25 August, 2000 (to appear)

[6] E. Fausett, A. Pasko, V. Adzhiev "Space-time and higher dimensional modeling for animation", Computer Animation 2000, University of Pennsilvania, PA USA, May 3-5 2000, pp.156-165.

[7] A. Pasko, V. Savchenko, A. Sourin "Synthetic carving using implicit surface primitives", Computer-Aided Design, Special issue on CAD and the Arts, Elsevier, 2000 (to appear).

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