# Local and Iterative Subdivision Schemes

Fedor A.Pletenev
*RFNC (VNIIEF)*
James T.Hurley
*Intel Corporation*

Many of 3D graphics scenes are described by polygons. The scales of these polygons may be changing during changing of camera position. It may give visible defects connected with flatness of polygons. Besides, many graphics researches (such as *Displacement Mapping*, *Terrain Rendering* etc.) require smooth geometry distributions (subdivisions) inside of polygons.

"*Subdivision*" is very researched area. All researches in this direction may be divided on two directions: Local and Iterative.

For subdividing arbitrary meshes there some main approaches such as: Doo-Sabin, Catmull-Clark, Loop-Hope etc. It used information about neighboring polygons for building of smooth geometry distributions inside of concrete polygon. So almost all of these algorithms were iterative. The last require looking of large information and have slow performance. And so these algorithms don't suit for hardware implementation. These algorithms may work only on Geometry Engine stage.

We propose local approaches of Subdivision. We use only information concerning only one polygon (such as position of polygon vertices, vertex normal vectors, edge normal vectors etc.). We shall describe different smooth interpolations inside one polygon (Quadratic, Bi-quadratic, Cubic and Bi-cubic). Note that, information concerning vertex normal vectors and edge normal vectors (in one concrete polygon) contain (of course) inside itself the some geometry information concerning neighboring polygons. It give chance to built smooth geometry distributions inside of concrete polygon (not only with $C^0$ smoothness but with $C^1$ smoothness and even $C^2$ smoothness).

The main idea of local Subdivision is consist in next. Along the edge we built smooth curve, which pass through vertices of this edge and this curve touch normal planes in these points. Engaging of edge normal vectors give chance to built interpolation with more smoothness. But we must note that smooth edge subdivision not always permit to built smooth polygon subdivision with same smoothness. We must engage additional information about polygon.

In our talking we will tell also on researching of iterative Subdivision approaches. We will compare it between themselves. Also we will propose some own iterative Subdivisions schemes, improving Catmull-Clark approach by using Loop-Hope tessellation for arbitrary triangular meshes. Also we will discuss using normal vectors for building iterative Subdivisions schemes with remaining positions of old vertexes (limit surface will contain initial meshes).

Besides we will discuss some methods of curve refinement (such as Chaikin's algorithms), which lie in base of many surface subdivision schemes. Also we will propose some own curve refinement algorithms.

Note that hardware implementation demand constant reviewing of Subdivision schemes. Yesterday, new hardware performance gives opportunity to involve for implementing even complex iterative Subdivision schemes. We will discuss also some such possible implementations.

Dr. Fedor A.Pletenev
The head of Laboratory,
Mathematical Department,
Russian Federal Nuclear Center (VNIIEF)
Mira St. 37, Sarov, N.Novgorod reg., Russia
Tel.: +831-30-1-97-81
E-mail: fedor@rstl.vniief.ru

James T.Hurley
Principal Engineer
Microcomputer Graphics Laboratory
Intel Corporation
Microcomputer Research Laboratory
RN6-35
2200 Mission College Blvd.
Santa Clara, CA 95052-8119
Tel. (408) 765-5096
Fax (408) 653-6967
Email: Jim_Hurley@intel.com