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(54) **METHOD AND APPARATUS FOR PROVIDING CONTINUOUS LEVEL OF DETAIL**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

5,659,691	8/1997	Durward et al.	395/329
5,675,721	10/1997	Freedman et al.	395/129
5,917,494 *	4/2000	Arai et al.	345/419
6,049,625 *	4/2000	Sakamoto	345/419

OTHER PUBLICATIONS

Li, J. et al; "Progressive compression of 3D graphic models," Proc. IEEE Intl Conference on Multimedia Computing and Systems, Apr. 1997.
Deering, M; "Geometry Compression," Computer Graphics Proc., Los Angeles CA, Aug. 1995, pp. 13–20.
Evans, F. et al.; "Optimizing Triangle Strips for fast Rendering," Proc. of the Visualization Conference, San Francisco, CA, Oct. 1996, pp. 319–326.
Popovic, J. et al.; "Progressive Simplicial Complexes," Computer Graphics Proc., Siggraph 97, Los Angeles, CA, Aug. 1997, pp. 217–224.
Taubin, G., et al.; "Geometric Compression through Topological Surgery," Research Report RC–20340 (#89924), Jan. 16, 1996, pp. 1–32; http://www.research.ibm.com/vrml/binary/pdfs/ibm20340r1.pdf.
Arikawa, M. et al., "Dynamic LoD for QoS Management in the Next Generation VRML," Proceedings of the Intl. Conf. on Multimedia Computing and Systems, Jun. 17, 1996.
Hoppe, H., Progressive Meshes, Computer Graphics Proceedings, Annual Conference Series, 1996, pp. 99–108.
Funkhouser, T.A. and Sequin, C.H., "Adaptive Display Algorithm for Interactive Frame Rates during Visualization of Complex Virtual Environments," Computer Graphics Proceedings, Annual Conf. Series 1993, pp. 247–254.

* cited by examiner

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(57) **ABSTRACT**

A method and apparatus that provides for off-line generation of, and run-time evaluation for, continuous LODs. The off-line multiresolution generation process is modified and constrained such that a progressive mesh representation for continuous LODs is created that allows properly designed run-time topological data structures to be overloaded to support both LOD construction and optimized rendering. More specifically, the offline generation process initially preprocesses the mesh to generate a triangle-fan covering composed of only complete cycles. The multiresolution generation process is then constrained to maintain this complete cycle covering for every interim mesh. For run-time evaluation, a topological adjacency representation is used that can serve dual uses. This supportive run-time representation is partitioned so as to allow efficient access by the renderer to the subset of the adjacency information that is the fan covering. The multiresolution representation can be generated so as to allow discontinuities to be rendered at some cost to rendering performance.
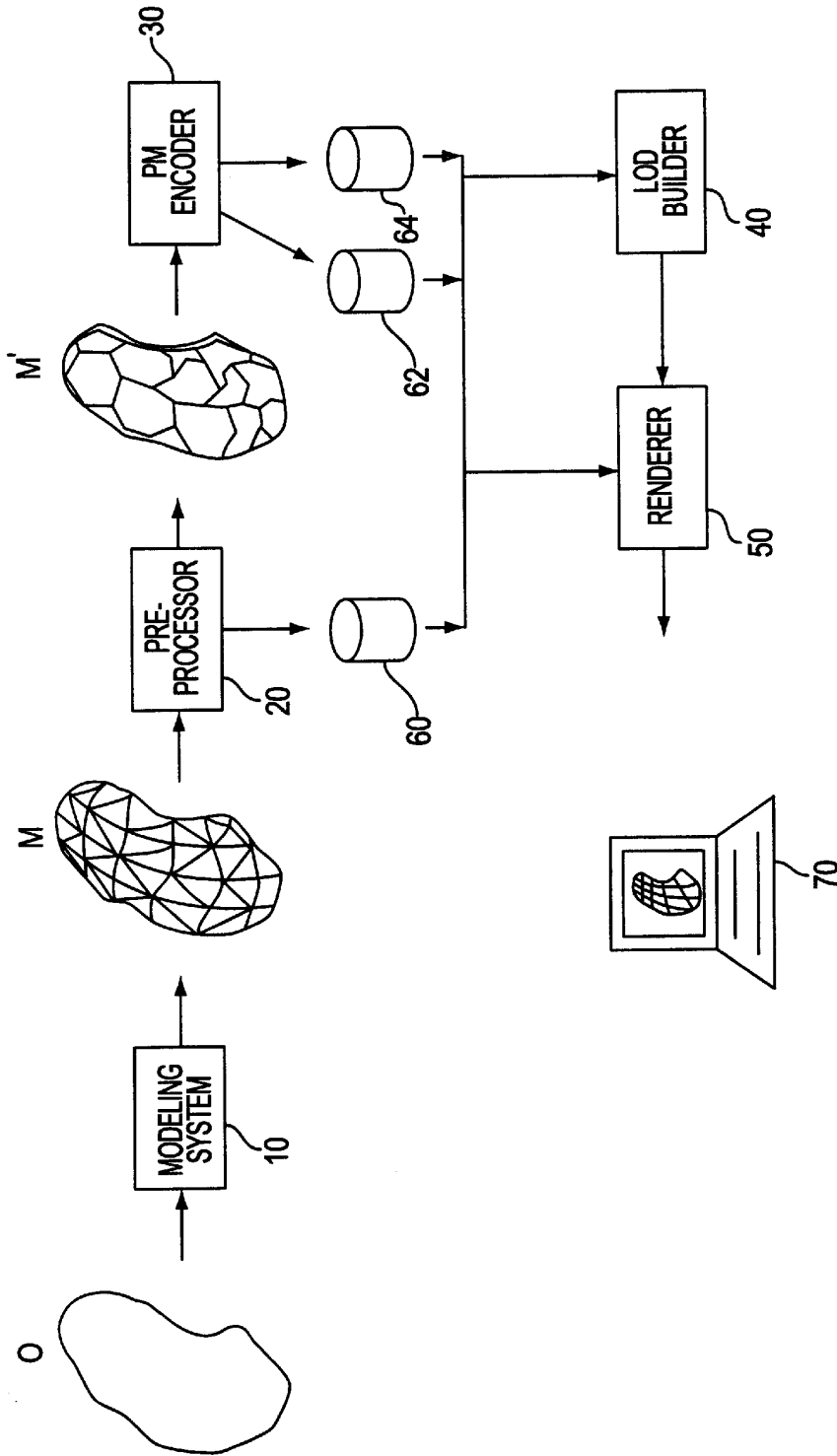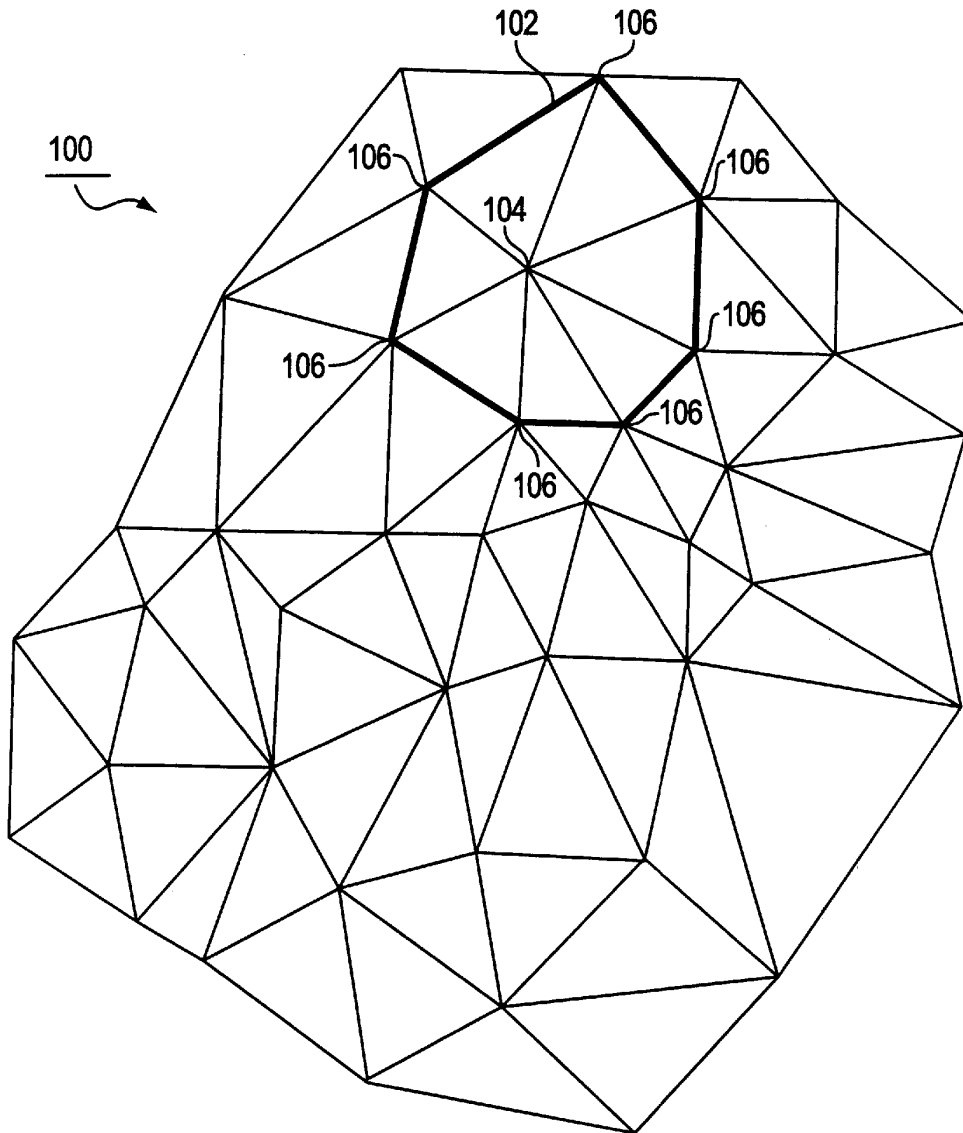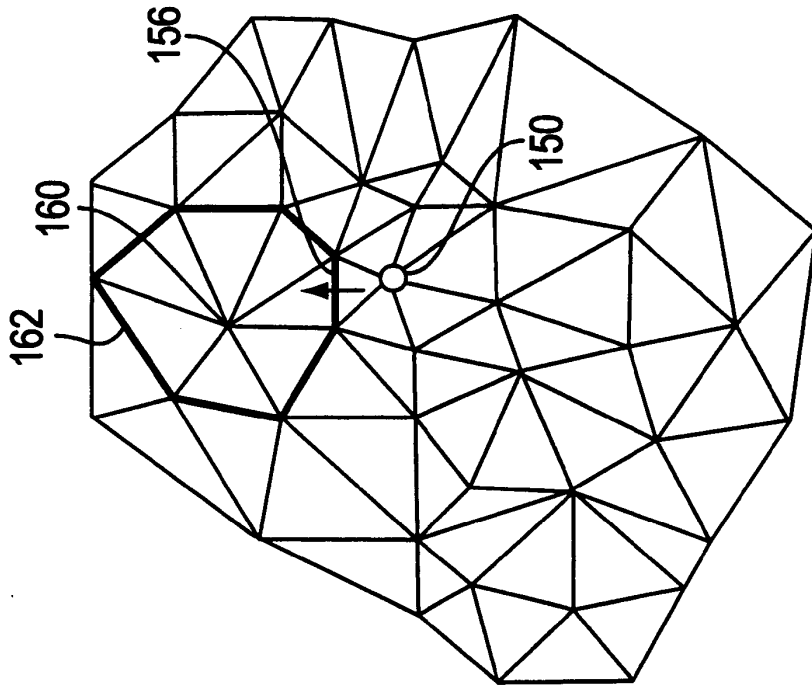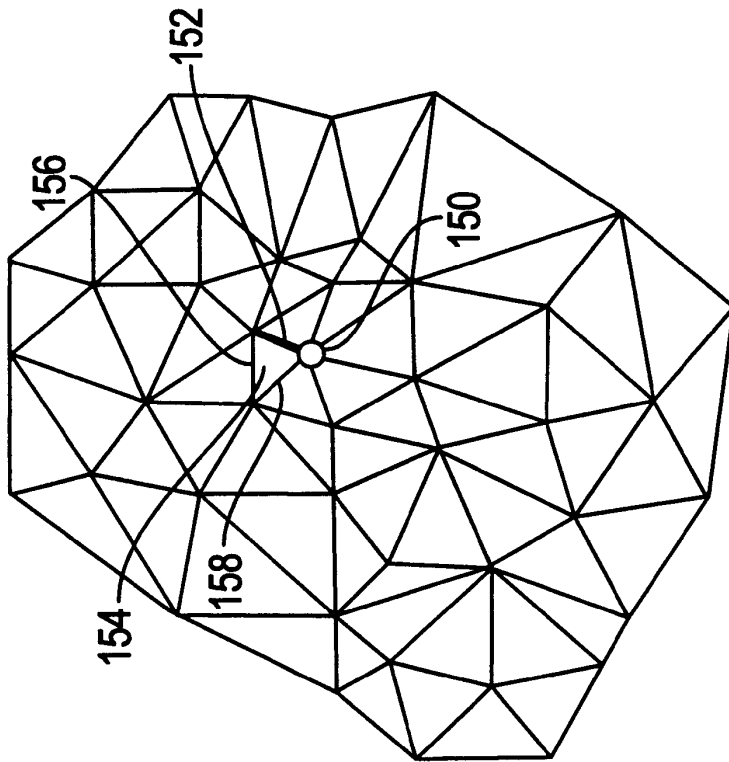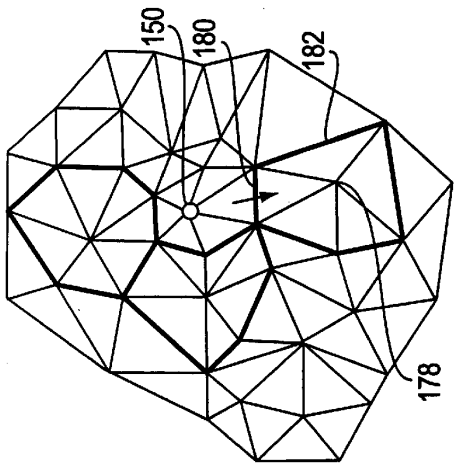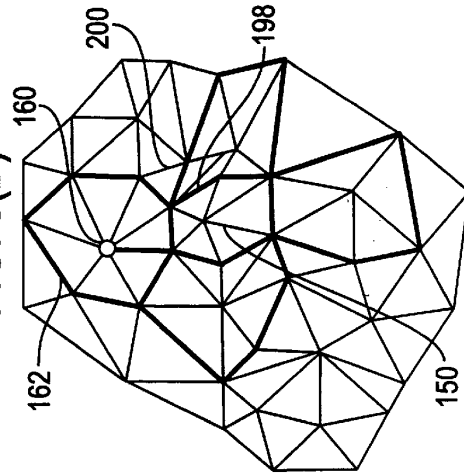
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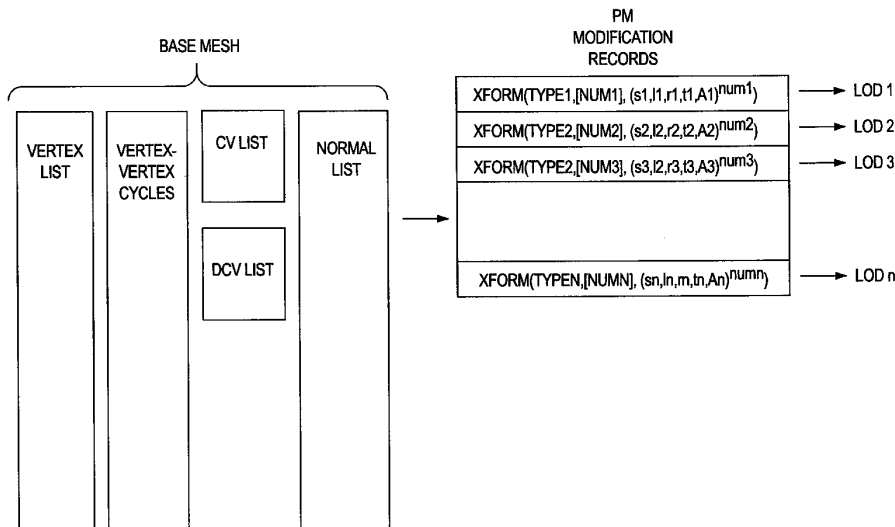
FIG. 1

FIG. 2

FIG. 3(B)

FIG. 3(A)
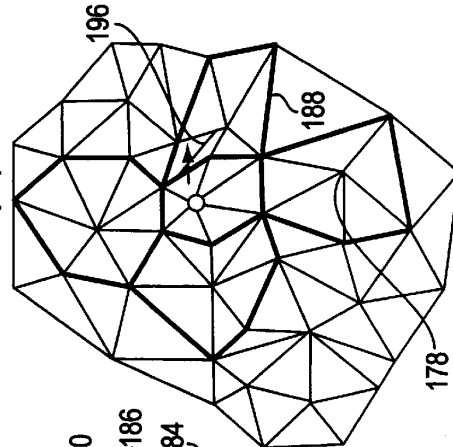
FIG. 3(E)

FIG. 3(H)
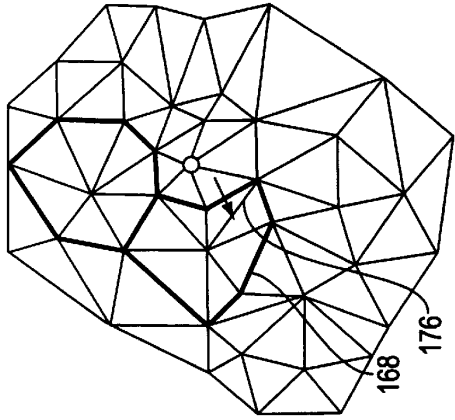
FIG. 3(D)

FIG. 3(G)

FIG. 3(C)

FIG. 3(F)

DOCKET ALARM
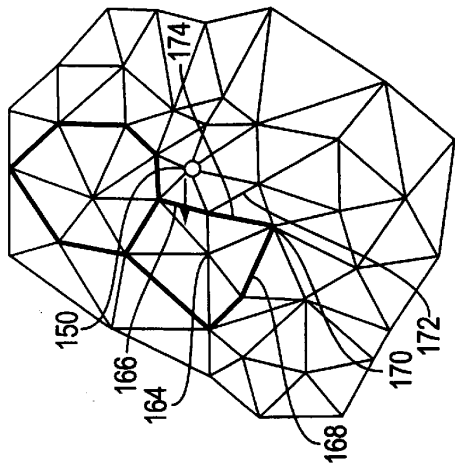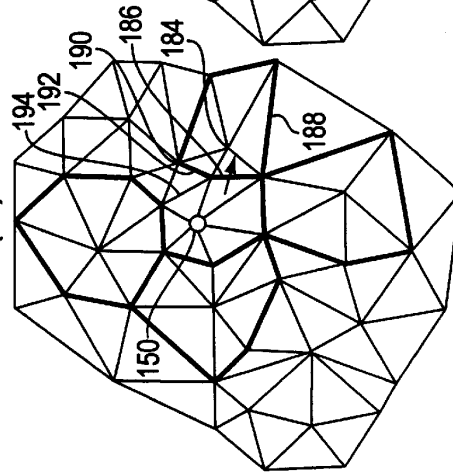
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