

(12) **United States Patent**
Rosasco

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(54) **MULTI-THREADED TEXTURE MODULATION FOR AXIS-ALIGNED VOLUME RENDERING**

Watt, A. and Watt, M., *Advanced Animation and Rendering Techniques: Theory and Practice*, Copyright 1992, ACM Press, pp. xi–xiv and 297–321.

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* cited by examiner

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **09/201,814**

(22) Filed: **Dec. 1, 1998**

(57) **ABSTRACT**

(51) **Int. Cl.**⁷ **G06T 11/40**

A method, system, and computer program product are provided for multi-threaded texture modulation in axis-aligned volume rendering. Three texture modulation threads are used to modulate texture of three sets of the volumetric data (image sets) in accordance with a texture modulation request. Control is returned from the first texture modulation thread to a main rendering thread while the first texture modulation thread is executing. A user can then interact with a display view while the first texture modulation thread is executing. An intermediate display view of a texture modulated set of volumetric data can be rendered. In one example, a plurality of display connections and contexts are opened for the main rendering thread and each texture modulation thread respectively. Sets of pixel buffers and look-up tables are provided for the respective texture modulation threads. A texture object is included in a context of the main rendering thread. Each pixel buffer stores a respective image set and is associated with the texture object. According to further feature, the sets of volumetric data are sorted based on the angle between normals to the sets and a current viewpoint. The texture modulation threads are then executed (unblocked) based on the sorted order of the sets. For a given graphics machine and especially on a low end machine, the multi-threaded texture modulation of the present invention increases speed, provides interactive control, and gives intermediate display views in axis-aligned volume rendering. A clinician or other user can see intermediate information and interact with the intermediate display view accordingly.

(52) **U.S. Cl.** **345/582; 345/467; 345/471; 345/472**

(58) **Field of Search** 345/430, 424, 345/423, 419, 429, 505, 425, 439, 472, 471, 467, 25, 470, 128; 600/461, 407; 382/128, 203, 217

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16 Claims, 13 Drawing Sheets

(1 of 13 Drawing Sheet(s) Filed in Color)

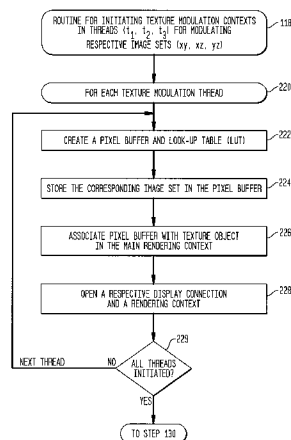


FIG. 1

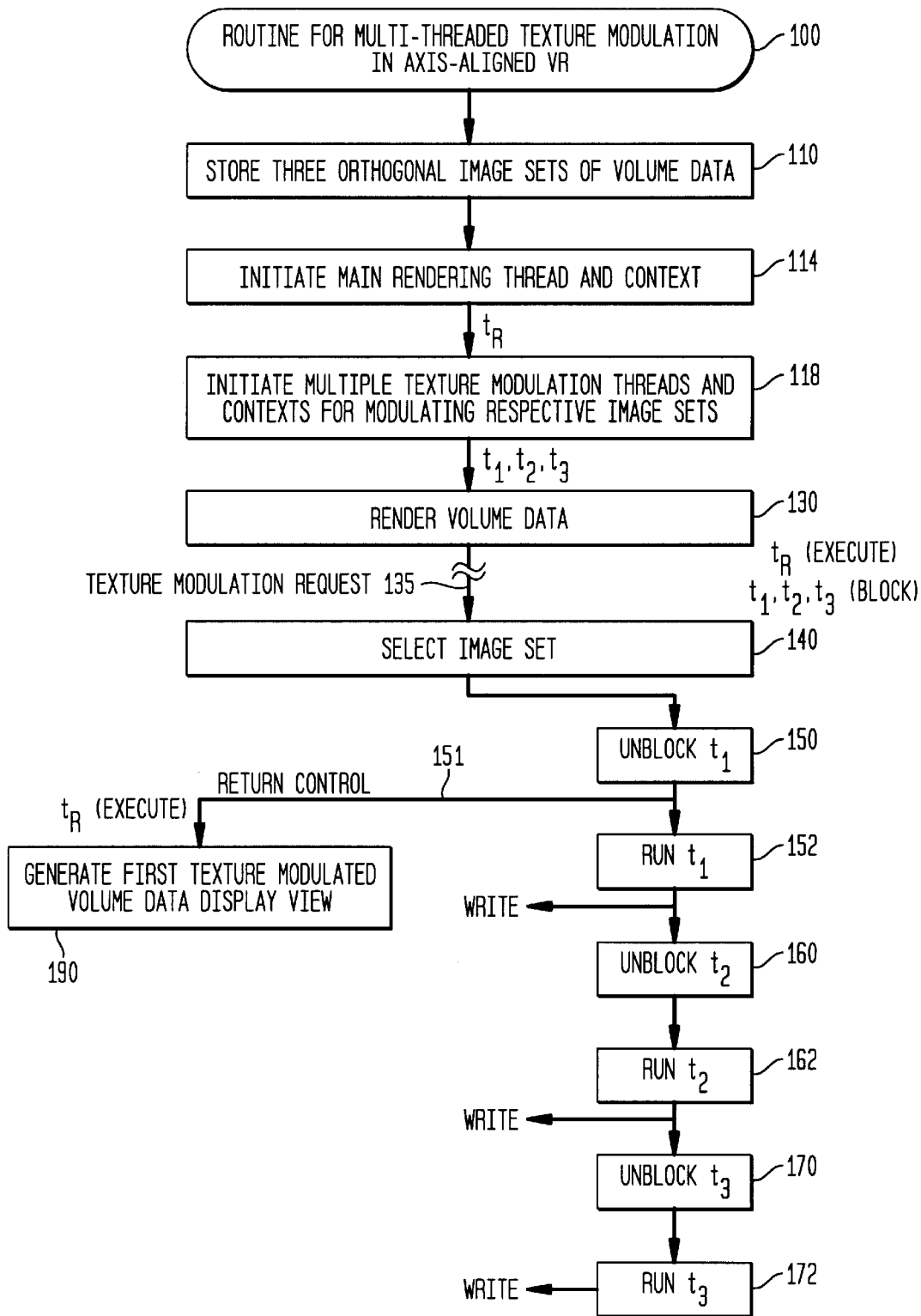


FIG. 2A

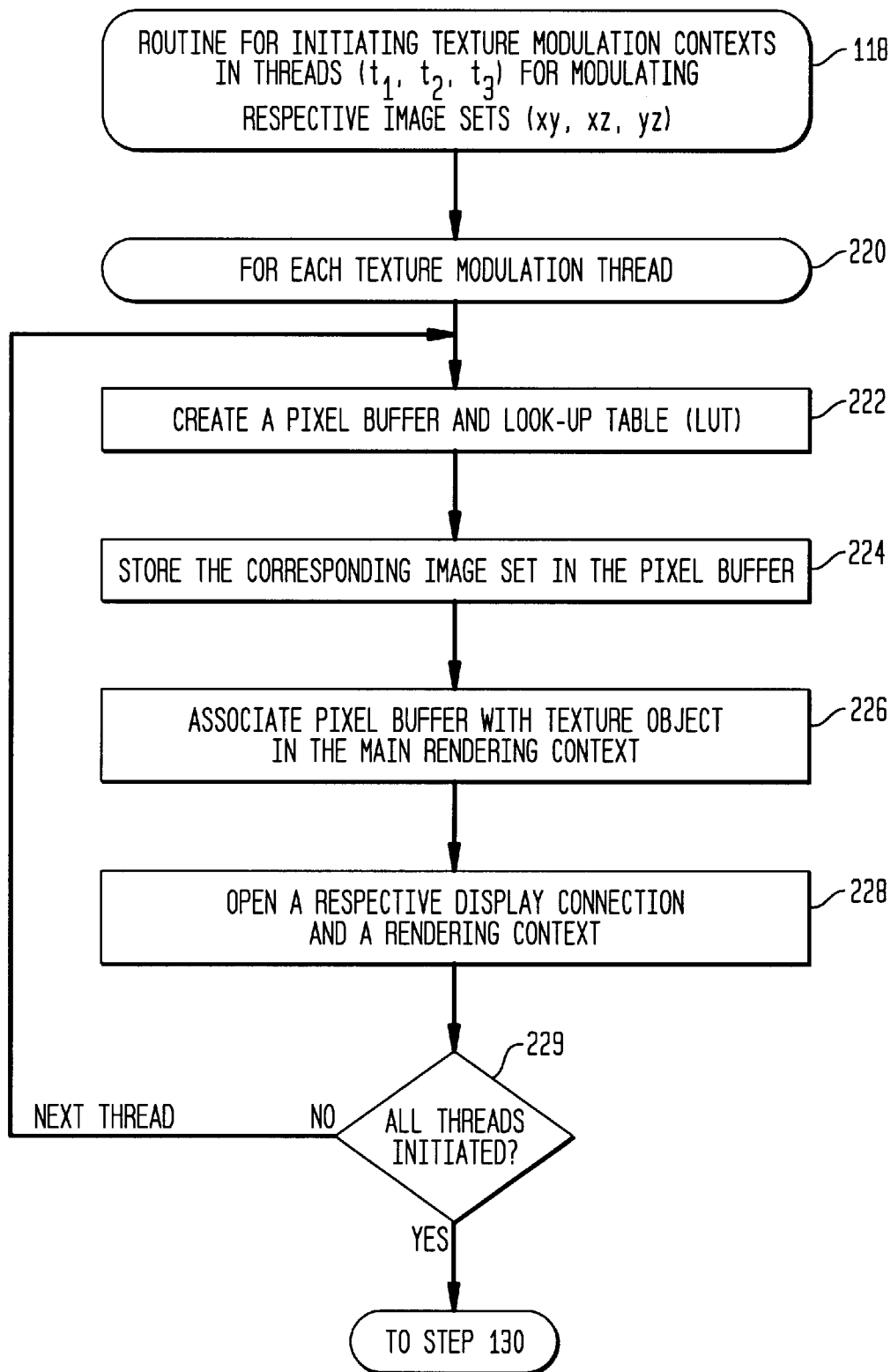


FIG. 2B

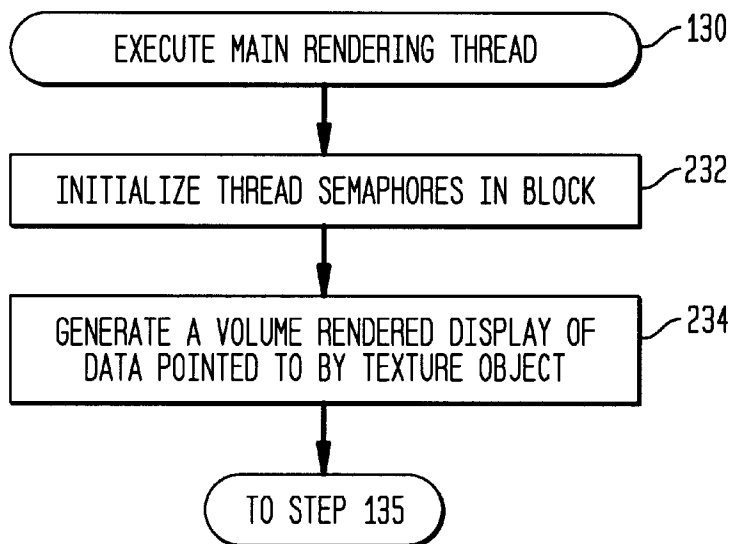


FIG. 2C

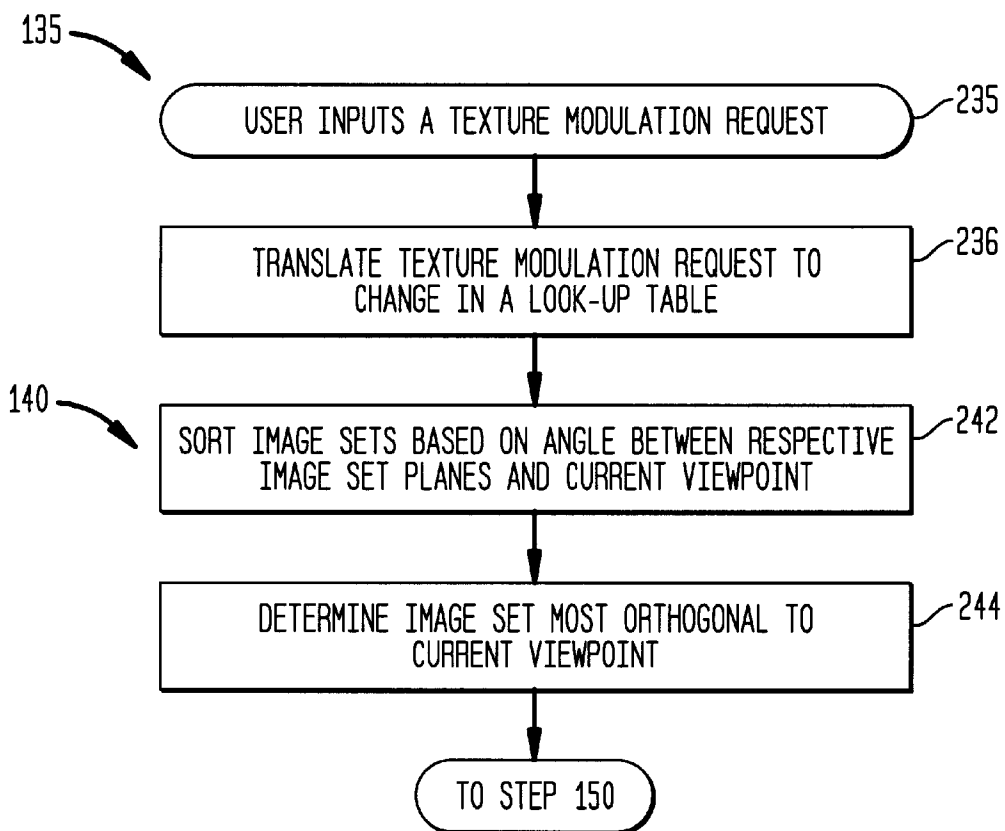


FIG. 2D

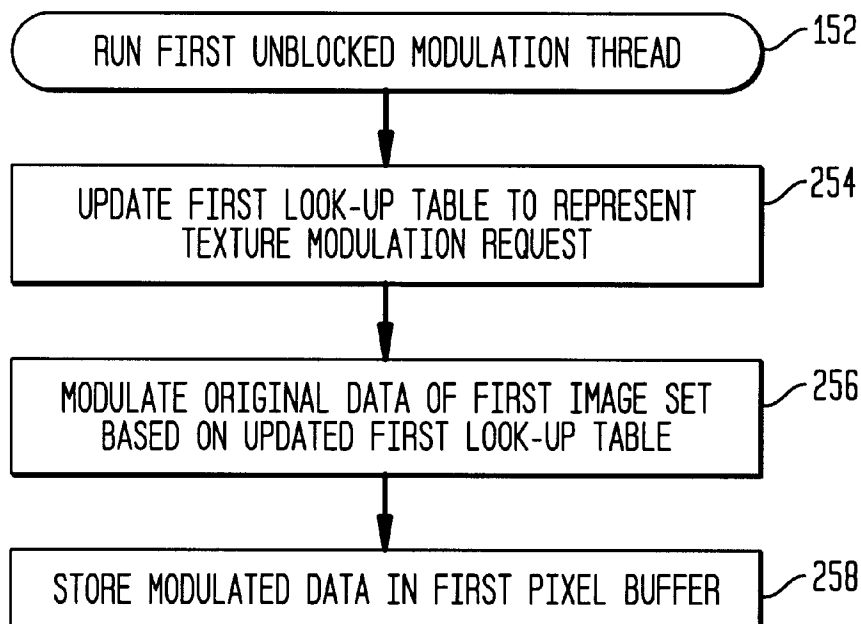
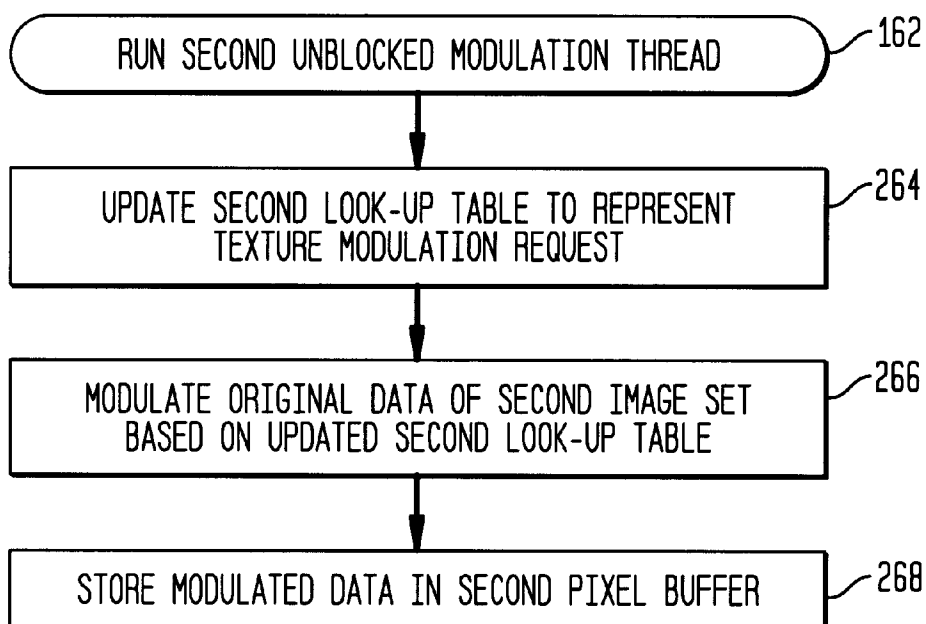


FIG. 2E



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