EXHIBIT D

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(12) **United States Patent**
Lindholm et al.

(10) **Patent No.: US 8,174,531 B1**
(45) **Date of Patent: May 8, 2012**

(54) **PROGRAMMABLE GRAPHICS PROCESSOR FOR MULTITHREADED EXECUTION OF PROGRAMS**

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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.

(21) Appl. No.: **12/649,201**

(22) Filed: **Dec. 29, 2009**

Related U.S. Application Data

(60) Division of application No. 11/458,633, filed on Jul. 19, 2006, which is a continuation-in-part of application No. 10/696,714, filed on Oct. 29, 2003, now Pat. No. 7,103,720, and a continuation-in-part of application No. 10/736,437, filed on Dec. 15, 2003, now Pat. No. 7,139,003, and a continuation-in-part of application No. 11/292,614, filed on Dec. 2, 2005, now Pat. No. 7,836,276.

(51) **Int. Cl.**

G06F 15/16	(2006.01)
G06F 15/80	(2006.01)
G06F 13/14	(2006.01)
G06T 1/20	(2006.01)

(52) **U.S. Cl.** **345/505**; 345/502; 345/506; 345/520

(58) **Field of Classification Search** 345/502, 345/505, 520, 506, 522

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,421,028	A	5/1995	Swanson
5,579,473	A	11/1996	Schlapp et al.
5,815,166	A	9/1998	Baldwin
5,838,988	A	11/1998	Panwar et al.
5,860,018	A	1/1999	Panwar et al.
5,890,008	A	3/1999	Panwar et al.
5,948,106	A	9/1999	Hetherington et al.
5,958,047	A	9/1999	Panwar et al.
5,978,864	A	11/1999	Hetherington et al.
5,996,060	A	11/1999	Medelson et al.
5,999,727	A	12/1999	Panwar et al.

(Continued)

FOREIGN PATENT DOCUMENTS

JP	2003-35589	5/2003

OTHER PUBLICATIONS

Intel, IA-32 Intel Architecture Software Developer's Manual, vol. 1, pp. 11-23 through 11-25. 2004.

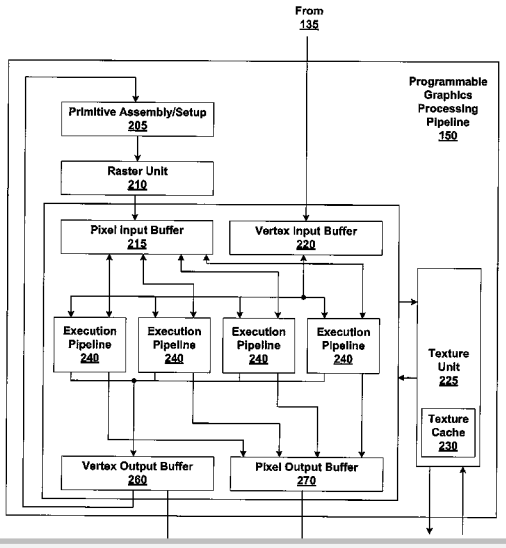
(Continued)

Primary Examiner — Hau Nguyen
(74) *Attorney, Agent, or Firm* — Patterson & Sheridan, LLP.

(57) **ABSTRACT**

A processing unit includes multiple execution pipelines, each of which is coupled to a first input section for receiving input data for pixel processing and a second input section for receiving input data for vertex processing and to a first output section for storing processed pixel data and a second output section for storing processed vertex data. The processed vertex data is rasterized and scan converted into pixel data that is used as the input data for pixel processing. The processed pixel data is output to a raster analyzer.

10 Claims, 14 Drawing Sheets



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U.S. PATENT DOCUMENTS

6,178,481	B1	1/2001	Krueger et al.	
6,204,856	B1	3/2001	Wood et al.	
6,222,550	B1	4/2001	Roseman et al.	
6,266,733	B1	7/2001	Knittel et al.	
6,279,086	B1	8/2001	Arimilli et al.	
6,279,100	B1	8/2001	Tremblay et al.	
6,288,730	B1	9/2001	Duluk, Jr. et al.	
6,397,300	B1	5/2002	Arimilli et al.	
6,405,285	B1	6/2002	Arimilli et al.	
6,418,513	B1	7/2002	Arimilli et al.	
6,434,667	B1	8/2002	Arimilli et al.	
6,446,166	B1	9/2002	Arimilli et al.	
6,463,507	B1	10/2002	Arimilli et al.	
6,559,852	B1	5/2003	Ashburn et al.	
6,658,447	B2	12/2003	Cota-Robles	
6,704,925	B1	3/2004	Bugnion	
6,750,869	B1	6/2004	Dawson	
6,771,264	B1	8/2004	Duluk et al.	
6,816,161	B2	11/2004	Lavelle et al.	
6,819,325	B2	11/2004	Boyd et al.	
6,919,896	B2 *	7/2005	Sasaki et al.	345/505
6,947,047	B1	9/2005	Moy et al.	
7,015,718	B2	3/2006	Burky et al.	
7,103,720	B1	9/2006	Moy et al.	
7,139,003	B1	11/2006	Kirk et al.	
7,237,094	B2	6/2007	Curran et al.	
7,254,697	B2	8/2007	Bishop et al.	
7,278,011	B2	10/2007	Elsen et al.	
7,328,438	B2	2/2008	Armstrong et al.	
7,447,873	B1	11/2008	Nordquist	
7,577,869	B2 *	8/2009	Mantor et al.	714/11
2001/0056456	A1	12/2001	Cota-Robeles	
2003/0097395	A1	5/2003	Peterson	
2004/0024993	A1	2/2004	Parthasarathy	
2004/0194096	A1	9/2004	Armstrong et al.	
2004/0207623	A1	10/2004	Isard et al.	
2004/0208066	A1	10/2004	Burkey et al.	
2005/0108720	A1	5/2005	Cervini	
2005/0122330	A1	6/2005	Boyd et al.	
2006/0020772	A1	1/2006	Hussain	
2006/0155966	A1	7/2006	Burky et al.	

OTHER PUBLICATIONS

Intel, IA-32 Intel Architecture Software Developer's Manual, vol. 2B, p. 4-72. 2004.

Lo, et al. "Converting Thread-Level Parallelism to Instruction-Level Parallelism via Simultaneous Multithreading," ACM Transactions on Computer Systems, vol. 15, No. 3, Aug. 1997, pp. 322-354.

Tullsen, et al. "Exploiting Choice: Instruction Fetch and Issue on an Implementable Simultaneous Multithreading Processor," Proceedings of the 23rd Annual International Symposium on Computer Architecture, May 1996, pp. 1-12.

Eggers, et al. "Simultaneous Multithreading: A Platform for Next-Generation Processors," IEEE Micro, vol. 17, No. 5, pp. 12-19, Sep./Oct. 1997.

English abstract of JP 2003-35589 with additional translated information.

Translated copy of Japanese Office Action dated Jun. 9, 2008 (provided as an explanation of relevance of Citation No. B1).

Hinton, et al. "The Microarchitecture of the Pentium 4 Processor," Intel Technology Journal Q1, 2001, pp. 1-12.

Sen et al., "Shadow Silhouette Maps" Jul. 2003, ACM transactions on Graphics 22, 3, pp. 521-526.

* cited by examiner

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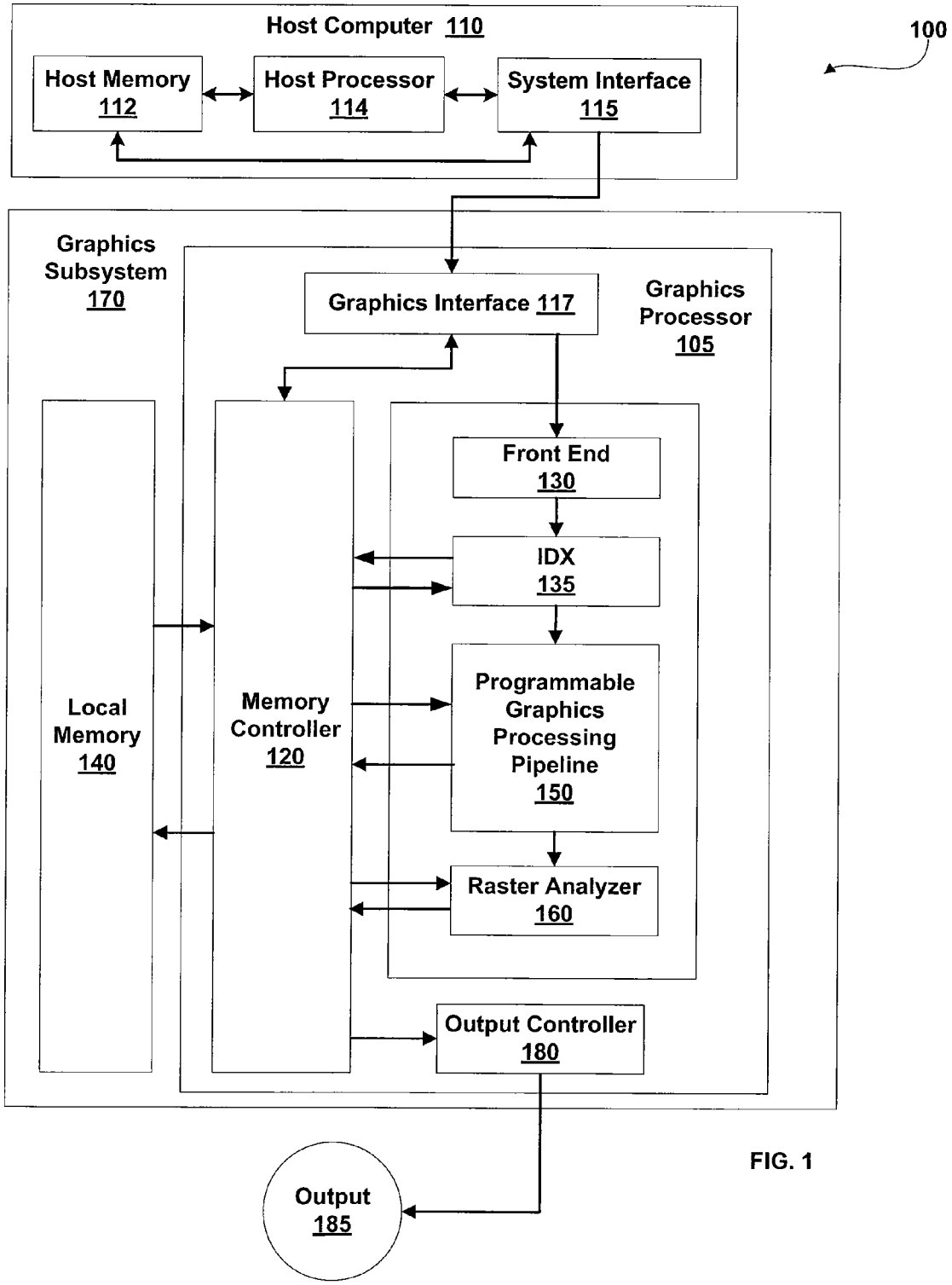

FIG. 1

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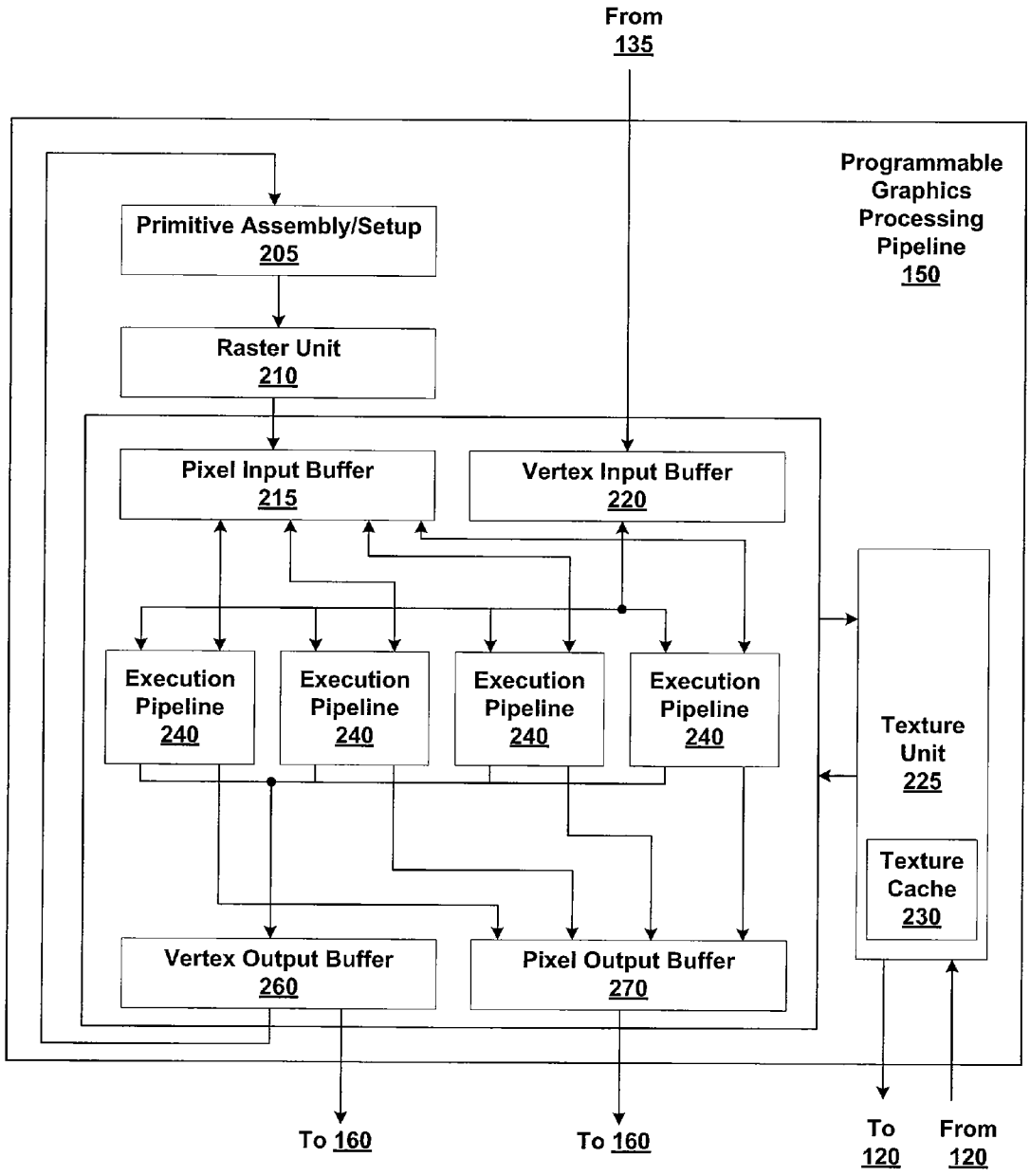

FIG. 2

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