US009411445B2

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

(10) **Patent No.: US 9,411,445 B2**
(45) **Date of Patent: Aug. 9, 2016**

(54) **INPUT OBJECT CLASSIFICATION**

(71) Applicant: **Synaptics Incorporated**, San Jose, CA (US)

(72) Inventors: **Chia-yun Kuan**, Sunnyvale, CA (US); **Shwetank Kumar**, San Jose, CA (US)

(73) Assignee: **Synaptics Incorporated**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 228 days.

(21) Appl. No.: **13/929,514**

(22) Filed: **Jun. 27, 2013**

(65) **Prior Publication Data**

US 2015/0002405 A1 Jan. 1, 2015

(51) **Int. Cl.**

G06F 3/041	(2006.01)
G06F 3/044	(2006.01)
G06K 9/00	(2006.01)
G06K 9/62	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 3/041*** (2013.01); ***G06F 3/044*** (2013.01); ***G06K 9/0002*** (2013.01); ***G06K 9/6278*** (2013.01); *G06F 2203/04101* (2013.01)

(58) **Field of Classification Search**

CPC G06F 3/0416; G06F 3/044; G06F 2203/04101; G06F 2203/04104; G06F 3/0488; G06F 3/041; G06K 9/00375

USPC 345/173–178; 324/679

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,846,755	A	11/1974	Hart	
4,782,328	A	11/1988	Denlinger	
4,783,829	A	11/1988	Miyakawa et al.	
5,335,298	A	8/1994	Hevenor et al.	
5,485,568	A	1/1996	Venable et al.	
5,892,854	A	4/1999	de Queiroz et al.	
5,969,339	A	10/1999	McMurray et al.	
6,201,888	B1	3/2001	Kalvin	
6,392,686	B1	5/2002	Kao et al.	
7,440,588	B2	10/2008	Kaneko et al.	
7,526,140	B2	4/2009	Fang et al.	
7,812,828	B2	10/2010	Westerman et al.	
7,835,568	B2	11/2010	Park et al.	
9,081,450	B1 *	7/2015	Mohindra	G06F 3/044
2004/0249584	A1	12/2004	Gibb et al.	
2005/0226505	A1 *	10/2005	Wilson	382/180
2006/0222221	A1	10/2006	Sathyanarayana	

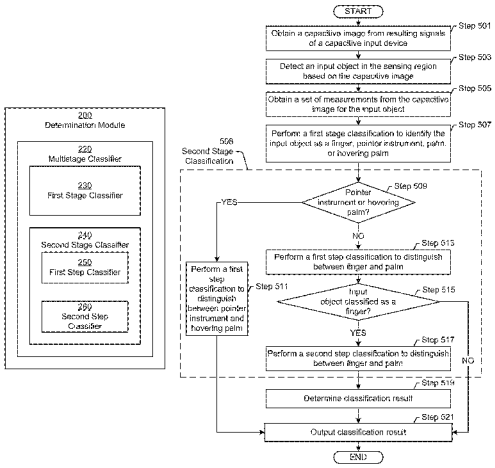
(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion in corresponding International Application No. PCT/US2014/038986, mailed Sep. 24, 2014 (14 pages).

Primary Examiner — Alexander Eisen
Assistant Examiner — Abhishek Sarma
(74) *Attorney, Agent, or Firm* — Osha Liang LLP

(57) **ABSTRACT**

A processing system for an input device includes a sensor module and a determination module. The sensor module includes sensor circuitry coupled to transmitter electrodes and receiver electrodes. The sensor module is configured to transmit transmitter signals with the transmitter electrode and receive resulting signals with the receiver electrodes. The determination module is configured to obtain a set of measurements for an input object detected in a sensing region of the input device from a capacitive image, and perform, based on the set of measurements, a multistage classification to obtain a classification result identifying a type of the input object. wherein the capacitive image is generated based on the resulting signals.

20 Claims, 6 Drawing Sheets