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16 June 2011

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(54) Title: TOUCH AND HOVER SENSING

(57) Abstract: Improved capacitive touch and hover sensing with a sensor array is provided. An AC ground shield positioned behind the sensor array and stimulated with signals of the same waveform as the signals driving the sensor array may concentrate the electric field extending from the sensor array and enhance hover sensing capability. The hover position and/or height of an object that is nearby, but not directly above, a touch surface of the sensor array, e.g., in the border area at the end of a touch screen, may be determined using capacitive measurements of sensors near the end of the sensor array by fitting the measurements to a model. Other improvements relate to the joint operation of touch and hover sensing, such as determining when and how to perform touch sensing, hover sensing, both touch and hover sensing, or neither.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/041391

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F3/044 G06F3/048 G06F3/041
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/167325 A1 (GEAGHAN BERNARD O [US]) 2 July 2009 (2009-07-02) paragraph [0024]; figure 1b	1-7
X	US 6 137 427 A (BINSTEAD RONALD PETER [GB]) 24 October 2000 (2000-10-24) column 2, lines 58-62 column 7, lines 7-22	1-7
A	WO 2008/121411 A1 (CIRQUE CORP [US]; BYTHEWAY JARED G [US]) 9 October 2008 (2008-10-09) page 4, line 15 - line 21 page 6, line 11 - page 8, line 15; figure 3	5

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 April 2011	20/04/2011

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/041391

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/041391

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2009/023880 A2 (BRUWER FREDERICK JOHANNES [ZA]; SWANEPOEL NICO JOHANN [ZA]; PRETORIUS) 19 February 2009 (2009-02-19) paragraph [0117]	5
X	US 2008/158174 A1 (LAND BRIAN RICHARDS [US] ET AL) 3 July 2008 (2008-07-03) paragraphs [0038] - [0039]; figures 1-2	1
X	US 2009/174675 A1 (GILLESPIE DAVE [US] ET AL) 9 July 2009 (2009-07-09) paragraph [0025] paragraph [0032] paragraph [0039] - paragraph [0067]; figures 4-5	8-17
X	US 2009/045823 A1 (TASHER NIR [IL] ET AL) 19 February 2009 (2009-02-19) paragraph [0200] - paragraph [0230]; figures 19-20	8-17
X	US 2008/174321 A1 (KANG SUNGCHUL [KR] ET AL) 24 July 2008 (2008-07-24) the whole document	18-28
A	US 2008/042660 A1 (ELY DAVID [GB] ET AL) 21 February 2008 (2008-02-21) paragraph [0077]	25,26

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2010/041391

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-7

A capacitive touch and haver sensing apparatus comprising:
a cover surface,
a sensor array,
a touch and hover control system that transmits a first alternating current (AC) signal to the sensor array and measures a capacitance of the sensor array resulting from the AC signal;
characterised by
an AC shield, wherein the sensor array is positioned substantially between the AC shield and the cover surface, and
an AC shield driving system that transmits a second AC signal to the AC shield such that a first voltage of the sensor array is substantially the same as a voltage of the AC shield.

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2. claims: 8-17

A method of detecting a hover position of an object near a distal end of a sensor array and outside of a space directly above the sensor array, the method comprising:
obtaining a set of capacitance measurements of a plurality of sensors of the sensor array in a range of sensor positions near the distal end of the sensor array, the capacitance measurements being caused by the object;
characterised by
fitting the set of capacitive measurements to a model that defines a curve including a local maximum with a position outside of the range of sensor positions, and determining the hover position based on the position of the local maximum.

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3. claims: 18-28

A capacitive touch and hover sensing apparatus comprising :
a sensor array,
a sensor control system,
characterised in that
a first capacitance is measured by driving the sensor array with a first voltage, thereby detecting a touch event,
a second capacitance is measured by driving the sensor array with a second voltage, thereby detecting a hover event.
