



(51) International Patent Classification:

A61C 11/00 (2006.01) G06T 19/00 (2011.01)  
G06T 7/00 (2006.01) A61C 7/08 (2006.01)

(21) International Application Number:

PCT/IB2010/002063

(22) International Filing Date:

19 August 2010 (19.08.2010)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

12/583,479 21 August 2009 (21.08.2009) US

(71) Applicant (for all designated States except US): **ALIGN TECHNOLOGY, INC.** [—/US]; 2560 Orchard Parkway, San Jose, CA 95131 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **BOLTUNOV, Anatoliy** [RU/RU]; Marshala Poluboyrova Str. 20-57, 109156 Moscow (RU). **BRAILOV, Yury** [RU/RU]; Dejneva Str. 24-59, 127081 Moscow (RU). **CHELNOKOV, Fedor** [RU/RU]; Kudryavceva Str. 4-66, Khimki Town, 141401 Moscow Region (RU). **ROSCHIN, Roman** [RU/RU]; Teply Stan Str. 11-1-150, 117465 Moscow (RU). **MASON, David** [US/US]; 1145 Teresa Lane, Morgan Hill, CA 95037 (US).

AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(88) Date of publication of the international search report:

7 September 2012

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

(54) Title: DIGITAL DENTAL MODELING

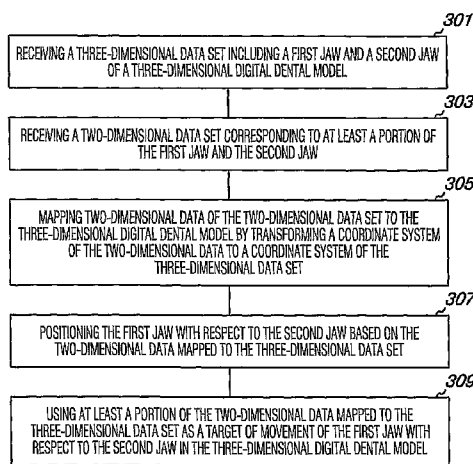


Fig. 3

(57) Abstract: Embodiments are provided for digital dental modeling. One method embodiment includes receiving a three-dimensional data set including a first jaw and a second jaw of a three-dimensional digital dental model and receiving a two-dimensional data set corresponding to at least a portion of the first jaw and the second jaw. The method includes mapping two-dimensional data of the two-dimensional data set to the three-dimensional digital dental model by transforming a coordinate system of the two-dimensional data to a coordinate system of the three-dimensional data set. The method includes positioning the first jaw with respect to the second jaw based on the two-dimensional data mapped to the three-dimensional data set. The method includes using at least a portion of the two-dimensional data mapped to the three-dimensional data set as a target of movement of the first jaw with respect to the second jaw in the three-dimensional digital dental model.



**INTERNATIONAL SEARCH REPORT**

International application No PCT/IB2010/002063
---------------------------------------------------

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. A61C11/00 G06T7/00  
 ADD. G06T19/00 A61C7/08

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)  
 A61C G06T

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 practicable, search terms used)

EPO-Internal, COMPENDEX, EMBASE, INSPEC, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/038684 A1 (KEATING SCOTT [US] ET AL) 14 February 2008 (2008-02-14) figures 1-4 paragraph [0010] - paragraph [0012] paragraph [0024] - paragraph [0027] paragraph [0029] - paragraph [0035] -----	1-10
X	US 2002/094509 A1 (DURBIN DUANE [US] ET AL) 18 July 2002 (2002-07-18) paragraph [0006] - paragraph [0009] paragraph [0011] paragraph [0022] - paragraph [0028] paragraph [0056] paragraph [0059] - paragraph [0062] paragraph [0068] figures 1,2a,2b,3,4,7 ----- -/--	1-9

Further documents are listed in the continuation of Box C.

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 application or patent 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

20 April 2012

Date of mailing of the international search report

18/07/2012

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
 NL - 2280 HV Rijswijk  
 Tel. (+31-70) 340-2040,  
 Fax: (+31-70) 340-3016

Authorized officer

Gauthier, J

## INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2010/002063

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/085851 A1 (DENTSPLY INT INC [US]; DURBIN DUANE M [US]; DURBIN DENNIS A [US]) 17 August 2006 (2006-08-17) figures 5,6,7,8,14,15,18,19,20 page 10, line 16 - line 20 page 11, line 1 - line 21 page 13, line 9 - page 14, line 18 page 15, line 8 - page 16, line 2 page 22, line 2 - line 17 page 23, line 9 - line 14 page 29, line 8 - line 22 -----	1-10
X	US 2003/235803 A1 (NIKOLSKIY SERGEY [RU] ET AL) 25 December 2003 (2003-12-25) figures 1,2c,4,6,8-11,12 paragraph [0038] - paragraph [0039] paragraph [0048] - paragraph [0069] -----	1-10
A	WO 2006/065955 A2 (ORTHOCLER HOLDINGS INC; WEN HUAFENG [US]) 22 June 2006 (2006-06-22) paragraph [0028] paragraph [0035] - paragraph [0037] paragraph [0048] - paragraph [0051] paragraph [0057] - paragraph [0060] paragraph [0063] paragraph [0075] paragraph [0094] - paragraph [0097] paragraph [0102] paragraph [0110] - paragraph [0111] figures 4,5A,6,9 -----	1-10
A	US 2002/150859 A1 (IMGRUND HANS [DE] ET AL) 17 October 2002 (2002-10-17) paragraph [0014] - paragraph [0016] paragraph [0025] - paragraph [0027] paragraph [0065] - paragraph [0073] -----	1-10

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IB2010/002063

## 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.:

1-10

### 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.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

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

1. claims: 1-10

Three dimensional alignment of the two jaws of a 3D digital dental model using bidimensional landmarks.

---

2. claims: 11-17

Anatomically realistic articulation of the upper and lower jaws of a 3D digital dental model based on a series of 2D images.

---

3. claims: 18-24

Physics-based simulation of biting movement by the upper and lower jaws of a 3D digital dental model.

---

4. claims: 25-33

2D/3D registration of a patient's jaws photograph with a 3D digital dental model.

---

5. claims: 34-40

Appearance-based extraction of a plurality of articulation configurations of the upper and lower jaws of a 3D digital dental model based on a set of 2D images.

---

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2010/002063

Patent document cited in search report	Publication date	Publication date	Patent family member(s)	Publication date
US 2008038684	A1	14-02-2008	NONE	
-----				
US 2002094509	A1	18-07-2002	NONE	
-----				
WO 2006085851	A1	17-08-2006	CA 2597036 A1	17-08-2006
			EP 1845889 A1	24-10-2007
			WO 2006085851 A1	17-08-2006
-----				
US 2003235803	A1	25-12-2003	NONE	
-----				
WO 2006065955	A2	22-06-2006	NONE	
-----				
US 2002150859	A1	17-10-2002	AU 2003226345 A1	17-11-2003
			US 2002150859 A1	17-10-2002
			US 2005095552 A1	05-05-2005
			US 2005095562 A1	05-05-2005
			US 2005118555 A1	02-06-2005
			US 2005153255 A1	14-07-2005
			WO 03092536 A1	13-11-2003
-----				