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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
62/417,985	11/04/2016		260	14187-701.100		

CONFIRMATION NO. 1060

UPDATED FILING RECEIPT

OC000000093871447

141884
ALIGN / SHAY GLENN LLP
2755 CAMPUS DRIVE, SUITE 210
SAN MATEO, CA 94403

Date Mailed: 08/25/2017

Receipt is acknowledged of this provisional patent application. It will not be examined for patentability and will become abandoned not later than twelve months after its filing date. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Maurice CARRIER, Durham, NC;
Phillip HARRIS, Cary, NC;
Sergey VINNICHENKO, Cary, NC;
Sam BLANCO, Santa Clara, CA;
Aleksandr Sergeevich KARSAKOV, Nizhny Novgorod, RUSSIAN FEDERATION;
Sebastien HARENG, San Jose, CA;
Leon RASOVSKY, Sunnyvale, CA;

Applicant(s)

Maurice CARRIER, Durham, NC;
Phillip HARRIS, Cary, NC;
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Aleksandr Sergeevich KARSAKOV, Nizhny Novgorod, RUSSIAN FEDERATION;
Sebastien HARENG, San Jose, CA;
Leon RASOVSKY, Sunnyvale, CA;

Power of Attorney:
Richard Shoop--45763

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No
Title

METHODS AND APPARATUSES FOR DENTAL IMAGES

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
62/417,985	11/04/2016	Maurice CARRIER	14187-701.100

CONFIRMATION NO. 1060

141884
ALIGN / SHAY GLENN LLP
2755 CAMPUS DRIVE, SUITE 210
SAN MATEO, CA 94403

OC000000093671448

Date Mailed: 08/25/2017

NOTICE OF ACCEPTANCE OF AUTHORIZATION TO PERMIT ACCESS TO APPLICATION VIA PRIORITY DOCUMENT EXCHANGE

This is in response to the applicant's authorization to permit access to the application-as-filed by participating offices under 37 CFR 1.14(h)(1) submitted on 08/23/2017.

The authorization to permit access to the application under 37 CFR 1.14(h)(1) is accepted.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/hnguyen/

PTO/SB/39 (11-15)
Approved for use through 07/31/2018. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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AUTHORIZATION OR RESCISSION OF AUTHORIZATION TO PERMIT ACCESS TO APPLICATION-AS-FILED BY PARTICIPATING OFFICES

Send completed form to: Commissioner for Patents
P.O. Box 1450, Alexandria, VA 22313-1450

Application Number (if known): 62/417,985	Filing Date: November 4, 2016
First Named Inventor: Maurice CARRIER	Attorney Docket Number: 14187-701.100
Title (Required) METHODS AND APPARATUSES FOR DENTAL IMAGES	

Check either box 1 or 2 below, but **not** both:

1. ☒ By checking this box, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization(WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

2. ☐ By checking this box, the undersigned hereby **rescinds the previous authority granted to the USPTO** to provide the EPO, JPO, KIPO, SIPO, WIPO or any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement access to the documents and information identified in paragraph 1 above.

This rescission of the previous authorization will not be effective unless and until an appropriate USPTO official recognizes and acts on the rescission.

However, once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

NOTE: This form must be signed by an authorized party in accordance with 37 CFR 1.14(c). Please see 37 CFR 1.4(d) for the form of the signature. If necessary, submit multiple forms for more than one signature, see below.*

Signature /Richard D. Shoop/	Date August 23, 2017
Name (Print/Typed) Richard D. Shoop	Practitioner Registration Number (if applicable) 45,763
Name of Assignee (if applicable) ALIGN TECHNOLOGY, INC.	Title (if applicable)

☑ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.14(h). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	30167786
Application Number:	62417985
International Application Number:	
Confirmation Number:	1060
Title of Invention:	METHODS AND APPARATUSES FOR DENTAL IMAGES
First Named Inventor/Applicant Name:	Maurice CARRIER
Customer Number:	141884
Filer:	Richard Douglas Shoop/Kristine Le
Filer Authorized By:	Richard Douglas Shoop
Attorney Docket Number:	14187-701.100
Receipt Date:	23-AUG-2017
Filing Date:	04-NOV-2016
Time Stamp:	20:38:38
Application Type:	Provisional

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Auth or Resc of Auth to Access Appl by DAS/PDX Office	14187-701-100_Auth-permit-access.pdf	108186 eafc3450d828d2ed3607b80c6e5b19f7b7c59ec9	no	2

Warnings:

Information:	
Total Files Size (in bytes):	108186

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
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CONFIRMATION NO. 1060

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SAN MATEO, CA 94403

Date Mailed: 12/07/2016

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Leon RASOVSKY, Sunnyvale, CA;

Power of Attorney:
Richard Shoop--45763

Permission to Access Application via Priority Document Exchange: No

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 12/05/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 62/417,985**

Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No
Title

METHODS AND APPARATUSES FOR DENTAL IMAGES

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Doc Code: **TR.PROV**
Document Description: Provisional Cover Sheet (SB16)

PTO/SB/16 (11-08)
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U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

Inventor(s)

Inventor 1 — Remove

Given Name	Middle Name	Family Name	City	State	Country ¡
Maurice		CARRIER	Durham	NC	US

Inventor 2 — Remove

Given Name	Middle Name	Family Name	City	State	Country ¡
Phillip		HARRIS	Cary	NC	US

Inventor 3 — Remove

Given Name	Middle Name	Family Name	City	State	Country ¡
Sergey		VINNICHENKO	Cary	NC	US

Inventor 4 — Remove

Given Name	Middle Name	Family Name	City	State	Country ¡
Sam		BLANCO	Santa Clara	CA	US

Inventor 5 — Remove

Given Name	Middle Name	Family Name	City	State	Country ¡
Aleksandr	Sergeevich	KARSAKOV	Nizhny Novgoro		RU

Inventor 6 — Remove

Given Name	Middle Name	Family Name	City	State	Country ¡
Sebastien		HARENG	San Jose	CA	US

Inventor 7 — Remove

Given Name	Middle Name	Family Name	City	State	Country ¡
Leon		RASOVSKY	Sunnyvale	CA	US

All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. — Add

PTO/SB/16 (11-08)
Approved for use through 05/31/2015. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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Title of Invention	METHODS AND APPARATUSES FOR DENTAL IMAGES
Attorney Docket Number (if applicable)	14187-701.100

Correspondence Address

Direct all correspondence to (select one):

◉ The address corresponding to Customer Number	◯ Firm or Individual Name
Customer Number	141884

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.
• No.
Yes, the invention was made by an agency of the United States Government. The U.S. Government agency name is:
Yes, the invention was under a contract with an agency of the United States Government. The name of the U.S. Government agency and Government contract number are:

PTO/SB/16 (11-08)
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Entity Status
Applicant asserts small entity status under 37 CFR 1.27 or applicant certifies micro entity status under 37 CFR 1.29

- ○ Applicant asserts small entity status under 37 CFR 1.27
- ○ Applicant certifies micro entity status under 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
- ◉ No

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First Name	Richard	Last Name	Shoop	Registration Number (If appropriate)	45763

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UNITED STATES PROVISIONAL PATENT APPLICATION

METHODS AND APPARATUSES FOR DENTAL IMAGES

Inventors:

Maurice CARRIER

Phillip HARRIS

Sergey VINNICHENKO

Sam BLANCO

Aleksandr Sergeevich KARSAKOV

Sebastien HARENG

Leon RASOVSKY

ShayGlennLLP

Shay Glenn LLP
2755 Campus Drive, Suite 210
San Mateo, CA 94403
(650) 212-1700 Telephone
(650) 212-7562 Facsimile

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/Mary Buggie/	11/4/2016
Mary Buggie	Date

METHODS AND APPARATUSES FOR DENTAL IMAGES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] None.

INCORPORATION BY REFERENCE

[0002] All publications and patent applications mentioned in this specification are herein incorporated by reference in their entirety to the same extent as if each individual publication or patent application was specifically and individually indicated to be incorporated by reference.

FIELD

[0003] This disclosure relates generally to methods and apparatuses for image capturing, and more specifically to methods and apparatuses for capturing dental images.

BACKGROUND

[0004] In dental and/or orthodontic treatment, a set of 2D facial and dental photos is often required in addition to 3D impressions. Traditional dental photography uses a camera, for example, a digital single-lens reflex (SLR) camera with a lens with a focal length of 90-100 mm and circular flash as shown in FIGS. 1A-1C. However, the SLR camera is expensive and it may be difficult to align the teeth of a patient to the SLR camera. The process may also be uncomfortable to the patient. Some doctors and dental technicians may instead attempt to capture dental photos using a mobile phone. However, mobile phones typically have a wide angle camera lens. If a camera of a mobile phone is held sufficiently close to the teeth of the patient to provide an image of the teeth having a high level of detail, dental photos may be blurry and have optical distortion. If the camera of the mobile phone is too far to the teeth, dental photos cannot meet the orthodontic standards. In general, commonly available cameras, and particularly mobile phone cameras, may be faster and easier to use.

[0005] Thus, there is a need for new and useful methods and apparatuses for obtaining high quality dental images.

SUMMARY OF THE DISCLOSURE

[0006] Described herein are methods, apparatuses (including devices and systems, such as non-transitory, computer-readable storage media) for capturing high quality dental images. In general, the methods and apparatuses to perform them described herein may obtain an image of a patient's teeth for therapeutic use, which may include viewing the patient's teeth, for example, on a screen of a mobile phone (or other hand-held personal computing device, such as smartwatch, pad, laptop, etc.). The method can further comprise displaying, on the screen, an overlay comprising an outline of teeth in a predetermined view, wherein the overlay is displayed atop the view of the patient's teeth. The method can comprise moving the mobile phone so that the overlay approximately matches the patient's teeth in the view of the patient's teeth. The method can further comprise capturing an image of the view of the patient's teeth.

[0007] For example, a method of obtaining an image of a patient's teeth for therapeutic use is described herein. The method can comprise viewing the patient's teeth, for example, on a screen of a mobile phone. The method can further comprise displaying, on the screen, an overlay comprising an outline of teeth in a predetermined view, wherein the overlay is displayed atop the view of the patient's teeth. The method can comprise moving the mobile phone relative to the patient's teeth and triggering an indicator when the overlay approximately matches with the patient's teeth. The method can comprise capturing an image of the view of the patient's teeth when the indicator is triggered.

[0008] A method to obtain and an image of a patient's teeth for therapeutic use may include viewing, on a screen of a mobile phone, the patient's teeth. The method can further comprise displaying, on the screen, an overlay comprising a cropping frame and an outline of teeth in one of an anterior view, a buccal view an upper jaw view, or a lower jaw view, wherein the overlay is displayed atop the view of the patient's teeth. The method can further comprise moving the mobile phone so that the overlay approximately matches the patient's teeth in the view of the patient's teeth. The method can comprise capturing an image of the view of the patient's teeth. The method can further comprise reviewing the captured image on the mobile phone and indicating on the screen of the mobile phone if the captured image is out of focus. The

method can further comprise automatically cropping the captured image as indicated by the cropping frame.

[0009] For example, the overlay can comprise a generic overlay in some embodiments. For another example, the overlay can comprise a patient-specific overlay derived from the patient's teeth in some other embodiments.

[0010] For example, the method can further comprise automatically triggering an indicator when the overlay approximately matches with the patient's teeth. For example, the method can further comprise triggering the indicator when the overlay approximately matches with the patient's teeth comprises estimating an indicator of the distance between an edge of the patient's teeth in the view of the patient's teeth and the outline of teeth in the overlay. For another example, the method can further comprise triggering the indicator when the overlay approximately matches with the patient's teeth comprises estimating an indicator of the distance between an edge of the patient's teeth at two or more regions and the outline of teeth and comparing that indicator to a threshold value. For example, the indicator can be a visual indicator, such as a change of color. In some variations, the indicator can be other forms of indicators, such as a voice indicator.

[0011] The method can further comprise automatically capturing an image of the patient's teeth when the overlay approximately matches with the patient's teeth.

[0012] The method can further comprise checking the image quality of the captured image and displaying on the screen if the image quality is below a threshold for image quality.

[0013] The method can further comprise cropping the captured image based on a cropping outline displayed as part of the overlay. Cropping may be manual or automatic

[0014] Any of these methods can further comprise evaluating the captured image for medical treatment by using the image. For example, the method can further comprise transmitting the captured image to a remote server.

[0015] The predetermined view can comprise an anterior view, a buccal view an upper jaw view, or a lower jaw view. The predetermined view can comprise a set of dental images according to the orthodontic standards. For example, the method can further comprise repeating the steps of viewing, displaying, moving and capturing to capture anterior, buccal, upper jaw and lower jaw images of the patient's teeth.

[0016] The method can further comprise imaging a patient's identification using the mobile phone and automatically populating a form with user identification information based on the imaged identification.

[0017] Any of these methods can further comprise displaying instructions about positioning the patient's teeth on the screen of the mobile phone prior to displaying the overlay.

[0018] Also described herein are apparatuses adapted to perform any of the methods described herein, including in particular software, firmware, and/or hardware adapted to perform one or more of these methods. Specifically, described herein are non-transitory, computer-readable storage media storing a set of instructions capable of being executed by a processor (e.g., of a mobile phone), that, when executed by the processor, causes the processor to display real-time images of the patient's teeth on a screen of the mobile phone, display an overlay comprising an outline of teeth in a predetermined view atop the images of the patient's teeth, and enable capturing of an image of the patient's teeth.

[0019] For example, described herein are non-transitory, computer-readable storage media storing a set of instructions capable of being executed by a processor of a mobile phone, that, when executed by the processor, causes the processor to display real-time images of the patient's teeth on a screen of the mobile phone, display an overlay comprising an outline of teeth in a predetermined view atop the images of the patient's teeth, trigger an indicator when the overlay approximately matches with the patient's teeth, and enable capturing of an image of the patient's teeth when the indicator is triggered.

[0020] Also described herein are non-transitory, computer-readable storage medium storing a set of instructions capable of being executed by a processor of a mobile phone, that, when executed by the processor, causes the processor to display real-time images of the patient's teeth on a screen of the mobile phone and display an overlay comprising a cropping frame and an outline of teeth in one of an anterior view, a buccal view an upper jaw view, or a lower jaw view, wherein the overlay is displayed atop the images of the patient's teeth, and enable capturing of an image of the patient's teeth. The non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to review the captured image and indicate on the screen if the captured image is out of focus and automatically crop the captured image as indicated by the cropping frame.

[0021] The set of instructions, when executed by the processor, can further cause the processor to display a generic overlay. For another example, set of instructions can cause the processor to display a patient-specific overlay derived from the patient's teeth.

[0022] The set of instructions, when executed by the processor, can further cause the processor to automatically trigger an indicator when the overlay approximately matches with the patient's teeth. For example, the set of instructions can further cause the processor to estimate an indicator of the distance between an edge of the patient's teeth in the view of the patient's teeth and to trigger the indicator when the outline of teeth in the overlay is less than or equal to a threshold value. The set of instructions, when executed by the processor, can further cause the processor to estimate an indicator of the distance between an edge of the patient's teeth at two or more regions in the view of the patient's teeth and to trigger the indicator when the outline of teeth in the overlay is less than or equal to a threshold value. The set of instructions can cause the processor to trigger the indicator by displaying a visual indicator on the screen. Any appropriate visual indicator may be displayed, including a color, intensity (e.g., changing the color and/or intensity of the outline of the teeth overlay, cropping window, etc.), a textual/character indicator, or some combination thereof. Alternatively or additionally the indicator may be audible (beeping, tonal, etc.) and/or tactile (a vibration, buzzing, etc.).

[0023] The set of instructions, when executed by the processor, can further cause the processor to check the image quality of the captured image and displaying on the screen if the image quality is below a threshold for image quality. The quality may automatically determine focus, lighting (dark/light), etc. of the image and may alert the user and/or automatically reject or accept the image. The apparatus may further process the image (e.g., sharpen, lighten/darken, etc., including cropping). For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to automatically crop the captured image based on a cropping outline displayed as part of the overlay.

[0024] The set of instructions, when executed by the processor, can further cause the processor to transmit the captured image to a remote server. Transmission may be automatic or manual.

[0025] The apparatus (e.g., including the non-transient set of instructions) can further cause the processor to display an overlay comprising an outline of teeth in a predetermined view such

as an anterior view, a buccal view an upper jaw view, or a lower jaw view. The apparatus may be configured to take a full or partial set of views. For example, the set of instructions, when executed by the processor, can further cause the processor to repeat the steps of viewing, displaying, moving and capturing to capture anterior, buccal, upper jaw and lower jaw images of the patient's teeth.

[0026] In addition to taking one or more views (e.g., anterior, buccal, upper jaw and lower jaw) the apparatuses described herein may be configured to automatically determine patient-specific information on the identity and other patient characteristics, and to associate this information with the images taken. For example, the set of instructions can cause the processor to capture an image of a patient's identification (e.g., driver's license) using the mobile phone and automatically populate a form with user identification information based on the imaged identification.

[0027] In any of these apparatuses the set of instructions can further cause the processor to display instructions on positioning the patient's teeth on the screen of the mobile phone prior to displaying the overlay.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The novel features of the invention are set forth with particularity in the claims that follow. A better understanding of the features and advantages of the present invention will be obtained by reference to the following detailed description that sets forth illustrative embodiments, in which the principles of the invention are utilized, and the accompanying drawings of which:

[0029] FIGS. 1A-1C illustrate one example of traditional dental photography using a digital SLR camera.

[0030] FIG. 2A illustrates an example of a screen of an apparatus (such as a smartphone running the app as described herein) including an overlay comprising an outline of teeth in a predetermined view, which is an anterior view of teeth, on a screen of a mobile phone according to one embodiment of the disclosure.

[0031] FIG. 2B illustrates another example of an example of the screen of the apparatus, similar to that shown in FIG. 2B, showing the overlay and another anterior view of teeth.

[0032] FIG. 2C shows an example of an screen of an apparatus for taking a photograph of a patient's teeth in a left buccal open bite configuration, including an overlay on the screen which shows what teeth should be visible in the view.

[0033] FIG. 3A illustrates an example of a patient-specific overlay according to another embodiment of the disclosure.

[0034] FIG. 3B illustrates an example of an indicator which is triggered when the overlay approximately matches with the patient's teeth. The trigger may be visual (including changing the color of the overlay, displaying or flashing an image/icon/color/symbol on the screen, etc.) and/or audible (emitting a ping, tone, etc.), and/or tactile (e.g., vibrating), etc.

[0035] FIGS. 4A-4H illustrate 8 specific overlay images for the required types of photos according to the orthodontic standard, including an anterior view in FIG. 4A, an another anterior view in FIG. 4B, an upper jaw view in FIG. 4C, a lower jaw view in FIG. 4D, a left buccal view in FIG. 4E, an another left buccal view in FIG. 4F, a right buccal view in FIG. 4G, and an another right buccal view in FIG. 4H.

[0036] FIG. 5A is an example of a user interface to enable a user to select one of a plurality of overlays for a plurality of dental images in a plurality of predetermined views.

[0037] FIG. 5B is an example of on-screen message to guide a user to take dental images.

[0038] FIG. 5C is an example of a user interface to take a profile image of a patient.

[0039] FIG. 5D is an example of a user interface to take a facial image of the patient.

[0040] FIG. 6A is an example screenshot which indicates the captured image is out of focus after reviewing the image quality.

[0041] FIG. 6B is an example of a poor quality image of the teeth.

[0042] FIG. 7A shows an example overlay comprising a cropping frame and an outline of teeth in an upper jaw view.

[0043] FIG. 7B shows another example overlay comprising a cropping frame and an outline of teeth in anterior view.

[0044] FIG. 7C shows an example of an image captured using the overlay of FIG. 7B.

[0045] FIG. 8 is an example of a block diagram of a method to obtain an image of teeth of a patient.

[0046] FIG. 9 is an example of a set of facial and dental images of a patient captured by using a digital SLR camera.

[0047] FIG. 10 is an example of a set of facial and dental images of a patient captured by using a mobile phone through the method disclosed herein.

[0048] FIGS. 11A-11H are examples of a set of dental images captured by using the mobile phone through the method disclosed herein.

DETAILED DESCRIPTION

[0049] The following description of the various embodiments of the invention is not intended to limit the invention to these embodiments, but rather to enable any person skilled in the art to make and use this invention.

[0050] Described herein are methods and apparatuses, including devices and systems, for capturing high quality dental images, including obtaining an image or set of images (e.g., from predetermined positions) of a patient's teeth and/or face for therapeutic use. The methods (and apparatuses for performing them) can provide a view of the patient's teeth, for example, on a screen of a mobile phone and displaying, on the screen, an overlay comprising an outline of teeth in a predetermined view (or sequence of predetermined views), wherein the overlay is displayed atop the view of the patient's teeth (or other body parts, such as face, head, etc.). The user may then move the mobile phone so that the overlay approximately matches the patient's teeth in the view of the patient's teeth and capture (e.g., manually or automatically by means of the apparatus) an image of the view of the patient's teeth (and in some instances, face and head).

[0051] Mobile phones can be used to capture dental images instead of using expensive and bulky SLR cameras. FIG. 1A shows the use of a traditional SLR camera to image a patient's teeth. The camera is typically held by the user (e.g., dentist, orthodontist, technician) and images are taken from various positions. The user must manually adjust the patient position and/or camera position. FIG. 1B shows a typical image. In addition, one or more retractors or other elements may be used to assist in taking the photograph, as shown in FIG. 1C. Any of the methods and apparatuses described herein may include the use of one or more such retractors or other assistance devices, and the apparatuses described herein may prompt the user to place and/or position such devices, including providing guidance for proper positions.

[0052] As mentioned above, it may be helpful to adapt a traditional handheld consumer electronics device, such as phone (e.g., smartphone, smartwatch, pad, tablet, etc.) to take one or, more preferably, a series of images of the teeth at sufficient clarity, e.g., focus, magnification,

resolution, lighting, etc. Such images (and image series) when taken from the proper orientations and with sufficient clarity (focus, magnification, resolution, lighting, etc.) may be used in one or more of: planning a dental/orthodontist procedure, determining the feasibility of a dental/orthodontic procedure for a particular patient, tracking patient progress during a dental/orthodontic procedure, determining the effectiveness of a dental/orthodontic procedure, etc. For example, and of the methods and apparatuses described herein may be used to specifically track a portion of an orthodontic procedure, including one or more phases of treatment (such as palatal expansion).

[0053] In general, these method and apparatuses may improve on existing technology by guiding a user through the process of collecting relevant patient images (e.g., a predetermined set of images), enhancing and/or confirming the image quality, associating patient information and transmitting the set of images so that they may be used in a dental/orthodontic procedure.

[0054] For example, the methods and apparatuses described herein may use a user's own handheld electronics apparatus having a camera (e.g., smartphone) and adapt it so that the user's device guides the user in taking high-quality images (e.g., at the correct aspect ratio/sizing, magnification, lighting, focus, etc.) of a predetermined sequence of orientations. In particular, these apparatuses and methods may include the use of an 'overlay' on a real-time image of the screen, providing immediate feedback on each of the desired orientations.

[0055] An overlay may include an outline (e.g., a perspective view outline) of a set of teeth that may be used as a guide to assist in placement of the camera to capture the patient image. The overlay may be based on a generic image of teeth, or it may be customized to the user's teeth, or to a patient-specific category (by patient age and/or gender, and/or diagnosis, etc.). The overlay may be shown as partially transparent, or it may be solid, and/or shown in outline.

[0056] FIG. 2A illustrates an example of an overlay comprising an outline of teeth in a first predetermined view, which is an anterior view of teeth, on a screen of a mobile phone. FIG. 2B illustrates another example of the overlay in another anterior view of teeth, on the screen of the mobile phone. As shown in FIG. 2A and FIG. 2B, the on-screen overlay is displayed atop the view of the patient's teeth. The on-screen overlay can help doctors to move the mobile phone to a desired position such that the overlay approximately matches the patient's teeth in the view of the patient's teeth. Therefore, doctors can be guided to take dental photos by the on-screen

overlay, saving time and effort. In FIG. 2A the teeth are too far from the camera, and do not line up with the overlay; in FIG. 2B the teeth are too close, and do not line up.

[0057] High quality dental images are usually required to submit a dental case or request a case assessment. The overlay on the screen of the mobile phone can increase the quality of dental images by increasing the accuracy of the alignment of the camera lenses with teeth of the patient. The on-screen overlay with the outline of teeth can help doctors to take quality dental photos using the mobile phone.

[0058] Moreover, the dental photos captured by the mobile phone can be uploaded automatically. The method can further comprise uploading the captured dental images automatically. In general, the method described herein can increase the efficiency of the user. Taking dental photos by using the method disclosed herein can be much faster than using digital cameras. The dental images captured by the method can be higher than simply using a default camera application of a mobile phone.

[0059] As shown in FIGS. 2A and 2B, users can approximately match visually on-screen overlay with the teeth of the patient. The camera of the mobile phone has to be positioned at a right distance and a right angle to the teeth in order to capture high quality dental images. The user can refer to the on-screen overlay to guide the movement of the mobile phone camera to set a correct view and distance to the teeth of the patient in the view of the patient's teeth. The overly can help to precisely align the phone camera lens with the teeth of the patient and position the mobile phone at a right distance and a right angle to the teeth of the patient. For example, the mobile phone may have to be placed close enough to the teeth without being too close. Matching the overlay with the teeth of the patient can greatly facilitate the process of alignment. Once the overlay is matching (and the image focused, e.g., using autofocusing), the image of the view of the patient's teeth can be captured.

[0060] The overlay with an outline of teeth in a predetermined view can further provide information such as required visible teeth in the predetermined view. For example, FIG. 2C, illustrates a buccal view overlay which shows what teeth should be visible in the view. In this example, the overlay doesn't represent actual patient teeth, but may be generated from a typical patient or synthesized from a population of patients to form an average or typical overlay

arrangement. In general, an approximate visual match is needed to select the correct distance, correct angle and correct view of the patient's teeth.

[0061] As mentioned, the overlay can be an average (generic) overlay obtained by an artificial model. The average overlay does not need specific information from a patient. For example, the average overlay can be obtained by the artificial model which approximately fits most of patients. Users can be guided to approximately match the average overlay with the teeth of a patient. In some other embodiments, the average overlay can comprise a plurality of overlays with a plurality of sizes and types based a plurality of artificial models, for example, overlays for different age groups, overlays for female and male patients, overlays for patient's having an overbite, under bite, etc. etc. Users can select one of the plurality overlays that best fit the teeth of the patient and be guided to match the selected overlay with the teeth of the patient.

[0062] In some other embodiments, the overlay can be a patient-specific overlay derived from the patient's teeth. In some variations the apparatus (e.g., software/application software) may image the users teeth or may receive data derived from a scan, including digital scan, of the users teeth, and may generate an overlay, such as the outline overlay shown in FIGS. 2A-2C. For example, the patient-specific overlay 301 can be obtained from a specific model of teeth for a specific patient and/or from 3D scan or 3D impressions of the teeth of the patient. This may provide optimal matching for positioning the handheld electronics (e.g., smart phone) when taking the image(s).

[0063] Aligning may be done manually by the user, or automatically. For example, any of the methods and apparatuses described herein may be used to indicate (e.g., by visual and/or audible and/or tactile) image that the teeth are aligned in the frame with the overlay. For example, FIG. 3A illustrates an example of automatic detection of alignment in real-time with a patient's teeth and an overlay. In FIG. 3A the overlay (in a first color, such as red) shows lines that illustrate the outline of teeth in a first desired predetermined view (e.g., frontal), when the patient's teeth are not aligned with the overlay. Once the apparatus (e.g., software/application software) determines that the teeth are in alignment with the overlay, as shown in FIG. 3B, the screen may display an indicator, such as, in FIG. 3B, changing the color of the overlay from the first color to a second color (e.g., green, blue, etc.) and/or automatically taking the image. Note that the method or apparatus may automatically determine alignment between the overlay and the patient's teeth in a variety of ways. For example, the method or apparatus may determine

alignment when a threshold amount/percentage of the edges of the patient's teeth in the image are within a predetermined minimum distance of the overlay. For example, alignment may be indicated when greater than 50%, greater than 60%, greater than 70%, greater than 80%, greater than 90%, etc. of the edges of the teeth are within about 1 mm, about 0.5 mm, about 0.1 mm, about 0.05mm, etc.). The edges of the teeth may be determined by any appropriate technique (e.g., edge detection image processing, etc.).

[0064] As mentioned, in general, the overlay may be generic, categorical (e.g., appropriate for all patients having one or more citatory-related characteristics) or specific to the patient. The overlay can be a treatment-specific overlay. The teeth of a patient can change. For example, the teeth of the patient can change over time including with treatment. The overlay can be modified according to the predicted or actual changes of teeth of the patient with treatment (e.g., sequential alignment treatment), thus matching the teeth of the patient more precisely. The patient specific overlay or treatment specific overlay can give user's real-time insight into the treatment progress.

[0065] During the imaging procedure, users can view the patient's teeth, for example, on the screen of the mobile phone. Users can further display, on the screen, the overlay comprising the outline of teeth in a predetermined view, wherein the overlay is displayed atop the view of the patient's teeth. The overlay can be an average overlay, or a patient specific overlay, or a treatment specific overlay. Users can move the mobile phone relative to the patient's teeth so that the overlay approximately matches the patient's teeth in the view of the patient's teeth. Users can then capture an image of the view of the patient's teeth.

[0066] As mentioned, the method can further comprise estimating the quality of contour matching between the outline of the overlay and the teeth of the patient in order to help take high quality photos. When the patient's teeth are located on expected place and at the right angle, the overlay approximately matches the patient's teeth in the view of the patient's teeth. The method and apparatuses described herein can help prevent accidently confusing view or angle, and may comprise real-time reaction on the image on the screen of the mobile phone. Interactive contour matching estimation can enable capturing high quality dental images. The method can comprise real-time interactively estimating contour matching between the outline of the overlay and the teeth of the patient, for example, by using an indicator. In some embodiments, the methods and

apparatuses can automatically detect matching between the patient's teeth on the screen and the overlay to confirm the position of the teeth.

[0067] Thus, the methods and apparatuses disclosed herein may trigger an indicator when the overlay approximately matches with the patient's teeth. The method or apparatus can automatically capture (or enhance manual capture of) an image of the view of the patient's teeth when the indicator is triggered as shown in FIG. 3B. Users can move the mobile phone relative to the patient's teeth to match the on-screen overlay with the teeth of patient. If the overlay nearly matches the teeth, the indicator can be triggered, which indicates the moment to capture the image, for example, for progress tracking. Alternatively, in some other embodiments, an image of the teeth can be captured automatically by the mobile phone when the indicator is triggered.

[0068] As mentioned, the indicator can be triggered by estimating an indicator of the distance between an edge of the patient's teeth in the view of the patient's teeth and the outline of teeth in the overlay. For another example, the indicator can be triggered by estimating an indicator of the distance between an edge of the patient's teeth at two or more regions and the outline of teeth and comparing that indicator to a threshold value. For yet another example, the indicator can be triggered by estimating an indicator of an average deviation of the outline from a contour of the teeth of the patient. The indicator can be triggered by a variety of ways of estimating a match between the outline of the overlay and the teeth of the patient, not being limited to the examples illustrated herein. In general, in any of the example described herein, images taken may be associated (including marking, labeling, etc.) with an indicator of the predetermined view and/or user identification information and/or date information. For example an image such as shown in 3B may be taken and marked "frontal".

[0069] The indicator can be a visual indicator, such as a color change as illustrated in FIG. 3B. When the users move the mobile phone such that the overlay nearly matches the teeth, the outline of the overlay can change color to green. For example, it may be not perfectly match, but each tooth on the contour may coincide with each real tooth on the screen. When the color of the outline changes from red to green, it is indicating the overlay nearly matches the teeth and it is the moment to capture the image.

[0070] In some variations the apparatus and methods may include providing one or more visual or audible clues to the user in aligning the images. For example, one or more arrows may

be shown on the screen to indicate that the user should move the mobile phone in a particular direction (or by a particular amount) to align the patient's teeth with the overlay.

[0071] For another example, the indicator can be a sound (e.g., tone or voice) which is triggered when the overlay matches the teeth of the patient. For example, the phone can generate a beeping sound and indicate the overlay matches the teeth and it is the moment to capture the image. The method can comprise automatically capturing an image of the patient's teeth when the indicator is triggered and/or permit the user to manually take one or more image.

[0072] Automatically capturing an image of the patient's teeth when the overlay approximately matches with the patient's teeth may be triggered by the apparatus. For example, the shutter of the camera of the mobile phone can be triggered by an internal indicator.

[0073] Generally, the methods and apparatuses described herein are configured to take a series of predetermined specific views of the teeth. Thus, the apparatus may be an application software ("app") that guides a user in taking a sequence of specific images. The specific images may be a set that has particular clinical and/or therapeutic significance, such as frontal/anterior (mouth closed), frontal/anterior (mouth open), left buccal (mouth closed/open), right buccal (mouth closed/open), upper jaw, lower jaw, profile, face, etc.

[0074] FIGS. 4A-4H illustrate 8 specific overlay images for the required types of photos according to the orthodontic standard, including an anterior view in FIG. 4A, an another anterior view in FIG. 4B, an upper jaw view in FIG. 4C, a lower jaw view in FIG. 4D, a left buccal view in FIG. 4E, an another left buccal view in FIG. 4F, a right buccal view in FIG. 4G, and an another right buccal view in FIG. 4H.

[0075] For example, a method to obtain an image of the teeth may include displaying, on the screen, an overlay comprising an outline of teeth in one of an anterior view, a buccal view, an upper jaw view, or a lower jaw view, wherein the overlay is displayed atop the view of the patient's teeth. The method and apparatus may walk the user through taking a complete or partial set of these images. For example, FIG. 5A shows an example of a user interface to enable a user to select one of a plurality of overlays for a plurality of dental images in a plurality of predetermined views, or to show the user what images it will walk them through taking. The predetermined views can include a set of dental images according to known orthodontic standards.

[0076] In FIG. 5A, eight views (including three external/head or facial views) are included as part of the predetermined set. The apparatus may walk the user through taking each of these, and may allow the user to select which image to take (e.g., in any order) or may require a predetermined order be used. In addition, as shown in FIG. 5B, the apparatus may provide positioning or other guidance to the user in taking the images. FIG. 5B is an example of on-screen message to guide a user to take dental images with a retractor. The image may be a pop-up message/reminder, which may be optionally disabled, e.g., for experienced users.

[0077] FIG. 5C is an example of a user interface of the apparatus assisting a user in taking a profile image of a patient. In FIG. 5D the user interface shows an overlay of a facial image (head in profile) of a generic patient.

[0078] The method can include display on a user interface a plurality of overlays for each of a plurality of dental images in a plurality of predetermined views. As mentioned above, the user can select one of the overlays. For example, there can be three different facial images and 8 different dental images as shown in FIG. 5A. For each required views of the dental images, there can be an open position image and a closed position image.

[0079] The method can further allow the users to take more images of their choice. For example, the method can have a user interface to allow a user to input an angle and a distance of his or her choice, thus giving the user freedom to capture custom images. In some embodiments, the method can further enable the user to take several photos in motion to restore 3D structure of the teeth.

[0080] Any of these methods and apparatuses may further include reviewing the captured image on the mobile phone to confirm image quality and/or automatically accept/reject the image(s). For example, a method or apparatus may be configured to check the image quality of the captured image and displaying on the screen if the image quality is below a threshold for image quality. FIG. 6A is an example of a user interface that indicates the captured image is out of focus after reviewing the image quality. FIG. 6B is an example of a poor quality image of the teeth. In some other embodiments, the method can comprise automatically filtering out images of bad quality such as blurred, wrong angle of view, etc. For example, when the image is too dark or some of all of the teeth are blocked, as shown in FIG. 6B, the image can be excluded and the user required to take an alternative image.

[0081] The method can comprise evaluating the image quality and warning doctors if the image might be rejected. For example, if the image is too dark, or blurry, or out of focus, a warn message is shown on the screen to warn the doctors to retake the photo. The quality of the image can be evaluated and reviewed by a variety of methods. For example, the method can comprise evaluating the focus status of the image. For another example, the method can comprise analyzing the image using a library. For yet another example, the method can comprise analyzing the brightness of the image. In some embodiments, the method can further comprise using image recognition algorithms to ensure that all required teeth are visible.

[0082] FIG. 7A shows an example overlay comprising a cropping frame and an outline of teeth in an upper jaw view. FIG. 7B shows another example overlay comprising a cropping frame and an outline of teeth in anterior view. In some embodiments, the method can further comprise displaying, on the screen, an overlay comprising a cropping frame and an outline of teeth in one of an anterior view, a buccal view an upper jaw view, or a lower jaw view, wherein the overlay is displayed atop the view of the patient's teeth. The method can further comprise automatically cropping the captured image as indicated by the cropping frame.

[0083] Often doctors have to wait one or more days to crop and edit the dental images before uploading the images, the method described herein can further comprise displaying the overlay with the cropping frame and the outline of teeth in the predetermined view, and automatically cropping the captured image. FIG. 7A illustrate a cropping frame 72 in the upper jaw view of teeth. FIG. 7B illustrate another cropping frame 74 in the anterior view of teeth. By matching the overlay, the method can automatically crop the image to get the correct view of the teeth. Once the photo is taken, the doctors can still re-crop and edit later.

[0084] FIG. 8 is an example of a block diagram of a method to obtain an image of teeth of a patient. Doctors will get quick feedback of treatment progress. As shown in FIG. 8, the method can comprise using patient ID for authorization in step 801. For example, the method can comprise imaging a patient's identification using a mobile phone. The method can further comprise automatically populating a form with user identification information based on the imaged identification. The method can comprise viewing, on a screen of the mobile phone, the patient's teeth as shown in step 803. The method can comprise displaying, on the screen, an overlay comprising a cropping frame and an outline of teeth in one of: an anterior view, a buccal view an upper jaw view, or a lower jaw view, wherein the overlay is displayed atop the view of the

patient's teeth as shown in step 805. The method can further comprise enabling the user to choose treatment stage. For example, a user interface can show the user treatment stage and a plurality overlays for a plurality of predetermined photo views (for example, anterior, left buccal, right buccal, occlusal maxillary, occlusal mandibular). The user can select one of the plurality overlays to capture the corresponding dental images. For each predetermined view, the overlay with an outline is shown on the screen of the mobile phone. The method can further comprise moving the mobile phone so that the overlay approximately matches the patient's teeth in the view of the patient's teeth as shown in step 806. For example, the method can further comprise displaying instructions about positioning the patient's teeth on the screen of the mobile phone prior to displaying the overlay.

[0085] In some embodiments, the method can further comprise triggering an indicator when the overlay approximately matches with the patient's teeth as in (optional) step 807. For example, if the overlay is not matched, it will be displayed using red color. If the overlay matches the teeth, the color of the outline changes to green. The method can further comprise capturing an image of the view of the patient's teeth as shown in step 808. Steps 803 to step 808 can be performed for each predetermined photo view. The user may take several photos for each view for more accurate treatment progress estimation. The method can further comprise repeating the steps of viewing, displaying, moving and capturing to capture anterior, buccal, upper jaw and lower jaw images of the patient's teeth.

[0086] The method can further comprise evaluating the captured image for medical treatment by using the image as in step 809 and transmitting the captured image to a remote server as in step 810. The captured dental images can be transferred to server part for performing more precise estimation of treatment progress. For example, the captured dental images can be used for case evaluation before starting aligner treatment to evaluate if the patient is a candidate for the treatment. The captured dental images can also be used to set up case property when doctors start the treatment, for example, the captured images can be used to fills prescription forms. The captured dental images can further enable doctors to track treatment process and give them real time clue or feedback of treatment process.

[0087] FIG. 9 is an example of a set of facial and dental images of a patient captured by using a digital SLR camera. FIG. 10 is an example of a set of facial and dental images of a patient captured by using a mobile phone through the method disclosed herein. FIGS. 11A-11H

are examples of a set of dental images captured by using the mobile phone through the method disclosed herein. As shown in FIGS. 9-11H, the method disclosed herein can enable the users to capture high quality dental images in a plurality of predetermined views to meet the orthodontic standards.

[0088] Various embodiments of the disclosure further disclose a non-transitory, computer-readable storage medium storing a set of instructions capable of being executed by a processor of a mobile phone, that, when executed by the processor, causes the processor to display real-time images of the patient's teeth on a screen of the mobile phone, display an overlay comprising an outline of teeth in a predetermined view atop the images of the patient's teeth, and enable capturing of an image of the patient's teeth. For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to display a generic overlay. For another example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to display a patient-specific overlay derived from the patient's teeth.

[0089] For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to automatically trigger an indicator when the overlay approximately matches with the patient's teeth. For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to estimate an indicator of the distance between an edge of the patient's teeth in the view of the patient's teeth and to trigger the indicator when the outline of teeth in the overlay is less than or equal to a threshold value. For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to estimate an indicator of the distance between an edge of the patient's teeth at two or more regions in the view of the patient's teeth and to trigger the indicator when the outline of teeth in the overlay is less than or equal to a threshold value. For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to trigger the indicator by displaying a visual indicator on the screen.

[0090] In general, various embodiments of the disclosure further disclose a non-transitory, computer-readable storage medium storing a set of instructions capable of being executed by a

processor of a mobile phone, that, when executed by the processor, causes the processor to display real-time images of the patient's teeth on a screen of the mobile phone and display an overlay comprising a cropping frame and an outline of teeth in one of an anterior view, a buccal view an upper jaw view, or a lower jaw view, wherein the overlay is displayed atop the images of the patient's teeth, and enable capturing of an image of the patient's teeth. The non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to review the captured image and indicate on the screen if the captured image is out of focus and automatically crop the captured image as indicated by the cropping frame.

[0091] For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to check the image quality of the captured image and displaying on the screen if the image quality is below a threshold for image quality. For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to automatically crop the captured image based on a cropping outline displayed as part of the overlay. For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to transmit the captured image to a remote server.

[0092] For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to display an overlay comprising an outline of teeth in a predetermined view such as an anterior view, a buccal view an upper jaw view, or a lower jaw view. For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to repeat the steps of viewing, displaying, moving and capturing to capture anterior, buccal, upper jaw and lower jaw images of the patient's teeth. For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can further cause the processor to capture an image of a patient's identification using the mobile phone and automatically populate a form with user identification information based on the imaged identification. For example, the non-transitory, computer-readable storage medium, wherein the set of instructions, when executed by the processor, can

further cause the processor to display instructions on positioning the patient's teeth on the screen of the mobile phone prior to displaying the overlay.

[0093] The systems, devices, and methods of the preferred embodiments and variations thereof can be embodied and/or implemented at least in part as a machine configured to receive a computer-readable medium storing computer-readable instructions. The instructions are preferably executed by computer-executable components preferably integrated with the system including the computing device configured with software. The computer-readable medium can be stored on any suitable computer-readable media such as RAMs, ROMs, flash memory, EEPROMs, optical devices (e.g., CD or DVD), hard drives, floppy drives, or any suitable device. The computer-executable component is preferably a general or application-specific processor, but any suitable dedicated hardware or hardware/firmware combination can alternatively or additionally execute the instructions.

Examples

[0094] In one example, described herein is a photo uploading mobile app (control software) that may be installed on a mobile device such as a smartphone and may control the smartphone camera to take dental images of a patient in a particular manner. The particular manner may include a specific sequence of photos, as well as controlling the image quality and/or imaging characteristics in order to more accurately plan or track a therapeutic treatment, e.g., of a series of dental aligners.

[0095] For example, the application ("app") may be configured to require login (username, password) in order to use. Alternative logins (e.g., fingerprint, passcode, etc.) may be used to login. Once logged in, the app may present a list of patients and/or may allow patients to be added. The user may select or add a patient, e.g., from a selectable list that is displayed. Adding a patient may include entering identifying information about the patient (e.g., first name, last name, date of birth, location such as country, city, state, zip code, etc., and gender. Thereafter, the app may guide the doctor or clinician in taking a predetermined series of images, such as those shown in FIG. 5A, and described above.

[0096] For existing patients, the app may allow the user to view photos that were already taken and/or begin taking new photos. Thus, any of the apparatuses (including apps) described herein may allow the user to take the requested series of images (which may depend on the patient identity, treatment plan, etc.) and may include taking additional images (e.g. 3 or more, 4

or more, 5 or more, 6 or more, 7 or more, 8 or more, 9 or more, 10 or more, 11 or more, 12 or more, etc.). For each patient, photos may be taken at different times, showing the progression of treatment. For example, a series of photographs (such as those shown in FIG. 5A) may be taken prior to treatment, and one or more times during treatment, and/or post-treatment. Additional photos may be taken at any of these times as well. When the user is taking photographs in the series, the app may guide the user in taking patient photos from the predetermined series, and may display on the screen one or more outlines (including outlines of a typical set of teeth, head/face, etc., as described above). The app may also guide the user in applying assistance devices, such as a retractor and/or dental mirror. Once the image is taken, the app may be pre-cropped and/or cropped manually by the user. The app may also examine the content of the image to confirm focus, subject matter (angle, etc.) illumination, etc. The app may prompt the user to re-take and/or save the image(s).

[0097] Images/photos taken may be uploaded by the apparatus into a remote server or site, and stored for later retrieval by the physician and/or transmission to a third party along with patient and/or physician identifying information, and/or information about when they were taken. The physicians may approve or review the images using the app, or using another computer accessing the remote site. Images may be individually uploaded, or they may be uploaded as a composite of multiple separate images.

[0098] A physician may also comment and/or append comments, on the images or to accompany the images. In any of these apparatuses, the app may also provide access to patient case management software including modeling and 3D images/rendering of the patient's teeth.

[0099] The app may also include instructions (e.g., a frequently asked questions portion, a tutorial, etc.).

[0100] In some variations, the physician may mark or otherwise signify that a particular patient or case be processed by a remote server, e.g., for clinical assessment, and/or to prepare a series of aligners. As mentioned above, the app may be used on any mobile device having or communicating with a camera, such as a smartphone, smartwatch, pad, etc.

[0101] When a feature or element is herein referred to as being "on" another feature or element, it can be directly on the other feature or element or intervening features and/or elements may also be present. In contrast, when a feature or element is referred to as being "directly on" another feature or element, there are no intervening features or elements present. It will also be

understood that, when a feature or element is referred to as being "connected", "attached" or "coupled" to another feature or element, it can be directly connected, attached or coupled to the other feature or element or intervening features or elements may be present. In contrast, when a feature or element is referred to as being "directly connected", "directly attached" or "directly coupled" to another feature or element, there are no intervening features or elements present. Although described or shown with respect to one embodiment, the features and elements so described or shown can apply to other embodiments. It will also be appreciated by those of skill in the art that references to a structure or feature that is disposed "adjacent" another feature may have portions that overlap or underlie the adjacent feature.

[0102] Terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. For example, as used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups thereof. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items and may be abbreviated as "/".

[0103] Spatially relative terms, such as "under", "below", "lower", "over", "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if a device in the figures is inverted, elements described as "under" or "beneath" other elements or features would then be oriented "over" the other elements or features. Thus, the exemplary term "under" can encompass both an orientation of over and under. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly. Similarly, the terms "upwardly", "downwardly", "vertical", "horizontal" and the like are used herein for the purpose of explanation only unless specifically indicated otherwise.

[0104] Although the terms "first" and "second" may be used herein to describe various features/elements (including steps), these features/elements should not be limited by these terms,

unless the context indicates otherwise. These terms may be used to distinguish one feature/element from another feature/element. Thus, a first feature/element discussed below could be termed a second feature/element, and similarly, a second feature/element discussed below could be termed a first feature/element without departing from the teachings of the present invention.

[0105] As used herein in the specification and claims, including as used in the examples and unless otherwise expressly specified, all numbers may be read as if prefaced by the word "about" or "approximately," even if the term does not expressly appear. The phrase "about" or "approximately" may be used when describing magnitude and/or position to indicate that the value and/or position described is within a reasonable expected range of values and/or positions. For example, a numeric value may have a value that is +/- 0.1% of the stated value (or range of values), +/- 1% of the stated value (or range of values), +/- 2% of the stated value (or range of values), +/- 5% of the stated value (or range of values), +/- 10% of the stated value (or range of values), etc. Any numerical range recited herein is intended to include all sub-ranges subsumed therein.

[0106] Although various illustrative embodiments are described above, any of a number of changes may be made to various embodiments without departing from the scope of the invention as described by the claims. For example, the order in which various described method steps are performed may often be changed in alternative embodiments, and in other alternative embodiments one or more method steps may be skipped altogether. Optional features of various device and system embodiments may be included in some embodiments and not in others. Therefore, the foregoing description is provided primarily for exemplary purposes and should not be interpreted to limit the scope of the invention as it is set forth in the claims.

[0107] The examples and illustrations included herein show, by way of illustration and not of limitation, specific embodiments in which the subject matter may be practiced. As mentioned, other embodiments may be utilized and derived there from, such that structural and logical substitutions and changes may be made without departing from the scope of this disclosure. Such embodiments of the inventive subject matter may be referred to herein individually or collectively by the term "invention" merely for convenience and without intending to voluntarily limit the scope of this application to any single invention or inventive concept, if more than one is, in fact, disclosed. Thus, although specific embodiments have been illustrated and described

herein, any arrangement calculated to achieve the same purpose may be substituted for the specific embodiments shown. This disclosure is intended to cover any and all adaptations or variations of various embodiments. Combinations of the above embodiments, and other embodiments not specifically described herein, will be apparent to those of skill in the art upon reviewing the above description.

CLAIMS

What is claimed is:

1. A method to obtain an image of a patient's teeth, the method comprising:
   viewing, on a screen of a mobile phone, the patient's teeth;
   displaying, on the screen, an overlay comprising an outline of teeth in a predetermined view, wherein the overlay is displayed atop the view of the patient's teeth;
   moving the mobile phone so that the overlay approximately matches the patient's teeth in the view of the patient's teeth; and
   capturing an image of the view of the patient's teeth.

2. A method to obtain an image of a patient's teeth, the method comprising:
   viewing, on a screen of a mobile phone, the patient's teeth;
   displaying, on the screen, an overlay comprising an outline of teeth in a predetermined view, wherein the overlay is displayed atop the view of the patient's teeth;
   moving the mobile phone relative to the patient's teeth and **triggering an indicator** when the overlay approximately matches with the patient's teeth; and
   capturing an image of the view of the patient's teeth when the indicator is triggered.

3. A method to obtain an image of a patient's teeth, the method comprising:
   viewing, on a screen of a mobile phone, the patient's teeth;
   displaying, on the screen, an overlay comprising a cropping frame and an outline of teeth in one of: an anterior view, a buccal view an upper jaw view, or a lower jaw view, wherein the overlay is displayed atop the view of the patient's teeth;
   moving the mobile phone so that the overlay approximately matches the patient's teeth in the view of the patient's teeth;
   capturing an image of the view of the patient's teeth;
   reviewing the captured image on the mobile phone and indicating on the screen of the mobile phone if the captured image is out of focus; and
   automatically cropping the captured image as indicated by the cropping frame.

4. The method in claim 1, 2 or 3, wherein the overlay comprises a generic overlay.

5. The method in claim 1, 2 or 3, wherein the overlay comprises a patient-specific overlay derived from the patient's teeth.

6. The method of claim 1 or 3, further comprising: automatically triggering an indicator when the overlay approximately matches with the patient's teeth.

7. The method of claim 1 or 2, wherein the predetermined view comprises: an anterior view, a buccal view an upper jaw view, or a lower jaw view.

8. The method of claim 1 or 3, further comprising: automatically capturing an image of the patient's teeth when the overlay approximately matches with the patient's teeth.

9. The method in claim 2, wherein triggering the indicator when the overlay approximately matches with the patient's teeth comprises estimating an indicator of the distance between an edge of the patient's teeth in the view of the patient's teeth and the outline of teeth in the overlay.

10. The method in claim 2, wherein triggering the indicator when the overlay approximately matches with the patient's teeth comprises estimating an indicator of the distance between an edge of the patient's teeth at two or more regions and the outline of teeth and comparing that indicator to a threshold value.

11. The method in claim 2, wherein the indicator is a visual indicator.

12. The method in claim 1 or 2, further comprising checking the image quality of the captured image and displaying on the screen if the image quality is below a threshold for image quality.

13. The method in claim 1 or 2, further comprising cropping the captured image based on a cropping outline displayed as part of the overlay.

14. The method in claim 1, 2 or 3, further comprising evaluating the captured image for medical treatment by using the image.

15. The method in claim 1, 2 or 3, further comprising transmitting the captured image to a remote server.

16. The method in claim 1, 2 or 3, further comprising repeating the steps of viewing, displaying, moving and capturing to capture anterior, buccal, upper jaw and lower jaw images of the patient's teeth.

17. The method of claim 1, 2 or 3, further comprising imaging a patient's identification using the mobile phone and automatically populating a form with user identification information based on the imaged identification.

18. The method of claim 1, 2 or 3, further comprising displaying instructions about positioning the patient's teeth on the screen of the mobile phone prior to displaying the overlay.

19. A non-transitory, computer-readable storage medium storing a set of instructions capable of being executed by a processor of a mobile phone, that, when executed by the processor, causes the processor to:

    display real-time images of the patient's teeth on a screen of the mobile phone;

    display an overlay comprising an outline of teeth in a predetermined view atop the images of the patient's teeth; and

    enable capturing of an image of the patient's teeth.

20. A non-transitory, computer-readable storage medium storing a set of instructions capable of being executed by a processor of a mobile phone, that, when executed by the processor, causes the processor to:

    display real-time images of the patient's teeth on a screen of the mobile phone;

    display an overlay comprising an outline of teeth in a predetermined view atop the images of the patient's teeth;

    trigger an indicator when the overlay approximately matches with the patient's teeth; and

    enable capturing of an image of the patient's teeth when the indicator is triggered.

21. A non-transitory, computer-readable storage medium storing a set of instructions capable of being executed by a processor of a mobile phone, that, when executed by the processor, causes the processor to:

    display real-time images of the patient's teeth on a screen of the mobile phone;

    display an overlay comprising a cropping frame and an outline of teeth in one of: an anterior view, a buccal view an upper jaw view, or a lower jaw view, wherein the overlay is displayed atop the images of the patient's teeth;

    enable capturing of an image of the patient's teeth;

    review the captured image and indicate on the screen if the captured image is out of focus; and

    automatically crop the captured image as indicated by the cropping frame.

22. The non-transitory, computer-readable storage medium of claim 19, 20 or 21, wherein the set of instructions, when executed by the processor, causes the processor to display a generic overlay.

23. The non-transitory, computer-readable storage medium of claim 19, 20 or 21, wherein the set of instructions, when executed by the processor, causes the processor to display a patient-specific overlay derived from the patient's teeth.

24. The non-transitory, computer-readable storage medium of claim 19, 20 or 21, wherein the set of instructions, when executed by the processor, causes the processor to automatically trigger an indicator when the overlay approximately matches with the patient's teeth.

25. The non-transitory, computer-readable storage medium of claim 19 or 20, wherein the set of instructions, when executed by the processor, causes the processor to display an overlay comprising an outline of teeth in a predetermined view comprising: an anterior view, a buccal view an upper jaw view, or a lower jaw view.

26. The non-transitory, computer-readable storage medium of claim 19 or 21, wherein the set of instructions, when executed by the processor, causes the processor to automatically capture an image of the patient's teeth when the overlay approximately matches with the patient's teeth.

27. The non-transitory, computer-readable storage medium of claim 20, wherein the set of instructions, when executed by the processor, causes the processor to estimate an indicator of the distance between an edge of the patient's teeth in the view of the patient's teeth and to trigger the indicator when the outline of teeth in the overlay is less than or equal to a threshold value.

28. The non-transitory, computer-readable storage medium of claim 20, wherein the set of instructions, when executed by the processor, causes the processor to estimate an indicator of the distance between an edge of the patient's teeth at two or more regions in the view of the patient's teeth and to trigger the indicator when the outline of teeth in the overlay is less than or equal to a threshold value

29. The non-transitory, computer-readable storage medium of claim 20, wherein the set of instructions, when executed by the processor, causes the processor to trigger the indicator by displaying a visual indicator on the screen.

30. The non-transitory, computer-readable storage medium of claim 19 or 20, wherein the set of instructions, when executed by the processor, causes the processor to check the image quality of the captured image and displaying on the screen if the image quality is below a threshold for image quality.

31. The non-transitory, computer-readable storage medium of claim 19 or 20, wherein the set of instructions, when executed by the processor, causes the processor to automatically crop the captured image based on a cropping outline displayed as part of the overlay.

32. The non-transitory, computer-readable storage medium of claim 19, 20 or 21, wherein the set of instructions, when executed by the processor, causes the processor to transmit the captured image to a remote server.

33. The non-transitory, computer-readable storage medium of claim 19, 20 or 21, wherein the set of instructions, when executed by the processor, causes the processor to repeat the steps of viewing, displaying, moving and capturing to capture anterior, buccal, upper jaw and lower jaw images of the patient's teeth.

34. The non-transitory, computer-readable storage medium of claim 19, 20 or 21, wherein the set of instructions, when executed by the processor, causes the processor to capture an image of a patient's identification using the mobile phone and automatically populate a form with user identification information based on the imaged identification.

35. The non-transitory, computer-readable storage medium of claim 19, 20 or 21, wherein the set of instructions, when executed by the processor, causes the processor to display instructions on positioning the patient's teeth on the screen of the mobile phone prior to displaying the overlay.

METHODS AND APPARATUSES FOR CAPTURING DENTAL IMAGES

ABSTRACT

Described herein are methods and apparatuses to obtain an image of a patient's teeth for therapeutic use. The method can comprise viewing the patient's teeth, displaying an overlay comprising an outline of teeth in a predetermined view. The method can comprise moving the mobile phone so that the overlay approximately matches the patient's teeth in the view of the patient's teeth. The method can further comprise capturing an image of the view of the patient's teeth. Various embodiments of the disclosure further disclose a non-transitory, computer-readable storage medium storing a set of instructions capable of being executed by a processor of a mobile phone, that, when executed by the processor, causes the processor to display an overlay comprising an outline of teeth in a predetermined view atop the images of the patient's teeth, and enable capturing of an image of the patient's teeth.

FIG. 1A

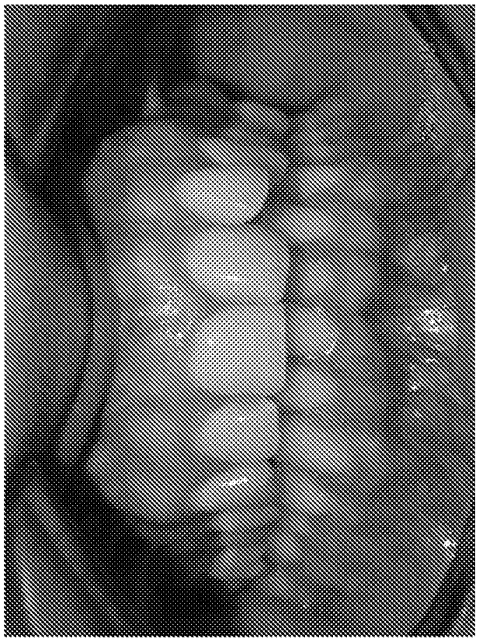


FIG. 1B

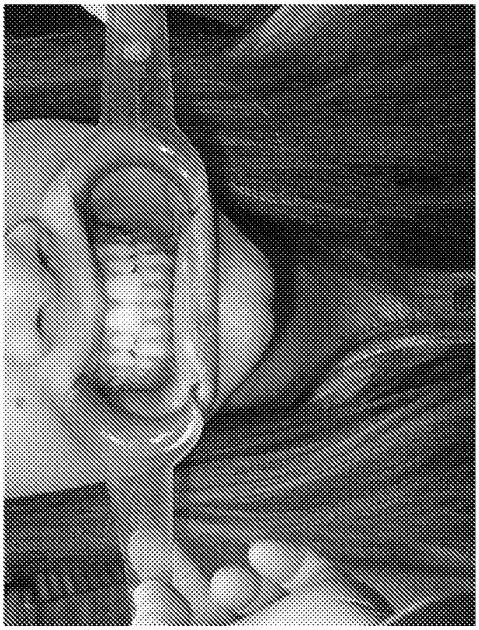


FIG. 1C

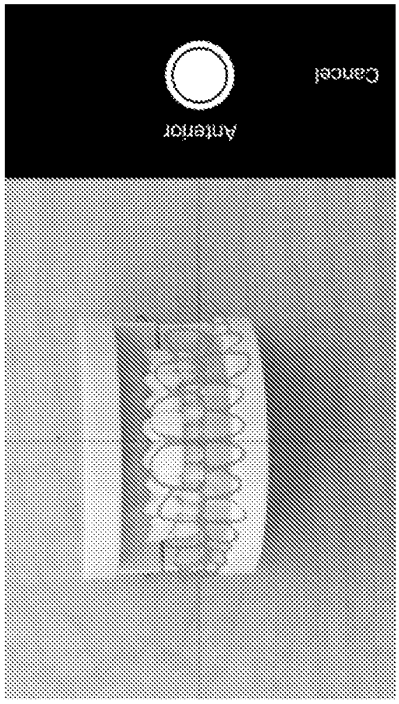


FIG. 2A

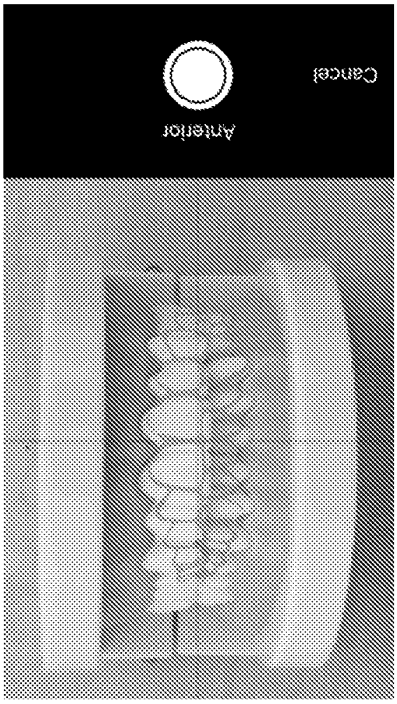


FIG. 2B

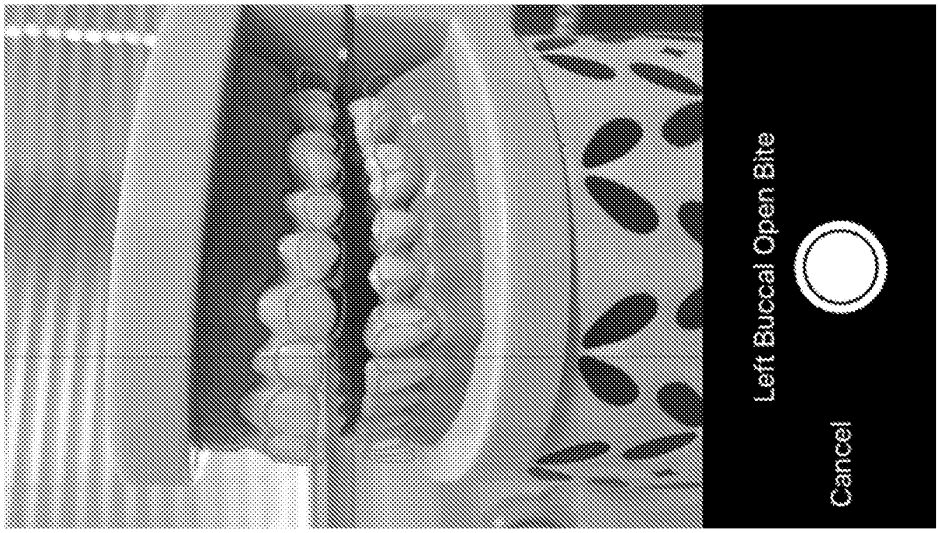


FIG. 2C

FIG. 3A

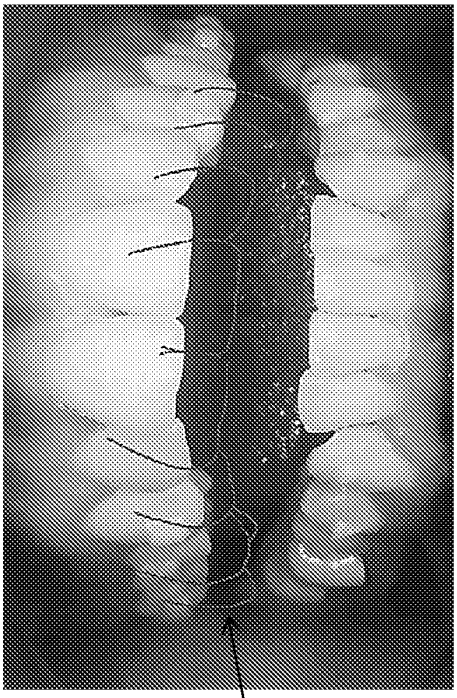
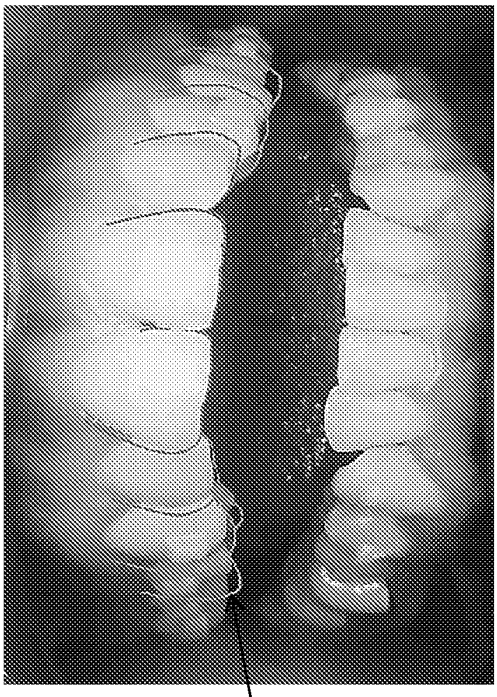


FIG. 3B



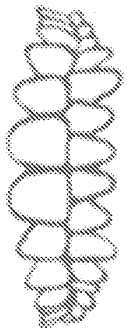


FIG. 4A

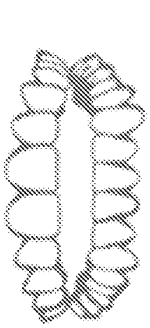


FIG. 4B

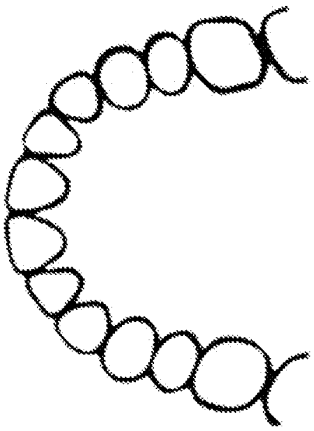


FIG. 4C

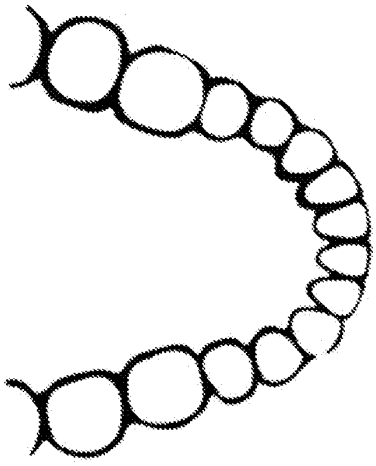


FIG. 4D

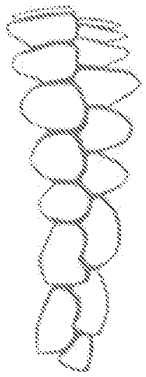


FIG. 4E

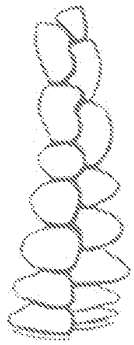


FIG. 4G

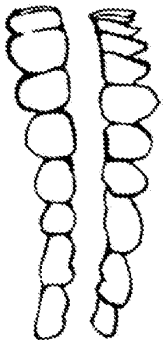


FIG. 4F

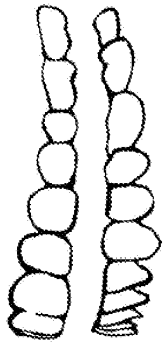


FIG. 4H

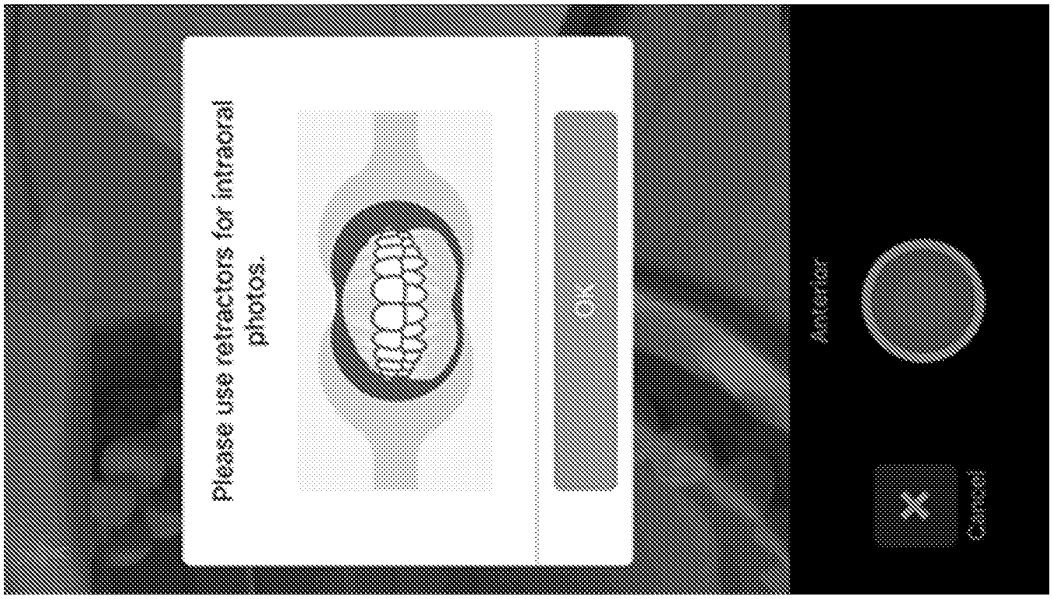
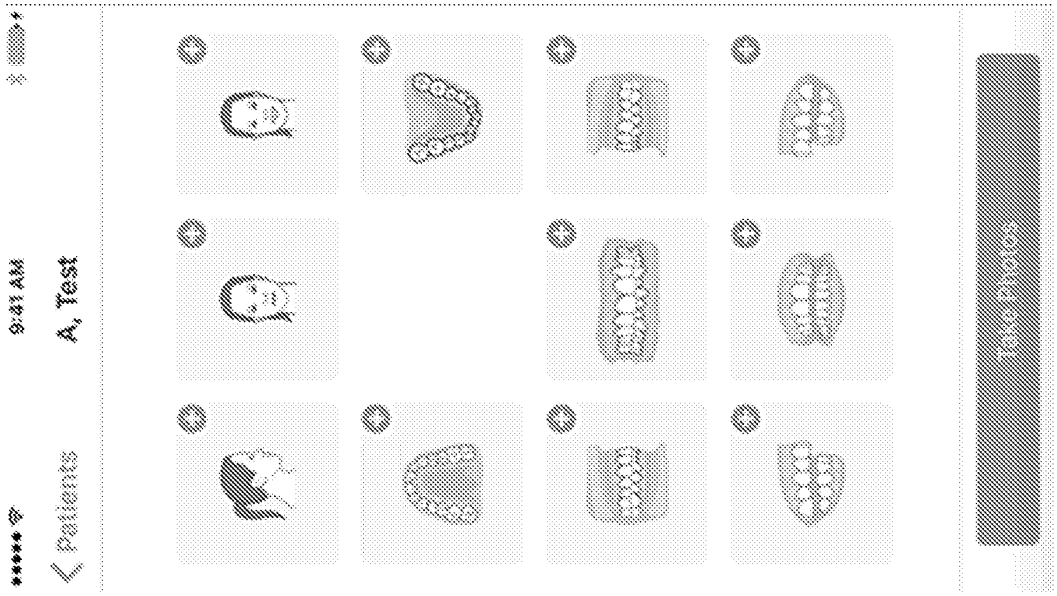

Please use retractors for intraoral photos.
Anterior
Cancel

FIG. 5B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Patients
A, Test
Take Photos

FIG. 5A

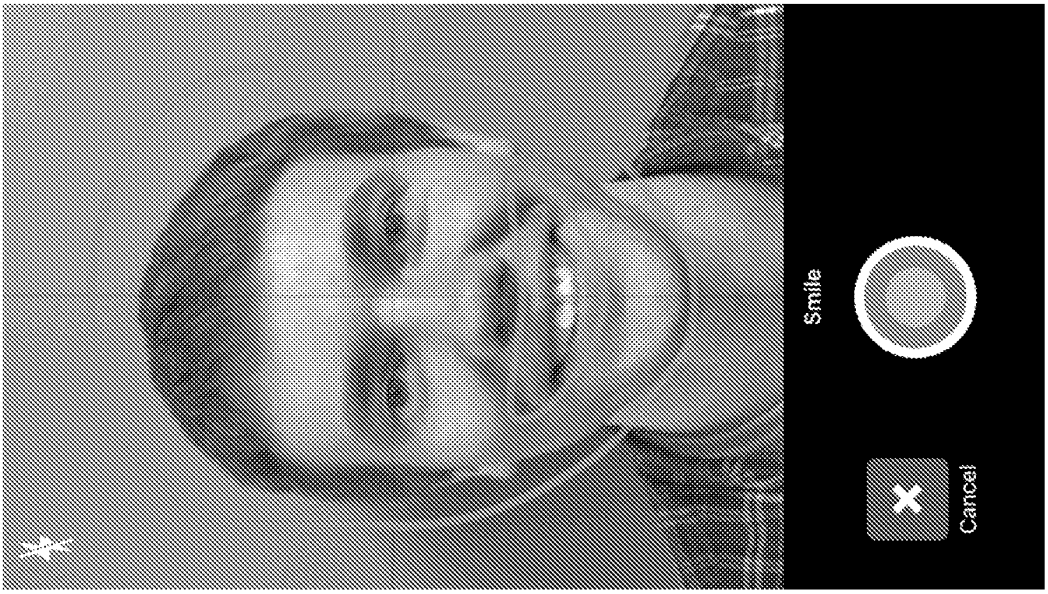


FIG. 5D

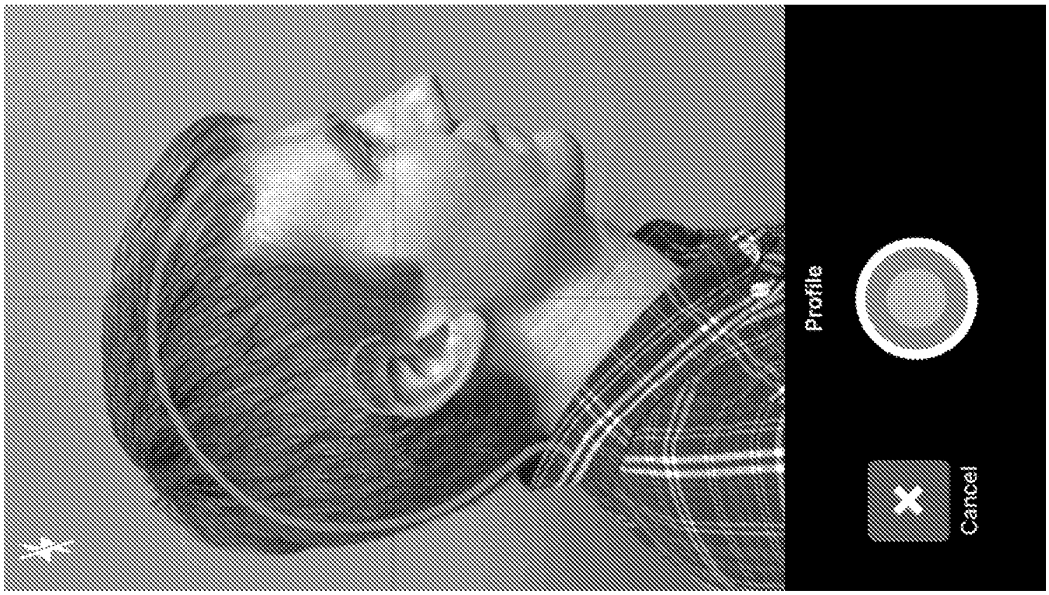
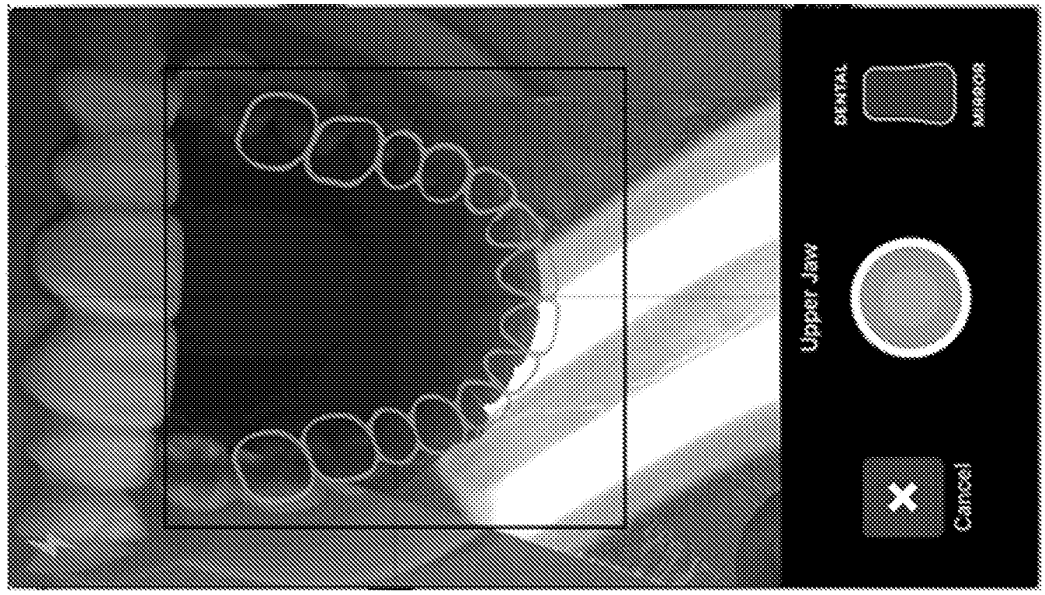


FIG. 5C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Upper Jaw
DENTAL
MIRROR

FIG. 6B

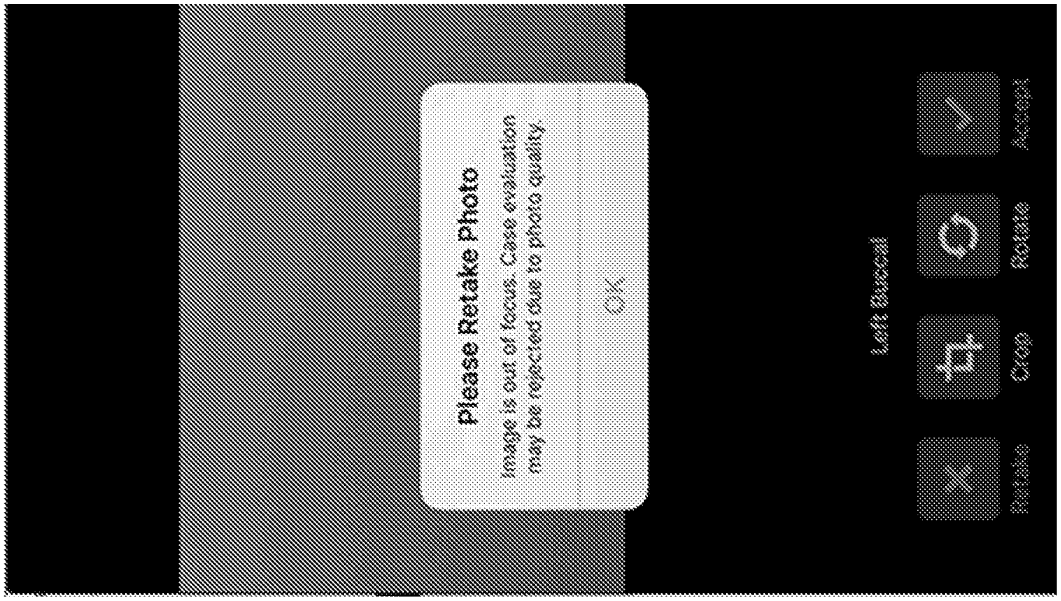
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Image is out of focus. Case evaluation may be rejected due to photo quality
OK
Retake
Crop
Rotate
Accept
Left Buccal

FIG. 6A

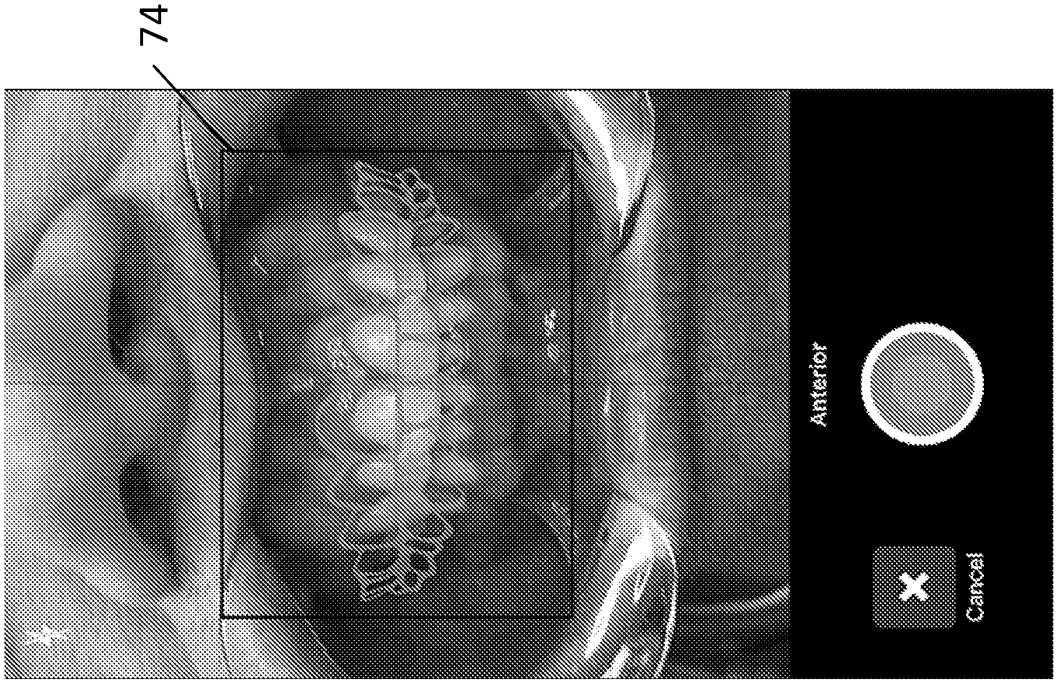

FIG. 7B

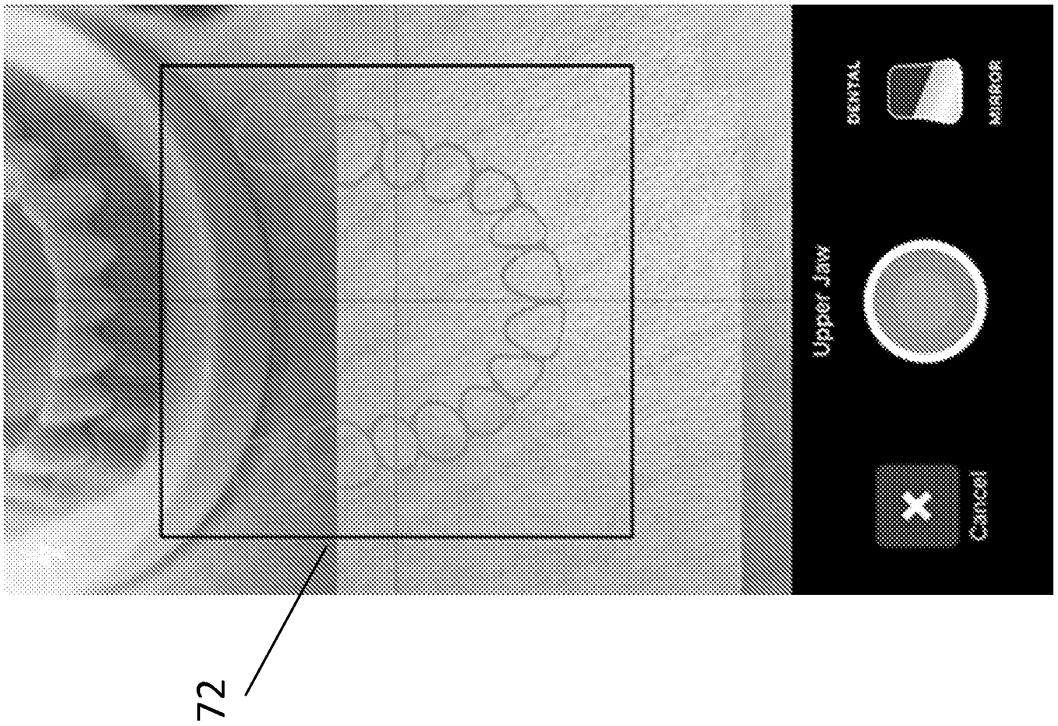

FIG. 7A

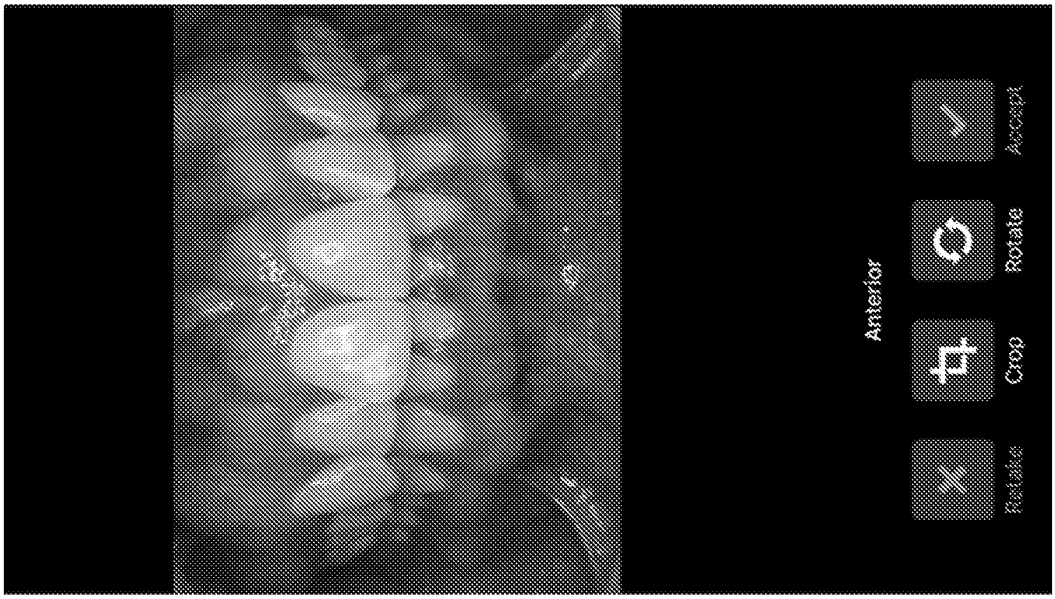

FIG. 7C

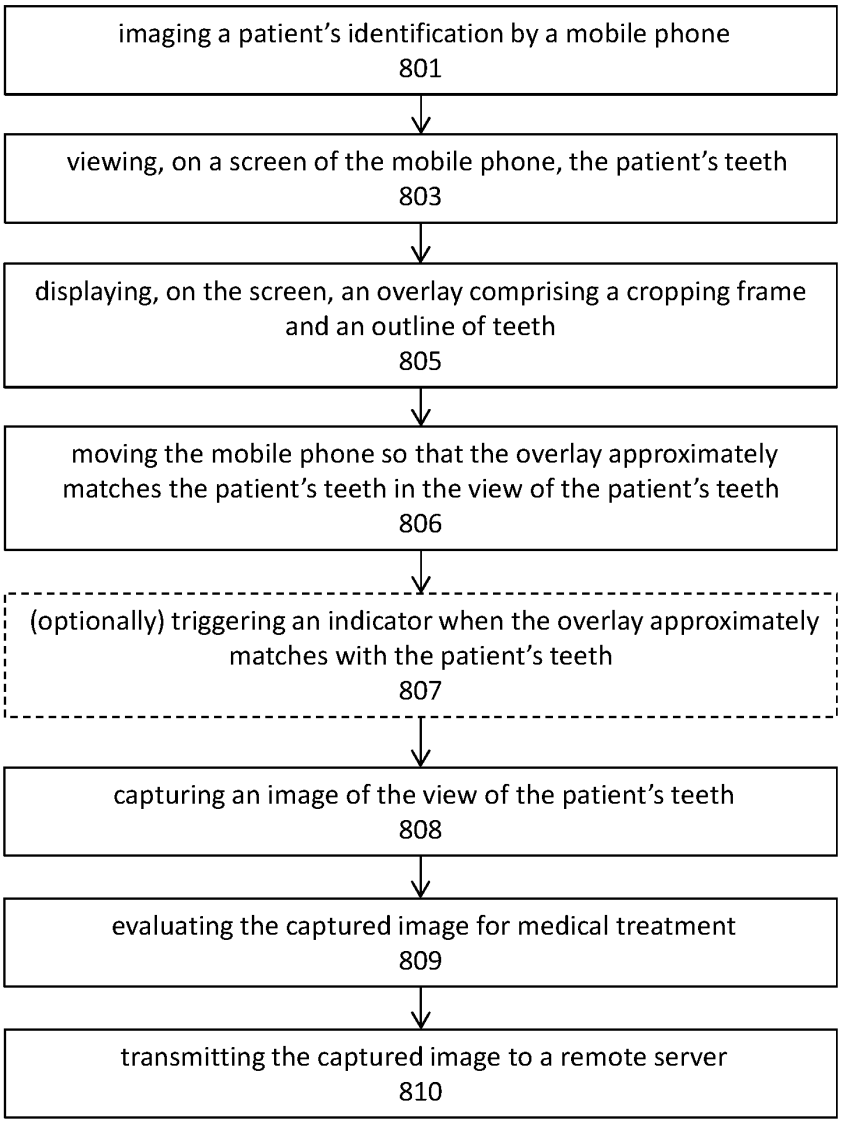
imaging a patient's identification by a mobile phone
801
viewing, on a screen of the mobile phone, the patient's teeth
803
displaying, on the screen, an overlay comprising a cropping frame and an outline of teeth
805
moving the mobile phone so that the overlay approximately matches the patient's teeth in the view of the patient's teeth
806
(optionally) triggering an indicator when the overlay approximately matches with the patient's teeth
807
capturing an image of the view of the patient's teeth
808
evaluating the captured image for medical treatment
809
transmitting the captured image to a remote server
810

FIG. 8

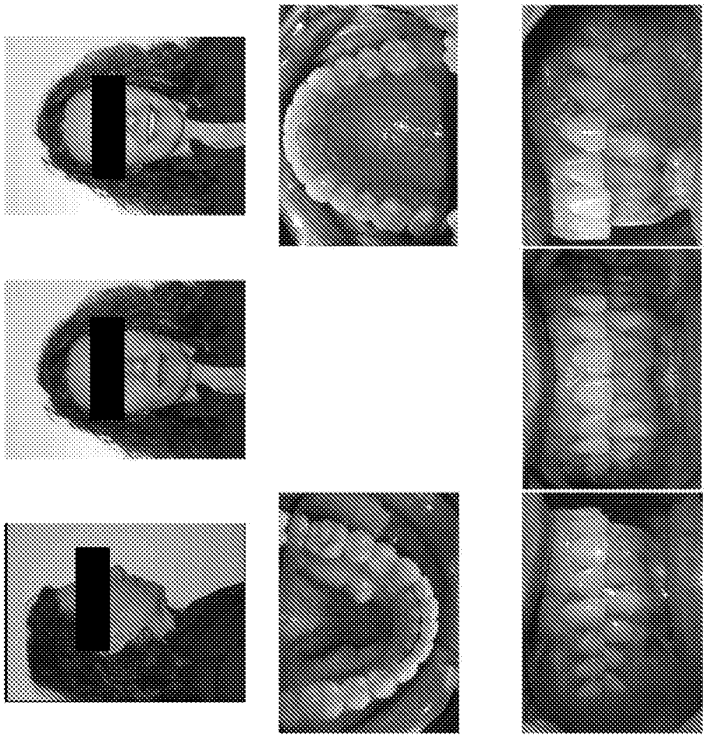

FIG. 10

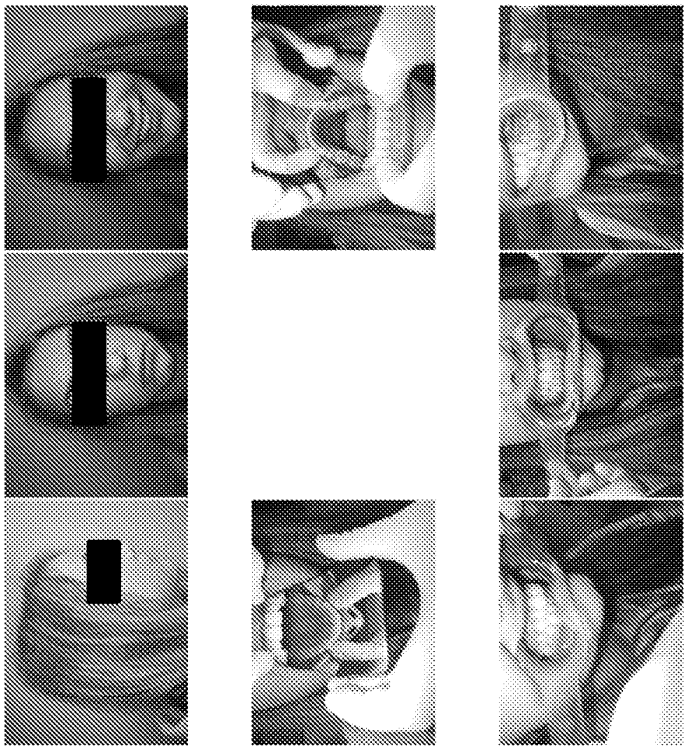

FIG. 9

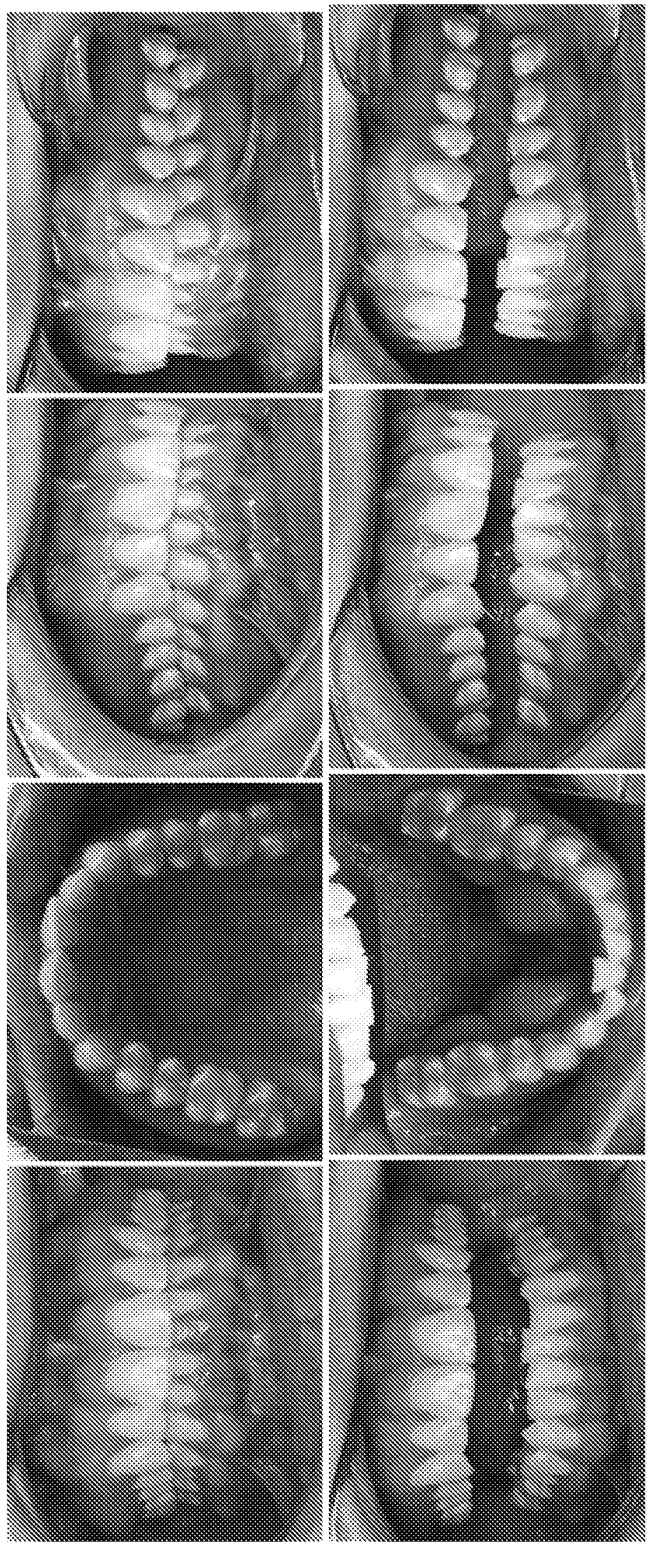

FIG. 11A FIG. 11B FIG. 11C FIG. 11D FIG. 11E FIG. 11F FIG. 11G FIG. 11H

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHODS AND APPARATUSES FOR DENTAL IMAGES
First Named Inventor/Applicant Name:	Maurice CARRIER
Filer:	Richard Douglas Shoop/Mary Buggie
Attorney Docket Number:	14187-701.100

Filed as Large Entity

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Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
PROVISIONAL APPLICATION FILING	1005	1	260	260
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**260**

Electronic Acknowledgement Receipt	
EFS ID:	27427721
Application Number:	62417985
International Application Number:	
Confirmation Number:	1060
Title of Invention:	METHODS AND APPARATUSES FOR DENTAL IMAGES
First Named Inventor/Applicant Name:	Maurice CARRIER
Customer Number:	141884
Filer:	Richard Douglas Shoop/Mary Buggie
Filer Authorized By:	Richard Douglas Shoop
Attorney Docket Number:	14187-701.100
Receipt Date:	04-NOV-2016
Filing Date:	
Time Stamp:	19:12:21
Application Type:	Provisional

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Payment was successfully received in RAM	$260
RAM confirmation Number	110716INTEFSW00015869504050
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1	Provisional Cover Sheet (SB16)	14187-701-100_Provisional_Cover_Sheet.pdf	1477553 8a127cc645e00e0da96b7b6f37e93da536d7a990	no	4
Warnings:					
Information:					
2		14187-701-100_Application.pdf	1836895 bd26d56e759d64eec178febb03ec74866ea75dc5	yes	32

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	25
Claims	26	31
Abstract	32	32

Warnings:					
Information:					
3	Drawings-other than black and white line drawings	14187-701-100_Drawings.pdf	7292701 6e7e87007ebc78e50e6dce1901775aec263eb07e	no	12
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4	Fee Worksheet (SB06)	fee-info.pdf	29915 c879267a0f7585fdc9df9993b4bf09956d7831a2	no	2
Warnings:					
Information:					
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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
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