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APPLICATION NUMBER: ***16/001,049***
FILING DATE: ***June 06, 2018***
PATENT NUMBER: ***11109945***
ISSUE DATE: ***September 07, 2021***

UNITED STATES PATENT AND TRADEMARK OFFICE · DEPARTMENT OF COMMERCE

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Philippe SALAH et al.

Filing Date : Herewith

Title : METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

Customer No. : 108676
Docket No : N&P-51411

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Preliminary Amendment

Sir:

Prior to examination please amend the above identified application as follows:

Amendments to the Abstract begin on page 2 of this paper.

Amendments to the Claims are reflected in the listing of claims that begins on page 3 of this paper.

Remarks / Arguments begin on page 6 of this paper.

IN THE ABSTRACT

Please replace the Abstract with the enclosed new Abstract enclosed herewith on a separate page.

Listing of Claims:

The listing of claims will replace all prior versions, and listings, of claims in this application:

CLAIMS:

1. (Original) A method for evaluating the shape of an orthodontic aligner worn by a patient, said method comprising the following steps:
   1) acquisition of at least one two-dimensional image of teeth of said patient, referred to as "updated image", under actual acquisition conditions;
      at least one updated image referred to as "aligner image", at least partially representing the aligner in a service position in which it is worn by said teeth; and
      at least one updated image referred to as "dentition image", identical to or different from the aligner image, representing said teeth,
   2) if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions used during the acquisition of the aligner image in step 1);
   3) determination, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively;
   4) comparison of the interior and exterior tooth outlines, followed by determination of at least one score according to said comparison.

2. (Original) The method as claimed in claim 1, comprising, after step 4), the following step:
   5) comparison of the score against an acceptability threshold and the emission of information according to the result of the comparison.

3. (Original) The method as claimed in claim 1, in which the dentition and aligner images are different, the method comprising the following steps:

(a) prior to step 1), the creation of a digital three-dimensional model of at least part of a dental arch bearing said teeth, or "initial reference model" and, for each tooth of the initial reference model, definition of a digital three-dimensional reference model of said tooth, or "tooth model";

(b) modification of the initial reference model by moving the tooth models until a final reference model compatible with the dentition image is obtained;

(c) search for a two-dimensional view of the final reference model that is compatible with the aligner image;

(d) conversion of the dentition image into said view.

4. (Currently Amended) The method as claimed in ~~claims~~ claim 1, in which the dentition and aligner images are the same image.

5. (Original) The method as claimed in claim 1, in which step 4) comprises the following steps:

for each of a plurality of teeth for which the interior and exterior tooth outlines have been determined;

i) determination of a distance between the interior and exterior tooth outlines;

ii) determination of a distance threshold, preferably using the distances determined in the immediately preceding step;

iii) for each of said teeth, determination of a distance score dependent on

- the distance between the interior and exterior teeth outlines, and
- the distance threshold.

6. (Original) The method as claimed in claim 1, in which the distances are measured in pixels.

7. (Original) The method as claimed in claim 5, in which, in step ii), the distance threshold is dependent on the smallest of the distances determined in step i).

8. (Original) The method as claimed in claim 1, in which step 4) comprises the following steps:

i') for each pair of an adjacent left-hand tooth and of an adjacent right-hand tooth in at least a triplet of adjacent first, second and third teeth, for each of which interior and exterior tooth outlines have been determined, the first and third teeth being adjacent to the second tooth,

determination of an offset between the interior teeth outline of said left-hand tooth and the interior teeth outline of said right-hand tooth, referred to as "interior offset", and determination of an offset between the exterior teeth outline of said left-hand tooth and the exterior teeth outline of said right-hand tooth, referred to as the "exterior offset",

then

determination of the difference between the interior offset and the exterior offset, known as the "offset difference";

ii') determination of an offset-difference threshold, preferably using the offset differences determined in step i');

iii') the determination, for each tooth of said triplet, of at least one offset score, dependent on the offset difference with an adjacent tooth, and on the offset-difference threshold.

9. (Original) The method as claimed in claim 8, in which the interior and exterior offsets are measured in pixels.

10. (Original) The method as claimed in claim 9, in which, in step iii'), the offset-difference threshold is dependent on the smallest of the offset differences determined in step ii').

REMARKS/ARGUMENTS

If there are any fees resulting from this communication, please charge same to our Deposit Account No. 505088, our Order No. N&P-51411.

Respectfully submitted,
Cooper Legal Group

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June 6, 2018

Abstract

A method for evaluating the shape of an orthodontic aligner worn by a patient. Acquisition of at least one two-dimensional image of teeth of the patient as "updated image." At least one updated image as "aligner image," at least partially representing the aligner in a service position. At least one updated image as "dentition image," representing the teeth. If the dentition image is different from the aligner image, conversion of the dentition image so that it represents the teeth as seen under the acquisition conditions used during the acquisition of the aligner image. Determination, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of the tooth on the dentition and aligner images. Comparison of the interior and exterior tooth outlines, followed by determination of at least one score according to the comparison.

METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

Technical Field

The present invention relates to a method of evaluating the shape of a tray-like orthodontic appliance known as an "aligner", worn by a patient, particularly so as to evaluate how well the shape of the orthodontic aligner conforms to the positioning of the teeth of said patient. The invention also relates to a method for adapting a treatment using orthodontic aligners. The invention finally relates to a computer program for implementing these methods.

Prior Art

Conventionally, at the start of orthodontic treatment, the orthodontist determines the positioning of the teeth, referred to as the "set-up", that he wishes to obtain at the end of the treatment. The set-up may be defined by means of an impression or from a three-dimensional scan of the teeth of the patient. The orthodontist then accordingly manufactures an orthodontic appliance suited to this treatment.

The orthodontic appliance may be a tray-like device known as an aligner. An aligner conventionally comes in the form of a removable monobloc appliance, conventionally made of a transparent polymer, which comprises a tray shaped in such a way that several teeth of a dental arch, generally all the teeth of an arch, can be housed therein.

The shape of the aligner is tailored to hold the aligner in position on the teeth while at the same time applying an action towards correcting the positioning of certain teeth.

The shapes that the various aligners at various stages in the treatment need to adopt are conventionally determined at the start of the treatment, then all of the corresponding aligners are manufactured. At predetermined moments, the patient changes aligner.

Treatment using aligners is advantageously less of a burden on the patient. In particular, the number of orthodontist appointments is limited. Furthermore, the pain is less than with a metal orthodontic arch wire attached to the teeth.

The market for orthodontic aligners is therefore growing.

At regular intervals, the patient visits the orthodontist for a visual inspection, notably to check whether the movement of the teeth meets expectations and whether the aligner being worn by the patient is still suitable for the treatment.

If the orthodontist diagnoses that the treatment is inappropriate, he takes a new impression of the teeth, or as is equivalent, a new three-dimensional scan of the teeth, then orders a new series of aligners configured accordingly. It is reckoned that, on average, the number of aligners ultimately manufactured is around 45, rather than the 20 aligners conventionally intended at the start of the treatment.

The need to travel to the orthodontist's is a burden on the patient. The patient's confidence in his orthodontist may also be undermined. The unsuitability may be inesthetic. Finally, this results in additional expense.

The number of orthodontist check-ups needs therefore to be limited.

There is a need for solutions that remedy these problems.

One object of the invention is to provide an at least partial response to this need.

Summary of the invention

The invention provides a method for evaluating the shape of an orthodontic aligner worn by a patient, said method comprising the following steps:

1) acquisition of at least one two-dimensional image of the teeth of said patient, referred to as "updated image", under actual acquisition conditions;
   at least one updated image referred to as "aligner image", at least partially representing the aligner in a service position in which it is worn by said teeth; and
   at least one updated image referred to as "dentition image", identical to or different from the aligner image, representing said teeth,
2) if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth (represented on the dentition image) as seen under the acquisition conditions used during the acquisition of the aligner image in step 1);
3) determination, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively;
4) comparison of the interior and exterior tooth outlines, followed by determination of at least one score according to said comparison.

As will be seen in greater detail in what follows of the description, a method according to the invention makes it considerably easier to evaluate the suitability of the aligner for the

treatment, while at the same time making this evaluation particularly reliable. In particular, the method can be implemented using simple photographs or films, taken without special precaution, for example by the patient. The number of orthodontist appointments can therefore be limited.

For preference, an evaluation method according to the invention also has one or more of the following optional features:

- the method comprises, after step 4), the following step:

  5) comparison of the score against an acceptability threshold and the emission of information according to the result of the comparison;

- the dentition and aligner images are different and the method comprises the following steps:

  (a) prior to step 1) for preference at the start of the treatment or before the start of the treatment, the creation of a digital three-dimensional model of at least part of a dental arch bearing said teeth, or "initial reference model" and, for each tooth of the initial reference model, definition of a digital three-dimensional reference model of said tooth, or "tooth model";

  (b) modification of the initial reference model by moving the tooth models until a final reference model compatible with the dentition image is obtained;

  (c) search for a two-dimensional view of the final reference model that is compatible with the aligner image;

  (d) conversion of the dentition image into said view;

- alternatively, said dentition and aligner images are one and the same image;

- step 4) comprises the following steps:

  for each of a plurality of teeth for which the interior and exterior tooth outlines have been determined;

  i) determination of a distance between the interior and exterior tooth outlines;

  ii) determination of a distance threshold, preferably using the distances determined in step i);

  iii) for each of said teeth, determination of a distance score dependent on

  - the distance between the interior and exterior tooth outlines, and
  - the distance threshold;

- said distances are measured in pixels;

- in step ii), the distance threshold is dependent on the smallest of the distances determined in step i);
- alternatively, step 4) comprises the following steps:

i') for each pair of an adjacent left-hand tooth and of an adjacent right-hand tooth in at least one triplet of adjacent first, second and third teeth, for each of which interior and exterior tooth outlines have been determined, the first and third teeth being adjacent to the second tooth,

determination of an offset between the interior teeth outline of said left-hand tooth and the interior teeth outline of said right-hand tooth, referred to as "interior offset", and determination of an offset between the exterior teeth outline of said left-hand tooth and the exterior teeth outline of said right-hand tooth, referred to as "exterior offset",

then

determination of the difference between the interior offset and the exterior offset, known as the "offset difference";

ii') determination of an offset-difference threshold, preferably using the offset differences determined in step i');

iii') determination, for at least one, preferably for each, tooth of said triplet, of at least one offset score, dependent on the offset difference with an adjacent tooth, and on the offset-difference threshold;

- the interior and exterior offsets are measured in pixels;
- in step iii'), the offset-difference threshold is dependent on the smallest of the offset differences determined in step i').

The invention also relates to a method of adapting an orthodontic treatment, in which method an evaluation method according to the invention is implemented and then, according to the result of said evaluation, a new aligner is manufactured.

The invention also relates to:

- a computer program and, in particular, a specialist application for a mobile telephone, comprising program code instructions for executing one or more, preferably all, of steps 1) to 4), preferably 1) to 5), when said program is run by a computer,
- a computer medium on which such a program is recorded, for example a memory or a CD-ROM; and

- a personal device, in particular a mobile phone or a tablet, on which such a program is loaded.

The invention also relates to a system comprising:

- a three-dimensional scanner able to implement step (a) described hereinbelow, and
- a personal device, preferably a mobile telephone, loaded with a program according to the invention.

Definitions

A "dentition" is understood to mean a set of teeth.

A "patient" is understood to mean any person for whom a method according to the invention is implemented, whether this person is sick or not.

The "acquisition conditions" specify the position and orientation in space of an image acquisition apparatus relative to the patient's teeth (actual acquisition conditions) or to a three-dimensional model of the teeth of the patient (virtual acquisition conditions), and preferably the calibration of this image acquisition apparatus, and notably the values of aperture, exposure time, focal length and sensitivity. Acquisition conditions are said to be "virtual", or "theoretical", when they correspond to a simulation in which the acquisition apparatus would be under said acquisition conditions (theoretical positioning and preferably virtual calibration of the acquisition apparatus).

A 3-D scanner is an apparatus that makes it possible to obtain a three-dimensional representation of an object.

What is meant by an "image" is a two-dimensional image such as a photograph. An image is made up of pixels.

A three-dimensional digital model of a set of teeth of a patient is "compatible" with an image when there is a view of this model that corresponds to said image, that is to say such that the elements of said model, for example the outlines of the tooth models, are positioned, relative to one another, like the actual elements that they are modeling, for example the outlines of said teeth, on said image. Thus, a final reference model is compatible with a dentition image if a view of the final reference model allows for the outlines of the tooth models to be viewed in such a way as to make them superposable on the outlines of said teeth on said dentition image.

Said view may be observed by a virtual image acquisition device, under virtual acquisition conditions that may also be qualified as being "compatible" with the image.

When a three-dimensional digital model is compatible with an image, the positioning of the tooth models in this model is also qualified as being "compatible" with the image.

The "service position" is the position in which the aligner is worn by the patient.

The terms "comprise", "include" or "have" should be interpreted broadly and without limitation, unless specified otherwise.

Brief description of the figures

Additional features and advantages of the invention will become further apparent upon reading the following detailed description and from studying the attached drawing, in which:

- figures 1 and 2 depict an orthodontic aligner;
- figure 3 depicts an updated image of a dental arch bearing an orthodontic aligner like that of figures 1 and 2;
- figure 4 depicts the dentition outline defined from the image of figure 3;
- figure 5 depicts the aligner outlines defined from the image of figure 3 and capable of being used according to the invention;
- figure 6 depicts the aligner outline defined from the image of figure 3 and used in figures 7 and 8 for comparing against a dentition outline;
- figures 7 and 8 depict the dentition and aligner outlines of figures 4 and 6 as depicted on the updated image of figure 3;
- figure 9 schematically depicts a method according to the invention;
- figure 10 schematically depicts step 2) of a method according to the invention.

Detailed description

As depicted in figure 1, an aligner 10 extends in such a way as to follow the successive teeth D of the dental arch to which it is fitted. It defines a tray in the overall shape of a "U".

The interior surface of the aligner is referred to as the "tray" 12. The shape of the tray is determined to fix the aligner on the teeth, but also according to a target positioning desired for the teeth. More specifically, the shape is determined in such a way that, when the

aligner is in its service position, it applies forces that tend to move the treated teeth toward their target positioning.

A "tooth outline" is understood to mean a line displaying the shape of a free end 22 of a tooth on an image.

Of course, such a line may delimit the free end of this tooth. The tooth outline is then qualified as an "interior tooth outline" 14. A "dentition outline" 16 is made up of the set of interior tooth outlines of a set of teeth (figure 4).

Such a line may also delimit part of the aligner. The tooth outline is then qualified as an "exterior tooth outline" 18. In particular, the bottom 20 of the tray has a shape that substantially compliments that of the free ends 22 of the teeth. As a result, in an image depicting the bottom of the tray, the tray-bottom outline defines a set of exterior tooth outlines 18.

The aligner material that separates the exterior surface 24 of the aligner and the tray 12 defines the thickness of the orthodontic aligner. This thickness may be seen in figure 5. Conventionally, the aligner has a substantially constant thickness. The exterior surface 24 of the aligner, which extends facing the bottom 20 of the tray, is therefore also substantially the same shape as the bottom of the tray. As a result, in an image, the outline of the exterior surface 24 of the aligner also defines a set of exterior tooth outlines 18.

An "aligner outline" 28 is made up of a set of exterior tooth outlines 18. It may therefore be defined by the bottom 20 of the tray or by the exterior surface 24 of the aligner.

When a tooth is positioned in the tray in such a way that its free end 22 is in contact with the bottom of the tray, its interior tooth outline substantially coincides with the corresponding exterior tooth outline if the exterior tooth outline 18 is defined by the bottom 20 of the tray, or is offset and substantially parallel to the corresponding exterior tooth outline if the exterior tooth outline is defined by the exterior surface 24 of the aligner.

For preference, the exterior tooth outlines used to define the aligner outline 28 are defined by the exterior surface 24 of the aligner, which is more visible.

The method of the invention is aimed at detecting situations in which the free end 22 of a tooth is no longer in contact with the bottom of the tray, and at measuring the amplitude of this separation (figure 9).

In step 1), at least one image of the teeth, referred to as "updated image" is taken, using an image acquisition apparatus.

For preference, at least one reminder informing the patient of the need to create an updated image is sent to the patient. This reminder may come on paper, or, for preference, comes in electronic form, for example in the form of an email, of an automatic alert on a specialist mobile application, or of an SMS. Such a reminder may be sent by the patient's orthodontist practice or laboratory or by his dentist or by his specialist mobile application, for example.

Step 1) is performed at the instant that the evaluation of the shape of an aligner is desired, for example over 4 weeks after the start of the treatment using the aligner.

The image acquisition apparatus is preferably a mobile phone, a "connected" camera, a smartwatch, a tablet or a desktop or laptop personal computer, including an image acquisition system, such as a webcam or a camera.

The acquisition is preferably performed by the patient or someone close to the patient, but may be performed by any other individual, notably a dentist or orthodontist, preferably without imposing a requirement for the image acquisition apparatus to be positioned accurately with respect to the teeth.

For preference, the updated image is a photograph or an image extracted from a film. It is preferably in color, preferably true color.

According to the invention, the shape of the aligner is evaluated by comparing an outline of this aligner, in its service position, with an outline of the teeth wearing it.

In step 1), it is therefore necessary to acquire enough updated images to be able to make this comparison, namely at least one image of the aligner in its service position, or "aligner image", and at least one image of teeth bearing this aligner in the service position, or "dentition image".

In one embodiment, the dentition image is the aligner image. In other words, the same updated image makes it possible not only to see the aligner outline 28 but also to see the dentition outline 16, through the aligner (figure 3). This single image therefore makes it possible to compare aligner and dentition outlines. Advantageously, readjustment step 2), described later, is not needed.

In another embodiment, the dentition image is an image of the teeth in the absence of the orthodontic aligner, referred to as the "bare dentition image". This embodiment is needed if the dentition outline 16 is not clearly visible, through the aligner, on the aligner image.

The operator then takes a first image of the aligner in the service position and, at another moment, having removed the aligner, takes a second image of teeth that wear the part of the aligner depicted in the first image, namely the bare dentition image.

Because the updated images are preferably taken without any special precautions, the bare dentition image is not normally acquired under the same acquisition conditions as the aligner image. In particular, the positions in space of the acquisition apparatus with respect to the teeth and/or the adjustment thereof ("the calibration" of the acquisition apparatus), for example the amount of zoom, may differ when acquiring these two images. The aligner and dentition outlines defined from the bare dentition and aligner images respectively, are therefore not normally immediately comparable. Step 2) is intended to make these outlines comparable by redefining the dentition image.

In a particularly preferred embodiment, **step 2)** (figure 10) comprises the steps (a) to (d):

Step (a) is prior to step 1).

It is preferably performed at the start of the orthodontic treatment or before the start of the treatment. It may also be performed at the start of the treatment or before the start of the treatment using the aligner.

Step (a) consists in creating a digital three-dimensional model of a dental arch bearing the teeth treated, or "initial reference model".

The initial reference model is, for example, of the .stl or .Obj, .DXF 3D, IGES, STEP, VDA, or scattergram type. Advantageously, such a model, referred to as a "3-D" model, can be viewed from any angle.

The initial reference model can be prepared from measurements taken from the teeth of the patient or from a physical model of his teeth, for example a plaster cast.

The initial reference model is preferably created by means of a professional device, for example by means of a 3-D scanner, preferably operated by a healthcare professional, for example by an orthodontist, or an orthodontistry laboratory. In an orthodontist practice, the patient or the physical model of his teeth may advantageously be arranged in a precise position and the professional apparatus may be perfected. This results in a highly accurate initial reference model. The initial reference model preferably provides information regarding the positioning of the teeth with an error of less than 5/10 mm, preferably less than 3/10 mm, preferably less than 1/10 mm.

In the initial reference model, a part which corresponds to a tooth is referred to as a "tooth model". The tooth models may be defined as described, for example, in international application PCT/EP2015/074896.

Step (b) comprises modifying the initial reference model, by moving the tooth models, until a positioning of the tooth models that is compatible with the dentition image is obtained.

For preference, step (b) is performed fewer than 4 weeks, fewer than 2 weeks, less than one week, preferably more or less immediately after the acquisition of the dentition image.

It preferably consists in an iterative process in which, upon each iteration, one or more tooth models are moved, then optimum conditions for acquiring the initial model thus modified (referred to as the "reference model to be tested") are determined, the optimum conditions being defined as the conditions allowing the reference model to be tested to be observed in such a way that the view of said model is as close as possible to the dentition image.

Steps c) to e) described in PCT/EP2015/074896 are preferably implemented:

c) analysis of the dentition image (updated image in PCT/EP2015/074896) and creation of an updated map relating to discriminating information;

d) optionally, determination, for the dentition image, of rough virtual acquisition conditions approximating the actual acquisition conditions of said dentition image;

e) the search, using the updated map, for a final reference model corresponding to the positioning of the teeth at the time of the acquisition of the dentition image, the search preferably being carried out by means of a metaheuristic, preferably evolutionary method, preferably by simulated annealing.

All the features of steps c) to e) described in PCT/EP2015/074896 are applicable.

According to step c), the dentition image is analyzed so as to create an updated map relating to at least one item of discriminating information.

"Discriminating information" is characteristic information that can be extracted from an image (*"image feature"*), conventionally through the computer processing of this image.

Discriminating information may exhibit a variable number of values. For example, outline information may be equal to 1 or 0 according to whether or not a pixel belongs to an

outline. Brightness information may adopt a great many values. Image processing makes it possible to extract and quantify the discriminating information.

The updated map represents discriminating information in the frame of reference of the dentition image. The discriminating information is preferably chosen from the group consisting of outline information, color information, density information, distance information, brightness information, saturation information, information regarding reflections and combinations of this information.

In optional step d), the actual acquisition conditions for the dentition image acquired in step 1), namely the position and orientation in space of the acquisition apparatus with respect to the teeth and the calibration thereof are evaluated, roughly. Step d) advantageously makes it possible to limit the number of tests on virtual acquisition conditions during step e) and therefore allows step e) to be speeded up considerably.

Use is preferably made of one or more heuristic rules. For example, for preference, conditions that correspond to a position of the image acquisition apparatus behind the teeth or at a distance greater than 1 m away from the teeth, are excluded from the virtual acquisition conditions that can be tested for in step e). In a preferred embodiment, use is made of markers marked on the dentition image in order to determine a substantially conical region of the space that delimits the virtual acquisition conditions that can be tested for in step e), or "test cone".

The objective of step e) is to modify the initial reference model until a final reference model is obtained that corresponds to the dentition image. Ideally, the final reference model is therefore a digital three-dimensional reference model from which the dentition image could have been taken had this model been real.

A succession of reference models "to be tested" is therefore tested, the choice of a reference model to be tested being dependent preferably on the level of correspondence between the previously tested reference models "to be tested" and the dentition image. This choice is preferably made by following a known optimization method, particularly chosen from meta-heuristic optimization methods, preferably evolutionary methods, particularly from simulated annealing methods.

For preference, step e) comprises the following steps:

e1) definition of a reference model to be tested as being the initial reference model, then

e2) following the subsequent steps, testing virtual acquisition conditions with the reference model to be tested in order to achieve a fine approximation of said actual acquisition conditions;

e21) determining virtual acquisition conditions to be tested;

e22) creation of a two-dimensional reference image of the reference model to be tested under said virtual acquisition conditions to be tested;

e23) processing of the reference image to create at least a reference map at least partially representing said discriminating information;

e24) comparison of the updated and reference maps so as to determine a value for a first evaluation function, said value for the first evaluation function being dependent on the differences between said updated and reference maps and corresponding to a decision as to whether to continue or stop the search for virtual acquisition conditions approximating said actual dentition-image acquisition conditions with greater precision than said virtual acquisition conditions to be tested as determined the last time step e21) was run;

e25) if said value for the first evaluation function corresponds to a decision to continue said search, modification of the virtual acquisition conditions to be tested, then resumption from step e22);

e3) determination of a value for a second evaluation function, said value for the second evaluation function being dependent on the differences between the dentition and reference maps under the virtual acquisition conditions best approximating said actual acquisition conditions and resulting from the last running of step e2), said value for the second evaluation function corresponding to a decision to continue or stop the search for a reference model approximating the positioning of the teeth at the time of the acquisition of the dentition image with greater precision than said reference model to be tested that was used the last time step e2) was run, and if said value for the second evaluation function corresponds to a decision to continue said search, modification of the reference model to be tested by moving one or more tooth models, followed by resumption from step e2).

Steps e1) to e3) are described in detail in PCT/EP2015/074896, or WO2016066651.

The final reference model obtained at the end of step e) is a three-dimensional model resulting from successive modifications to the very precise initial reference model.

Advantageously, it is thus itself very precise, even though it has been obtained from simple photographs taken without any special precautions.

Step (c), is a search for a view of the final reference model that corresponds to the aligner image. Specifically, the aligner image has been acquired under actual acquisition conditions in which the teeth were insufficiently visible. The purpose of step (c) is to determine a view of the final reference model that is compatible with the aligner image, namely a view representing the teeth as they would have been represented on the aligner image had they been sufficiently visible.

In particular, this search leads to a virtual movement of a virtual image acquisition apparatus around the final reference model until a "readjusted" position compatible with the aligner image is found, namely a position in which teeth or parts of teeth can be observed as they would have been represented on the aligner image had the aligner been transparent.

For preference, the search for the view of the final reference model that best corresponds to the aligner image is performed by iteration, preferably by means of a heuristic method, more preferably still by means of one of the methods described hereinafter. These methods advantageously make it possible to guide the virtual movement of the virtual image acquisition apparatus around the final reference model in order to speed up the determination of said readjusted position.

In order to readjust the virtual image acquisition apparatus, it is necessary to identify, in the aligner image, markings of which the position in the final reference model is known. Such markings may generally be identified. Failing that, it is necessary to acquire a new aligner image and to repeat the search for such markings.

The markings preferably belong to teeth that are known to be immobile, for example because they are not being treated (if such teeth are visible on the aligner image) or to parts of the aligner in contact with such teeth, which are therefore likewise immobile. The immobile teeth can be easily identified during step (c), because these are teeth the tooth model of which has not been moved during step (b).

The readjustment entails the use of at least three non-aligned points as markers.

The final reference model is then observed under various virtual acquisition conditions until a view of the final reference model is obtained that is compatible with the aligner image, which means to say in which the markers have identical relative positions. The virtual image acquisition apparatus is then in the readjusted position.

In step (d), the dentition image is replaced with the final view of the reference model observed in the readjusted position, namely under the virtual acquisition conditions determined in step (c).

Indeed the final reference model represents, in three dimensions, the teeth in their positioning at the instant at which the dentition image was acquired, in step 1). Moreover, the virtual acquisition conditions determined in step (c) are substantially identical to the actual acquisition conditions at the instant at which the aligner image was taken in step 1). By observing the final reference model under the virtual acquisition conditions determined in step (c), the teeth are therefore observed at the moment at which the dentition image was taken, under the image acquisition conditions of the aligner image. The view of the final reference model under these virtual acquisition conditions is therefore comparable with the aligner image and therefore replaces the dentition image acquired in step 1). For the sake of clarity, this view is also referred to as "dentition image", which means to say that the view is converted into the dentition image.

The shapes and dimensions of the outlines on the dentition image thus defined are therefore comparable with those of the outlines on the aligner image.

Step 3), determines, for each of a plurality of teeth represented in the dentition and aligner images, the interior and exterior tooth outlines.

A person skilled in the art knows how to process an image in order to isolate an outline. This processing for example involves the well-known application of masks or filters, which come with image processing software. Such processing operations for example make it possible to detect the regions of greatest contrast.

These processing operations notably comprise one or more of the following known and preferred methods, namely:

- by application of a Canny filter, notably to search for outlines using the Canny algorithm;
- by application of a Sobel filter, notably for calculating derivatives by means of the extended Sobel operator;
- by application of a Laplace filter to calculate the Laplacian of an image;
- by detecting blobs on an image ("Blobdetecor") ;
- by applying a "Threshold" to apply a fixed threshold to each element of a vector;

- by resizing, using relationships between pixel zones ("Resize(Area)") or bi-cubic interpolations on the pixel environment;
- by image erosion by means of a specific structuring element;
- by image expansion by means of a specific structuring element;
- by image correction, particularly using regions in the vicinity of the restored zone;
- by application of a bilateral filter;
- by application of Gaussian blurring;
- by application of an Otsu filter, to look for the threshold that minimizes variance between classes;
- by application of an A*filter, to search for a path between points;
- by application of an "Adaptive Threshold" for applying an adaptive threshold to a vector;
- by application of a histogram equalization filter to an image in grayscale in particular;
- by "BlurDetection", to calculate the entropy of an image using its laplacian;
- by detecting outlines ("FindContour") of a binary image ;
- by filling with color ("FloodFill"), notably to fill a connected element with a determined color.

The following nonlimiting methods, although not preferred, can also be used:

- by application of a "MeanShift" filter so as to find an object on a projection of the image;
- by application of a "CLAHE" filter, which stands for "Contrast Limited Adaptive Histogram Equalization";
- by application of a "Kmeans" filter, to determine the center of clusters and of groups of samples around clusters;
- by application of a DFT filter, so as to perform a direct or inverse Discrete Fourier Transform on a vector;
- by calculating moments;
- by application of a "HuMoments" filter to calculate invariant Hu invariants;
- by calculating the integral of an image;
- by application of a Scharr filter, making it possible to calculate a derivative of the image by using a Scharr operator;

- by searching for the convex envelope of points ("ConvexHull");
- by searching for the set of convex points of an outline ("ConvexityDefects");
- by shape comparison ("MatchShapes");
- by checking whether points form a part of an outline ("PointPolygonTest") ; by Harris outline detection ("CornerHarris");
- by looking for minimum eigenvalues in matrices of gradients, in order to detect the corners ("CornerMinEigenVal");
- by application of a Hough transform in order to find circles in a grayscale image ("HoughCircles");
- by "Active contour modeling" (plotting the outline of an object from a potentially "noisy" 2-D image);
- by calculating a field of forces, termed GVF ("gradient vector flow"), in part of the image;
- by "CascadeClassification".

Tooth outline determination can be optimized by following the teachings of PCT/EP2015/074900.

In step 4) of comparing the outlines, the procedure is preferably in accordance with one of the two particular embodiments hereinbelow, corresponding respectively to figures 7 and 8:

In a first particular embodiment, step 4) comprises steps i) to iii) for each of a plurality of teeth for which interior and exterior tooth outlines have been determined.

In step i), a distance *d* between the interior and exterior tooth outlines of each of said teeth is determined (figure 7).

The distance between the interior 14 and exterior 18 tooth outlines of a tooth may for example be the mean distance or the maximum distance between the pixels of said outlines corresponding to one and the same point on the tooth.

The distance is preferably measured in pixels, which advantageously avoids the need to establish the scale of the dentition and aligner images.

In step ii), a distance threshold *Sd* is determined, preferably using the distances determined in step i).

For preference, in step ii), the distance threshold *Sd* is substantially equal to the smallest of the distances determined in step i) (d_{min}). Conventionally, in step 1), at least one of the teeth being treated is in contact with the bottom of the tray in which it is inserted. The

distance between the interior and exterior tooth outlines of this tooth is then equal to a minimum distance d_{min} corresponding to a normal situation. It can therefore be used as a benchmark in order, in step iii), to evaluate the distances between the interior and exterior teeth outlines of the other teeth.

In step iii), a score known as the "distance score" $S(d,Sd)$, is determined, for each of the teeth, as a function

- of the distance d between the interior and exterior tooth outlines and
- of the distance threshold Sd.

For preference, the distance score for a tooth is equal to $S(d,Sd)$ namely the difference between the distance between the interior and exterior tooth outlines for this tooth and the distance threshold. The higher the distance score, the greater the separation of the tooth concerned from the tray.

Figure 7 illustrates one example of implementation of steps i) to iii), in which a tooth D1 has separated from the bottom of the tray and such that $d\text{-}d_{min} > Sd$.

In a second particular embodiment, step 4) comprises the steps i') to iii').

Step i') considers at least one triplet made up of first, second and third teeth, D1, D2 and D3 respectively, the first and third teeth being adjacent to the second tooth, which means to say that the first, second and third teeth succeed one another along a dental arch.

The dentition and aligner outlines comprising the respective interior tooth oulines14_1, 14_2 and 14_3, and respective exterior tooth outlines 18_1, 18_2 and 18_3, of respective teeth D1, D2 and D3, are determined.

An interior or exterior "offset" respectively, represents a distance between the, respectively interior or exterior, tooth outlines of two adjacent teeth.

The following are determined

- an offset between the interior tooth outline of said first tooth 14_1 and the interior tooth outline of said second tooth 14_2, and referred to as the "first interior offset", $\Delta_{1\text{-}2}i$;
- an offset between the interior tooth outline of said second tooth 14_2 and the interior tooth outline of said third tooth 14_3, and referred to as the "second interior offset", $\Delta_{2\text{-}3}i$;
- an offset between the exterior tooth outline of said first tooth 18_1 and the exterior tooth outline of said second tooth 18_2, and referred to as the "first exterior offset", $\Delta_{1\text{-}2}e$;

- an offset between the exterior tooth outline of said second tooth 18_2 and the exterior tooth outline of said third tooth 18_3, and referred to as the "second exterior offset", $\Delta_{2\text{-}3}e$;

The interior offset between the interior tooth outlines of two adjacent teeth is preferably equal to the largest distance between the interior tooth outlines of these two teeth on the dentition outline.

The exterior offset between the exterior tooth outlines of two adjacent teeth is preferably equal to the largest distance between the exterior tooth outlines of these two teeth on the aligner outline.

The interior offsets and the exterior offsets are preferably measured in pixels, which advantageously avoids the need to establish the scale of the dentition and aligner images.

The following are then determined:

- the difference between the first interior offset $\Delta_{1\text{-}2}i$ and the first exterior offset $\Delta_{1\text{-}2}e$, referred to as "first offset difference" $\Delta_{1\text{-}2}$ (= $\Delta_{1\text{-}2}i$ - $\Delta_{1\text{-}2}e$);
- the difference between the second interior offset $\Delta_{2\text{-}3}i$ and the second exterior offset $\Delta_{2\text{-}3}e$, referred to as "second offset difference" $\Delta_{2\text{-}3}$ (= $\Delta_{2\text{-}3}i$ - $\Delta_{2\text{-}3}e$);

In the example of figure 8, $\Delta_{1\text{-}2}$ is far smaller than $\Delta_{2\text{-}3}$.

Step ii'), determines an offset-difference threshold $S\Delta$, preferably from the first and second offset differences $\Delta_{1\text{-}2}$ and $\Delta_{2\text{-}3}$ determined in step i').

For preference, in step ii'), the offset threshold is substantially equal to the smallest of the offset differences determined in step i').

Conventionally, in step 1), at least two adjacent teeth being treated are in contact with the bottom of the tray in which they are inserted. The difference in offset between these two treated teeth is then substantially zero. This zero difference in offset corresponds to a normal situation and can therefore be used as a benchmark for evaluating the differences in offset between adjacent treated teeth.

In figure 8, the difference in offset between two teeth D_1 and D_2 is substantially zero.

In step iii'), at least one score known as the "offset score", is determined, for each pair of teeth of said triplet, as a function of the difference in offset with a tooth adjacent to said tooth and of the offset-difference threshold.

In particular, the difference in offset of the first tooth with the second tooth may be compared against the offset-difference threshold $S\Delta$, for example of zero. The offset-difference threshold may notably be subtracted from the offset difference of the first tooth

with respect to the second tooth in order to determine a score for the offset between the first and second teeth.

This offset score indicates, for example if it is positive, that one or each of the first and second teeth is liable to be separated from the bottom of the tray.

In figure 8, the difference in offset between the two teeth D_2 and D_3 is positive, which is an indication that the second or third tooth has separated.

In figure 8, since the difference in offset between the two teeth D_1 and D_2 is substantially zero, the positive difference in offset between the two teeth D_2 and D_3 therefore indicates that the third tooth has separated.

In general, when a first offset score for first and second teeth indicates the separation of one of these two teeth, a second offset score is determined for the second tooth and a third tooth adjacent to the second tooth. If the second offset score is lower than the first offset score, it is probable that it is the first tooth that has separated from the bottom of the tray. If not, it is probably the second tooth that has separated.

In step 5), information, for example an alert, is sent to an operator to inform him, if appropriate, that the situation is abnormal. The information relating to a tooth is dependent on the score or scores established in step 4). For preference, the information comprises a value making it possible to quantify, for at least one tooth, the level of separation of the aligner over this tooth, this value preferably being established from the score or scores calculated for this tooth in step 4).

In one embodiment, this information is used to establish a diagnosis and/or to modify the treatment, particularly to recommend a change in aligner and/or to determine the characteristics of a future aligner for the patient.

As is now clearly apparent, a method according to the invention makes it possible, from simple photos or a simple film, to determine the regions in which the aligner has come away from the teeth and evaluate the extent of this separation.

Of course, the invention is not restricted to the embodiments described hereinabove and depicted.

Finally, the patient is not limited to a human being. In particular, a method according to the invention can be used on another animal.

CLAIMS

1. A method for evaluating the shape of an orthodontic aligner worn by a patient, said method comprising the following steps:

1) acquisition of at least one two-dimensional image of teeth of said patient, referred to as "updated image", under actual acquisition conditions;

at least one updated image referred to as "aligner image", at least partially representing the aligner in a service position in which it is worn by said teeth; and

at least one updated image referred to as "dentition image", identical to or different from the aligner image, representing said teeth,

2) if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions used during the acquisition of the aligner image in step 1);

3) determination, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively;

4) comparison of the interior and exterior tooth outlines, followed by determination of at least one score according to said comparison.

2. The method as claimed in claim 1, comprising, after step 4), the following step:

5) comparison of the score against an acceptability threshold and the emission of information according to the result of the comparison.

3. The method as claimed in claim 1, in which the dentition and aligner images are different, the method comprising the following steps:

(a) prior to step 1), the creation of a digital three-dimensional model of at least part of a dental arch bearing said teeth, or "initial reference model" and, for each tooth of the initial reference model, definition of a digital three-dimensional reference model of said tooth, or "tooth model";

(b) modification of the initial reference model by moving the tooth models until a final reference model compatible with the dentition image is obtained;

(c) search for a two-dimensional view of the final reference model that is compatible with the aligner image;

(d) conversion of the dentition image into said view.

4. The method as claimed in claims 1, in which the dentition and aligner images are the same image.

5. The method as claimed in claim 1, in which step 4) comprises the following steps:
for each of a plurality of teeth for which the interior and exterior tooth outlines have been determined;
i) determination of a distance between the interior and exterior tooth outlines;
ii) determination of a distance threshold, preferably using the distances determined in the immediately preceding step;
iii) for each of said teeth, determination of a distance score dependent on
- the distance between the interior and exterior teeth outlines, and
- the distance threshold.

6. The method as claimed in claim 1, in which the distances are measured in pixels.

7. The method as claimed in claim 5, in which, in step ii), the distance threshold is dependent on the smallest of the distances determined in step i).

8. The method as claimed in claim 1, in which step 4) comprises the following steps:
i') for each pair of an adjacent left-hand tooth and of an adjacent right-hand tooth in at least a triplet of adjacent first, second and third teeth, for each of which interior and exterior tooth outlines have been determined, the first and third teeth being adjacent to the second tooth,
determination of an offset between the interior teeth outline of said left-hand tooth and the interior teeth outline of said right-hand tooth, referred to as "interior offset", and determination of an offset between the exterior teeth outline of said left-hand tooth and the exterior teeth outline of said right-hand tooth, referred to as the "exterior offset",
then
determination of the difference between the interior offset and the exterior offset, known as the "offset difference";
ii') determination of an offset-difference threshold, preferably using the offset differences determined in step i');

iii') the determination, for each tooth of said triplet, of at least one offset score, dependent on the offset difference with an adjacent tooth, and on the offset-difference threshold.

9. The method as claimed in claim 8, in which the interior and exterior offsets are measured in pixels.

10. The method as claimed in claim 9, in which, in step iii'), the offset-difference threshold is dependent on the smallest of the offset differences determined in step ii').

ABSTRACT

DENTAL MONITORING

METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

The invention relates to a method for evaluating the shape of an orthodontic aligner worn by a patient, said method comprising the following steps:

1) acquisition of at least one two-dimensional image of teeth of said patient, referred to as "updated image", under actual acquisition conditions;

   at least one updated image referred to as "aligner image", at least partially representing the aligner in a service position in which it is worn by said teeth; and

   at least one updated image referred to as "dentition image", identical to or different from the aligner image, representing said teeth,

2) if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions used during the acquisition of the aligner image in step 1);

3) determination, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively;

4) comparison of the interior and exterior tooth outlines, followed by determination of at least one score according to said comparison.

No figure for the abstract

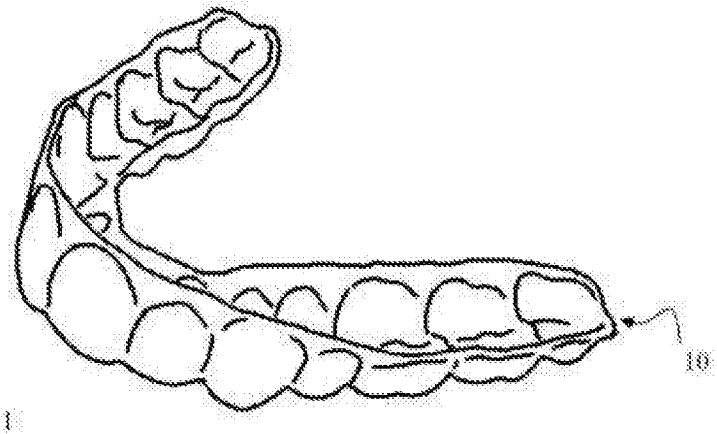


Fig. 1

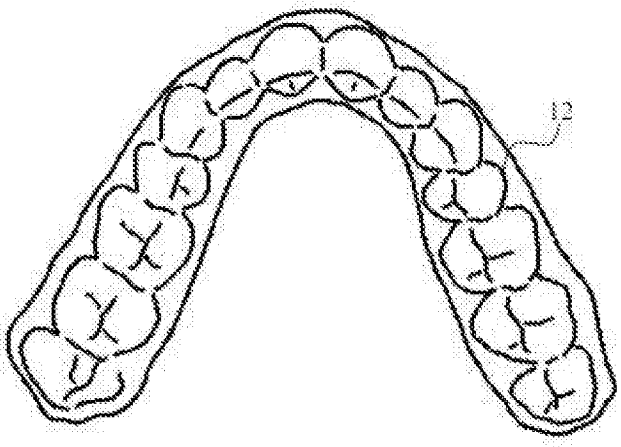


Fig. 2

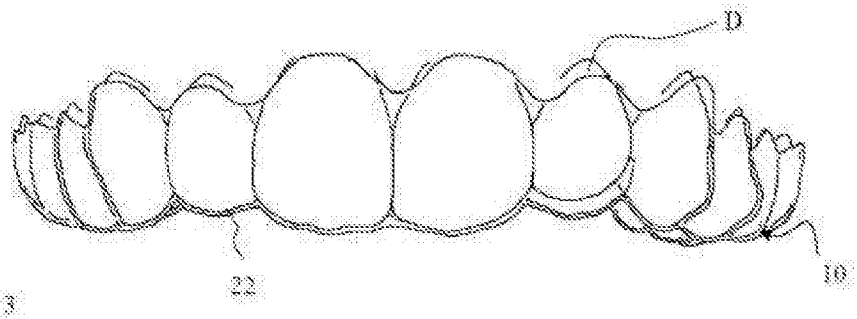


Fig. 3

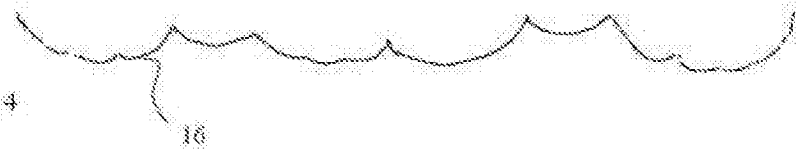


Fig. 4



Fig. 5



Fig. 6



Fig. 7

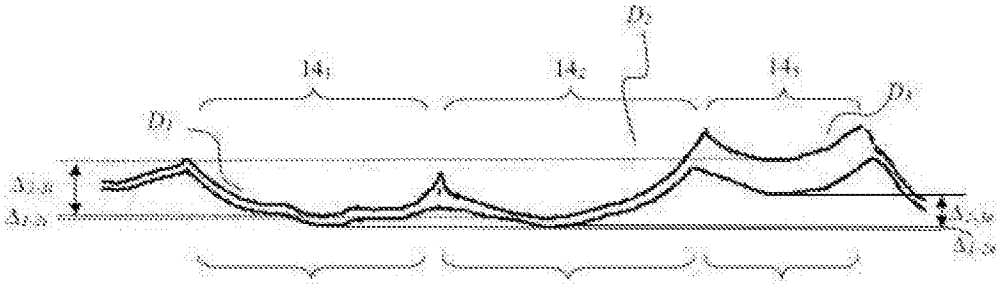


Fig. 8

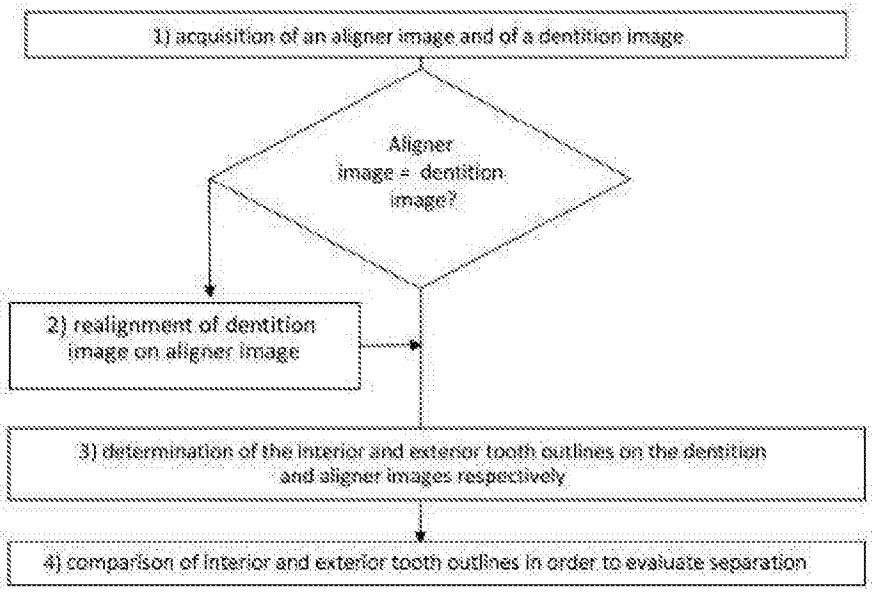

1) acquisition of an aligner image and of a dentition image
Aligner image = dentition image?
2) realignment of dentition image on aligner image
3) determination of the interior and exterior tooth outlines on the dentition and aligner images respectively
4) comparison of interior and exterior tooth outlines in order to evaluate separation

Fig. 9

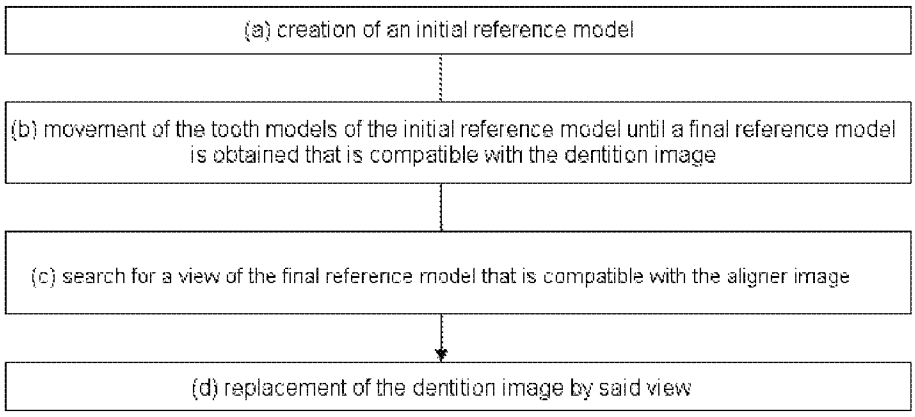

(a) creation of an initial reference model
(b) movement of the tooth models of the initial reference model until a final reference model is obtained that is compatible with the dentition image
(c) search for a view of the final reference model that is compatible with the aligner image
(d) replacement of the dentition image by said view

Fig. 10

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Application Number	
Filing Date	
First Named Inventor	Philippe SALAH
Art Unit	
Examiner Name	
Attorney Docket Number	N&P-51411

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	1	20100068672	A1	2010-03-18	Arjomand et al.	Cited in French Search Report

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	1	2016066637	WO	A1	2016-05-06	Salah et al.	Cited in French Search Report	☐

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	Application Number	
	Filing Date	
	First Named Inventor	Philippe SALAH
	Art Unit	
	Examiner Name	
	Attorney Docket Number	N&P-51411

	1	Corresponding French Application, French Search Report, Application no.: 1755187, dated January 22, 2018, 2 pages	☐

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	Application Number	
	Filing Date	
	First Named Inventor	Philippe SALAH
	Art Unit	
	Examiner Name	
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OR

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☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Ronald M. Kachmarik/	Date (YYYY-MM-DD)	2018-06-06
Name/Print	Ronald M. Kachmarik	Registration Number	34512

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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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N° d'enregistrement national

FA 839242
FR 1755187

DOCUMENTS CONSIDÉRÉS COMME PERTINENTS		Revendication(s) concernée(s)	Classement attribué à l'invention par l'INPI
Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes		
A	WO 2016/066637 A1 (H43 DEV [LU]) 6 mai 2016 (2016-05-06)	1-10	A61C7/00
A	US 2010/068672 A1 (ARJOMAND HOSSEIN [US] ET AL) 18 mars 2010 (2010-03-18)	1-10	

DOMAINES TECHNIQUES RECHERCHÉS (IPC)

A61C

Date d'achèvement de la recherche	Examinateur
22 janvier 2018	Salvatore, Claudio

CATÉGORIE DES DOCUMENTS CITÉS

X : particulièrement pertinent à lui seul
Y : particulièrement pertinent en combinaison avec un autre document de la même catégorie
A : arrière-plan technologique
O : divulgation non-écrite
P : document intercalaire

T : théorie ou principe à la base de l'invention
E : document de brevet bénéficiant d'une date antérieure à la date de dépôt et qui n'a été publié qu'à cette date de dépôt ou qu'à une date postérieure.
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EPO FORM 1503 03.82 (P04C14)

ANNEXE AU RAPPORT DE RECHERCHE PRÉLIMINAIRE RELATIF A LA DEMANDE DE BREVET FRANÇAIS NO. FR 1755187 FA 839242

La présente annexe indique les membres de la famille de brevets relatifs aux documents brevets cités dans le rapport de recherche préliminaire visé ci-dessus.
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Document brevet cité au rapport de recherche	Date de publication	Membre(s) de la famille de brevet(s)	Date de publication
WO 2016066637 A1	06-05-2016	EP 3212113 A1	06-09-2017
		FR 3027504 A1	29-04-2016
		WO 2016066637 A1	06-05-2016
US 2010068672 A1	18-03-2010	AUCUN	

EPO FORM P0459

Pour tout renseignement concernant cette annexe : voir Journal Officiel de l'Office européen des brevets, No.12/82

(12) DEMANDE INTERNATIONALE PUBLIÉE EN VERTU DU TRAITÉ DE COOPÉRATION EN MATIÈRE DE BREVETS (PCT)

(19) Organisation Mondiale de la Propriété Intellectuelle
Bureau international

(43) Date de la publication internationale
6 mai 2016 (06.05.2016)

WIPO | PCT

(10) Numéro de publication internationale
WO 2016/066637 A1

(51) Classification internationale des brevets :
A61C 7/00 (2006.01) *A61C 19/06* (2006.01)
A61C 9/00 (2006.01) *A61C 19/10* (2006.01)
G06T 7/00 (2006.01) *A61B 5/06* (2006.01)
A61B 5/00 (2006.01) *G01J 3/00* (2006.01)
A61B 1/32 (2006.01) *G06K 9/00* (2006.01)

(21) Numéro de la demande internationale :
PCT/EP2015/074859

(22) Date de dépôt international :
27 octobre 2015 (27.10.2015)

(25) Langue de dépôt : français

(26) Langue de publication : français

(30) Données relatives à la priorité :
14 60310 27 octobre 2014 (27.10.2014) FR

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(81) États désignés *(sauf indication contraire, pour tout titre de protection nationale disponible)* : AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) États désignés *(sauf indication contraire, pour tout titre de protection régionale disponible)* : ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), eurasien (AM, AZ, BY, KG, KZ, RU, TJ, TM), européen (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Publiée :

— *avec rapport de recherche internationale (Art. 21(3))*

WO 2016/066637 A1

(54) Title : METHOD FOR MONITORING AN ORTHODONTIC TREATMENT

(54) Titre : PROCÉDÉ DE CONTRÔLE D'UN TRAITEMENT ORTHODONTIQUE

(57) Abstract : The invention relates to a method for monitoring the positioning of the teeth of a patient, said method including the following steps: a) less than three months after the start of an orthodontic treatment, producing an initial reference model of the arches of the patient, and, for each tooth, defining, from the initial reference model, a tooth model; b) acquiring at least one updated image of said arches, under actual acquisition conditions; c) analysing each updated image and producing, for each updated image, an updated map relative to a piece of discriminating information; d) optionally determining, for each updated image, rough virtual acquisition conditions that approximate said actual acquisition conditions; e) searching each updated image for a final reference model corresponding to the positioning of the teeth during the acquisition of the updated image, and; f) for each tooth model, comparing the positions of said tooth model in the initial reference model and in the reference model obtained at the end of the preceding steps, in order to determine the movement of the teeth between steps a) and b).

(57) Abrégé : L'invention concerne un procédé de contrôle du positionnement de dents d'un patient, ledit procédé comportant les étapes suivantes; a) moins de 3 mois après le début d'un traitement orthodontique, réalisation d'un modèle de référence initial des arcades du patient, et, pour chaque dent, définition, à partir du modèle de référence initial, d'un modèle de dent; b) acquisition d'au moins une image actualisée desdites arcades, dans des conditions d'acquisition réelles; c) analyse de chaque image actualisée et réalisation, pour chaque image actualisée, d'une carte actualisée relative à une information discriminante; d) optionnellement, détermination, pour chaque image actualisée, de conditions d'acquisition virtuelles grossières approximant lesdites conditions d'acquisition réelles; e) recherche, pour chaque image actualisée, d'un modèle de référence final correspondant au positionnement des dents lors de l'acquisition de l'image actualisée, et; f) pour chaque modèle de dent, comparaison des positionnements dudit modèle de dent dans le modèle de référence initial et dans le modèle de référence obtenu à l'issue des étapes précédentes, afin de déterminer le déplacement des dents entre les étapes a) et b).

PROCEDE DE CONTROLE D'UN TRAITEMENT ORTHODONTIQUE

Domaine technique

La présente invention concerne un procédé de contrôle du positionnement de dents d'un patient et un programme informatique pour la mise en œuvre de ce procédé.

Etat de la technique

Il est souhaitable que chacun fasse régulièrement contrôler sa dentition, notamment afin de vérifier que la position de ses dents n'évolue pas défavorablement. Lors d'un traitement orthodontique, cette évolution défavorable peut notamment conduire à modifier le traitement. Après un traitement orthodontique, cette évolution défavorable, appelée « récidive », peut conduire à une reprise d'un traitement. Enfin, de manière plus générale et indépendamment de tout traitement, chacun peut souhaiter suivre les déplacements éventuels de ses dents.

Classiquement, les contrôles sont effectués par un orthodontiste ou un dentiste qui seuls disposent d'un appareillage adapté. Ces contrôles sont donc coûteux. En outre, les visites sont contraignantes.

US 2009/0291417 décrit un procédé permettant de créer, puis de modifier des modèles tridimensionnels, notamment pour la fabrication d'appareils orthodontiques.

Un objectif de la présente invention est de répondre, au moins partiellement, aux problèmes susmentionnés.

Résumé de l'invention

L'invention fournit un procédé de contrôle du positionnement de dents d'un patient, ledit procédé comportant les étapes suivantes :

a) réalisation d'un modèle de référence tridimensionnel numérique des arcades du patient, ou « modèle de référence initial » et, pour chaque dent, définition, à partir du modèle de référence initial, d'un modèle de référence tridimensionnel numérique de ladite dent, ou « modèle de dent » ;

b) acquisition d'au moins une image bidimensionnelle desdites arcades, dite « image actualisée », dans des conditions d'acquisition réelles ;

c) analyse de chaque image actualisée et réalisation, pour chaque image actualisée, d'une carte actualisée relative à une information discriminante ;

d) optionnellement, détermination, pour chaque image actualisée, de conditions d'acquisition virtuelles grossières approximant lesdites conditions d'acquisition réelles ;

e) recherche, pour chaque image actualisée, d'un modèle de référence final correspondant au positionnement des dents lors de l'acquisition de l'image actualisée, la recherche étant de préférence effectuée au moyen d'une méthode métaheuristique, de préférence évolutionniste, de préférence par recuit simulé, et

f) pour chaque modèle de dent, comparaison des positionnements dudit modèle de dent dans le modèle de référence initial et dans le modèle de référence obtenu à l'issue des étapes précédentes, dit « modèle de référence final », afin de déterminer le déplacement des dents entre les étapes a) et b).

Comme on le verra plus en détail dans la suite de la description, un procédé selon l'invention permet, à partir d'une simple image des dents, prise sans pré-positionnement précis des dents par rapport à l'appareil d'acquisition d'images, par exemple d'une photographie prise par le patient, d'évaluer avec précision le déplacement des dents depuis la réalisation du modèle de référence initial. Cette évaluation peut en outre être effectuée par un simple ordinateur ou un téléphone mobile.

De préférence, l'étape e) comporte

- une première opération d'optimisation permettant de rechercher des conditions d'acquisition virtuelles correspondant au mieux aux conditions d'acquisition réelles dans un modèle de référence à tester déterminé à partir du modèle de référence initial, et
- une deuxième opération d'optimisation permettant de rechercher, en testant une pluralité de dits modèles de référence à tester, le modèle de référence correspondant au mieux au positionnement des dents du patient lors de l'acquisition de l'image actualisée à l'étape b).

De préférence, une première opération d'optimisation est effectuée pour chaque test d'un modèle de référence à tester lors de la deuxième opération d'optimisation.

De préférence, la première opération d'optimisation et/ou la deuxième opération d'optimisation, de préférence la première opération d'optimisation et la deuxième opération d'optimisation mettent en œuvre une méthode métaheuristique, de préférence évolutionniste, de préférence un recuit simulé.

De préférence, l'étape e) comporte les étapes suivantes :

e1) définition du modèle de référence à tester comme étant le modèle de référence initial puis,

e2) suivant les étapes suivantes, test de conditions d'acquisition virtuelles avec le modèle de référence à tester afin d'approximer finement lesdites conditions d'acquisition réelles ;

e21) détermination de conditions d'acquisition virtuelles à tester;

e22) réalisation d'une image de référence bidimensionnelle du modèle de référence à tester dans lesdites conditions d'acquisition virtuelles à tester ;

e23) traitement de l'image de référence pour réaliser au moins une carte de référence représentant ladite information discriminante ;

e24) comparaison des cartes actualisée et de référence de manière à déterminer une valeur pour une première fonction d'évaluation, ladite valeur pour la première fonction d'évaluation dépendant des différences entre lesdites cartes actualisée et de référence et correspondant à une décision de poursuivre ou de stopper la recherche de conditions d'acquisition virtuelles approximant lesdites conditions d'acquisition réelles avec plus d'exactitude que lesdites conditions d'acquisition virtuelles à tester déterminées à la dernière occurrence de l'étape e21) ;

e25) si ladite valeur pour la première fonction d'évaluation correspond à une décision de poursuivre ladite recherche, modification des conditions d'acquisition virtuelles à tester, puis reprise à l'étape e22) ;

e3) détermination d'une valeur pour une deuxième fonction d'évaluation, ladite valeur pour la deuxième fonction d'évaluation dépendant des différences entre les cartes actualisée et de référence dans les conditions d'acquisition virtuelles approximant au mieux lesdites conditions d'acquisition réelles et résultant de la dernière occurrence de l'étape e2), ladite valeur pour la deuxième fonction d'évaluation correspondant à une décision de poursuivre ou de stopper la recherche d'un modèle de référence approximant le positionnement des dents lors de l'acquisition

de l'image actualisée avec plus d'exactitude que ledit modèle de référence à tester utilisé à la dernière occurrence de l'étape e2), et si ladite valeur pour la deuxième fonction d'évaluation correspond à une décision de poursuivre ladite recherche, modification du modèle de référence à tester par déplacement d'un ou plusieurs modèles de dents puis reprise à l'étape e2).

Un procédé selon l'invention peut encore comporter une ou plusieurs des caractéristiques optionnelles suivantes :

- à l'étape a), on détermine un plan d'occlusion suivant les opérations suivantes :
  - I. détermination des points du modèle de référence initial qui appartiennent à une arcade et qui sont à une distance de l'autre arcade qui est inférieure à une distance prédéterminée, de préférence à une distance inférieure à 3 mm de l'autre arcade, dits « points de contact » ;
  - II. optionnellement, filtrage d'une partie des points de contact, de préférence de manière que le nombre de points de contact appartenant à l'arcade supérieure soit identique au nombre de points de contact appartenant à l'arcade inférieure, de préférence en éliminant les points d'une arcade les plus éloignés de l'autre arcade ;
  - III. régression linéaire, de préférence par la méthode des moindres carrés, sur l'ensemble des points de contact restant de manière à déterminer le plan d'occlusion ;

- à l'étape a), on effectue les opérations suivantes :
  - i. projection, dans un plan d'occlusion, des points de contact entre les dents des arcades supérieure et inférieure du patient, les points de contact et/ou le plan d'occlusion étant de préférence déterminés, suivant les étapes I à III ;
  - ii. détermination du barycentre des projections desdits points de contact et création d'un référentiel, dans le plan d'occlusion, centré sur ledit barycentre ;
  - iii. détermination, dans ledit référentiel, de la fonction parabolique, présentant le plus grand coefficient de corrélation avec l'ensemble des projections des points de contact ;

iv. rotation de l'ensemble des projections des points de contact autour du barycentre, et reprise de l'opération précédente *iii* jusqu'à ce que l'ensemble des projections des points de contact ait parcouru un secteur déterminé, de préférence supérieur à 90°, supérieur à 180°, voire d'environ 360° ;

v. identification du coefficient de corrélation le plus élevé pour l'ensemble des positions angulaires de l'ensemble des projections des points de contact autour du barycentre, et de l'axe de la fonction parabolique correspondante ;

vi. détermination d'un plan longitudinal médian du modèle de référence initial, ledit plan passant par ledit axe et étant perpendiculaire au plan d'occlusion ;

- à l'étape a), on délimite au moins particllement un modèle de dent en suivant les opérations suivantes :

i'. détermination, au moins partielle, des bords gingivaux intérieur et extérieur de l'arcade de la dent concernée, de préférence par analyse des variations de l'orientation de la surface du modèle de référence initial ;

ii'. projection, dans le plan d'occlusion, des bords gingivaux intérieur et extérieur ;

iii'. identification des déformations des projections des bords gingivaux intérieur et extérieur correspondant aux régions interdentaires, les sommets de ces déformations étant appelés « point de rapprochement » (dans une région interdentaire, les deux projections présentent chacune une pointe, les deux pointes pointant sensiblement l'une vers l'autre, l'extrémité d'une pointe étant un point de rapprochement) ;

iv'. détermination du plus court chemin, à la surface du modèle de référence initial, entre deux points de rapprochement de bords gingivaux intérieur et extérieur, respectivement, d'une région interdentaire, de préférence par une méthode métaheuristique, de préférence évolutionniste, de préférence par recuit simulé, ledit plus court chemin délimitant au moins partiellement un modèle de dent ;

- une image actualisée est acquise moins de 7 jours après l'étape a), puis les étapes c) à f) sont mises en œuvre à partir de cette image actualisée ;

- à l'étape b), on utilise un appareil d'acquisition porté à la main (et en particulier qui n'est pas immobilisé, par exemple au moyen d'un support reposant sur le sol) et/ou la tête du patient n'est pas immobilisée ;
- à l'étape b), on utilise un appareil individuel choisi dans le groupe formé par un appareil photo connecté, une montre intelligente, une tablette numérique, un scanner 3D portable et un ordinateur couplé un système d'acquisition d'images, telle une webcam ou un appareil photo numérique, pour mettre en œuvre l'étape b) et, de préférence au moins une des étapes, de préférence toutes les étapes c) à f) ;
- à l'étape b), on utilise un appareil d'acquisition d'images fournissant une image actualisée infrarouge ;
- à l'étape b), on utilise un écarteur comportant une, de préférence plus de deux marques de repérage, de préférence non alignées, et, de préférence, on utilise la représentation des marques de repérage sur l'image actualisée pour
  - à l'étape c), redécouper l'image et/ou,
  - à l'étape d), évaluer grossièrement les conditions d'acquisition réelles ;
- à l'étape c), l'information discriminante est choisie dans le groupe constitué par une information de contour, une information de couleur, une information de densité, une information de distance, une information de brillance, une information de saturation, une information sur les reflets et des combinaisons de ces informations ;
- à l'étape d), on utilise des données fournies par l'appareil d'acquisition et, de préférence, concernant son orientation ;
- à l'étape e2), les conditions d'acquisition virtuelles recherchées comprennent des paramètres de calibration de l'appareil d'acquisition mis en œuvre à l'étape b) ;
- on met en œuvre une optimisation par une méthode métaheuristique, de préférence évolutionniste, de préférence par recuit simulé pour :
  - à l'étape a), déterminer au moins partiellement un bord gingival délimitant un modèle de dent et/ou,
  - à l'étape e2), rechercher les conditions d'acquisition virtuelles correspondant aux conditions d'acquisition réelles et/ou,
  - à l'étape e), rechercher un modèle de référence correspondant à l'image actualisée ;

- ladite méthode métaheuristique est choisie dans le groupe formé par
  - les algorithmes évolutionnistes, de préférence choisie parmi: les stratégies d'évolution, les algorithmes génétiques, les algorithmes à évolution différentielle, les algorithmes à estimation de distribution, les systèmes immunitaires artificiels, la recomposition de chemin Shuffled Complex Evolution, le recuit simulé, les algorithmes de colonies de fourmis, les algorithmes d'optimisation par essaims particulaires, la recherche avec tabous, et la méthode GRASP ;
  - l'algorithme du kangourou,
  - la méthode de Fletcher et Powell,
  - la méthode du bruitage,
  - la tunnelisation stochastique,
  - l'escalade de collines à recommencements aléatoires,
  - la méthode de l'entropie croisée, et
  - les méthodes hybrides entre les méthodes métaheuristiques citées ci-dessus.

De préférence, l'étape b) est exécutée par une personne sans formation universitaire à l'orthodontie et/ou en dehors de tout cabinet médical, de dentisterie ou d'orthodontie, et/ou sans recours à un dispositif de stabilisation mécanique de l'appareil d'acquisition et/ou sans recours à d'autres appareils qu'un téléphone mobile et/ou sans recours à une jauge étalon de calibration.

L'invention concerne aussi l'utilisation d'un procédé selon l'invention pour

- détecter une récidive, et/ou
- déterminer une vitesse d'évolution d'un changement de positionnement des dents, et/ou
- optimiser la date de prise de rendez-vous chez un orthodontiste ou un dentiste, et/ou
- évaluer l'efficacité d'un traitement orthodontique, et/ou
- évaluer l'évolution du positionnement de dents vers un modèle théorique correspondant à un positionnement déterminé des dents, en particulier un positionnement amélioré des dents, et/ou
- en dentisterie.

Le procédé peut notamment être mis en œuvre pendant un traitement orthodontique, notamment pour en contrôler le déroulement, l'étape a) étant mise en œuvre moins de 3 mois, moins de 2 mois, moins de 1 mois, moins d'une semaine, moins de 2 jours après le début du traitement, c'est-à-dire après la pose d'un appareil destiné à corriger le positionnement des dents du patient, dit « appareil de contention actif ».

Le procédé peut être également mis en œuvre après un traitement orthodontique, pour vérifier que le positionnement des dents n'évolue pas de façon défavorable (« récidive »). L'étape a) est alors de préférence mise en œuvre moins de 3 mois, moins de 2 mois, moins de 1 mois, moins d'une semaine, moins de 2 jours après la fin du traitement, c'est-à-dire après la pose d'un appareil destiné maintenir les dents en position, dit « appareil de contention passif ».

L'invention concerne également :

- un programme d'ordinateur, et en particulier un applicatif spécialisé pour téléphone mobile, comprenant des instructions de code de programme pour l'exécution d'une ou plusieurs, de préférence toutes les étapes b) à f), lorsque ledit programme est exécuté par un ordinateur,
- un support informatique sur lequel est enregistré un tel programme, par exemple une mémoire ou un CD-ROM, et
- un appareil personnel, en particulier un téléphone mobile ou une tablette, dans lequel est chargé un tel programme.

L'invention concerne enfin un système comportant

- un scanner tridimensionnel apte à mettre en œuvre l'étape a) d'un procédé selon l'invention,
- un appareil personnel, de préférence un téléphone mobile, chargé avec un programme selon l'invention.

Définitions

Par « patient », on entend toute personne pour laquelle un procédé est mis en œuvre afin d'en contrôler les dents, que cette personne soit malade ou non.

Par « professionnel des soins dentaires », on entend un dentiste, un orthodontiste ou un laboratoire d'orthodontie.

Par « dentiste », on entend un dentiste ou un assistant dentaire travaillant sous la responsabilité d'un dentiste.

Par « dentition », on entend les deux arcades dentaires du patient.

On appelle "téléphone mobile" un appareil de moins de 500 g, doté d'un capteur lui permettant de capturer des images, capable d'échanger des données avec un autre appareil éloigné de plus de 500 km du téléphone mobile, et capable d'afficher lesdites données, et notamment lesdites images.

Les « conditions d'acquisition » précisent la position et l'orientation dans l'espace d'un appareil d'acquisition d'images relativement aux dents du patient ou à un modèle de dents du patient, et de préférence la calibration de cet appareil d'acquisition d'images.

La « calibration » d'un appareil d'acquisition est constituée par l'ensemble des valeurs des paramètres de calibration. Un paramètre de calibration est un paramètre intrinsèque à l'appareil d'acquisition (à la différence de sa position et de son orientation) dont la valeur influence l'image acquise. Par exemple, l'ouverture de diaphragme est un paramètre de calibration qui modifie la profondeur de champ. Le temps d'exposition est un paramètre de calibration qui modifie la luminosité (ou « l'exposition ») de l'image. La distance focale est un paramètre de calibration qui modifie l'angle de vue, c'est-à-dire le degré de « zoom ». La « sensibilité » est un paramètre de calibration qui modifie la réaction du capteur d'un appareil d'acquisition numérique à la lumière incidente.

De préférence, les paramètres de calibration sont choisis dans le groupe formé par l'ouverture de diaphragme, le temps d'exposition, la distance focale et la sensibilité.

Le "plan d'occlusion" est le plan qui fournit la meilleure corrélation linéaire avec l'ensemble des points de contact entre les dents de l'arcade supérieure d'une part et les dents de l'arcade inférieure d'autre part.

Le "plan longitudinal médian" est le plan sensiblement vertical lorsque le patient tient la tête droite, qui sépare de manière sensiblement symétrique des parties droite et gauche de chaque arcade.

Une « tablette » est un ordinateur portable à écran tactile.

Un scanner 3D est un appareil permettant d'obtenir une représentation en trois dimensions d'un objet.

Par "image", on entend une image en deux dimensions, comme une photographie. Une image est formée de pixels.

Une "information discriminante" est une information caractéristique qui peut être extraite d'une image (*"image feature"*), classiquement par un traitement informatique de cette image.

Une information discriminante peut présenter un nombre variable de valeurs. Par exemple, une information de contour peut être égale à 1 ou 0 selon qu'un pixel appartient ou non à un contour. Une information de brillance peut prendre un grand nombre de valeurs. Le traitement de l'image permet d'extraire et de quantifier l'information discriminante.

Des conditions d'acquisition sont dites "virtuelles" lorsqu'elles correspondent à une simulation dans laquelle l'appareil d'acquisition serait dans lesdites conditions d'acquisition (positionnement et de préférence calibration théoriques de l'appareil d'acquisition).

Par "comprenant un" ou "comportant un" ou "présentant un", on entend "comportant au moins un", sauf indication contraire.

Brève description des figures

D'autres caractéristiques et avantages de l'invention apparaîtront encore à la lecture de la description détaillée qui va suivre et à l'examen du dessin annexé dans lequel :

- la figure 1 représente un logigramme illustrant la mise en œuvre d'un procédé selon l'invention,
- la figure 2 représente un exemple de modèle de référence initial,
- la figure 3 illustre le traitement effectué pour déterminer le plan d'occlusion,
- la figure 4 (4a-4d) illustre l'étape nécessaire pour déterminer les modèles de dent dans un modèle de référence,
- la figure 5 (5a-5d) illustre l'acquisition d'images actualisées, ainsi que l'opération de découpage,
- la figure 6 (6a-6b) illustre le traitement d'une image actualisée permettant de déterminer le contour des dents, et
- la figure 7 illustre schématiquement la position relative de marques de repérage 12 sur des images actualisées 14_1 et 14_2 d'un écarteur 10, selon la direction d'observation (trait interrompu), et

- les figures 8a et 8b illustrent deux vues d'un modèle tridimensionnel avec deux distances focales différentes.

Description détaillée

Un procédé selon l'invention comporte les étapes mentionnées ci-dessus.

A l'étape a), un modèle de référence initial des arcades, ou d'une partie des arcades du patient est créé (voir figure 2).

Le modèle de référence initial est un modèle numérique en trois dimensions des arcades du patient, par exemple du type .stl ou .Obj, .DXF 3D, IGES, STEP, VDA, ou Nuages de points. Avantageusement, un tel modèle, dit « 3D », peut être observé selon un angle quelconque.

Pour le suivi d'un traitement orthodontique, le modèle de référence initial est de préférence préparé au début du traitement. Le modèle de référence initial peut correspondre à un positionnement des dents du patient avant le traitement ou à un positionnement des dents du patient que le traitement se propose d'atteindre. Dans ce cas, le modèle de référence initial est classiquement calculé à partir d'un premier modèle tridimensionnel correspondant au positionnement des dents du patient avant le traitement.

Pour le contrôle de la récidive, le modèle de référence initial est de préférence préparé moins de six mois, de préférence moins de trois mois, de préférence encore moins d'un mois après la fin du traitement orthodontique, généralement immédiatement après la fin du traitement. Il correspond ainsi à un positionnement sensiblement optimal des dents.

Le modèle de référence initial peut être également préparé indépendamment de tout traitement, par exemple parce que le patient souhaite surveiller les mouvements de ses dents.

Le modèle de référence initial peut être préparé à partir de mesures effectuées sur les dents du patient ou sur un modèle physique de ses dents, par exemple un modèle en plâtre.

Le modèle de référence initial est de préférence créé au moyen d'un appareil professionnel, par exemple au moyen d'un scanner 3D, de préférence mis en œuvre par un professionnel de la santé, par exemple par un orthodontiste ou un laboratoire d'orthodontie. Dans un cabinet d'orthodontie, le patient ou le modèle physique de ses dents peuvent être avantageusement disposés dans une position précise et l'appareil professionnel peut être

perfectionné. Il en résulte un modèle de référence initial très précis. Le modèle de référence initial fournit de préférence une information sur le positionnement des dents avec une erreur inférieure à 5/10 mm, de préférence inférieure à 3/10 mm, de préférence inférieure à 1/10 mm.

Orientation du modèle de référence initial :

De préférence, on détermine l'orientation du modèle de référence initial dans l'espace, et notamment, de préférence, le plan d'occlusion et le plan longitudinal médian.

Le plan d'occlusion et le plan longitudinal médian peuvent être déterminés manuellement, de manière approximative. Les inventeurs ont cependant découvert des procédés permettant de déterminer ces plans par traitement informatique.

De préférence, le modèle de référence est un modèle des arcades bouche fermée, c'est-à-dire dans une position dans laquelle des dents de l'arcade supérieure sont en contact avec des dents de l'arcade inférieure.

Classiquement, le modèle de référence initial fourni par un scanner tridimensionnel permet de distinguer l'arcade supérieure de l'arcade inférieure. Généralement, le modèle est fourni sous la forme de deux fichiers correspondant respectivement à ces arcades, et comportant des données permettant de positionner les modèles de ces arcades l'un par rapport à l'autre dans la position d'occlusion.

De préférence, pour estimer les points de contact entre les dents des arcades supérieure et inférieure, on détermine l'ensemble des points du modèle de l'arcade supérieure et de l'arcade inférieure qui sont à une distance inférieure à une limite prédéterminée, cette limite étant de préférence inférieure à 3 mm, de préférence d'environ 2 mm. Tous les autres points de ces modèles sont ensuite ignorés, ce qui conduit à la représentation de la figure 3b. Une régression linéaire permet alors de déterminer le plan d'occlusion (« plan 1 » sur la figure 3c).

Le modèle de référence initial peut ainsi être orienté suivant le plan d'occlusion (Fig. 3d).

Si le modèle de référence initial ne comporte pas de données permettant de positionner les arcades supérieure et inférieure l'une par rapport à l'autre, on utilise de préférence un mordu d'occlusion faisant apparaître les points de contact entre les dents supérieures et les dents inférieures, puis on repositionne les modèles des arcades supérieure et inférieure par rapport à ce mordu d'occlusion.

Le plan longitudinal médian est perpendiculaire au plan d'occlusion, mais son orientation n'est pas connue.

De préférence, on procède de la manière suivante pour déterminer l'orientation du plan longitudinal médian :

On considère des axes [Ox) et [Oy) dans le plan d'occlusion, le point O étant le barycentre des projections normales des points de contact sur le plan d'occlusion.

- Dans ce référentiel (xOy), on recherche la courbe, de préférence parabolique, présentant le plus grand coefficient de corrélation avec l'ensemble desdites projections.
- L'ensemble des projections des points de contact est ensuite déplacé dans le plan d'occlusion, par rotation autour du point O, et on recommence l'étape précédente à partir de cette nouvelle position angulaire des projections des points de contact.

Le cycle des opérations précédentes est poursuivi, de préférence jusqu'à avoir fait tourner l'ensemble des points de contact de 360° autour du barycentre O. On compare ensuite les coefficients de corrélation correspondant aux différentes orientations de l'ensemble des points de contact. L'axe de la courbe qui conduit au coefficient de corrélation le plus élevé est alors considéré comme inclus dans le plan longitudinal médian, ce qui permet de définir exactement l'orientation de ce dernier.

L'orientation dans l'espace du modèle de référence initial est ainsi parfaitement déterminée, de manière rapide.

Création des modèles de dent

Dans le modèle de référence initial, une partie qui correspond à une dent, ou « modèle de dent », est délimitée par un bord gingival qui peut être décomposé en un bord gingival intérieur (du côté de l'intérieur de la bouche par rapport à la dent), un bord gingival extérieur (orienté vers l'extérieur de la bouche par rapport à la dent) et deux bords gingivaux latéraux. Les bords gingivaux correspondent à des régions dans lesquelles l'orientation de la surface définie par le modèle de référence initial subit des modifications de fortes amplitudes. Ces variations d'orientation peuvent être identifiées selon des techniques connues, par exemple en identifiant les changements de direction de la normale à la surface modélisée. La figure 4a représente une vue du modèle de référence initial

traitée pour faire apparaître ces changements de direction. La figure 4b montre le bord gingival intérieur qui peut être extrait par l'analyse de l'image de la figure 4a.

Plusieurs vues du modèle de référence initial sont ainsi analysées, ce qui permet de déterminer les bords gingivaux intérieur et extérieur en trois dimensions, comme représenté sur la figure 4c.

Par ailleurs, en projection dans le plan d'occlusion, les contours gingivaux intérieur et extérieur d'une arcade se rapprochent de part et d'autre d'une dent. Pour déterminer un bord gingival latéral d'une dent, on recherche le plus court chemin, sur la surface du modèle de référence initial, entre les deux points des bords gingivaux intérieur et extérieur ainsi rapprochés et qui se font sensiblement face. La recherche du plus court chemin entre deux points sur un modèle tridimensionnel fait appel à des techniques d'optimisation bien connues. De préférence, cette recherche résulte d'une méthode métaheuristique, de préférence évolutionniste, de préférence d'un recuit simulé.

Deux bords gingivaux latéraux adjacents et les parties des bords gingivaux intérieur et extérieur qui connectent ces bords gingivaux latéraux permettent ainsi de délimiter une dent au niveau de la gencive. En tenant compte du fait qu'une dent s'étend depuis le contour gingival vers le plan d'occlusion, il est ainsi possible de déterminer les parties du modèle de référence initial qui correspondent aux différentes dents (« modèles de dent »). La figure 4d représente l'ensemble des modèles de dent d'une arcade.

Le modèle de référence initial peut être stocké dans une base de données centralisée, regroupant les modèles de référence initiaux d'une pluralité de patients. Cette base de données peut être physiquement installée dans un établissement spécialisé. Elle peut être également installée dans un laboratoire ou un cabinet d'orthodontie, ce qui limite les transferts d'informations confidentielles.

Dans un mode de réalisation, le modèle de référence initial est remis au patient. De préférence, un fichier informatique correspondant au modèle de référence initial est enregistré sur un support amovible, par exemple sur une clé USB ou sur une carte électronique, de préférence sur un téléphone mobile, une tablette ou un ordinateur portable du patient, et en particulier sur l'appareil personnel qui sera de préférence utilisé aux étapes b) et suivantes. De préférence, le patient ou un professionnel des soins dentaires charge le modèle de référence initial dans ledit appareil individuel ou le met à disposition

pour chargement dans ledit appareil individuel. Le patient charge de préférence le modèle de référence initial à partir d'internet.

Dans un mode de réalisation préféré, le modèle de référence n'est pas remis au patient. De préférence, le modèle de référence est seulement rendu disponible à un établissement spécialisé pour mettre en œuvre les étapes c) à f). Il peut rester stocké dans l'établissement dans lequel il a été réalisé à l'étape a) et où, de préférence, les étapes c) à f) sont mises en œuvre.

A l'étape b), on prend une image actualisée des arcades au moyen d'un appareil d'acquisition d'images. L'étape b) est de préférence réalisée par le patient ou un proche du patient, mais peut être réalisée par un dentiste.

Moment de l'acquisition

De préférence, l'image actualisée est prise après un intervalle de temps Δt après l'étape a). L'intervalle de temps Δt peut être prédéterminé. Il peut être constant, quelle que soit l'occurrence du procédé, c'est-à-dire que cet intervalle concerne la première exécution du procédé ou une exécution ultérieure. Il peut être variable, et dépendre par exemple des résultats obtenus suite à une exécution antérieure du procédé. En particulier, pour le contrôle de la récidive, l'intervalle de temps Δt peut être d'autant plus court que cette exécution a permis de détecter une dérive importante.

Dans un mode de réalisation préféré, l'intervalle de temps Δt est déterminé par l'orthodontiste, en fonction d'un planning des contrôles. En fonction de l'évolution de la position des dents, l'orthodontiste peut modifier ce planning et modifier en conséquence l'intervalle de temps Δt. Dans un mode de réalisation, le procédé selon l'invention est exécuté plusieurs fois, les intervalles de temps entre chaque exécution pouvant être identiques ou différents. Les intervalles des temps entre deux exécutions successives peuvent être tous déterminés avant la première exécution pour correspondre à un planning de contrôles élaboré par l'orthodontiste.

L'intervalle de temps Δt peut être également indéterminé et dépendre par exemple de décisions du patient. Par exemple, la création d'une image actualisée peut être effectuée à l'occasion d'un rendez-vous chez le dentiste ou à tout moment lorsque le patient le souhaite, voire indépendamment de tout traitement orthodontique.

L'intervalle de temps Δt est de préférence déterminé pour correspondre à une évolution potentiellement significative du positionnement des dents.

Par exemple, pour le contrôle de la récidive, l'intervalle de temps Δt est de préférence inférieur à trois mois lors de la première année après le traitement. Après cette première année, l'intervalle de temps Δt est de préférence supérieur à un mois, voire supérieur à six mois ou supérieur à douze mois. En particulier pour la détection d'une dérive des dents, un intervalle de temps compris entre six mois et dix-huit mois est adapté.

De préférence, au moins un rappel informant le patient de la nécessité de créer une image actualisée est adressé au patient. Ce rappel peut être sous forme papier ou, de préférence, sous forme électronique, par exemple sous la forme d'un courriel, d'une alerte automatique de l'applicatif spécialisé mobile ou d'un SMS. Un tel rappel peut être envoyé par le cabinet ou le laboratoire d'orthodontie ou par le dentiste ou par l'applicatif spécialisé mobile du patient, par exemple.

Dans un mode de réalisation préféré, une image actualisée est acquise avant que les dents n'aient pu se déplacer significativement, sensiblement au même moment que la création du modèle de référence initial, de préférence moins de 7 jours, moins de 3 jours, moins de 1 jour après l'étape a), c'est-à-dire avant que les dents n'aient pu se déplacer significativement. La mise en œuvre du procédé avec cette image actualisée permet avantageusement de vérifier que le procédé ne conduit à la détection d'aucune différence entre les modèles de référence initial et final, et donc fonctionne correctement.

Dans un mode de réalisation, l'image actualisée peut être acquise avant la création du modèle de référence initial. Par exemple, les étapes a) et b) peuvent être effectuées à la fin et au début d'un traitement orthodontique, respectivement. Il est ainsi notamment possible d'évaluer l'efficacité du traitement en l'absence de modèle 3D en début de traitement. L'intervalle de temps Δt' séparant les étapes a) et b) dans ce mode de réalisation peut notamment prendre les valeurs décrites ci-dessus pour Δt.

Appareil d'acquisition d'images

De préférence, l'appareil d'acquisition d'images est un appareil personnel couramment disponible dans le commerce, par exemple un téléphone mobile, un appareil photo dit « connecté », une montre dite « intelligente », ou « smartwatch », ou une tablette ou un ordinateur personnel, fixe ou portable, comportant un système d'acquisition d'images, comme une webcam ou un appareil photo, de préférence un appareil photo numérique.

Même si l'image actualisée peut en particulier être créée par un dentiste, elle l'est de préférence par le patient lui-même ou par un de ses proches.

En particulier, l'image actualisée peut être créée par une personne qui n'a pas de connaissances particulières en orthodontie, et en particulier qui ne possède aucun diplôme d'orthodontie ou de dentisterie.

De préférence, le même appareil d'acquisition est utilisé pour prendre toutes les images actualisées.

L'appareil d'acquisition d'images pèse de préférence moins de 3 kg, moins de 2 kg, moins de 1 kg, moins de 500 g, de préférence moins de 300 g.

L'étape b) peut donc avantageusement être réalisée à distance de l'étape a), c'est-à-dire dans un lieu différent de celui dans lequel est réalisée l'étape a), en particulier à plus de 50 m, plus de 100 m, plus de 1 km du lieu où est réalisée l'étape a), en particulier hors cabinet orthodontique. Dans un mode de réalisation, l'étape b) n'est pas réalisée dans un cabinet dentaire, un cabinet d'orthodontie ou un laboratoire d'orthodontie, sauf, éventuellement, lors d'une séance destinée à former le patient.

De préférence, l'image actualisée est une photographie, en particulier une photographie panoramique. Dans un mode de réalisation, l'image actualisée est extraite d'un film.

Dans un mode de réalisation préféré, le procédé utilise plusieurs images actualisées pour disposer d'au moins une représentation de chaque dent, de préférence au moins trois images actualisées correspondant à une vue de face, une vue à droite et une vue à gauche des dents du patient.

De préférence, à l'étape b), on prend au moins une image actualisée en position bouche fermée et au moins une image actualisée en position bouche ouverte. L'image bouche fermée permet avantageusement d'identifier les déplacements relatifs entre les deux arcades. L'image actualisée bouche ouverte permet avantageusement de bien identifier les contours des dents, sans que les dents de l'arcade supérieure ne viennent masquer les dents de l'arcade inférieure ou réciproquement.

Des images actualisées peuvent être prises soit pour l'arcade supérieure, soit pour l'arcade inférieure, soit, de préférence, pour les deux arcades.

Plusieurs images similaires (représentant sensiblement les mêmes dents) peuvent être également utiles afin de rechercher le meilleur score. En fonction des conditions

d'acquisition, une information discriminante pourra en particulier conduire à des scores différents selon l'image actualisée utilisée.

De préférence, on utilise un écarteur lors de l'étape b), comme représenté sur les figures 5a et 5c. La première fonction de l'écarteur est d'écarter les lèvres afin d'améliorer la visibilité des dents. De préférence, un écarteur est remis au patient, par exemple lors d'un rendez-vous avec son orthodontiste ou son dentiste.

L'appareil d'acquisition d'images fournit de préférence des images en couleurs, et/ou des images infrarouges de la bouche du patient, voire du visage du patient. Les images en couleurs représentent de préférence la bouche du patient avec les couleurs réelles de cette bouche. Les images infrarouges permettent avantageusement de faire apparaître les dents avec un excellent contraste.

De préférence, l'appareil d'acquisition d'images comporte un applicatif spécialisé permettant de mettre en œuvre l'étape b), mais aussi, de préférence, des étapes suivantes, de préférence l'ensemble des étapes suivantes. De préférence encore, cet applicatif gère des rappels et informe le patient de la nécessité de créer une image actualisée.

De préférence, l'applicatif spécialisé est chargé dans l'appareil d'acquisition d'images à partir d'un support physique comme une clé USB ou un CD-ROM, ou est téléchargé sur internet ou par voie hertzienne. Dans un mode de réalisation, l'applicatif spécialisé est fourni au patient par le cabinet et/ou le laboratoire d'orthodontie. Il peut en particulier prendre la forme d'un applicatif du type de ceux couramment téléchargés sur les iPhones de la marque Apple® ou les appareils de toutes marques mettant en œuvre les systèmes d'exploitation Android® ou tout autre système d'exploitation.

L'appareil d'acquisition d'images comporte de préférence un appareil photo ou une caméra vidéo ou infrarouge, que l'utilisateur, par exemple le patient ou un de ses proches, positionne au moyen d'un viseur ou d'un écran, avant de l'actionner.

Moyens détrompeurs

Un procédé selon l'invention ne requiert pas un positionnement précis de l'appareil d'acquisition d'images par rapport aux dents.

Dans un mode de réalisation, aucune contrainte de positionnement permettant d'assurer une disposition de l'appareil d'acquisition d'images à moins de 30 cm, moins de 20 cm, de 10 cm ou moins de 5 cm d'un emplacement déterminé n'est imposée

De préférence, l'appareil d'acquisition d'images comporte cependant des moyens détrompeurs facilitant son positionnement approximatif par rapport au patient avant l'acquisition de l'image actualisée.

L'utilisateur peut être guidé par des messages écrits et/ou vocaux pour l'acquisition. Par exemple, l'appareil personnel peut annoncer « prenez une photo de face », émettre un signal pour informer l'utilisateur que la photo est acceptable ou qu'au contraire, il doit refaire une photo, annoncer « prenez une photo de droite », de préférence en affichant une flèche pour orienter l'utilisateur, etc. La fin du processus d'acquisition peut être également annoncée par l'appareil. L'appareil peut également aider au positionnement, par exemple par des messages visuels (par exemple par affichage de flèches), et/ou sonores (comme une succession de bips dont la fréquence augmente à mesure que le positionnement de l'appareil s'améliore), et/ou écrits et/ou vocaux (« plus haut », plus bas », etc.).

Les moyens détrompeurs peuvent en particulier comporter des références qui apparaissent sur le viseur ou l'écran. Les références peuvent par exemple comporter une ligne destinée à être alignée avec la direction générale de la jointure entre les dents supérieures et/ou les dents inférieures lorsque les dents sont serrées par le patient, ou une ligne verticale destinée à être alignée avec la jointure entre les deux incisives supérieures. Les références peuvent également faire référence à d'autres parties du patient. Par exemple, elles peuvent être constituées par des marques correspondant à la position des yeux ou prendre la forme d'un contour dans lequel doit être positionné la bouche ou le visage du patient.

La ou les références sont de préférence "immobiles" sur l'écran, c'est-à-dire qu'elles ne se déplacent pas sur l'écran lorsque l'appareil d'acquisition est en mouvement.

Dans un mode de réalisation préféré, la ou les références correspondent chacune à une marque de repérage portée par un référentiel rapporté sur le patient, c'est-à-dire que le patient ne présentait pas avant la mise en œuvre du procédé, de préférence portée par un écarteur dentaire. Un référentiel peut être également une pièce mordue par le patient.

La marque de repérage peut présenter une surface supérieure à 0,5 mm^2, de préférence supérieure à 1 mm^2, de préférence supérieure à 2 mm^2, de préférence supérieure à 5 mm^2, de préférence supérieure à 10 mm^2, voire supérieure à 20 mm^2, voire supérieure à 30 mm^2, et/ou inférieure à 50 mm^2.

De grandes dimensions conférées à une marque de repérage ou une multiplication des marques de repérage permettent avantageusement d'améliorer la précision du positionnement de l'appareil d'acquisition.

Les marques de repérage peuvent être identiques ou différentes.

Les marques de repérage peuvent être notamment différentes selon leur position, par exemple selon qu'elles sont en partie supérieure ou en partie inférieure du référentiel, et en particulier de l'écarteur, ou à droite ou à gauche du référentiel, et en particulier de l'écarteur.

La marque de repérage peut être identique ou différente de la référence correspondante. Elle est de préférence de forme géométrique, par exemple un point, un ou plusieurs traits, par exemple parallèles, une étoile, un cercle, un oval, un polygone régulier, notamment un carré, un rectangle ou un losange.

La marque de repérage peut être également une image, une lettre, un chiffre ou une séquence de lettres et/ou de chiffres.

La marque de repérage est de préférence d'une couleur différente de la surface de l'écarteur qui l'environne, de préférence de manière à offrir un contraste élevé.

Une marque de repérage peut être visible ou invisible à l'œil nu, pourvu qu'elle apparaisse sur l'écran de l'appareil d'acquisition.

Pour améliorer la précision, les marques de repérage sont de préférence écartées les unes des autres de manière que, lorsqu'elles correspondent à leurs références respectives sur l'écran, au moins des première et deuxième marques de repérage soient à moins de 3 cm, de préférence moins de 2 cm, de préférence moins de 1 cm, de préférence moins de 0,5 cm, de premier et deuxième bords, respectivement, de l'écran. Les premier et deuxième bords sont de préférence des bords opposés de l'écran.

La marque de repérage peut présenter une ou plusieurs dimensions et/ou une forme et/ou une couleur identique(s) ou différente(s) de celle(s) de la référence correspondante.

La « correspondance » d'une référence et d'une marque de repérage est une disposition prédéfinie de l'une par rapport à l'autre. Elle indique un positionnement particulier de l'appareil d'acquisition par rapport à la marque de repérage. La correspondance dépend de la nature de la référence et de la marque de repérage. La situation prédéfinie, qui correspond à des conditions d'acquisition cibles, peut notamment être une superposition,

totale ou partielle, une juxtaposition, ou un alignement de la référence et de la marque de repérage.

La superposition exacte de la référence et de la marque de repérage permet non seulement déterminer la direction vers laquelle l'objectif de l'appareil d'acquisition doit pointer et/ou la distance entre l'appareil d'acquisition et l'écarteur, mais aussi, si la référence et/ou la marque de repérage sont asymétriques, l'orientation de l'appareil d'acquisition autour de cette direction.

Les dimensions et/ou les surfaces d'une marque de repérage et de la référence correspondante et/ou la distance entre plusieurs marques de repérage et entre des références correspondantes peuvent être utilisées pour régler la distance entre l'appareil d'acquisition et les arcades.

La référence peut être par exemple

- une ligne fixe, sur laquelle l'utilisateur doit par exemple aligner des marques de repérage,
- une forme, de préférence asymétrique, correspondant à la forme d'une marque de repérage à superposer, par exemple un point que l'utilisateur doit par exemple superposer à la marque de repérage, ou un cercle dans lequel l'utilisateur doit par exemple placer la marque de repérage,
- une forme colorée correspondant à la couleur d'une marque de repérage à superposer,
- une forme complémentaire à la forme d'une marque de repérage, de préférence de manière que la mise en correspondance de la marque de repérage et de la référence conduise à une forme ayant un sens, comme une forme géométrique, une lettre ou un texte, un dessin, ou un motif, par exemple.

Dans un mode de réalisation préféré, les références sont définies, au moins partiellement, à partir d'informations fournies par le modèle de référence initial. Par exemple, suivant les principes de la « réalité augmentée », la référence peut être une vue du modèle de référence initial, par exemple une vue de face ou une vue de droite ou une vue de gauche du modèle de référence initial, rendue visible, en transparence, sur l'écran de l'appareil d'acquisition d'images lors de l'acquisition. Il est ainsi très facile pour le patient de superposer approximativement une telle vue avec les dents qu'il doit prendre en photo.

Dans un mode de réalisation, le positionnement de l'appareil d'acquisition d'images résulte de la seule mise en concordance de références apparaissant sur l'écran dudit appareil d'acquisition avec des marques de repérage correspondantes, de préférence avec des marques de repérage d'un écarteur dentaire.

Dans un mode de réalisation, la ou les références qui apparaissent sur l'écran sont déterminées en fonction du patient et/ou du traitement thérapeutique. Autrement dit, le programme d'ordinateur est paramétré en fonction du patient afin que les images acquises correspondent spécifiquement aux besoins du patient. Avantageusement, au moment de l'acquisition des images, l'appareil d'acquisition est donc positionné dans une position sensiblement optimale au regard des particularités du patient et/ou du traitement thérapeutique appliqué.

Comme on le verra plus en détails dans la suite de la description, les marques de repérage de l'écarteur ont de préférence plusieurs fonctions. Elles permettent d'abord de guider le positionnement de l'appareil d'acquisition d'images au moment de l'acquisition des images, au moyen de références correspondantes apparaissant sur l'écran de l'appareil d'acquisition. Elles permettent également, à l'étape c), un redécoupage des images actualisées. Enfin, les marques de repérage, qui apparaissent sur les images, permettent, à l'étape d), de déterminer grossièrement des conditions d'acquisition virtuelles approximant les conditions d'acquisition réelles, ce qui permet d'accélérer le traitement informatique.

Les étapes c) et suivantes sont de préférence réalisées soit sur un appareil personnel du patient, de préférence avec l'appareil utilisé à l'étape b), soit avec un applicatif chez un professionnel des soins dentaires, soit avec un serveur tiers dédié.

A l'étape c), chaque image actualisée est analysée de manière à réaliser, pour chaque image actualisée, une carte actualisée relative à au moins une information discriminante.

<u>Redécoupage</u>

L'analyse de l'image peut comporter un redécoupage de l'image actualisée afin d'isoler la partie pertinente, en particulier pour supprimer, au moins partiellement, de l'image actualisée les éléments qui n'ont pas fait l'objet du modèle de référence initial, comme le nez ou les yeux du patient ou l'écarteur. Ce redécoupage, ou « croppage », est facilité par la représentation de marques de repérage sur l'image actualisée.

En particulier, de préférence, comme représenté sur les figures 5a et 5c, l'écarteur 10 porte au moins trois marques de repérage 12 non alignées. Si l'écarteur est en plusieurs parties, par exemple classiquement en deux parties, chaque partie porte de préférence au moins trois marques de repérage non alignées.

La forme d'une marque de repérage, par exemple une forme asymétrique, peut être également utilisée pour repérer la position de l'écarteur sur l'image actualisée.

De préférence, les marques de repérage présentent des formes et/ou des couleurs facilitant leur identification sur une image actualisée. Par exemple, elles peuvent être de couleur noire alors que le reste de l'écarteur est de couleur blanche.

Dans un mode de réalisation, les marques de repérage présentent des formes et/ou des couleurs permettant de les identifier individuellement. Par exemple, elles peuvent être chacune de couleur différente.

L'identification des marques de repérage sur l'image actualisée permet d'identifier la zone de l'image actualisée contenant les éléments ayant fait l'objet du modèle de référence initial, c'est-à-dire les dents et les gencives. L'image actualisée peut alors être rognée en conséquence. La comparaison des figures 5a et 5b, ou 5c et 5d, illustre l'effet du redécoupage sur une image actualisée.

Carte actualisée

Une carte actualisée représente une information discriminante dans le référentiel de l'image actualisée. Par exemple, la figure 6b est une carte actualisée relative au contour des dents obtenue à partir de l'image actualisée de la figure 6a.

L'information discriminante est de préférence choisie dans le groupe constitué par une information de contour, une information de couleur, une information de densité, une information de distance, une information de brillance, une information de saturation, une information sur les reflets et des combinaisons de ces informations.

L'homme de l'art sait comment traiter une image actualisée pour faire apparaître l'information discriminante. Ce traitement comporte par exemple l'application de masques ou de filtres bien connus, fournis avec des logiciels de traitement d'images.

A l'étape optionnelle d), on détermine, de manière grossière, les conditions d'acquisition réelles lors de l'étape b). Autrement dit, on détermine au moins la position relative de l'appareil d'acquisition d'images au moment où il a pris l'image actualisée (position de

l'appareil d'acquisition dans l'espace et orientation de cet appareil). L'étape d) permet avantageusement de limiter le nombre de tests sur des conditions d'acquisition virtuelles lors de l'étape e), et permet donc d'accélérer considérablement l'étape e).

On utilise de préférence une ou plusieurs règles heuristiques. Par exemple, de préférence, on exclut des conditions d'acquisition virtuelles susceptibles d'être testées à l'étape e), les conditions qui correspondent à une position de l'appareil d'acquisition d'images derrière les dents ou à une distance des dents supérieure à 1 m.

Dans un mode de réalisation préféré, comme illustré sur la figure 7, on utilise des marques de repérage représentées sur l'image actualisée, et en particulier des marques de repérage 12 de l'écarteur, pour déterminer une région de l'espace sensiblement conique délimitant des conditions d'acquisition virtuelles susceptibles d'être testées à l'étape e), ou "cône de test".

Précisément, on dispose de préférence au moins trois marques de repérage 12 non alignées sur l'écarteur 10, par exemple, et on mesure précisément leurs positions relatives sur l'écarteur.

Les marques de repérage sont ensuite repérées sur l'image actualisée, comme décrit précédemment. De simples calculs trigonométriques permettent de déterminer approximativement la direction selon laquelle l'image actualisée a été prise. Un cône orienté selon cette direction, dont le sommet est au niveau de l'écarteur et dont le demi-angle au sommet est de préférence inférieur à 10°, de préférence inférieur à 5°, par exemple de 3° peut alors être défini comme "cône de test". Le demi-angle au sommet correspond à un degré d'incertitude. Plus le demi-angle au sommet est petit, plus grande est la probabilité que les conditions d'acquisition virtuelles correspondant aux conditions d'acquisition réelles soient hors du cône de test.

Par exemple, lorsque l'image actualisée est prise perpendiculairement au plan des trois marques de repérage sur l'écarteur, on peut en déduire que l'appareil d'acquisition était sensiblement dans un cône de test dont l'axe est sensiblement perpendiculaire à ce plan lors de la prise de l'image actualisée. Si les positions relatives des trois marques de repérage sur l'image actualisée sont différentes de celles que les marques de repérage occupent sur l'écarteur, l'axe du cône de test dans lequel est limitée la recherche du positionnement de l'appareil d'acquisition lors de l'acquisition de l'image actualisée est incliné par rapport au plan des marques de repérage, comme représenté sur la figure 7.

Dans un mode de réalisation particulier, comme illustré sur les figures 5a et 5c, l'écarteur comporte des parties gauche et droite indépendantes, qui comportent chacune au moins trois marques de repérage, de préférence au moins quatre marques de repérage. Un cône de test gauche peut être ainsi déterminé au moyen des marques de repérage de la partie gauche et un cône de test droit peut être déterminé au moyen des marques de repérage de la partie droite de l'écarteur. Les conditions d'acquisition virtuelles susceptibles d'être testées peuvent être ensuite limitées à des positions de l'appareil d'acquisition dans l'espace appartenant à ces deux cônes de test. On peut aussi considérer que la meilleure évaluation de la position de l'appareil d'acquisition correspond à la position moyenne entre la meilleure position dans le cône de test gauche et la meilleure position dans le cône de recherche droit.

La position des marques de repérage sur l'image actualisée permet également d'évaluer l'assiette de l'appareil d'acquisition lors de la capture de l'image actualisée. Par exemple, si on sait que deux marques de repérage sont sensiblement alignées selon une direction horizontale lors de l'acquisition de l'image actualisée, la direction de la droite contenant ces deux points sur l'image actualisée fournit une indication sur l'orientation de l'appareil d'acquisition dans les conditions d'acquisition réelles.

Enfin, la taille des marques de repérage sur l'image actualisée ou leur espacement peuvent permettre d'évaluer la distance entre l'appareil d'acquisition d'images et les dents lors de l'acquisition de l'image actualisée, et donc de réduire le cône de test à un tronc de cône.

A l'étape optionnelle d), on peut également utiliser des données fournies par l'appareil d'acquisition et concernant son orientation, par exemple des données gyroscopiques.

De préférence, à l'étape d), on détermine, de manière grossière, la calibration de l'appareil d'acquisition réelle lors de l'étape b).

La façon dont chaque paramètre de calibration agit sur l'image acquise est bien connue. En particulier, le fonctionnement d'un appareil d'acquisition peut être classiquement modélisé de manière à pouvoir tester une calibration particulière sur l'image acquise. Les inventeurs ont inversé un tel modèle, sans difficulté technique particulière, afin que par l'analyse de la représentation de l'écarteur, il soit possible d'évaluer grossièrement la calibration de l'appareil d'acquisition lors de l'étape b).

Par exemple, le rapport entre la surface des marques de repérage sur l'image actualisée et la surface de l'image actualisée permet d'évaluer la distance focale de l'appareil d'acquisition

lors de l'étape b). La représentation d'une marque de repérage dont on connait les caractéristiques optiques permettent d'évaluer le temps d'exposition et la sensibilité.

Dans un mode de réalisation préféré, une marque de repérage est un relief qui ne s'étend pas exclusivement dans le plan général de l'écarteur, correspondant à un plan parallèle au frontal (ou coronal). De préférence, une marque de repérage est un relief qui s'étend dans un plan sensiblement perpendiculaire au plan général de l'écarteur. Le relief peut en particulier présenter la forme d'une languette qui, lorsque l'écarteur est dans sa position de service, s'étend vers le fond de la bouche.

L'analyse de la représentation de ce relief permet avantageusement d'évaluer la profondeur de champ. Alternativement, deux marques de repérage qui ne sont pas dans un même plan frontal peuvent être utilisées à cet effet.

L'étape d) ne permet qu'une évaluation grossière des conditions d'acquisition réelles. L'étape d) permet cependant de déterminer un ensemble restreint de conditions d'acquisition virtuelles susceptibles de correspondre aux conditions d'acquisition réelles, et, dans cet ensemble, des conditions d'acquisition virtuelles constituant le meilleur point de départ pour l'étape e1) décrite ci-après.

L'étape d) permet également de détecter des images actualisées inadaptées pour la poursuite du procédé, par exemple une image actualisée qui ne ferait pas apparaître les marques de repérage. De préférence, le procédé est alors repris à l'étape c) avec une nouvelle image actualisée.

Bien entendu, les différentes méthodes pouvant être mises en œuvre à l'étape d) peuvent être combinées.

L'objectif de l'étape e) est de modifier le modèle de référence initial jusqu'à obtenir un modèle de référence final qui corresponde à l'image actualisée. Idéalement, le modèle de référence final est donc un modèle de référence tridimensionnel numérique à partir duquel l'image actualisée aurait pu être prise si ce modèle avait été réel.

On teste donc une succession de modèles de référence « à tester », le choix d'un modèle de référence à tester étant de préférence dépendant du niveau de correspondance des modèles de référence « à tester » précédemment testés avec l'image actualisée. Ce choix est de préférence effectué en suivant un procédé d'optimisation connu, en particulier choisi parmi

les procédés d'optimisation métaheuristiques, de préférence évolutionnistes, en particulier dans les procédés de recuit simulé.

A l'étape e1), on détermine que le modèle de référence à tester est le modèle de référence initial lors de la première exécution de l'étape e2).

A l'étape e2), on commence par déterminer des conditions d'acquisition virtuelles à tester, c'est-à-dire une position et une orientation virtuelles susceptibles de correspondre à la position et l'orientation réelles de l'appareil d'acquisition lors de la capture de l'image actualisée, mais aussi, de préférence, une calibration virtuelle susceptible de correspondre à la calibration réelle de l'appareil d'acquisition lors de la capture de l'image actualisée.

Les premières conditions d'acquisition virtuelles à tester peuvent être aléatoires. De préférence, elles sont choisies dans l'ensemble limité déterminé à l'étape d), et de préférence encore, correspondent à des conditions d'acquisition virtuelles correspondant, d'après l'étape d), aux conditions d'acquisition virtuelles les plus prometteuses, c'est-à-dire constituant le meilleur tremplin pour approcher, le plus rapidement possible, les conditions d'acquisition réelles (étape e21)).

On configure ensuite virtuellement l'appareil d'acquisition d'images dans les conditions d'acquisition virtuelles à tester afin d'acquérir une image de référence du modèle de référence dans ces conditions d'acquisition virtuelles à tester. L'image de référence correspond donc à l'image qu'aurait prise l'appareil d'acquisition d'images s'il avait été placé, par rapport au modèle de référence à tester, et optionnellement calibré dans les conditions d'acquisition virtuelles à tester (étape e22)).

Si l'image actualisée a été prise au même moment que le modèle de référence a été réalisé, et si les conditions d'acquisition virtuelles sont exactement les conditions d'acquisition réelles, l'image de référence est donc exactement superposable à l'image actualisée. Les différences entre l'image actualisée et l'image de référence résultent d'erreurs dans l'évaluation des conditions d'acquisition virtuelles (si elles ne correspondent pas exactement aux conditions d'acquisition réelles) et de déplacements des dents entre l'étape b) et le modèle de référence à tester.

Pour comparer les images actualisée et de référence, on compare l'information discriminante sur ces deux images. Plus précisément, on réalise, à partir de l'image de référence, une carte de référence représentant l'information discriminante (étape e23)).

Les cartes actualisées et de référence, portant toutes les deux sur la même information discriminante, sont ensuite comparées et on évalue la différence entre ces deux cartes au moyen d'un score. Par exemple, si l'information discriminante est le contour des dents, on peut comparer la distance moyenne entre les points du contour des dents qui apparait sur l'image de référence et les points du contour correspondant qui apparaît sur l'image actualisée, le score étant d'autant plus élevé que cette distance est faible.

Le score peut être par exemple un coefficient de corrélation.

De préférence, les conditions d'acquisition virtuelles comprennent les paramètres de calibration de l'appareil d'acquisition. Le score est d'autant plus élevé que les valeurs des paramètres de calibration testées sont proches des valeurs des paramètres de calibration de l'appareil d'acquisition utilisé à l'étape b). Par exemple, si l'ouverture de diaphragme testée est éloignée de celle de l'appareil d'acquisition utilisé à l'étape b), l'image de référence présente des régions floues et des régions nettes qui ne correspondent pas aux régions floues et aux régions nettes de l'image actualisée. Si l'information discriminante est le contour des dents, les cartes actualisée et de référence ne représenteront donc pas les mêmes contours et le score sera faible.

Le score est ensuite évalué au moyen d'une première fonction d'évaluation. La première fonction d'évaluation permet de décider si le cyclage sur l'étape e2) doit être poursuivi ou stoppé. La première fonction d'évaluation peut par exemple être égale à 0 si le cyclage doit être stoppé ou être égale à 1 si le cyclage doit se poursuivre.

La valeur de la première fonction d'évaluation peut dépendre du score atteint. Par exemple, il peut être décidé de poursuivre le cyclage sur l'étape e2) si le score ne dépasse pas un premier seuil. Par exemple, si une correspondance exacte entre les images actualisée et de référence conduit à un score de 100%, le premier seuil peut être, par exemple, de 95%. Bien entendu, plus le premier seuil sera élevé, meilleure sera la précision de l'évaluation des conditions d'acquisition virtuelles si le score parvient à dépasser ce premier seuil.

La valeur de la première fonction d'évaluation peut également dépendre de scores obtenus avec des conditions d'acquisition virtuelles testées précédemment.

La valeur de la première fonction d'évaluation peut également dépendre de paramètres aléatoires et/ou du nombre de cycles de l'étape e2) déjà effectués.

En particulier, il est possible qu'en dépit de la répétition des cycles, on ne parvienne pas à trouver des conditions d'acquisition virtuelles qui soient suffisamment proches des conditions d'acquisition réelles pour que le score atteigne ledit premier seuil. La première fonction d'évaluation peut alors conduire à la décision de quitter le cyclage bien que le meilleur score obtenu n'ait pas atteint ledit premier seuil. Cette décision peut résulter, par exemple, d'un nombre de cycles supérieur à un nombre maximal prédéterminé.

Un paramètre aléatoire dans la première fonction d'évaluation peut également autoriser la poursuite de tests de nouvelles conditions d'acquisition virtuelles, bien que le score apparaisse satisfaisant.

Les fonctions d'évaluation classiquement utilisées dans les procédés d'optimisation métaheuristiques, de préférence évolutionnistes, en particulier dans les procédés de recuit simulé, peuvent être utilisées pour la deuxième fonction d'évaluation.

Si la valeur de la première fonction d'évaluation indique qu'il est décidé de poursuivre le cyclage sur l'étape e2), on modifie les conditions d'acquisition virtuelles testées (étape e25)) et on recommence un cycle (étape e2)) consistant à réaliser une image de référence et une carte de référence, puis à comparer cette carte de référence avec la carte actualisée pour déterminer un score.

La modification des conditions d'acquisition virtuelles correspond à un déplacement virtuel dans l'espace et/ou à une modification de l'orientation et/ou, de préférence, à une modification de la calibration de l'appareil d'acquisition. Cette modification peut être aléatoire, à condition cependant que les nouvelles conditions d'acquisition virtuelles à tester appartiennent toujours à l'ensemble déterminé à l'étape d). La modification est de préférence guidée par des règles heuristiques, par exemple en favorisant les modifications qui, d'après une analyse des précédents scores obtenus, apparaissent les plus favorables pour augmenter le score.

Les figures 8a et 8b illustrent par exemple l'effet d'une modification des conditions d'acquisition virtuelles, en l'occurrence d'une modification de la distance focale, sur l'image de référence.

Le cyclage sur e2) est poursuivi jusqu'à ce que la valeur de la première fonction d'évaluation indique qu'il est décidé de sortir de ce cyclage et de poursuivre à l'étape e3), par exemple si le score atteint ou dépasse ledit premier seuil.

L'optimisation des conditions d'acquisition virtuelles à l'étape e2) est de préférence effectuée en utilisant une méthode métaheuristique, de préférence évolutionniste, de préférence un algorithme de recuit simulé. Un tel algorithme est bien connu pour l'optimisation non linéaire.

Si on a quitté le cyclage sur l'étape e2), sans qu'un score satisfaisant ait pu être obtenu, par exemple sans que le score ait pu atteindre ledit premier seuil, le procédé peut être arrêté (situation d'échec) ou repris à l'étape c) avec une nouvelle information discriminante et/ou avec une nouvelle image actualisée. Le procédé peut être également poursuivi avec les conditions d'acquisition virtuelles correspondant au meilleur score atteint. Un avertissement peut être émis afin d'informer l'utilisateur de l'erreur sur le résultat.

Si on a quitté le cyclage sur l'étape e2) alors qu'un score satisfaisant a pu être obtenu, par exemple parce que le score a atteint, voire dépassé ledit premier seuil, les conditions d'acquisition virtuelles correspondent sensiblement aux conditions d'acquisition réelles. De préférence, les conditions d'acquisition virtuelles comprennent les paramètres de calibration de l'appareil d'acquisition. Le procédé conduit permet ainsi d'évaluer les valeurs de ces paramètres sans qu'il soit nécessaire de connaître la nature de l'appareil d'acquisition ou son réglage. L'étape b) peut donc être réalisée sans précaution particulière, par exemple par le patient lui-même au moyen de son téléphone portable.

En outre, la recherche de la calibration réelle est effectuée en comparant une image actualisée avec des vues d'un modèle de référence initial dans des conditions d'acquisition virtuelles que l'on teste. Avantageusement, elle ne nécessite pas que l'image actualisée fasse apparaître une jauge étalon de calibration, c'est-à-dire une jauge dont on connaît précisément les caractéristiques permettant déterminer la calibration de l'appareil d'acquisition.

WO2006/065955, incorporé par référence, décrit l'utilisation d'images pour fabriquer des modèles tridimensionnels dans le domaine des traitements orthodontiques. Cependant, ce document ne décrit pas de procédé permettant d'utiliser de simples photographies, présentant classiquement des images partielles des dents, des portions d'image floues et des reflets variables, prises généralement de manière non simultanée, sans avoir besoin de sélectionner des points remarquables sur les images, et avec un appareil d'acquisition dont la calibration n'est pas connue.

Dans un procédé de contrôle du positionnement de dents selon l'invention, les images actualisées ne servent pas à créer un modèle tridimensionnel actualisé totalement nouveau, mais seulement à modifier le modèle de référence initial, très précis. Un modèle tridimensionnel actualisé totalement nouveau créé à partir de simples photographies prises sans précautions particulières serait en particulier trop imprécis pour qu'une comparaison avec le modèle de référence initial puisse conduire à des conclusions sur le déplacement des dents.

Des différences peuvent subsister entre les conditions d'acquisition virtuelles déterminées et les conditions d'acquisition réelles, en particulier si des dents se sont déplacées entre les étapes a) et b). La corrélation entre les images actualisée et de référence peut alors être encore améliorée en reprenant l'étape e2), le modèle de référence à tester étant alors modifié par déplacement d'un ou plusieurs modèles de dents (étape e3)).

La recherche du modèle de référence approximant au mieux le positionnement des dents lors de l'acquisition de l'image actualisée peut être effectuée comme la recherche des conditions d'acquisition virtuelles approximant au mieux les conditions d'acquisition réelles (étape e2)).

En particulier, le score est évalué au moyen d'une deuxième fonction d'évaluation. La deuxième fonction d'évaluation permet de décider si le cyclage sur les étapes e2) et e3) doit être poursuivi ou stoppé. La deuxième fonction d'évaluation peut par exemple être égale à 0 si le cyclage doit être stoppé ou être égale à 1 si le cyclage doit se poursuivre.

La valeur de la deuxième fonction d'évaluation dépend de préférence du meilleur score obtenu avec le modèle de référence à tester, c'est-à-dire des différences entre les cartes actualisée et de référence, dans les conditions d'acquisition virtuelles approximant au mieux lesdites conditions d'acquisition réelles.

La valeur de la deuxième fonction d'évaluation peut également dépendre du meilleur score obtenu avec un ou plusieurs modèles de référence testés précédemment.

Par exemple, il peut être décidé de poursuivre le cyclage si le score ne dépasse pas un deuxième seuil minimal. La valeur de la deuxième fonction d'évaluation peut également dépendre de paramètres aléatoires et/ou du nombre de cycles des étapes e2) et e3) déjà effectués.

Les fonctions d'évaluation classiquement utilisées dans les procédés d'optimisation métaheuristiques, de préférence évolutionnistes, en particulier dans les procédés de recuit simulé, peuvent être utilisées pour la deuxième fonction d'évaluation.

Si la valeur de la deuxième fonction d'évaluation indique qu'il est décidé de poursuivre le cyclage sur les étapes e2) et e3), on modifie le modèle de référence à tester et on recommence un cycle (étapes e2) et e3)) avec le nouveau modèle de référence à tester.

La modification du modèle de référence à tester correspond à un déplacement d'un ou plusieurs modèles de dents. Cette modification peut être aléatoire. La modification est de préférence guidée par des règles heuristiques, par exemple en favorisant les modifications qui, d'après une analyse des précédents scores obtenus, apparaissent les plus favorables pour augmenter le score.

De préférence, on recherche le déplacement d'un modèle de dent qui a le plus fort impact sur le score, on modifie le modèle de référence à tester en déplaçant ce modèle de dent, puis on poursuit le cyclage sur les étapes e2) et e3) de manière à optimiser le score. On peut ensuite rechercher, parmi les autres modèles de dent, celui qui a le plus fort impact sur l'amélioration du score, et à nouveau rechercher le déplacement optimal de cet autre modèle de dent sur le score. On peut poursuivre ainsi avec chaque modèle de dent.

Ensuite, il est possible de reprendre un cycle sur l'ensemble des modèles de dent et de poursuivre ainsi jusqu'à l'obtention d'un score supérieur à au deuxième seuil. Bien entendu, d'autres stratégies peuvent être utilisées pour déplacer un ou plusieurs modèles de dent dans le modèle de référence à tester et rechercher le score maximal.

Le cyclage sur les étapes e2) et e3) est poursuivi jusqu'à ce que la valeur de la deuxième fonction d'évaluation indique qu'il est décidé de sortir de ce cyclage et de poursuivre à l'étape f), par exemple si le score atteint ou dépasse ledit deuxième seuil.

La recherche d'un modèle de référence avec un cyclage sur les étapes e2) et e3) pour rechercher les positions des modèles de dent qui optimisent le score est de préférence effectuée en utilisant une méthode métaheuristique, de préférence évolutionniste, de préférence un algorithme de recuit simulé. Un tel algorithme est bien connu pour l'optimisation non linéaire.

Si on a quitté le cyclage sur les étapes e2) et e3) sans qu'un score satisfaisant ait pu être obtenu, par exemple sans que le score ait pu atteindre ledit deuxième seuil, le procédé peut

être arrêté (situation d'échec) ou repris à l'étape c) avec une nouvelle information discriminante et/ou avec une nouvelle image actualisée.

S'il est décidé de relancer le procédé à l'étape c) à partir d'une autre information discriminante et/ou d'une autre image actualisée parce que le premier seuil ou le deuxième seuil n'a pas été atteint, le choix de la nouvelle information discriminante et/ou de la nouvelle image actualisée peut dépendre des scores obtenus précédemment, afin de favoriser l'information discriminante et/ou l'image actualisée qui, au regard de ces scores, apparaissent les plus prometteuses.

Une nouvelle information discriminante, obtenue par exemple par combinaison d'autres informations discriminantes déjà testées, peut être utilisée. Le cas échéant, il peut être également demandé d'acquérir une ou plusieurs nouvelles images actualisées. De préférence, on fournit des indications permettant de guider le positionnement de l'appareil d'acquisition pour la capture de cette nouvelle image actualisée. Par exemple, on peut indiquer au patient qu'il devrait prendre une photo de la partie droite de son arcade inférieure.

Si on a quitté le cyclage sur les étapes e2) et e3) sans qu'un score satisfaisant ait pu être obtenu, le procédé peut être également poursuivi avec le modèle de référence et les conditions d'acquisition virtuelles correspondant au meilleur score atteint. Un avertissement peut être émis afin d'informer l'utilisateur de l'erreur sur le résultat.

Si on a quitté le cyclage sur les étapes e2) et e3) alors qu'un score satisfaisant a pu être obtenu, par exemple parce que le score a atteint, voire dépassé ledit deuxième seuil, les conditions d'acquisition virtuelles correspondent sensiblement aux conditions d'acquisition réelles et les modèles de dents dans le modèle de référence obtenu (dit « modèle de référence final ») sont sensiblement dans la position des dents du patient au moment de l'étape b).

Le cyclage sur les étapes e2) et e3) permet avantageusement d'améliorer l'évaluation des paramètres de calibration de l'appareil d'acquisition à l'étape b).

A l'étape f), on compare le modèle de référence final, résultant de l'optimisation par déplacement des modèles de dents, avec le modèle de référence initial. Le modèle de référence final correspond sensiblement à l'image actualisée. La comparaison de l'étape f) permet donc d'observer les différences entre le positionnement des dents à l'étape a) (modèle de référence initial) et lors de l'acquisition de l'image actualisée (étape b)). Le

procédé permet ainsi de déterminer précisément, pour chacune des dents, les mouvements entre ces deux étapes.

En répétant les étapes b) et suivantes, il est également possible d'évaluer la vitesse d'évolution de la position des dents, et ainsi de mesurer, par exemple, l'efficacité d'un traitement orthodontique. Un procédé selon l'invention peut par exemple être utilisé pour suivre à distance l'évolution d'un traitement orthodontique, et ainsi optimiser les rendez-vous des patients chez leurs orthodontistes.

Dans un mode de réalisation préféré, le procédé de contrôle selon l'invention est mis en œuvre plusieurs fois pour un même patient, de préférence successivement avec plusieurs informations discriminantes, de préférence plus de 2, plus de 3, plus de 5 informations discriminantes pour chaque image actualisée et/ou avec plusieurs images actualisées, de préférence plus de 2, plus de 3, plus de 5 images actualisées. L'évaluation du déplacement d'une dent peut être ainsi affinée en tenant compte des différents scores obtenus. La comparaison de ces scores permet également, le cas échéant, d'écarter les informations discriminantes et/ou les images actualisées insatisfaisantes.

En fonction du déplacement mesuré, une information pratique peut être générée. Si le déplacement est faible, cette information pratique peut être qu'aucune action n'est à engager. Au contraire, si une ou plusieurs dents se sont sensiblement déplacées, l'information peut être de planifier une visite chez le dentiste ou l'orthodontiste. De préférence, l'information pratique dépend du degré de déplacement des dents. Dans un mode de réalisation, un rendez-vous peut être automatiquement pris chez le dentiste ou l'orthodontiste, en fonction de l'amplitude et/ou de la nature des déplacements détectés.

Dans un mode de réalisation, l'information pratique est utilisée pour modifier l'intervalle de temps après lequel le patient devra être averti qu'une nouvelle image actualisée doit être créée.

Dans un mode de réalisation, l'appareil individuel permet d'afficher des images, voire une séquence d'images montrant le positionnement des dents à différentes dates. Ces images peuvent être présentées sous la forme d'une animation.

De préférence, l'appareil d'acquisition d'images est un téléphone qui permet de transmettre les résultats obtenus par la mise en œuvre du procédé, de préférence de manière sécurisée.

La communication peut être par exemple effectuée, au moins en partie, par la voie hertzienne, de préférence suivant au moins un protocole choisi parmi les protocoles edge, 3G, 4G, udmsa, hpdmsa, bluetooth, et wifi, ou par tout autre protocole, adapté aux équipements mobiles ou nomades, par synchronisation filaire avec l'ordinateur personnel, ou par transmission optique.

Comme cela apparaît clairement à présent, un procédé selon l'invention permet un contrôle précis et efficace du positionnement des dents du patient, sensiblement sans contrainte pour le patient. En particulier, de simples photographies prises sans précaution particulière, par exemple avec un téléphone mobile, suffit. Le patient peut donc facilement mettre en œuvre ce procédé.

Bien entendu, l'invention n'est pas limitée aux modes de réalisation décrits ci-dessus et représentés.

En particulier, le procédé est mis en œuvre successivement pour chacune des deux arcades ou simultanément pour les deux arcades.

En outre, plusieurs appareils différents peuvent être également mis en œuvre. Par exemple, l'acquisition peut être effectuée avec un téléphone mobile et les étapes suivantes par un ordinateur fixe.

Enfin, le patient n'est pas limité à un être humain. En particulier, un procédé selon l'invention peut être utilisé pour un autre animal.

REVENDICATIONS

1. Procédé de contrôle du positionnement de dents d'un patient, ledit procédé comportant les étapes suivantes :
   a) moins de 3 mois après le début d'un traitement orthodontique, réalisation d'un modèle de référence tridimensionnel numérique des arcades du patient, ou « modèle de référence initial » et, pour chaque dent, définition, à partir du modèle de référence initial, d'un modèle de référence tridimensionnel numérique de ladite dent, ou « modèle de dent » ;
   b) acquisition d'au moins une image bidimensionnelle desdites arcades, dite « image actualisée », dans des conditions d'acquisition réelles ;
   c) analyse de chaque image actualisée et réalisation, pour chaque image actualisée, d'une carte actualisée relative à une information discriminante ;
   d) optionnellement, détermination, pour chaque image actualisée, de conditions d'acquisition virtuelles grossières approximant lesdites conditions d'acquisition réelles ;
   e) recherche, pour chaque image actualisée, d'un modèle de référence final correspondant au positionnement des dents lors de l'acquisition de l'image actualisée, la recherche étant de préférence effectuée au moyen d'une méthode métaheuristique, de préférence évolutionniste, de préférence par recuit simulé,
   f) pour chaque modèle de dent, comparaison des positionnements dudit modèle de dent dans le modèle de référence initial et dans le modèle de référence obtenu à l'issue des étapes précédentes, dit « modèle de référence final », afin de déterminer le déplacement des dents entre les étapes a) et b).

2. Procédé selon la revendication immédiatement précédente, dans lequel, l'étape e) comporte
   - une première opération d'optimisation permettant de rechercher des conditions d'acquisition virtuelles correspondant au mieux aux conditions d'acquisition réelles dans un modèle de référence à tester déterminé à partir du modèle de référence initial, et
   - une deuxième opération d'optimisation permettant de rechercher, en testant une pluralité de dits modèles de référence à tester, le modèle de référence correspondant

au mieux au positionnement des dents du patient lors de l'acquisition de l'image actualisée à l'étape b).

3. Procédé selon la revendication immédiatement précédente, dans lequel une première opération d'optimisation est effectuée pour chaque test d'un modèle de référence à tester lors de la deuxième opération d'optimisation.

4. Procédé selon l'une quelconque des deux revendications immédiatement précédentes, dans lequel la première opération d'optimisation et/ou la deuxième opération d'optimisation, de préférence la première opération d'optimisation et la deuxième opération d'optimisation mettent en œuvre une méthode métaheuristique, de préférence évolutionniste, de préférence un recuit simulé.

5. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'étape e) comporte les étapes suivantes :

e1) définition du modèle de référence à tester comme étant le modèle de référence initial puis,

e2) suivant les étapes suivantes, test de conditions d'acquisition virtuelles avec le modèle de référence à tester afin d'approximer finement lesdites conditions d'acquisition réelles ;

e21) détermination de conditions d'acquisition virtuelles à tester;

e22) réalisation d'une image de référence bidimensionnelle du modèle de référence à tester dans lesdites conditions d'acquisition virtuelles à tester ;

e23) traitement de l'image de référence pour réaliser au moins une carte de référence représentant ladite information discriminante ;

e24) comparaison des cartes actualisée et de référence de manière à déterminer une valeur pour une première fonction d'évaluation, ladite valeur pour la première fonction d'évaluation dépendant des différences entre lesdites cartes actualisée et de référence et correspondant à une décision de poursuivre ou de stopper la recherche de conditions d'acquisition virtuelles approximant lesdites conditions d'acquisition réelles avec plus d'exactitude que lesdites conditions d'acquisition virtuelles à tester déterminées à la dernière occurrence de l'étape e21) ;

e25) si ladite valeur pour la première fonction d'évaluation correspond à une décision de poursuivre ladite recherche, modification des conditions d'acquisition virtuelles à tester, puis reprise à l'étape e22) ;

e3) détermination d'une valeur pour une deuxième fonction d'évaluation, ladite valeur pour la deuxième fonction d'évaluation dépendant des différences entre les cartes actualisée et de référence dans les conditions d'acquisition virtuelles approximant au mieux lesdites conditions d'acquisition réelles et résultant de la dernière occurrence de l'étape e2), ladite valeur pour la deuxième fonction d'évaluation correspondant à une décision de poursuivre ou de stopper la recherche d'un modèle de référence approximant le positionnement des dents lors de l'acquisition de l'image actualisée avec plus d'exactitude que ledit modèle de référence à tester utilisé à la dernière occurrence de l'étape e2), et si ladite valeur pour la deuxième fonction d'évaluation correspond à une décision de poursuivre ladite recherche, modification du modèle de référence à tester par déplacement d'un ou plusieurs modèles de dents puis reprise à l'étape e2).

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel à l'étape a), on détermine un plan d'occlusion suivant les opérations suivantes :

I. détermination des points du modèle de référence initial qui appartiennent à une arcade et qui sont à une distance de l'autre arcade qui est inférieure à une distance prédéterminée, de préférence à une distance inférieure à 3 mm de l'autre arcade, dits « points de contact » ;

II. optionnellement, filtrage d'une partie des points de contact, de préférence de manière que le nombre de points de contact appartenant à l'arcade supérieure soit identique au nombre de points de contact appartenant à l'arcade inférieure, de préférence en éliminant les points d'une arcade les plus éloignés de l'autre arcade ;

III. régression linéaire, de préférence par la méthode des moindres carrés, sur l'ensemble des points de contact restant de manière à déterminer le plan d'occlusion.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel, à l'étape a), on effectue les opérations suivantes :

   i. projection, dans un plan d'occlusion, des points de contact entre les dents des arcades supérieure et inférieure du patient, les points de contact et/ou le plan d'occlusion étant de préférence déterminés, suivant les étapes I à III ;

   ii. détermination du barycentre des projections desdits points de contact et création d'un référentiel, dans le plan d'occlusion, centré sur ledit barycentre ;

   iii. détermination, dans ledit référentiel, de la fonction parabolique, présentant le plus grand coefficient de corrélation avec l'ensemble des projections desdits points de contact ;

   iv. rotation de l'ensemble des projections des points de contact autour du barycentre, et reprise de l'opération précédente *iii* jusqu'à ce que l'ensemble des projections des points de contact ait parcouru un secteur déterminé, de préférence supérieur à 90°, supérieur à 180°, voire d'environ 360° ;

   v. identification du coefficient de corrélation le plus élevé pour l'ensemble des positions angulaires de l'ensemble des projections des points de contact autour du barycentre, et de l'axe de la fonction parabolique correspondante ;

   vi. détermination d'un plan longitudinal médian du modèle de référence initial, ledit plan passant par ledit axe et étant perpendiculaire au plan d'occlusion.

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel, à l'étape a), on délimite au moins partiellement un modèle de dent en suivant les opérations suivantes :

   i'. détermination, au moins partielle, des bords gingivaux intérieur et extérieur de l'arcade de la dent concernée, de préférence par analyse des variations de l'orientation de la surface du modèle de référence initial ;

   ii'. projection, dans le plan d'occlusion, des bords gingivaux intérieur et extérieur ;

iii'. identification des déformations des projections des bords gingivaux intérieur et extérieur correspondant aux régions interdentaires, les sommets de ces déformations étant appelés « point de rapprochement » ;

iv'. détermination du plus court chemin, à la surface du modèle de référence initial, entre deux points de rapprochement de bords gingivaux intérieur et extérieur, respectivement, d'une région interdentaire, de préférence par une méthode métaheuristique, de préférence évolutionniste, de préférence par recuit simulé, ledit plus court chemin délimitant au moins partiellement un modèle de dent.

9. Procédé selon l'une quelconque des revendications précédentes, dans lequel une image actualisée est acquise moins de 7 jours après l'étape a), puis les étapes c) à f) sont mises en œuvre à partir de cette image actualisée.

10. Procédé selon l'une quelconque des revendications précédentes, dans lequel à l'étape b), on utilise un appareil d'acquisition porté à la main et/ou la tête du patient n'est pas immobilisée.

11. Procédé selon l'une quelconque des revendications précédentes, dans lequel à l'étape b), on utilise un appareil individuel choisi dans le groupe formé par un appareil photo connecté, une montre intelligente, une tablette numérique, un scanner 3D portable et un ordinateur couplé un système d'acquisition d'images, telle une webcam ou un appareil photo numérique, pour mettre en œuvre l'étape b) et, de préférence au moins une des étapes, de préférence toutes les étapes c) à f).

12. Procédé selon l'une quelconque des revendications précédentes, dans lequel à l'étape b), on utilise un appareil d'acquisition d'images fournissant une image actualisée infrarouge.

13. Procédé selon l'une quelconque des revendications précédentes, dans lequel à l'étape b), on utilise un écarteur comportant une, de préférence plus de deux marques de repérage, de préférence non alignées, et, de préférence, on utilise la représentation des marques de repérage sur l'image actualisée pour

- à l'étape c), redécouper l'image et/ou,
- à l'étape d), évaluer grossièrement les conditions d'acquisition réelles.

14. Procédé selon l'une quelconque des revendications précédentes, dans lequel à l'étape c), l'information discriminante est choisie dans le groupe constitué par une

information de contour, une information de couleur, une information de densité, une information de distance, une information de brillance, une information de saturation, une information sur les reflets et des combinaisons de ces informations.

15. Procédé selon l'une quelconque des revendications précédentes, dans lequel à l'étape d), on utilise des données fournies par l'appareil d'acquisition et, de préférence, concernant son orientation.

16. Procédé selon l'une quelconque des revendications précédentes, dans lequel on met en œuvre une optimisation par une méthode métaheuristique, de préférence évolutionniste, de préférence par recuit simulé, pour :
    - à l'étape a), déterminer au moins partiellement un bord gingival délimitant un modèle de dent et/ou,
    - à l'étape e2), rechercher les conditions d'acquisition virtuelles correspondant aux conditions d'acquisition réelles et/ou,
    - à l'étape e), rechercher un modèle de référence correspondant à l'image actualisée.

17. Programme d'ordinateur, et en particulier un applicatif spécialisé pour téléphone mobile, comprenant des instructions de code de programme pour l'exécution des étapes b) et c), et optionnellement d) et/ou e) et/ou f) d'un procédé selon l'une quelconque des revendications précédentes, lorsque ledit programme est exécuté par un ordinateur

18. Système comportant

    un scanner tridimensionnel apte à mettre en œuvre l'étape a) d'un procédé selon l'une quelconque des revendications 1 à 16,

    un appareil personnel, de préférence un téléphone mobile, chargé avec un programme selon la revendication immédiatement précédente.

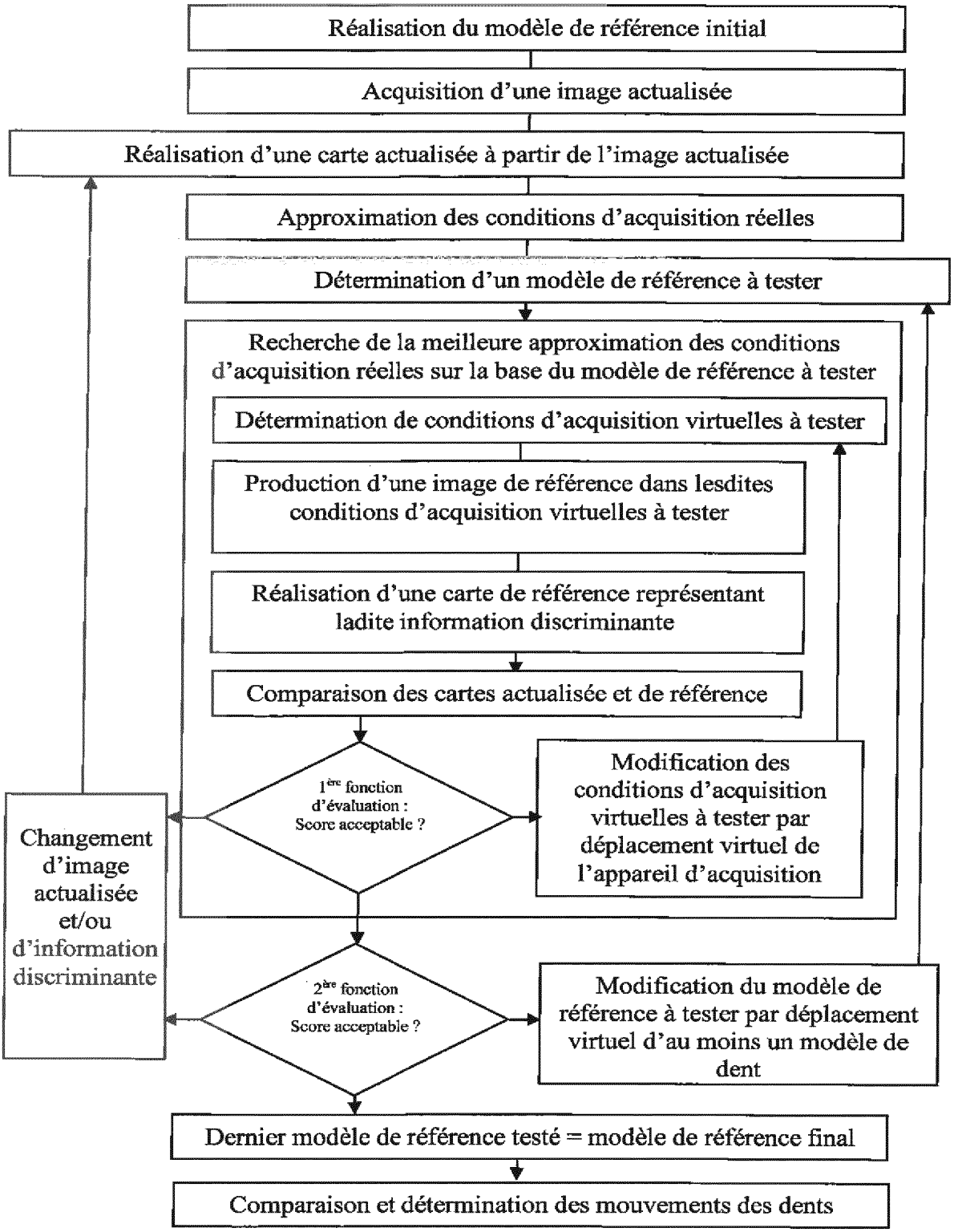

Réalisation du modèle de référence initial
Acquisition d'une image actualisée
Réalisation d'une carte actualisée à partir de l'image actualisée
Approximation des conditions d'acquisition réelles
Détermination d'un modèle de référence à tester
Recherche de la meilleure approximation des conditions d'acquisition réelles sur la base du modèle de référence à tester
Détermination de conditions d'acquisition virtuelles à tester
Production d'une image de référence dans lesdites conditions d'acquisition virtuelles à tester
Réalisation d'une carte de référence représentant ladite information discriminante
Comparaison des cartes actualisée et de référence
1ère fonction d'évaluation : Score acceptable ?
Modification des conditions d'acquisition virtuelles à tester par déplacement virtuel de l'appareil d'acquisition
Changement d'image actualisée et/ou d'information discriminante
2ère fonction d'évaluation : Score acceptable ?
Modification du modèle de référence à tester par déplacement virtuel d'au moins un modèle de dent
Dernier modèle de référence testé = modèle de référence final
Comparaison et détermination des mouvements des dents

Fig. 1

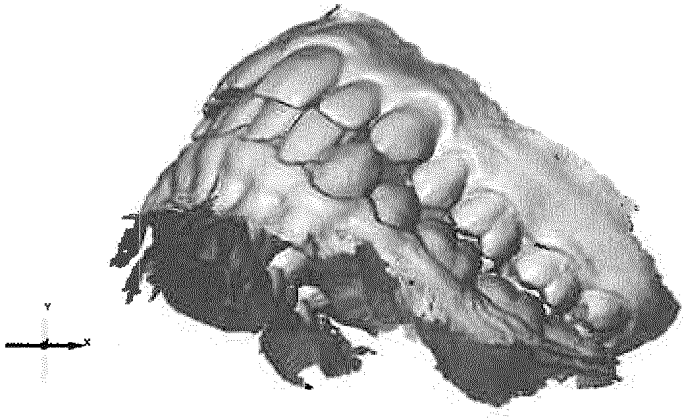


Fig.2

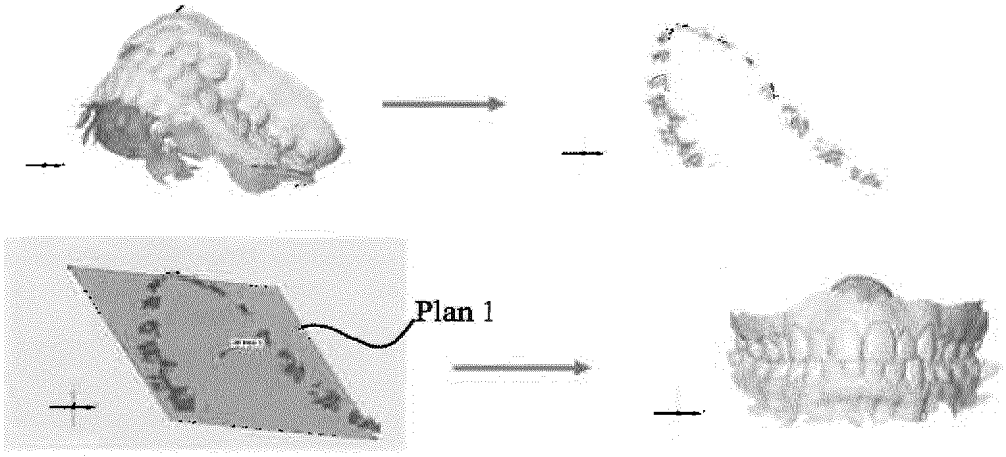


Fig.3

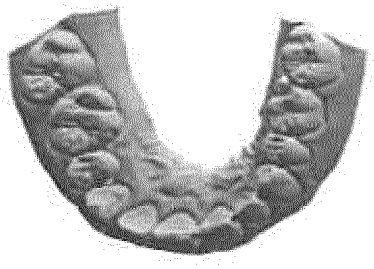


Fig. 4a

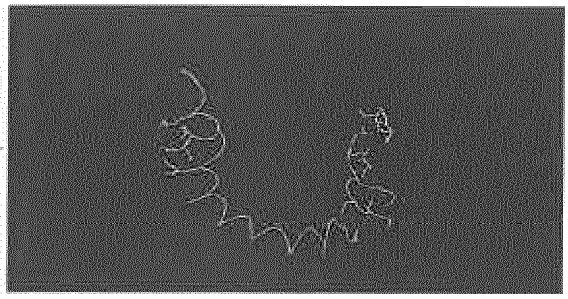


Fig. 4b



Fig. 4c

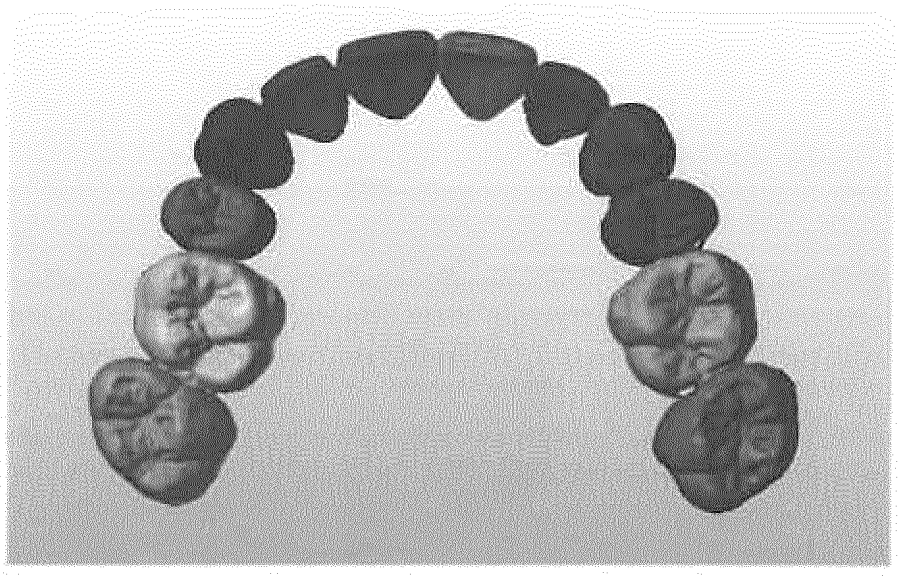


Fig. 4d

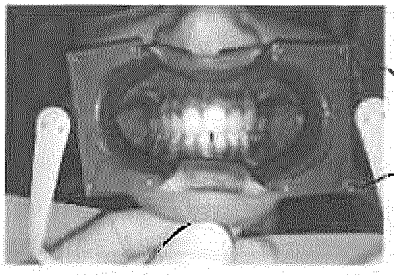


Fig. 5a

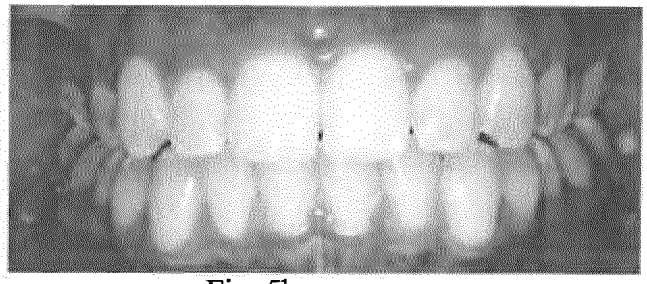


Fig. 5b

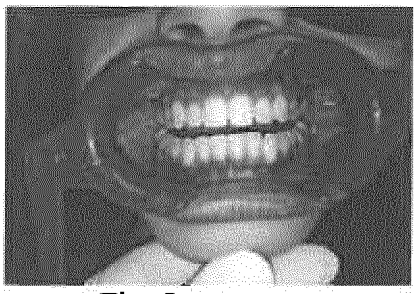


Fig. 5c

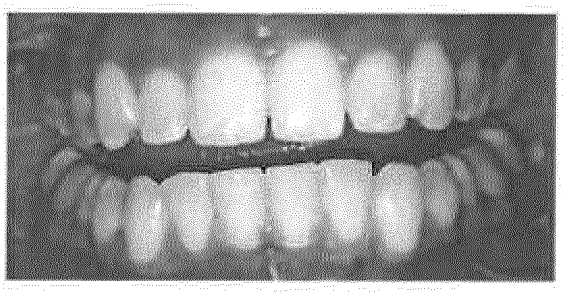


Fig. 5d

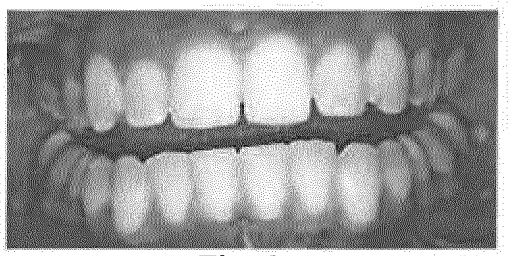


Fig. 6a

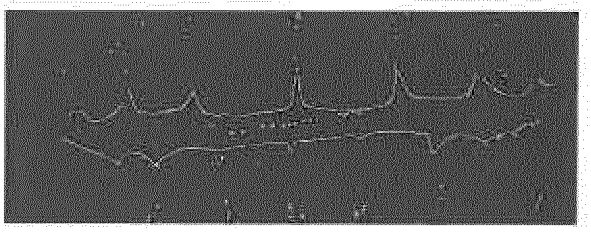


Fig. 6b

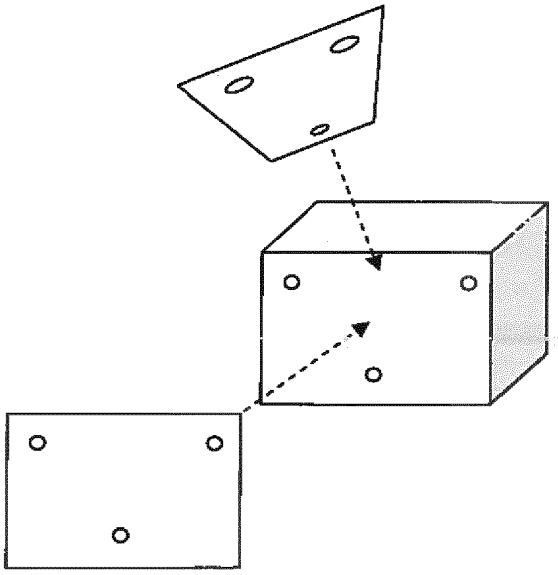


Fig. 7

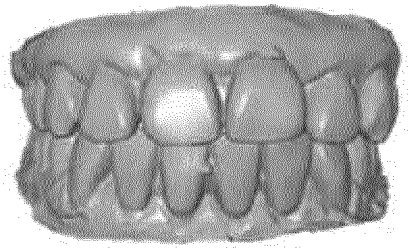


Fig. 8a

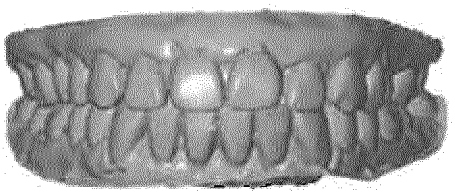


Fig. 8b

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/074859

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61C7/00 A61C9/00 G06T7/00 A61B5/00 A61B1/32
A61C19/06 A61C19/10 A61B5/06 G01J3/00 G06K9/00
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61C G06T

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/065955 A2 (ORTHOCLEAR HOLDINGS INC; WEN HUAFENG [US]) 22 June 2006 (2006-06-22)	1,9-12, 14,15
Y	paragraphs [0009], [0010], [0027] -	13
A	[0029], [0034], [0035], [0038], [0058], [0062], [0067], [0071], [0075]	2-8,16
Y	I. AHMAD: "Digital dental photography. Part 8: intra-oral set-ups", BDJ, vol. 207, no. 4, 22 August 2009 (2009-08-22), pages 151-157, XP055209322, ISSN: 0007-0610, DOI: 10.1038/sj.bdj.2009.715 the whole document	13

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

[X] See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 December 2015	18/02/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Kerner, Bodo

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/074859

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/048432 A1 (CHOI WONCHEOL [US] ET AL) 3 March 2005 (2005-03-03) paragraphs [0002], [0006] - [0009], [0027], [0034]	1-16
A	WO 2013/090843 A1 (TRYGGER LLC [US]) 20 June 2013 (2013-06-20) paragraph [0002]	1-16

1

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2015/074859

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2006065955 A2	22-06-2006	NONE	
US 2005048432 A1	03-03-2005	NONE	
WO 2013090843 A1	20-06-2013	NONE	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2015/074859

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

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

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

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

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

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

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

See supplemental sheet

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

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

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

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-16

Remark on Protest

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

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

☐ No protest accompanied the payment of additional search fees.

The International Searching Authority has found that the international application contains multiple (groups of) inventions, as follows:

1. Claims 1-16
A method for checking the positioning of a patient’ s teeth.

2. Claims 17-18
A computer programme (claim 18 being dependent on claim 17).

RAPPORT DE RECHERCHE INTERNATIONALE

Demande internationale n°
PCT/EP2015/074859

A. CLASSEMENT DE L'OBJET DE LA DEMANDE
INV. A61C7/00 A61C9/00 G06T7/00 A61B5/00 A61B1/32
A61C19/06 A61C19/10 A61B5/06 G01J3/00 G06K9/00
ADD.
Selon la classification internationale des brevets (CIB) ou à la fois selon la classification nationale et la CIB

B. DOMAINES SUR LESQUELS LA RECHERCHE A PORTE

Documentation minimale consultée (système de classification suivi des symboles de classement)
A61C G06T

Documentation consultée autre que la documentation minimale dans la mesure où ces documents relèvent des domaines sur lesquels a porté la recherche

Base de données électronique consultée au cours de la recherche internationale (nom de la base de données, et si cela est réalisable, termes de recherche utilisés)
EPO-Internal

C. DOCUMENTS CONSIDERES COMME PERTINENTS

Catégorie*	Identification des documents cités, avec, le cas échéant, l'indication des passages pertinents	no. des revendications visées
X	WO 2006/065955 A2 (ORTHOCLEAR HOLDINGS INC; WEN HUAFENG [US]) 22 juin 2006 (2006-06-22)	1,9-12, 14,15
Y	alinéas [0009], [0010], [0027] - [0029],	13
A	[0034], [0035], [0038], [0058], [0062], [0067], [0071], [0075]	2-8,16

Y	I. AHMAD: "Digital dental photography. Part 8: intra-oral set-ups", BDJ, vol. 207, no. 4, 22 août 2009 (2009-08-22) , pages 151-157, XP055209322, ISSN: 0007-0610, DOI: 10.1038/sj.bdj.2009.715 le document en entier	13

	-/--	

[X] Voir la suite du cadre C pour la fin de la liste des documents

[X] Les documents de familles de brevets sont indiqués en annexe

* Catégories spéciales de documents cités:

"A" document définissant l'état général de la technique, non considéré comme particulièrement pertinent

"E" document antérieur, mais publié à la date de dépôt international ou après cette date

"L" document pouvant jeter un doute sur une revendication de priorité ou cité pour déterminer la date de publication d'une autre citation ou pour une raison spéciale (telle qu'indiquée)

"O" document se référant à une divulgation orale, à un usage, à une exposition ou tous autres moyens

"P" document publié avant la date de dépôt international, mais postérieurement à la date de priorité revendiquée

"T" document ultérieur publié après la date de dépôt international ou la date de priorité et n'appartenant pas à l'état de la technique pertinent, mais cité pour comprendre le principe ou la théorie constituant la base de l'invention

"X" document particulièrement pertinent; l'invention revendiquée ne peut être considérée comme nouvelle ou comme impliquant une activité inventive par rapport au document considéré isolément

"Y" document particulièrement pertinent; l'invention revendiquée ne peut être considérée comme impliquant une activité inventive lorsque le document est associé à un ou plusieurs autres documents de même nature, cette combinaison étant évidente pour une personne du métier

"&" document qui fait partie de la même famille de brevets

Date à laquelle la recherche internationale a été effectivement achevée	Date d'expédition du présent rapport de recherche internationale
17 décembre 2015	18/02/2016

Nom et adresse postale de l'administration chargée de la recherche internationale	Fonctionnaire autorisé
Office Européen des Brevets, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Kerner, Bodo

1

Formulaire PCT/ISA/210 (deuxième feuille) (avril 2005)

RAPPORT DE RECHERCHE INTERNATIONALE

Demande internationale n°
PCT/EP2015/074859

C(suite). DOCUMENTS CONSIDERES COMME PERTINENTS

Catégorie*	Identification des documents cités, avec, le cas échéant, l'indication des passages pertinents	no. des revendications visées
A	US 2005/048432 A1 (CHOI WONCHEOL [US] ET AL) 3 mars 2005 (2005-03-03) alinéas [0002], [0006] - [0009], [0027], [0034]	1-16
A	WO 2013/090843 A1 (TRYGGER LLC [US]) 20 juin 2013 (2013-06-20) alinéa [0002]	1-16

1

Formulaire PCT/ISA/210 (suite de la deuxième feuille) (avril 2005)

RAPPORT DE RECHERCHE INTERNATIONALE

Renseignements relatifs aux membres de familles de brevets

Demande internationale n°
PCT/EP2015/074859

Document brevet cité au rapport de recherche	Date de publication	Membre(s) de la famille de brevet(s)	Date de publication
WO 2006065955 A2	22-06-2006	AUCUN	
US 2005048432 A1	03-03-2005	AUCUN	
WO 2013090843 A1	20-06-2013	AUCUN	

Demande internationale n°
PCT/EP2015/074859

RAPPORT DE RECHERCHE INTERNATIONALE

Cadre n°. II Observations - lorsqu'il a été estimé que certaines revendications ne pouvaient pas faire l'objet d'une recherche (suite du point 2 de la première feuille)

Le rapport de recherche internationale n'a pas été établi en ce qui concerne certaines revendications conformément à l'article 17.2)a) pour les raisons suivantes :

1. ☐ Les revendications n^{os} se rapportent à un objet à l'égard duquel l'administration chargée de la recherche internationale n'est pas tenue de procéder à la recherche, à savoir :

2. ☐ Les revendications n^{os} parce qu'elles se rapportent à des parties de la demande internationale qui ne remplissent pas suffisamment les conditions prescrites pour qu'une recherche significative puisse être effectueé, en particulier :

3. ☐ Les revendications n^{os} parce qu'elles sont des revendications dépendantes et ne sont pasrédigées conformément aux dispositions de la deuxième et de la troisième phrases de la règle 6.4.a).

Cadre n°. III Observations - lorsqu'il y a absence d'unité de l'invention (suite du point 3 de la première feuille)

L'administration chargée de la recherche internationale a trouvé plusieurs inventions dans la demande internationale, à savoir:

voir feuille supplémentaire

1. ☐ Comme toutes les taxes additionnelles exigées ont été payées dans les délais par le déposant, le présent rapport de recherche internationale porte sur toutes les revendications pouvant faire l'objet d'une recherche.

2. ☐ Comme toutes les revendications qui se prêtent à la recherche ont pu faire l'objet de cette recherche sans effort particulier justifiant des taxes additionnelles, l'administration chargée de la recherche internationale n'a sollicité le paiement d'aucunes taxes de cette nature.

3. ☐ Comme une partie seulement des taxes additionnelles demandées a été payée dans les délais par le déposant, le présent rapport de recherche internationale ne porte que sur les revendications pour lesquelles les taxes ont été payées, à savoir les revendications n^{os}:

4. ☒ Aucunes taxes additionnelles demandées n'ont été payées dans les délais par le déposant. En conséquence, le présent rapport de recherche internationale ne porte que sur l'invention mentionnée en premier lieu dans les revendications; elle est couverte par les revendications n^{os}:
1-16

Remarque quant à la réserve

☐ Les taxes additionnelles étaient accompagnées d'une réserve de la part du déposant et, le cas échéant, du paiement de la taxe de réserve.

☐ Les taxes additionnelles étaient accompagnées d'une réserve de la part du déposant mais la taxe de réserve n'a pas été payée dans le délai prescrit dans l'invitation.

☐ Le paiement des taxes additionnelles n'était assorti d'aucune réserve.

SUITE DES RENSEIGNEMENTS INDIQUES SUR PCT/ISA/ 210

L'administration chargée de la recherche internationale a trouvé plusieurs (groupes d') inventions dans la demande internationale, à savoir:

1. revendications: 1-16

   Procédé de contrôle du positionnement de dents d'un patient

   ---

2. revendications: 17, 18

   Programme d'ordinateur (la revendication 18 étant dépendante de la revendication 17)

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
First Named Inventor/Applicant Name:	Philippe SALAH
Filer:	Ronald M. Kachmarik/Jackie Carpenter
Attorney Docket Number:	N-P-51411

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
Pages:				
Claims:				
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	1051	1	160	160
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1880**

Electronic Acknowledgement Receipt

EFS ID:	32817453
Application Number:	16001049
International Application Number:	
Confirmation Number:	8141
Title of Invention:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
First Named Inventor/Applicant Name:	Philippe SALAH
Customer Number:	108676
Filer:	Ronald M. Kachmarik/Jackie Carpenter
Filer Authorized By:	Ronald M. Kachmarik
Attorney Docket Number:	N-P-51411
Receipt Date:	06-JUN-2018
Filing Date:	
Time Stamp:	11:32:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1880
RAM confirmation Number	060618INTEFSW11330000
Deposit Account	505088
Authorized User	Emily Arkutik

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	ADS.pdf	115702 3ad3ed9cdde21ead791ebf45b37cf39827a5a0fd	no	9

Warnings:

Information:

This is not an USPTO supplied ADS fillable form

2		N-P-51411UPPA.pdf	113365 fa4c73a6a916871b514ec54876ab0ff88da0d457	yes	7

Multipart Description/PDF files in .zip description

Document Description	Start	End
Preliminary Amendment	1	1
Abstract	2	2
Claims	3	5
Applicant Arguments/Remarks Made in an Amendment	6	6
Abstract	7	7

Warnings:

Information:

3		Application.pdf	172071 f5561ff099059c7c37ccf290a3ab52270f6e9b07	yes	23

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	19
Claims	20	22

	Abstract		23	23	
Warnings:					
Information:					
4	Drawings-only black and white line drawings	Figures.pdf	322923 a23fad44be772e29f863c88ef9e438d5e53f694f	no	4
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	IDS.pdf	66872 83a12f6289dde17a2d556678e096e2b9fa0589a8	no	4
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
6	Other Reference-Patent/App/Search documents	FrenchSR.pdf	73261 7054a0e863249b27725dbf36b4d951a439be58ea	no	2
Warnings:					
Information:					
7	Foreign Reference	WO2016066637A1.pdf	9145630 7224b05b9280f7932d0546bd0f36721255f8b618	no	57
Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	36630 47c8050193a799911dff2d225ca4fcc2b619570f	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	10046454		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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.

PTO/AIA/14 (11-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	N&P-51411
	Application Number	
Title of Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Philippe		SALAH	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Bagnolet	Country of Residence [i]	FR

Mailing Address of Inventor:

Address 1	18 rue Edouard VAILLANT		
Address 2			
City	Bagnolet	State/Province	
Postal Code	FR- 93170	Country [i]	FR

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Thomas		PELLISSARD	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	CLICHY	Country of Residence [i]	FR

Mailing Address of Inventor:

Address 1	13 avenue Anatole France		
Address 2			
City	CLICHY	State/Province	
Postal Code	FR-92110	Country [i]	FR

Inventor 3 Remove

Legal Name

PTO/AIA/14 (11-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	N&P-51411
	Application Number	
Title of Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Guillaume		GHYSELINCK	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Cantin	Country of Residence [i]	FR

Mailing Address of Inventor:

Address 1	41 rue d'Arleux		
Address 2			
City	Cantin	State/Province	
Postal Code	FR-59169	Country [i]	FR

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Laurent		DEBRAUX	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Paris	Country of Residence [i]	FR

Mailing Address of Inventor:

Address 1	57 rue des cascades		
Address 2			
City	Paris	State/Province	
Postal Code	FR-75020	Country [i]	FR

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

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	108676		
Email Address		Add Email	Remove Email

PTO/AIA/14 (11-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	N&P-51411
	Application Number	
Title of Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER	

Application Information:

Title of the Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER		
Attorney Docket Number	N&P-51411	**Small Entity Status Claimed** ☐	
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	4	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	108676		

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	N&P-51411
	Application Number	
Title of Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
1755187	FR	2017-06-09	

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (11-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	N&P-51411
	Application Number	
Title of Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, 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).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: 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.

PTO/AIA/14 (11-15)
Approved for use through 04/30/2017. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	N&P-51411
	Application Number	
Title of Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

○ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
◉ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:	

If the Applicant is an Organization check here. ☒

Organization Name	DENTAL MONITORING

Mailing Address Information For Applicant:

Address 1	47 avenue Hoche		
Address 2			
City	Paris	**State/Province**	
Country	FR	Postal Code	FR-75008
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (11-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	N&P-51411
	Application Number	
Title of Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Ronald M. Kachmarik/			Date (YYYY-MM-DD)	2018-06-06
First Name	Ronald M.	Last Name	Kachmarik	Registration Number	34512

Additional Signature may be generated within this form by selecting the Add button.

PTO/AIA/14 (11-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	N&P-51411
	Application Number	
Title of Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER	

This collection of information is required by 37 CFR 1.76. 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 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet 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.**

Privacy Act Statement

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:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

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.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

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.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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.

CD Submission Review Results

Internal Worksheet Only - Do Not Scan

Application Number	16001049	Receipt Date	Jun 6, 2018

X	New Application		Response To Notice	Date Of Response

[ ] Jumbo – Large tables are included on the CD

[X] **There are no problems with the CDs in the submission.**

Items checked below are to be selected in the PALM Pre-Exam CD problem list.

Omitted Items

	Files on compact disc are unreadable:
	Disc(s) of either set not readable:
	Disc(s) do not contain file names listed:
	Amended CD missing unamended files
	Missing compact discs

Missing Parts

	Disc(s) do not contain file names listed
	Discs contains files that are non-ASCII files:
	Only one copy of the CD, no duplicate:
	Wrong media type, e.g., CD-RW:
	The transmittal letter and specification do not list information:
	Both disc(s) contain unreadable files:
	One disc(s) contain unreadable files:
	Compact disc(s) contain viruses, but are still readable:
	EFS/Paper Submission:
	Table does not maintain data in proper alignment:
	Not proper subject matter for CD's:

Informality

	No statement in transmittal letter that CD's are the same:
	No incorporation by reference statement for the CD's:
	CD's not labeled "Copy 1" and "Copy 2":
	Deficient CD packaging:
	Deficient Labeling on CD's:
	The transmittal letter does not list information:
	The specification does not list information:
	Table less than 51 pages submitted on CD:

File Directory Attachment

	Copy of file directory listing is attached and should be mailed to applicant
	Copy of file directory listing is not attached
	Copy of file directory listing is not attached because it is over one page long

Additional Comments

Internal Worksheet Only - Do Not Scan

SCORE Placeholder Sheet for IFW Content

Application Number: 16001049 Document Date: 06/06/2018

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

- Drawing

At the time of document entry (noted above):

- USPTO employees may access SCORE content via eDAN using the Supplemental Content tab, or via the SCORE web page.
- External customers may access SCORE content via PAIR using the Supplemental Content tab.

Form Revision Date: August 26, 2013

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/001,049	06/06/2018	Philippe SALAH	N&P-51411

CONFIRMATION NO. 8141

108676
Ronald M. Kachmarik
Cooper Legal Group LLC
6505 Rockside Rd.
Suite 330
Independence, OH 44131

INFORMAL NOTICE

OC000000100500099

Date Mailed: 06/26/2018

INFORMATIONAL NOTICE TO APPLICANT

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

The item(s) indicated below are also required and should be submitted with any reply to this notice to avoid further processing delays.

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Philippe SALAH
  Thomas Pellissard
  Guillaume Ghyselinck
  Laurent Debraux

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**.

/lvongxay/

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/001,049

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	10 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1720

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/001,049	06/06/2018	3732	1880	N&P-51411	10	1

CONFIRMATION NO. 8141

FILING RECEIPT

108676
Ronald M. Kachmarik
Cooper Legal Group LLC
6505 Rockside Rd.
Suite 330
Independence, OH 44131

OC000000100500098

Date Mailed: 06/26/2018

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. 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)

Philippe SALAH, Bagnolet, FRANCE;
Thomas Pellissard, Clichy, FRANCE;
Guillaume Ghyselinck, Cantin, FRANCE;
Laurent Debraux, Paris, FRANCE;

Applicant(s)

DENTAL MONITORING, Paris, FRANCE

Power of Attorney: None

Domestic Applications for which benefit is claimed - None.
A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
FRANCE 1755187 06/09/2017

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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: 06/22/2018

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/001,049**

Projected Publication Date: 12/13/2018

Non-Publication Request: No

Early Publication Request: No

Title

METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

Preliminary Class

433

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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RÉPUBLIQUE FRANÇAISE

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DE LA PROPRIÉTÉ
INDUSTRIELLE

Brevet d'invention

Certificat d'utilité

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Fait à Lille, le 29 MARS 2018

Pour le Directeur général de l'Institut
national de la propriété industrielle
La Directrice du département des données

Anne DUFOUR

INSTITUT NATIONAL DE LA PROPRIÉTÉ INDUSTRIELLE

BREVET D'INVENTION

Code de la propriété intellectuelle - Livre VI

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REQUÊTE EN DÉLIVRANCE

REMISE DES PIÈCES DATE	09/06/2017
N° D'ENREGISTREMENT NATIONAL ATTRIBUÉ PAR L'INPI	1755187
DATE DE DÉPÔT ATTRIBUÉE PAR L'INPI	
Vos références pour ce dossier BR76746BMJSfb	

1 NOM ET ADRESSE DU DEMANDEUR OU DU MANDATAIRE À QUI LA CORRESPONDANCE DOIT ÊTRE ADRESSÉE

SARTORIUS Jérôme
NONY
11 rue Saint-Georges
75009 PARIS
FR

2 NATURE DE LA DEMANDE	
Nature	Brevet d'invention
3 TITRE DE L'INVENTION	
Titre	Procédé d'évaluation d'une gouttière orthodontique
4 PRIORITÉ	
5-1 DEMANDEUR	**Personne morale**
Nom	DENTAL MONITORING
Affaire suivie par	
Rue	47, avenue Hoche
Code postal et ville	75008 PARIS
Pays	FR
Nationalité	FR
Forme juridique	Société par actions simplifiées (SAS)
N° SIREN	824 001 259
Code APE-NAF	
N° de téléphone	
N° de télécopie	
Courrier électronique	
6 MANDATAIRE	
Nom	SARTORIUS
Prénom	Jérôme
Cabinet/Société	NONY

Qualité	CPI : 04-0309, pas de pouvoir			
Rue	11 rue Saint-Georges			
Code postal et ville	75009 PARIS			
Pays	FR			
N° de téléphone	01 43 12 84 60			
N° de télécopie	01 43 12 84 70			
Courrier électronique	nony@nony.fr			
7 RAPPORT DE RECHERCHE				
Type d'établissement	Établissement immédiat			
Type d'envoi	Envoi papier			
8 RÉDUCTION DU TAUX DES REDEVANCES				
En qualité de	PME			
9 DÉPÔT DE MATIERE BIOLOGIQUE				
10 SÉQUENCES DE NUCLÉOTIDES ET/OU D'ACIDES AMINÉS				
11 DOCUMENTS ET FICHIERS JOINTS	**Fichier électronique**		**Détails**	
Fichier corps du texte	textebrevet.pdf		page(s) 25, D 21, R 3, AB 1	
Drawings	dessins.pdf			
Attestation pour reduction de taxes. 1	redtax-1.pdf		page(s) 1	
12 EXTENSION DE LA PROTECTION				

En cochant la case ci-après, le(s) demandeur(s) manifestent l'intention d'étendre les effets de la demande de brevet et du brevet délivré sur la base de cette demande au territoire indiqué avec lequel des accords d'extension sont en vigueur à la date du dépôt de la demande.

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13 MODE DE PAIEMENT				
Mode de paiement	Prélèvement du compte client			
Numéro du compte	1713			
14 REDEVANCES JOINTES	Devise	Taux	Quantité	Montant à payer
062R Dépôt à taux réduit	EURO	13	1	13
063R Rapport de recherche à taux réduit	EURO	260	1	260
Total	EURO			273
15 ANNOTATION				

16 DATE ET SIGNATURE	
Signé numériquement par	Subject: FR, CABINET NONY, Pascale LE COUPANEC; Issuer: FR, INPI, INPI-EN-LIGNE 1.1
Date	09 June 2017
Signataire	Mandataire

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R E P U B L I Q U E F R A N C A I S E

INSTITUT NATIONAL DE LA PROPRIÉTÉ INDUSTRIELLE

BREVET D'INVENTION
CERTIFICAT D'UTILITE

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Numéro de demande	1755187	
Numéro de soumission	1000407913	
Date de réception	09 juin 2017	
Vos références	BR76746BMJSfb	
Demandeur	DENTAL MONITORING	
Pays	FR	
Titre de l'invention	Procédé d'évaluation d'une gouttière orthodontique	
Documents envoyés	package-data.xml	requetefr.xml
	application-body.xml	fr-fee-sheet.xml
	requetefr.pdf (3 p.)	validation-log.xml
	comment.pdf (1 p.)	indication-bio-deposit.xml
	fr-office-specific-info.xml	textebrevet.pdf (25 p.)
	dessins.pdf (4 p.)	redtax-1.pdf (1 p.)
Déposé par	EMAIL=nony@nony.fr,CN=Pascale LE COUPANEC,O=CABINET NONY,C=FR	
Méthode de dépôt	Dépôt électronique	
Date et heure de réception électronique	09 juin 2017, 16:23:15 (CEST)	
Empreinte officielle du dépôt	31:18:3E:15:13:45:D7:71:B6:F9:07:37:10:5D:01:7A:65:A2:61:69	

/INPI, section dépôt/

PROCEDE D'EVALUATION D'UNE GOUTTIERE ORTHODONTIQUE

Domaine technique

La présente invention concerne un procédé d'évaluation de la forme d'une gouttière orthodontique, ou « aligneur », portée par un patient, en particulier pour évaluer la conformité de la forme de la gouttière orthodontique au positionnement des dents dudit patient. L'invention concerne aussi un procédé d'adaptation d'un traitement au moyen de gouttières orthodontiques.

L'invention concerne enfin un programme informatique pour la mise en œuvre de ces procédés.

Etat de la technique

Classiquement, au début d'un traitement orthodontique, l'orthodontiste détermine le positionnement des dents qu'il souhaite obtenir à un instant du traitement, dit "set-up ". Le set-up peut être défini au moyen d'une empreinte ou à partir d'un scan tridimensionnel des dents du patient. L'orthodontiste fabrique alors, en conséquence, un appareil orthodontique adapté à ce traitement.

L'appareil orthodontique peut être une gouttière orthodontique (*« aligner »* en anglais). Une gouttière se présente classiquement sous la forme d'un appareil monobloc amovible, classiquement en un matériau polymère transparent, qui comporte une goulotte conformée pour que plusieurs dents d'une arcade, généralement toutes les dents d'une arcade, puissent y être logées.

La forme de la goulotte est adaptée pour maintenir en position la gouttière sur les dents, tout en exerçant une action de correction du positionnement de certaines dents.

On détermine classiquement, au début du traitement, les formes que doivent prendre les différentes gouttières à différents moments du traitement, puis on fait fabriquer l'ensemble des gouttières correspondantes. A des instants prédéterminés, le patient change de gouttière.

Le traitement au moyen de gouttières est avantageusement peu contraignant pour le patient. En particulier, le nombre de rendez-vous chez l'orthodontiste est limité. En outre, la douleur est plus faible qu'avec un arc orthodontique métallique attaché aux dents.

Le marché des gouttières orthodontiques est donc en croissance.

A intervalles réguliers, le patient se déplace chez l'orthodontiste pour un contrôle visuel, notamment pour vérifier si le déplacement des dents est conforme aux attentes et si la gouttière portée par le patient est toujours adaptée au traitement.

Si l'orthodontiste diagnostique une inadaptation au traitement, il effectue une nouvelle empreinte des dents, ou, de manière équivalente, un nouveau scan tridimensionnel des dents, puis commande une nouvelle série de gouttières configurées en conséquence. On considère qu'en moyenne, le nombre de gouttières finalement fabriquées est d'environ 45, au lieu des 20 gouttières classiquement prévues au début du traitement.

La nécessité de devoir se déplacer chez l'orthodontiste est une contrainte pour le patient. La confiance du patient en son orthodontiste peut être également entamée. L'inadaptation peut être inesthétique. Enfin, il en résulte un coût supplémentaire.

Le nombre de visites de contrôle chez l'orthodontiste doit donc être limité.

Il existe un besoin pour des solutions répondant à ces problèmes.

Un but de l'invention est de répondre, au moins partiellement, à ce besoin.

Résumé de l'invention

L'invention fournit un procédé d'évaluation de la forme d'une gouttière orthodontique portée par un patient, ledit procédé comportant les étapes suivantes :

1) acquisition d'au moins une image bidimensionnelle de dents dudit patient, dite « image actualisée », dans des conditions d'acquisition réelles,
   au moins une image actualisée, dite « image de gouttière », représentant au moins partiellement la gouttière dans une position de service dans laquelle elle est portée par lesdites dents;
   au moins une image actualisée, dite « image de dentition », identique ou différente de l'image de gouttière, représentant lesdites dents,
2) si l'image de dentition est différente de l'image de gouttière, transformation de l'image de dentition de manière qu'elle représente lesdites dents (représentées sur l'image de dentition) comme observées dans les conditions d'acquisition mises en œuvre lors de l'acquisition de l'image de gouttière à l'étape 1) ;
3) détermination pour chacune d'une pluralité de dents représentées sur les images de dentition et de gouttière, de contours de dent intérieur et extérieur représentant le

contour de l'extrémité libre de ladite dent sur les images de dentition et de gouttière, respectivement ;

4) comparaison des contours de dents intérieur et extérieur, puis détermination d'au moins un score en fonction de ladite comparaison.

Comme on le verra plus en détail dans la suite de la description, un procédé selon l'invention facilite considérablement l'évaluation de la bonne adéquation de la gouttière au traitement, tout en rendant cette évaluation particulièrement fiable. En particulier, le procédé peut être mis en œuvre à partir de simples photographies ou films, pris sans précaution particulière, par exemple par le patient. Le nombre de rendez-vous chez l'orthodontiste peut donc être limité.

De préférence, un procédé d'évaluation selon l'invention présente encore une ou plusieurs des caractéristiques optionnelles suivantes :

- le procédé comporte, après l'étape 4), l'étape suivante :

  5) comparaison du score à un seuil d'acceptabilité et émission d'une information en fonction du résultat de la comparaison ;

- les images de dentition et de gouttière sont différentes et le procédé comporte les étapes suivantes :

  (a) avant l'étape 1), de préférence en début de traitement ou avant le début du traitement, réalisation d'un modèle tridimensionnel numérique d'au moins une partie d'une arcade portant lesdites dents, ou « modèle de référence initial », et pour chaque dent du modèle de référence initial, définition d'un modèle de référence tridimensionnel numérique de ladite dent, ou « modèle de dent » ;

  (b) modification du modèle de référence initial par déplacement des modèles de dent, jusqu'à obtention d'un modèle de référence final compatible avec l'image de dentition ;

  (c) recherche d'une vue bidimensionnelle du modèle de référence final compatible avec l'image de gouttière ;

  (d) transformation de l'image de dentition en ladite vue ;

- alternativement, les images de dentition et de gouttière sont une même image ;

- l'étape 4) comporte les étapes suivantes :

  pour chacune d'une pluralité de dents pour lesquelles des contours de dent intérieur et extérieur ont été déterminés ;

  i) détermination d'une distance entre les contours de dent intérieur et extérieur ;

ii) détermination d'un seuil de distance, de préférence à partir des distances déterminées à l'étape i) ;

iii) pour chacune desdites dents, détermination d'un score en distance, en fonction
- de la distance entre les contours de dent intérieur et extérieur et
- du seuil de distance ;

- lesdites distances sont mesurées en pixels ;
- à l'étape ii), le seuil de distance est fonction de la plus faible des distances déterminées à l'étape i) ;
- alternativement, l'étape 4) comporte les étapes suivantes :

i') pour chaque couple d'une dent gauche et d'une dent droite adjacentes d'au moins un triplet de première, deuxième et troisième dents adjacentes pour chacune desquelles des contours de dent intérieur et extérieur ont été déterminés, les première et troisième dents étant adjacentes à la deuxième dent,
détermination d'un décalage entre le contour de dent intérieur de ladite dent gauche et le contour de dent intérieur de ladite dent droite, dit « décalage intérieur », et détermination d'un décalage entre le contour de dent extérieur de ladite dent gauche et le contour de dent extérieur de ladite dent droite, dit « décalage extérieur »,
puis
détermination de la différence entre le décalage intérieur et le décalage extérieur, dite « différence de décalages » ;

ii') détermination d'un seuil de différence de décalages, de préférence à partir des différences de décalages déterminées à l'étape i') ;

iii') détermination, pour au moins une, de préférence pour chaque dent dudit triplet, d'au moins un score en décalage, en fonction de la différence de décalages avec une dent adjacente et du seuil de différence de décalages ;

- les décalages intérieurs et extérieurs sont mesurés en pixels ;
- à l'étape iii'), le seuil de différence de décalages est fonction de la plus petite des différences de décalages déterminées à l'étape i').

L'invention concerne aussi un procédé d'adaptation d'un traitement orthodontique, procédé dans lequel on met en œuvre un procédé d'évaluation selon l'invention, puis, en fonction du résultat de ladite évaluation, on fabrique une nouvelle gouttière.

L'invention concerne également :

- un programme d'ordinateur, et en particulier un applicatif spécialisé pour téléphone mobile, comprenant des instructions de code de programme pour l'exécution d'une ou plusieurs, de préférence toutes les étapes 1) à 4), de préférence 1) à 5), lorsque ledit programme est exécuté par un ordinateur,
- un support informatique sur lequel est enregistré un tel programme, par exemple une mémoire ou un CD-ROM, et
- un appareil personnel, en particulier un téléphone mobile ou une tablette, dans lequel est chargé un tel programme.

L'invention concerne aussi un système comportant :

- un scanner tridimensionnel apte à mettre en œuvre l'étape (a) décrite ci-après, et
- un appareil personnel, de préférence un téléphone mobile, chargé avec un programme selon l'invention.

Définitions

Par « dentition », on entend un ensemble de dents.

Par « patient », on entend toute personne pour laquelle un procédé selon l'invention est mis en œuvre, que cette personne soit malade ou non.

Les « conditions d'acquisition » précisent la position et l'orientation dans l'espace d'un appareil d'acquisition d'images relativement aux dents du patient (conditions d'acquisition réelles) ou à un modèle tridimensionnel des dents du patient (conditions d'acquisition virtuelles), et de préférence la calibration de cet appareil d'acquisition d'images, et notamment les valeurs de l'ouverture de diaphragme, du temps d'exposition, de la distance focale et de la sensibilité. Des conditions d'acquisition sont dites "virtuelles", ou « théoriques », lorsqu'elles correspondent à une simulation dans laquelle l'appareil d'acquisition serait dans lesdites conditions d'acquisition (positionnement et de préférence calibration théoriques de l'appareil d'acquisition).

Un scanner 3D est un appareil permettant d'obtenir une représentation en trois dimensions d'un objet.

Par "image", on entend une image en deux dimensions, comme une photographie. Une image est formée de pixels.

Un modèle numérique tridimensionnel d'un ensemble de dents d'un patient est « compatible » avec une image lorsqu'il existe une vue de ce modèle qui correspond à ladite image, c'est-à-dire telle que les éléments dudit modèle, par exemple les contours des modèles de dents, sont positionnés, relativement les uns aux autres, comme les éléments réels qu'ils modélisent, par exemple les contours desdites dents, sur ladite image. Ainsi, un modèle de référence final est-il compatible avec une image de dentition si une vue du modèle de référence final permet d'observer les contours des modèles de dents de manière qu'ils soient superposables aux contours desdites dents sur ladite image de dentition.

Ladite vue peut être observée par un appareil d'acquisition d'images virtuel, dans des conditions d'acquisition virtuelles qui sont également qualifiées de « compatibles » avec l'image.

Lorsqu'un modèle numérique tridimensionnel est compatible avec une image, le positionnement des modèles de dents dans ce modèle est également qualifié de « compatible » avec l'image.

La « position de service » est la position dans laquelle la gouttière est portée par le patient.

« Comprendre », « comporter » ou « présenter » doivent être interprétés de manière large, non limitative, sauf indication contraire.

Brève description des figures

D'autres caractéristiques et avantages de l'invention apparaîtront encore à la lecture de la description détaillée qui va suivre et à l'examen du dessin annexé dans lequel :

- les figures 1 et 2 représentent une gouttière orthodontique ;
- la figure 3 représente une image actualisée d'une arcade dentaire portant une gouttière orthodontique comme celle des figures 1 et 2 ;
- la figure 4 représente le contour de dentition défini à partir de l'image de la figure 3 ;
- la figure 5 représente les contours de gouttière définis à partir de l'image de la figure 3 et susceptibles d'être utilisés selon l'invention ;
- la figure 6 représente le contour de gouttière défini à partir de l'image de la figure 3 et utilisé sur les figures 7 et 8 pour être comparé à un contour de dentition ;
- les figures 7 et 8 représentent les contours de dentition et de gouttière des figures 4 et 6 tels que représentés sur l'image actualisée de la figure 3 ;
- la figure 9 illustre schématiquement un procédé selon l'invention ;

- la figure 10 illustre schématiquement l'étape 2) d'un procédé selon l'invention.

Description détaillée

Comme représenté sur la figure 1, une gouttière 10 s'étend de manière à suivre les dents D successives de l'arcade sur laquelle elle est fixée. Elle définit une goulotte de forme générale en « U ».

On appelle « goulotte » 12 la surface intérieure de la gouttière. La forme de la goulotte est déterminée pour assurer la fixation de la gouttière sur les dents, mais également en fonction d'un positionnement cible souhaité pour les dents. Plus précisément, la forme est déterminée de manière que, lorsque la gouttière est dans sa position de service, elle exerce des contraintes tendant à déplacer les dents traitées vers leur positionnement cible.

Par « contour de dent», on entend une ligne présentant la forme d'une extrémité libre 22 d'une dent sur une image.

Bien entendu, une telle ligne peut délimiter l'extrémité libre de cette dent. Le contour de dent est alors qualifié de « contour de dent intérieur » 14. Un « contour de dentition » 16 est constitué par l'ensemble des contours de dent intérieurs d'un ensemble de dents (figure 4).

Une telle ligne peut également délimiter une partie de la gouttière. Le contour de dent est alors qualifié de « contour de dent extérieur » 18. En particulier, le fond 20 de la goulotte présente une forme sensiblement complémentaire à celle des extrémités libres 22 des dents. En conséquence, sur une image représentant le fond de la goulotte, le contour du fond de la goulotte définit un ensemble de contours de dents extérieurs 18.

La matière de la gouttière séparant la surface extérieure 24 de la gouttière et la goulotte 12 définit l'épaisseur de la gouttière orthodontique. Cette épaisseur est visible sur la figure 5. Classiquement, la gouttière présente une épaisseur sensiblement constante. La surface extérieure 24 de la gouttière, qui s'étend en face du fond 20 de la goulotte, est donc également sensiblement de même forme que le fond de la goulotte. En conséquence, sur une image, le contour de la surface extérieure 24 de la gouttière définit également un ensemble de contours de dents extérieurs 18.

Un « contour de gouttière » 28 est constitué d'un ensemble des contours de dent extérieurs 18. Il peut donc être défini par le fond 20 de la goulotte ou par la surface extérieure 24 de la gouttière.

Lorsqu'une dent est positionnée dans la goulotte de manière que son extrémité libre 22 soit en contact avec le fond de la goulotte, son contour de dent intérieur est sensiblement confondu avec le contour de dent extérieur correspondant si le contour de dent extérieur 18 est défini par le fond 20 de la goulotte, ou est écarté et sensiblement parallèle au contour de dent extérieur correspondant si le contour de dent extérieur est défini par la surface extérieure 24 de la gouttière.

De préférence, les contours de dent extérieurs utilisés pour définir le contour de gouttière 28 sont définis par la surface extérieure 24 de la gouttière, plus visible.

Le procédé de l'invention a pour objet de détecter les situations dans lesquelles l'extrémité libre 22 d'une dent n'est plus en contact avec le fond de la goulotte, et de mesurer l'ampleur de ce décollement (figure 9).

A l'étape 1), on prend au moins une image des dents, dite « image actualisée », au moyen d'un appareil d'acquisition d'images.

De préférence, au moins un rappel informant le patient de la nécessité de créer une image actualisée est adressé au patient. Ce rappel peut être sous forme papier ou, de préférence, sous forme électronique, par exemple sous la forme d'un courriel, d'une alerte automatique d'un applicatif spécialisé mobile ou d'un SMS. Un tel rappel peut être envoyé par le cabinet ou le laboratoire d'orthodontie ou par le dentiste ou par l'applicatif spécialisé mobile du patient, par exemple.

L'étape 1) est réalisée au moment où l'évaluation de la forme d'une gouttière est souhaitée, par exemple plus de 4 semaines après le début du traitement avec la gouttière.

L'appareil d'acquisition d'images est de préférence un téléphone mobile, un appareil photo dit « connecté », une montre dite « intelligente », ou « smartwatch », une tablette ou un ordinateur personnel, fixe ou portable, comportant un système d'acquisition d'images, comme une webcam ou un appareil photo.

L'acquisition est de préférence réalisée par le patient ou un proche du patient, mais peut être réalisée par toute autre personne, notamment un dentiste ou un orthodontiste, de préférence sans imposer un positionnement précis de l'appareil d'acquisition d'images par rapport aux dents.

De préférence, l'image actualisée est une photographie ou est une image extraite d'un film. Elle est de préférence en couleurs, de préférence en couleurs réelles.

Selon l'invention, on évalue la forme de la gouttière en comparant un contour de cette gouttière, dans sa position de service, avec un contour des dents qui la portent.

A l'étape 1), il est donc nécessaire d'acquérir suffisamment d'images actualisées pour autoriser cette comparaison, c'est-à-dire au moins une image de la gouttière dans sa position de service, ou « image de gouttière », et au moins une image de dents qui portent cette gouttière dans la position de service, ou « image de dentition ».

Dans un mode de réalisation, l'image de dentition est l'image de gouttière. Autrement dit, la même image actualisée permet non seulement d'apercevoir le contour de gouttière 28, mais aussi le contour de dentition 16, à travers la gouttière (figure 3). Cette seule image permet donc de comparer des contours de gouttière et de dentition. Avantageusement, l'étape 2) de recadrage, décrite ultérieurement, n'est pas nécessaire.

Dans un autre mode de réalisation, l'image de dentition est une image des dents en l'absence de la gouttière orthodontique, dite « image de dentition nue ». Ce mode de réalisation est nécessaire si le contour de dentition 16 n'est pas clairement visible, à travers la gouttière, sur l'image de gouttière. L'opérateur prend alors une première image de la gouttière en position de service, et, à un autre instant, après avoir retiré la gouttière, prend une deuxième image de dents portant la partie de la gouttière représentée sur la première image, c'est-à-dire l'image de dentition nue.

Les images actualisées étant de préférence réalisées sans précautions particulières, l'image de dentition nue n'est normalement pas acquise dans les mêmes conditions d'acquisition que l'image de gouttière. En particulier, les positions dans l'espace de l'appareil d'acquisition par rapport aux dents et/ou son réglage (« calibration » de l'appareil d'acquisition), par exemple le niveau de zoom, peuvent être différents pour acquérir ces deux images. Les contours de gouttière et de dentition définis à partir des images de dentition nue et de gouttière, respectivement, ne sont donc normalement pas immédiatement comparables. L'étape 2) est destinée à rendre ces contours comparables en redéfinissant l'image de dentition.

Dans un mode de réalisation particulier préféré, **l'étape 2)** (figure 10) comporte les étapes (a) à (d) :

L'étape (a) est antérieure à l'étape 1).

Elle est de préférence réalisée en début de traitement ou avant le début du traitement orthodontique. Elle peut être également réalisée en début de traitement ou avant le début du traitement avec la gouttière.

L'étape (a) consiste en la réalisation d'un modèle tridimensionnel numérique d'une arcade portant les dents traitées, ou « modèle de référence initial ».

Le modèle de référence initial est par exemple du type .stl ou .Obj, .DXF 3D, IGES, STEP, VDA, ou Nuages de points. Avantageusement, un tel modèle, dit « 3D », peut être observé selon un angle quelconque.

Le modèle de référence initial peut être préparé à partir de mesures effectuées sur les dents du patient ou sur un modèle physique de ses dents, par exemple un modèle en plâtre.

Le modèle de référence initial est de préférence créé au moyen d'un appareil professionnel, par exemple au moyen d'un scanner 3D, de préférence mis en œuvre par un professionnel de la santé, par exemple par un orthodontiste ou un laboratoire d'orthodontie. Dans un cabinet d'orthodontie, le patient ou le modèle physique de ses dents peuvent être avantageusement disposés dans une position précise et l'appareil professionnel peut être perfectionné. Il en résulte un modèle de référence initial très précis. Le modèle de référence initial fournit de préférence une information sur le positionnement des dents avec une erreur inférieure à 5/10 mm, de préférence inférieure à 3/10 mm, de préférence inférieure à 1/10 mm.

Dans le modèle de référence initial, une partie qui correspond à une dent est appelée « modèle de dent ». Les modèles de dents peuvent être définis comme décrit, par exemple, dans la demande internationale PCT/EP2015/074896.

L'étape (b) comprend une modification du modèle de référence initial, par déplacement des modèles de dents, jusqu'à retrouver un positionnement des modèles de dents compatible avec l'image de dentition.

De préférence, l'étape (b) est réalisée moins de 4 semaines, moins de 2 semaines, moins d'une semaine, de préférence sensiblement immédiatement après l'acquisition de l'image de dentition.

Elle consiste de préférence en un processus itératif selon lequel, à chaque itération, un ou plusieurs modèles de dents sont déplacés, puis des conditions d'acquisition optimales du modèle initial ainsi modifié (dit « modèle de référence à tester ») sont déterminées, les conditions optimales étant définies comme les conditions permettant d'observer le modèle

de référence à tester de manière que la vue dudit modèle soit la plus proche possible de l'image de dentition.

Les étapes c) à e) décrites dans PCT/EP2015/074896 sont de préférence mises en œuvre :

c) analyse de l'image de dentition (image actualisée dans PCT/EP2015/074896) et réalisation d'une carte actualisée relative à une information discriminante ;

d) optionnellement, détermination, pour l'image de dentition, de conditions d'acquisition virtuelles grossières approximant les conditions d'acquisition réelles de ladite image de dentition ;

e) recherche, à partir de la carte actualisée, d'un modèle de référence final correspondant au positionnement des dents lors de l'acquisition de l'image de dentition, la recherche étant de préférence effectuée au moyen d'une méthode métaheuristique, de préférence évolutionniste, de préférence par recuit simulé.

Toutes les caractéristiques des étapes c) à e) décrites dans PCT/EP2015/074896 sont applicables.

Suivant l'étape c), l'image de dentition est analysée de manière à réaliser une carte actualisée relative à au moins une information discriminante.

Une "information discriminante" est une information caractéristique qui peut être extraite d'une image (*"image feature"*), classiquement par un traitement informatique de cette image.

Une information discriminante peut présenter un nombre variable de valeurs. Par exemple, une information de contour peut être égale à 1 ou 0 selon qu'un pixel appartient ou non à un contour. Une information de brillance peut prendre un grand nombre de valeurs. Le traitement de l'image permet d'extraire et de quantifier l'information discriminante.

La carte actualisée représente une information discriminante dans le référentiel de l'image de dentition. L'information discriminante est de préférence choisie dans le groupe constitué par une information de contour, une information de couleur, une information de densité, une information de distance, une information de brillance, une information de saturation, une information sur les reflets et des combinaisons de ces informations.

A l'étape optionnelle d), on évalue, de manière grossière, les conditions d'acquisition réelles de l'image de dentition à l'étape 1), c'est-à-dire la position et l'orientation dans l'espace de l'appareil d'acquisition par rapport aux dents et sa calibration. L'étape d)

permet avantageusement de limiter le nombre de tests sur des conditions d'acquisition virtuelles lors de l'étape e), et permet donc d'accélérer considérablement l'étape e).

On utilise de préférence une ou plusieurs règles heuristiques. Par exemple, de préférence, on exclut des conditions d'acquisition virtuelles susceptibles d'être testées à l'étape e), les conditions qui correspondent à une position de l'appareil d'acquisition d'images derrière les dents ou à une distance des dents supérieure à 1 m. Dans un mode de réalisation préféré, on utilise des marques de repérage représentées sur l'image de dentition pour déterminer une région de l'espace sensiblement conique délimitant des conditions d'acquisition virtuelles susceptibles d'être testées à l'étape e), ou "cône de test".

L'objectif de l'étape e) est de modifier le modèle de référence initial jusqu'à obtenir un modèle de référence final qui corresponde à l'image de dentition. Idéalement, le modèle de référence final est donc un modèle de référence tridimensionnel numérique à partir duquel l'image de dentition aurait pu être prise si ce modèle avait été réel.

On teste donc une succession de modèles de référence « à tester », le choix d'un modèle de référence à tester dépendant de préférence du niveau de correspondance des modèles de référence « à tester » précédemment testés avec l'image de dentition. Ce choix est de préférence effectué en suivant un procédé d'optimisation connu, en particulier choisi parmi les procédés d'optimisation métaheuristiques, de préférence évolutionnistes, en particulier dans les procédés de recuit simulé.

De préférence, l'étape e) comporte les étapes suivantes :

e1) définition d'un modèle de référence à tester comme étant le modèle de référence initial puis,

e2) suivant les étapes suivantes, test de conditions d'acquisition virtuelles avec le modèle de référence à tester afin d'approximer finement lesdites conditions d'acquisition réelles ;

e21) détermination de conditions d'acquisition virtuelles à tester;

e22) réalisation d'une image de référence bidimensionnelle du modèle de référence à tester dans lesdites conditions d'acquisition virtuelles à tester ;

e23) traitement de l'image de référence pour réaliser au moins une carte de référence représentant, au moins partiellement, ladite information discriminante ;

e24) comparaison des cartes actualisée et de référence de manière à déterminer une valeur pour une première fonction d'évaluation, ladite valeur pour la première fonction d'évaluation dépendant des différences entre lesdites cartes actualisée et de référence et correspondant à une décision de poursuivre ou de stopper la recherche de conditions d'acquisition virtuelles approximant lesdites conditions d'acquisition réelles de l'image de dentition avec plus d'exactitude que lesdites conditions d'acquisition virtuelles à tester déterminées à la dernière occurrence de l'étape e21) ;

e25) si ladite valeur pour la première fonction d'évaluation correspond à une décision de poursuivre ladite recherche, modification des conditions d'acquisition virtuelles à tester, puis reprise à l'étape e22) ;

e3) détermination d'une valeur pour une deuxième fonction d'évaluation, ladite valeur pour la deuxième fonction d'évaluation dépendant des différences entre les cartes de dentition et de référence dans les conditions d'acquisition virtuelles approximant au mieux lesdites conditions d'acquisition réelles et résultant de la dernière occurrence de l'étape e2), ladite valeur pour la deuxième fonction d'évaluation correspondant à une décision de poursuivre ou de stopper la recherche d'un modèle de référence approximant le positionnement des dents lors de l'acquisition de l'image de dentition avec plus d'exactitude que ledit modèle de référence à tester utilisé à la dernière occurrence de l'étape e2), et si ladite valeur pour la deuxième fonction d'évaluation correspond à une décision de poursuivre ladite recherche, modification du modèle de référence à tester par déplacement d'un ou plusieurs modèles de dents, puis reprise à l'étape e2).

Les étapes e1) à e3) sont décrites en détail dans PCT/EP2015/074896, ou WO2016066651.

Le modèle de référence final obtenu à l'issue de l'étape e) est un modèle tridimensionnel résultant de modifications successives du modèle de référence initial, très précis. Avantageusement, il est ainsi lui-même très précis, bien qu'il ait été obtenu à partir de simples photographies prises sans précautions particulières.

A l'étape (c), on recherche une vue du modèle de référence final qui corresponde à l'image de gouttière. Plus précisément, l'image de gouttière a été acquise dans des conditions d'acquisition réelles dans lesquelles les dents n'étaient pas suffisamment visibles. L'étape (c) a pour objectif de déterminer une vue du modèle de référence final compatible avec

l'image de gouttière, c'est-à-dire une vue représentant les dents telles qu'elles auraient été représentées sur l'image de gouttière si elles avaient été suffisamment visibles.

En particulier, cette recherche conduit à virtuellement déplacer un appareil d'acquisition d'images virtuel autour du modèle de référence final jusqu'à trouver une position « recadrée » compatible avec l'image de gouttière, c'est-à-dire dans laquelle on peut observer des dents ou des parties de dents comme elles auraient été représentées sur l'image de gouttière si la gouttière avait été transparente.

De préférence, la recherche de la vue du modèle de référence final qui correspond le mieux à l'image de gouttière est effectuée par itération, de préférence au moyen d'une méthode heuristique, de préférence encore au moyen d'une des méthodes décrites ci-après. Ces méthodes permettent avantageusement de guider le déplacement virtuel de l'appareil d'acquisition d'images virtuel autour du modèle de référence final afin d'accélérer la détermination de ladite position recadrée.

Pour recadrer l'appareil d'acquisition d'images virtuel, il est nécessaire d'identifier sur l'image de gouttière des repères dont on connaît la position dans le modèle de référence final. De tels repères peuvent généralement être identifiés. A défaut, il est nécessaire d'acquérir une nouvelle image de gouttière et de reprendre la recherche de tels repères.

Les repères appartiennent de préférence à des dents que l'on sait immobiles, par exemple parce qu'elles ne sont pas traitées (si de telles dents sont visibles sur l'image de gouttière) ou à des parties de la gouttière en contact avec de tels dents, et donc également immobiles. Les dents immobiles peuvent être facilement identifiées lors de l'étape (c), puisqu'il s'agit des dents dont le modèle de dent n'a pas été déplacé lors de l'étape (b).

Le recadrage nécessite d'utiliser comme repères au moins trois points non alignés.

On observe ensuite le modèle de référence final suivant différentes conditions d'acquisition virtuelles jusqu'à obtenir une vue du modèle de référence final compatible avec l'image de gouttière, c'est-à-dire dans laquelle les repères ont des positions relatives identiques. L'appareil d'acquisition d'images virtuel est alors dans la position recadrée.

A l'étape (d), on remplace l'image de dentition par la vue du modèle de référence final observé dans la position recadrée, c'est-à-dire dans les conditions d'acquisition virtuelles déterminées à l'étape (c).

Le modèle de référence final représente en effet, en trois dimensions, les dents dans leur positionnement au moment où l'image de dentition a été acquise, à l'étape 1). Par ailleurs, les conditions d'acquisition virtuelles déterminées à l'étape (c) sont sensiblement

identiques aux conditions d'acquisition réelles au moment où l'image de gouttière a été acquise, à l'étape 1). En observant le modèle de référence final dans les conditions d'acquisition virtuelles déterminées à l'étape (c), on observe donc les dents au moment où l'image de dentition a été acquise, dans les conditions d'acquisition de l'image de gouttière. La vue du modèle de référence final dans ces conditions d'acquisitions virtuelles est donc comparable à l'image de gouttière et remplace donc l'image de dentition acquise à l'étape 1). Dans un souci de clarté, cette vue est appelée également « image de dentition », c'est-à-dire que la vue est transformée en l'image de dentition.

Les formes et les dimensions des contours sur l'image de dentition ainsi définie sont donc comparables à celles des contours sur l'image de gouttière.

A l'étape 3), on détermine pour chacune d'une pluralité de dents représentées sur les images de dentition et de gouttière, les contours de dent intérieur et extérieur.

L'homme de l'art sait comment traiter une image pour isoler un contour. Ce traitement comporte par exemple l'application de masques ou de filtres bien connus, fournis avec des logiciels de traitement d'images. De tels traitements permettent par exemple de détecter les régions de fort contraste.

Ces traitements comprennent notamment une ou plusieurs des méthodes connues et préférées suivantes, à savoir :

- par application d'un filtre Canny, notamment pour rechercher des contours en utilisant l'algorithme de Canny ;
- par application d'un filtre Sobel, notamment pour calculer des dérivées au moyen de l'opérateur étendu de Sobel;
- par application d'un filtre de Laplace, pour calculer le laplacien d'une image;
- par détection de tâches sur une image (« Blobdetecor ») ;
- par application d'un seuil (« Threshold ») pour appliquer un seuil fixe à chaque élément d'un vecteur ;
- par redimensionnement, en utilisant des relations entre les zones de pixels (« Resize(Area) ») ou des interpolations bi-cubiques sur l'environnement des pixels ;
- par érosion de l'image au moyen de d'un élément spécifique structurant ;
- par dilatation, de l'image au moyen de d'un élément spécifique structurant ;

- par retouche, en particulier en utilisant des régions au voisinage de la zone restaurée ;
- par application d'un filtre bilatéral ;
- par application d'un flou gaussien ;
- par application d'un filtre d'Otsu, pour rechercher le seuil qui minimise la variance intra-classes ;
- par application d'un filtre A*, pour rechercher un chemin entre des points ;
- par application d'un seuil adaptatif (« Adaptive Threshold ») pour appliquer un seuil adaptatif à un vecteur ;
- par application d'un filtre d'égalisation d'un histogramme d'une image en nuances de gris en particulier;
- par détection de flou ("BlurDetection"), pour calculer l'entropie d'une image en utilisant son laplacien ;
- par détection de contours (« FindContour ») d'une image binaire ;
- par remplissage de couleurs ("FloodFill"), notamment pour remplir un élément connecté avec une couleur déterminée.

Les méthodes non limitatives suivantes, bien qu'elles ne soient pas préférées, peuvent être également mises en œuvre :

- par application d'un filtre "MeanShift", de manière à trouver un objet sur une projection de l'image ;
- par application d'un filtre « CLAHE », pour « Contrast Limited Adaptive Histogram Equalization » ;
- par application d'un filtre « Kmeans", pour déterminer le centre de clusters et de groupes d'échantillons autour de clusters ;
- par application d'un filtre DFT, de manière à effectuer une transformation de Fourier discrète, directe ou inverse d'un vecteur ;
- par calcul de moments ;
- par application d'un filtre « HuMoments » pour calculer des invariants de Hu invariants ;
- par calcul de l'intégrale d'une image ;
- par application d'un filtre Scharr, permettant de calculer une dérivée de l'image en mettant en œuvre un opérateur de Scharr ;
- par recherche de l'enveloppe convexe de points ("ConvexHull") ;

- par recherche de points de convexité d'un contour ("ConvexityDefects") ;
- par comparaison de formes (« MatchShapes ») ;
- par vérification si des points sont dans un contour (« PointPolygonTest ») ; Par détection des contours Harris (« CornerHarris ») ;
- par la recherche des valeurs propres minimales de matrices de gradients, pour détecter les coins ("CornerMinEigenVal ») ;
- par application d'une transformée de Hough pour trouver des cercles dans une image en nuances de gris (« HoughCircles ») ;
- par "Active contour modeling" (traçage du contour d'un objet à partir d'une image 2D potentiellement « bruitée » ;
- par calcul d'un champ de forces, appelées GVF ("gradient vector flow"), dans une partie de l'image ;
- par classement en cascade (« CascadeClassification »).

La détermination des contours de dent peut être optimisée en suivant les enseignements de PCT/EP2015/074900.

A l'étape 4) de comparaison des contours, on procède de préférence suivant un des deux modes de réalisation particuliers ci-dessous, correspondant aux figures 7 et 8, respectivement :

Dans un premier mode de réalisation particulier, l'étape 4) comporte les étapes i) à iii) pour chacune d'une pluralité de dents pour lesquelles des contours de dent intérieur et extérieur ont été déterminés.

A l'étape i), on détermine une distance *d* entre les contours de dent intérieur et extérieur de chacune desdites dents (figure 7).

La distance entre les contours de dent intérieur 14 et extérieur 18 d'une dent peut être par exemple la distance moyenne ou la distance maximale entre les pixels desdits contours correspondant à un même point de la dent.

La distance est de préférence mesurée en pixels, ce qui avantageusement évite de devoir établir l'échelle des images de dentition et de gouttière.

A l'étape ii), on détermine un seuil de distance *Sd*, de préférence à partir des distances déterminées à l'étape i).

De préférence, à l'étape ii), le seuil de distance *Sd* est sensiblement égal à la plus faible des distances déterminées à l'étape i) (d_{min}). Classiquement, à l'étape 1), au moins une des dents traitées est en contact avec le fond de la goulotte dans laquelle elle est insérée. La

distance entre les contours de dent intérieur et extérieur de cette dent est alors égale à une distance minimale d_{min} correspondant à une situation normale. Elle peut donc servir d'étalon pour évaluer, à l'étape iii), les distances entre les contours de dent intérieur et extérieur des autres dents.

A l'étape iii), on détermine, pour chacune des dents, un score dit « score en distance » $S(d,Sd)$, en fonction

- de la distance d entre les contours de dent intérieur et extérieur et
- du seuil de distance Sd.

De préférence, le score en distance pour une dent est égal à $(d\text{-}Sd)$, c'est-à-dire à la différence entre la distance entre les contours de dent intérieur et extérieur de cette dent et le seuil de distance. Plus le score en distance est élevé, plus la dent concernée est décollée de la goulotte.

La figure 7 illustre un exemple de mise en œuvre des étapes i) à iii), dans lequel une dent D1 est décollée du fond de la gouttière et telle que $d - d_{min} > Sd$.

Dans un deuxième mode de réalisation particulier, l'étape 4) comporte les étapes i') à iii').

A l'étape i'), on considère au moins triplet constitué de première, deuxième et troisième dents, D1, D2 et D3, respectivement, les première et troisième dents étant adjacentes à la deuxième dent, c'est-à-dire les première, deuxième et troisième dents se succédant le long d'une arcade.

On détermine les contours de dentition et de gouttière comportant les contours de dent intérieurs 14_1, 14_2 et 14_3, respectivement, et extérieurs 18_1, 18_2 et 18_3, respectivement, des dents D1, D2 et D3, respectivement.

Un « décalage » intérieur ou extérieur, respectivement, représente une distance entre les contours de dent intérieur ou extérieur, respectivement, de deux dents adjacentes.

On détermine

- un décalage entre le contour de dent intérieur de ladite première dent 14_1 et le contour de dent intérieur de ladite deuxième dent 14_2, dit « premier décalage intérieur », $\Delta_{1\text{-}2}i$;
- un décalage entre le contour de dent intérieur de ladite deuxième dent 14_2 et le contour de dent intérieur de ladite troisième dent 14_3, dit « deuxième décalage intérieur », $\Delta_{2\text{-}3}i$;

- un décalage entre le contour de dent extérieur de ladite première dent 18_1 et le contour de dent extérieur de ladite deuxième dent 18_2, dit « premier décalage extérieur », $\Delta_{1\text{-}2}e$;
- décalage entre le contour de dent extérieur de ladite deuxième dent 18_2 et le contour de dent extérieur de ladite troisième dent 18_3, dit « deuxième décalage extérieur », $\Delta_{2\text{-}3}e$.

Le décalage intérieur entre les contours de dent intérieurs de deux dents adjacentes est de préférence égal à la plus grande distance entre les contours de dent intérieurs de ces deux dents sur le contour de dentition.

Le décalage extérieur entre les contours de dent extérieurs de deux dents adjacentes est de préférence égal à la plus grande distance entre les contours de dent extérieurs de ces deux dents sur le contour de gouttière.

Les décalages intérieurs et les décalages extérieurs sont de préférence mesurés en pixels, ce qui avantageusement évite de devoir établir l'échelle des images de dentition et de gouttière.

On détermine ensuite :

- la différence entre le premier décalage intérieur $\Delta_{1\text{-}2}i$ et le premier décalage extérieur $\Delta_{1\text{-}2}e$, dite « première différence de décalages » $\Delta_{1\text{-}2}$ ($= \Delta_{1\text{-}2}i - \Delta_{1\text{-}2}e$) ;
- la différence entre le deuxième décalage intérieur $\Delta_{2\text{-}3}i$ et le deuxième décalage extérieur $\Delta_{2\text{-}3}e$, dite « deuxième différence de décalages » $\Delta_{2\text{-}3}$ ($= \Delta_{2\text{-}3}i - \Delta_{2\text{-}3}e$).

Dans l'exemple de la figure 8, $\Delta_{1\text{-}2}$ est beaucoup plus faible que $\Delta_{2\text{-}3}$.

A l'étape ii'), on détermine un seuil de différence de décalages $S\Delta$, de préférence à partir des première et deuxième différences de décalages $\Delta_{1\text{-}2}$ et $\Delta_{2\text{-}3}$ déterminées à l'étape i').

De préférence, à l'étape ii'), le seuil de décalage est sensiblement égal à la plus petite des différences de décalages déterminées à l'étape i').

Classiquement, à l'étape 1), au moins deux dents traitées adjacentes sont en contact avec le fond de la goulotte dans laquelle elles sont insérées. La différence de décalages entre ces deux dents traitées est alors sensiblement nulle. Cette différence de décalages nulle correspondant à une situation normale, elle peut donc servir d'étalon pour évaluer les différences de décalages entre les dents traitées adjacentes.

Sur la figure 8, la différence de décalages entre les deux dents D_1 et D_2 est sensiblement nulle.

A l'étape iii'), on détermine pour chaque couple de dents dudit triplet, au moins un score, dit « score en décalage », en fonction de la différence de décalages avec une dent adjacente à ladite dent et du seuil de différence de décalages.

En particulier, la différence de décalages de la première dent avec la deuxième dent peut être comparée au seuil de différence de décalages $S\Delta$, par exemple de zéro. Le seuil de différence de décalages peut être notamment soustrait à la différence de décalages de la première dent avec la deuxième dent pour déterminer un score en décalage des première et deuxième dents.

Ce score en décalage indique, par exemple s'il est positif, qu'une ou chacune des première et deuxième dents est susceptible d'être décollée du fond de la goulotte.

Sur la figure 8, la différence de décalages entre les deux dents D_2 et D_3 est positive, ce qui constitue un indice de décollement de la deuxième ou de la troisième dent.

Sur la figure 8, la différence de décalages entre les deux dents D_1 et D_2 étant sensiblement nulle, la différence positive de décalages entre les deux dents D_2 et D_3 indique donc un décollement de la troisième dent.

De manière générale, quand un premier score en décalage pour des première et deuxième dents indique un décollement d'une de ces deux dents, on détermine un deuxième score en décalage pour la deuxième dent et une troisième dent adjacente à la deuxième dent. Si le deuxième score en décalage est inférieur au premier score en décalage, il est probable que c'est la première dent qui s'est décollée du fond de la goulotte. Sinon, c'est probablement la deuxième dent qui s'est décollée.

A l'étape 5), une information, par exemple un avertissement, est envoyée à un opérateur, pour l'informer, le cas échéant, que la situation est anormale. L'information relative à une dent dépend du ou des scores établis à l'étape 4). De préférence, l'information comporte une valeur permettant de quantifier, pour au moins une dent, le niveau de décollement de la gouttière au-dessus de cette dent, cette valeur étant de préférence établie à partir du ou des scores calculés à l'étape 4) pour cette dent.

Dans un mode de réalisation, cette information est utilisée pour établir un diagnostic et/ou pour modifier le traitement, en particulier pour préconiser un changement de gouttière et/ou déterminer des caractéristiques d'une future gouttière pour le patient.

Comme cela apparaît clairement à présent, un procédé selon l'invention permet, à partir de simples photos ou d'un simple film, de déterminer les régions dans lesquelles la gouttière s'est écartée des dents et d'évaluer l'ampleur de ce décollement.

Bien entendu, l'invention n'est pas limitée aux modes de réalisation décrits ci-dessus et représentés.

Enfin, le patient n'est pas limité à un être humain. En particulier, un procédé selon l'invention peut être utilisé pour un autre animal.

REVENDICATIONS

1. Procédé d'évaluation de la forme d'une gouttière orthodontique portée par un patient, ledit procédé comportant les étapes suivantes :

1) acquisition d'au moins une image bidimensionnelle de dents dudit patient, dite « image actualisée », dans des conditions d'acquisition réelles,

au moins une image actualisée, dite « image de gouttière », représentant au moins partiellement la gouttière dans une position de service dans laquelle elle est portée par lesdites dents;

au moins une image actualisée, dite « image de dentition », identique ou différente de l'image de gouttière, représentant lesdites dents,

2) si l'image de dentition est différente de l'image de gouttière, transformation de l'image de dentition de manière qu'elle représente lesdites dents comme observées dans les conditions d'acquisition mises en œuvre lors de l'acquisition de l'image de gouttière à l'étape 1) ;

3) détermination pour chacune d'une pluralité de dents représentées sur les images de dentition et de gouttière, de contours de dent intérieur et extérieur représentant le contour de l'extrémité libre de ladite dent sur les images de dentition et de gouttière, respectivement,

4) comparaison des contours de dents intérieur et extérieur, puis détermination d'au moins un score en fonction de ladite comparaison.

2. Procédé selon la revendication immédiatement précédente, comportant, après l'étape 4), l'étape suivante :

5) comparaison du score à un seuil d'acceptabilité et émission d'une information en fonction du résultat de la comparaison.

3. Procédé selon l'une quelconque des revendications précédentes, dans lequel les images de dentition et de gouttière sont différentes, le procédé comportant les étapes suivantes :

(a) avant l'étape 1), réalisation d'un modèle tridimensionnel numérique d'au moins une partie d'une arcade portant lesdites dents, ou « modèle de référence initial »,

et pour chaque dent du modèle de référence initial, définition d'un modèle de référence tridimensionnel numérique de ladite dent, ou « modèle de dent » ;

(b) modification du modèle de référence initial par déplacement des modèles de dent, jusqu'à obtention d'un modèle de référence final compatible avec l'image de dentition ;

(c) recherche d'une vue bidimensionnelle du modèle de référence final compatible avec l'image de gouttière ;

(d) transformation de l'image de dentition en ladite vue.

4. Procédé selon l'une quelconque des revendications 1 et 2, dans lequel les images de dentition et de gouttière sont une même image.

5. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'étape 4) comporte les étapes suivantes :
pour chacune d'une pluralité de dents pour lesquelles des contours de dent intérieur et extérieur ont été déterminés ;

i) détermination d'une distance entre les contours de dent intérieur et extérieur ;

ii) détermination d'un seuil de distance, de préférence à partir des distances déterminées à l'étape immédiatement précédente ;

iii) pour chacune desdites dents, détermination d'un score en distance, en fonction
- de la distance entre les contours de dent intérieur et extérieur et
- du seuil de distance.

6. Procédé selon la revendication immédiatement précédente, dans lequel les distances sont mesurées en pixels.

7. Procédé selon l'une quelconque des deux revendications immédiatement précédentes, dans lequel à l'étape ii), le seuil de distance est fonction de la plus faible des distances déterminées à l'étape i).

8. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel l'étape 4) comporte les étapes suivantes :

i') pour chaque couple d'une dent gauche et d'une dent droite adjacentes d'au moins triplet de première, deuxième et troisième dents adjacentes pour chacune desquelles

des contours de dent intérieur et extérieur ont été déterminés, les première et troisième dents étant adjacentes à la deuxième dent,

détermination d'un décalage entre le contour de dent intérieur de ladite dent gauche et le contour de dent intérieur de ladite dent droite, dit « décalage intérieur », et

détermination d'un décalage entre le contour de dent extérieur de ladite dent gauche et le contour de dent extérieur de ladite dent droite, dit « décalage extérieur »,

puis

détermination de la différence entre le décalage intérieur et le décalage extérieur, dite « différence de décalages » ;

ii') détermination d'un seuil de différence de décalages, de préférence à partir des différences de décalages déterminées à l'étape i') ;

iii') détermination, pour chaque dent dudit triplet, d'au moins un score en décalage, en fonction de la différence de décalages avec une dent adjacente et du seuil de différence de décalages ;

9. Procédé selon la revendication immédiatement précédente, dans lequel les décalages intérieurs et extérieurs sont mesurés en pixels.

10. Procédé selon l'une quelconque des deux revendications immédiatement précédentes, dans lequel à l'étape iii'), le seuil de différence de décalages est fonction de la plus petite des différences de décalages déterminées à l'étape ii').

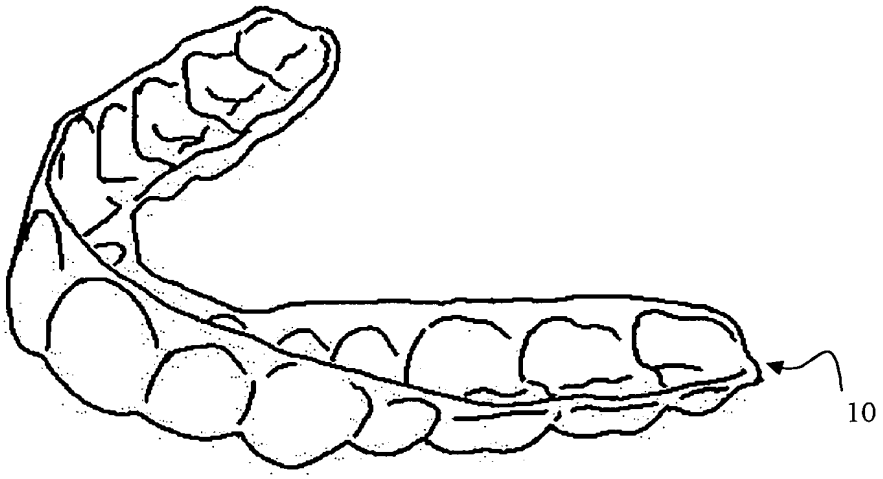


Fig. 1

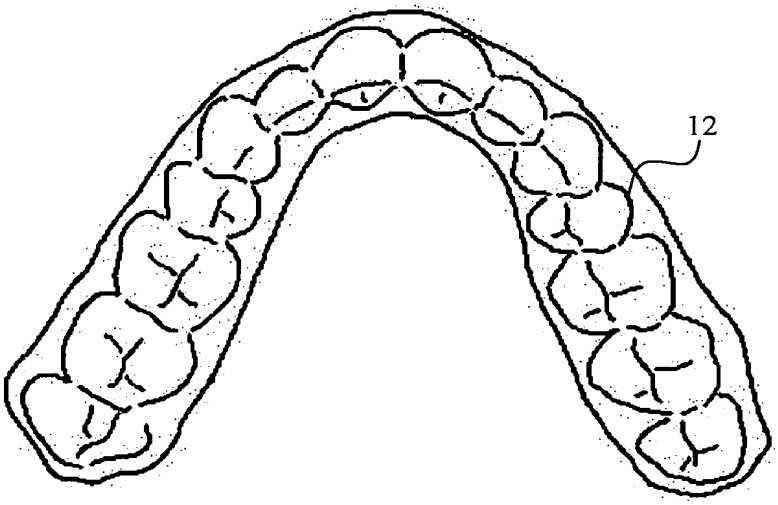


Fig. 2

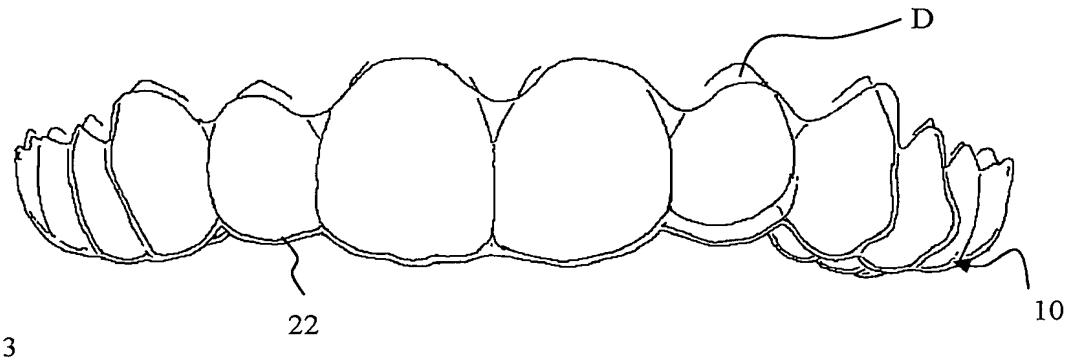


Fig. 3

5

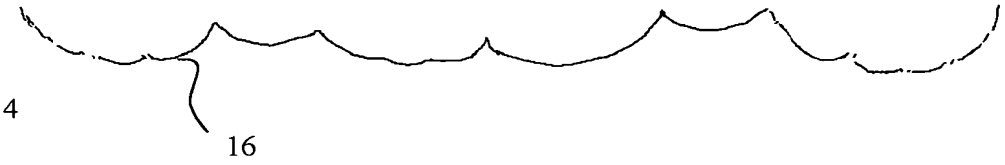


Fig. 4

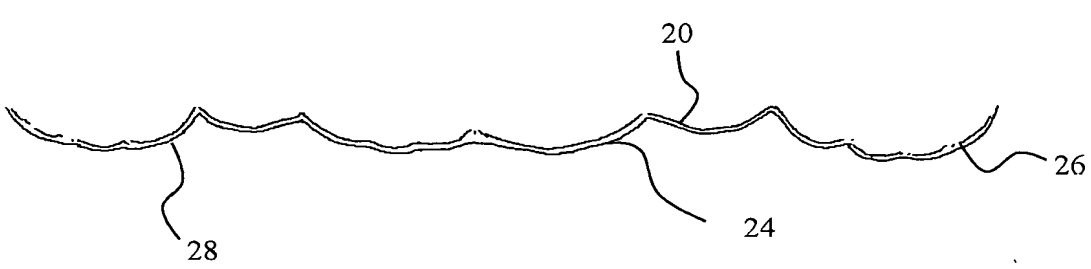


Fig. 5

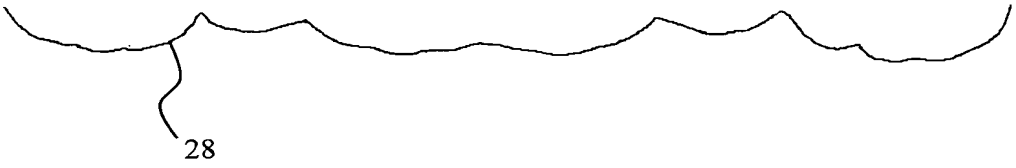


Fig. 6



Fig. 7

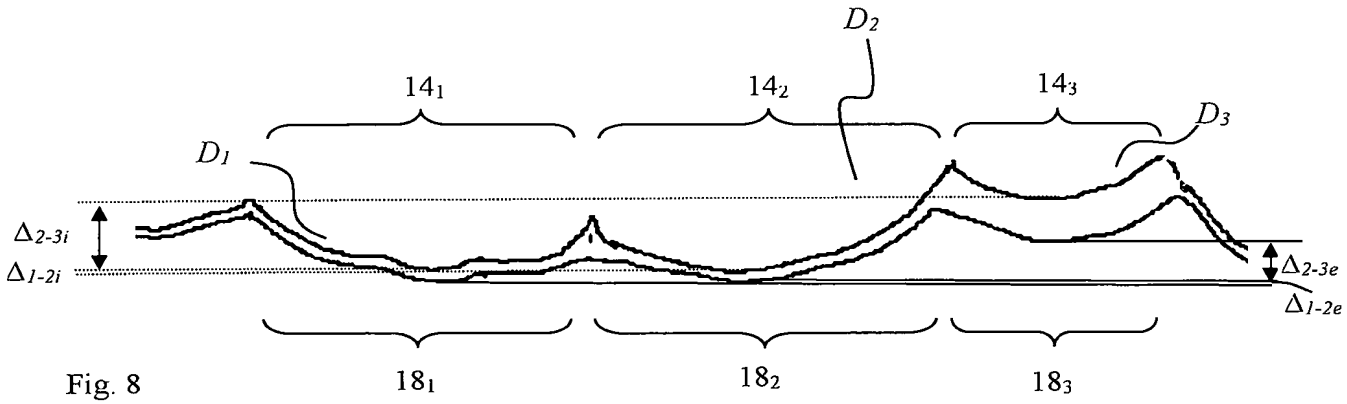

D2
14₁
14₂
14₃
D3
D1
Δ2-3i
Δ1-2i
Δ2-3e
Δ1-2e
18₁
18₂
18₃

Fig. 8

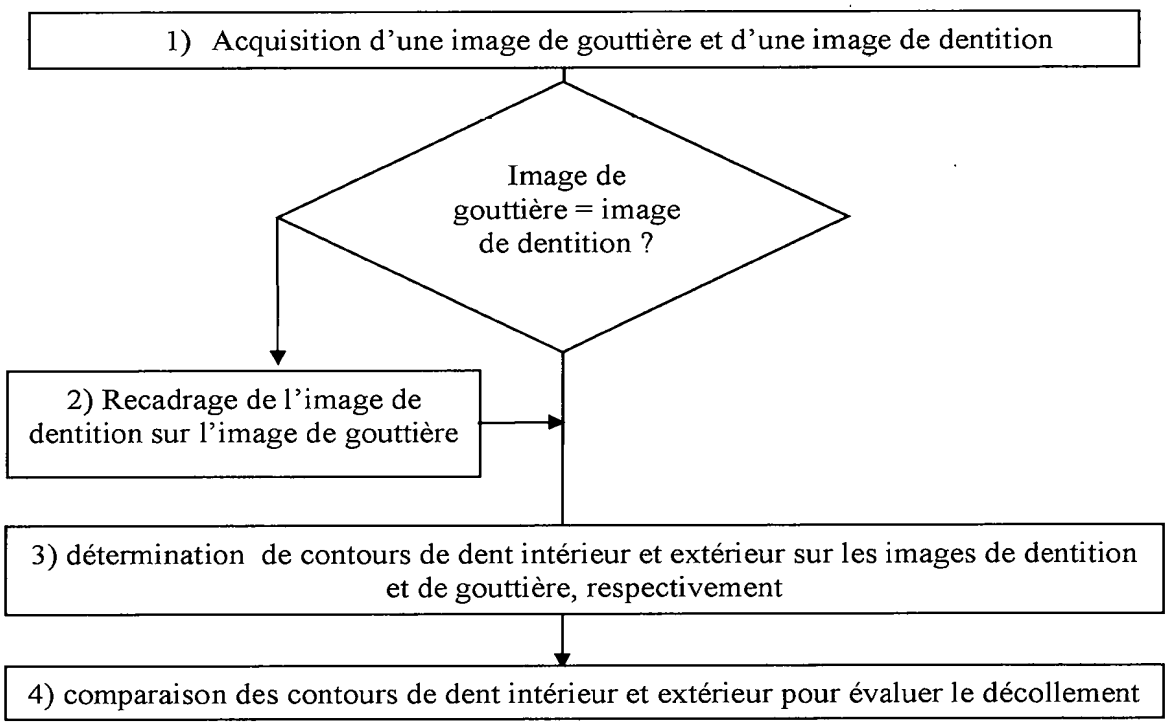

1) Acquisition d'une image de gouttière et d'une image de dentition
Image de gouttière = image de dentition ?
2) Recadrage de l'image de dentition sur l'image de gouttière
3) détermination de contours de dent intérieur et extérieur sur les images de dentition et de gouttière, respectivement
4) comparaison des contours de dent intérieur et extérieur pour évaluer le décollement

Fig. 9

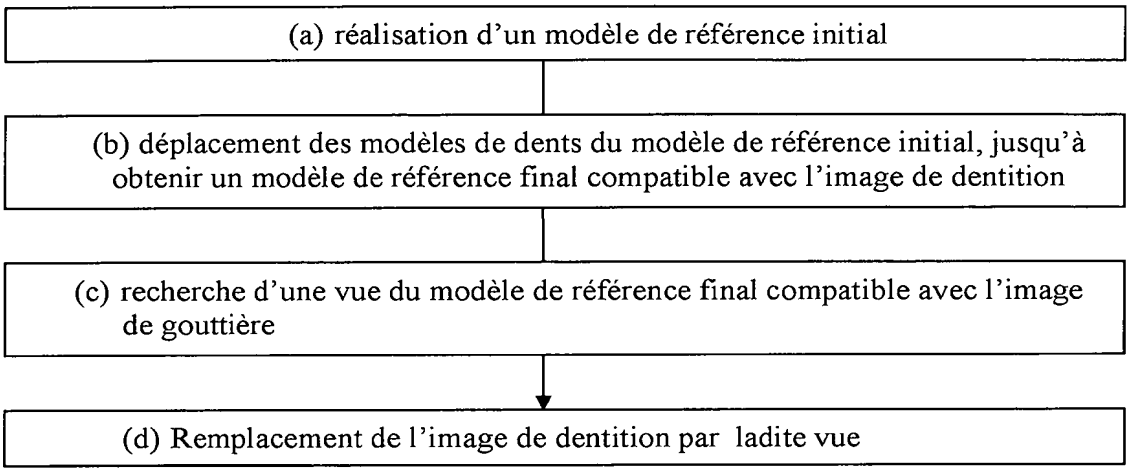

(a) réalisation d'un modèle de référence initial
(b) déplacement des modèles de dents du modèle de référence initial, jusqu'à obtenir un modèle de référence final compatible avec l'image de dentition
(c) recherche d'une vue du modèle de référence final compatible avec l'image de gouttière
(d) Remplacement de l'image de dentition par ladite vue

Fig. 10

OPAP AKIMA-15
JUN 2 6 2018
PATENT & TRADEMARK OFFICE

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	16/001,049
Applicant	:	Philippe SALAH
Filed	:	June 1, 2018
Title	:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
Conf. No.	:	8141
TC/A.U.		
Examiner	:	
Customer No.	:	108676
Docket No.	:	N&P-51411

LETTER

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir/Madam:

Enclosed, for filing in the above-referenced application, is a certified copy of the French priority document 1755187, priority of which has been claimed in the above-identified application.

Respectfully submitted,
COOPER LEGAL GROUP, LLC

By /Ronald M. Kachmarik/
Ronald M. Kachmarik, Reg. No. 34512

6505 Rockside Road
Suite 330
Independence, Ohio 44131
(216) 654-0090
June 22, 2018

I hereby certify that this correspondence is being deposited with the United States Postal Service as first-class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date indicated below.

Ronald M. Kachmarik
Name of Attorney for Applicant(s)

June 22, 2018 /Ronald M. Kachmarik/
Date Signature of Attorney

PTO/AIA/82A (07-13)
Approved for use through 11/30/2014. OMB 0651-0051
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	16/001,049
Filing Date	June 6, 2018
First Named Inventor	Philippe SALAH
Title	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
Art Unit	3732
Examiner Name	
Attorney Docket Number	N&P-51411

SIGNATURE of Applicant or Patent Practitioner

Signature	/Ronald M. Kachmarik/	Date (Optional)	September 25, 2018
Name	Ronald M. Kachmarik	Registration Number	34512
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. 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 3 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.**

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Doc Code: PA..
Document Description: Power of Attorney

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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☐ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 108676

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or Individual Name	Cooper Legal Group, LLC				
Address	6505 Rockside Road, Suite 330				
City	Independence	State	Ohio	Zip	44131
Country	US				
Telephone	216-654-6090	Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

DENTAL MONITORING

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature		Date (Optional)	04/07/2014
Name	PHILIPPE SALTI		
Title	DENTAL MONITORING	Chief Executive Officer	

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. 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 3 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.

Letter dated: September 21, 2018

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	: 16/001,049
Applicant	: Philippe SALAH
Filing Date	: June 6, 2018
Title	: METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
Conf. No.	: 8141
Customer No.	: 108676
Docket No	: N&P-51411

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Letter for Disclosure of Information concerning other pending applications

Sir:

Several patent applications, as listed below, are currently pending. As the applications progress through prosecution, each respective Examiner for each respective application is invited to monitor such progress/activity of the other applications.

Letter dated: September 21, 2018

LISTING OF APPLICATIONS:

N&P-51398 APPL. NO.: 15/952,635

N&P-51399 APPL NO.: 15/953,561

N&P-51400 APPL. NO.: 15/953,744

N&P-51410 APPL. NO.: 15/990,950

N&P-51411 APPL. NO.: 16/001,049

N&P-51421 APPL. NO.: 16/030,032

N&P-51422 APPL. NO.: 16/030,137

N&P-51423 APPL. NO.: 16/031,125

N&P-51424 APPL. NO.: 16/031,172

N&P-51425 APPL. NO.: 16/031,201

REMARKS/ARGUMENTS

If there are any fees resulting from this communication, please charge same to our Deposit Account No. 505088, our Order No. N&P-51411.

Respectfully submitted,
Cooper Legal Group

By: /Ronald M. Kachmarik/
Ronald M. Kachmarik, Reg. No. 34512

6505 Rockside Road
Suite 330
Cleveland Ohio 44131
(216) 654-0090
September 21, 2018

Electronic Acknowledgement Receipt

EFS ID:	33815303
Application Number:	16001049
International Application Number:	
Confirmation Number:	8141
Title of Invention:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
First Named Inventor/Applicant Name:	Philippe SALAH
Customer Number:	108676
Filer:	Ronald M. Kachmarik/Jackie Carpenter
Filer Authorized By:	Ronald M. Kachmarik
Attorney Docket Number:	N&P-51411
Receipt Date:	25-SEP-2018
Filing Date:	06-JUN-2018
Time Stamp:	10:08:24
Application Type:	Utility under 35 USC 111(a)

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	Power of Attorney	POA.pdf	1003647 ac22e0abe699606a92fc99989b8f7df0144beeeb	no	2

Warnings:

Information:					
2	Miscellaneous Incoming Letter	N-P-51411-LetterreDisclosure.pdf	60563 ba593f83548dcc137255c416bb864e972f0f6290	no	3
Warnings:					
Information:					
			Total Files Size (in bytes):	1064210	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/001,049	06/06/2018	Philippe SALAH	N&P-51411

CONFIRMATION NO. 8141

POA ACCEPTANCE LETTER

108676
Ronald M. Kachmarik
Cooper Legal Group LLC
6505 Rockside Rd.
Suite 330
Independence, OH 44131

OC000000102647455

Date Mailed: 09/28/2018

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 09/25/2018.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

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**.

/rnegga/

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

▒ United States application or PCT International application number 16/001,049

filed on June 6, 2018

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: Philippe SALAH Date (Optional) :

Signature:

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

▒ United States application or PCT international application number 16/001,049 filed on June 6, 2018.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

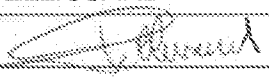
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LEGAL NAME OF INVENTOR

Inventor: Thomas PELLISSARD Date (Optional) :

Signature: 

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☐ The attached application, or

☒ United States application or PCT international application number 16/001,049

filed on June 6, 2018

The above-identified application was made or authorized to be made by me.

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LEGAL NAME OF INVENTOR

Inventor: Guillaume GHYSELINCK Date (Optional):

Signature:

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LEGAL NAME OF INVENTOR

Inventor: Laurent DEBRAUX Date (Optional): _____

Signature: _____

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L. D.

Electronic Acknowledgement Receipt

EFS ID:	34020275
Application Number:	16001049
International Application Number:	
Confirmation Number:	8141
Title of Invention:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
First Named Inventor/Applicant Name:	Philippe SALAH
Customer Number:	108676
Filer:	Ronald M. Kachmarik/Jackie Carpenter
Filer Authorized By:	Ronald M. Kachmarik
Attorney Docket Number:	N&P-51411
Receipt Date:	16-OCT-2018
Filing Date:	06-JUN-2018
Time Stamp:	11:22:46
Application Type:	Utility under 35 USC 111(a)

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	Oath or Declaration filed	Declaration.pdf	1490111 d1e007a6d3a8e03ad5d3810edcd725a7587370d4	no	8

Warnings:

Information:	
Total Files Size (in bytes):	1490111

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/001,049	06/06/2018	Philippe SALAH	N&P-51411

CONFIRMATION NO. 8141

108676
Ronald M. Kachmarik
Cooper Legal Group LLC
6505 Rockside Rd.
Suite 330
Independence, OH 44131

PUBLICATION NOTICE

OC000000104461862

Title:METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

Publication No.US-2018-0353263-A1
Publication Date:12/13/2018

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Letter dated: June 19, 2019

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	16/001,049
Applicant	:	Philippe SALAH
Filing Date	:	June 6, 2018
Title	:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
Examiner Name	:	Edward John Moran
Group Art Unit	:	3772
Conf. No.	:	8141
Customer No.	:	108676
Docket No	:	N&P-51411

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Letter for Disclosure of Information concerning other pending applications

Sir:

Several patent applications, as listed below, are currently pending. As the applications progress through prosecution, each respective Examiner for each respective application is invited to monitor such progress/activity of the other applications.

Letter dated: June 19, 2019

LISTING OF APPLICATIONS:

APPLICATION NO.: 15/522,554

N&P-51398 APPL. NO.: 15/952,635

N&P-51399 APPL NO.: 15/953,561

N&P-51400 APPL. NO.: 15/953,744

N&P-51410 APPL. NO.: 15/990,950

N&P-51411 APPL. NO.: 16/001,049

N&P-51421 APPL. NO.: 16/030,032

N&P-51422 APPL. NO.: 16/030,137

N&P-51423 APPL. NO.: 16/031,125

N&P-51424 APPL. NO.: 16/031,172

N&P-51425 APPL. NO.: 16/031,201

REMARKS/ARGUMENTS

If there are any fees resulting from this communication, please charge same to our Deposit Account No. 505088, our Order No. N&P-51411.

Respectfully submitted,
Cooper Legal Group

By: /Ronald M. Kachmarik/
Ronald M. Kachmarik, Reg. No. 34512

6505 Rockside Road
Suite 330
Cleveland Ohio 44131
(216) 654-0090
June 19, 2019

Electronic Acknowledgement Receipt

EFS ID:	36347714
Application Number:	16001049
International Application Number:	
Confirmation Number:	8141
Title of Invention:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
First Named Inventor/Applicant Name:	Philippe SALAH
Customer Number:	108676
Filer:	Ronald M. Kachmarik/Amy Ansbro
Filer Authorized By:	Ronald M. Kachmarik
Attorney Docket Number:	N&P-51411
Receipt Date:	19-JUN-2019
Filing Date:	06-JUN-2018
Time Stamp:	15:16:47
Application Type:	Utility under 35 USC 111(a)

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	Miscellaneous Incoming Letter	N-P-51411-Ltr-Disclosure.pdf	60831 4f57e1e681ef9654d4da27390f09d8fb21e6bded	no	3

Warnings:

Information:	
Total Files Size (in bytes):	60831

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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.

Letter dated: September 23, 2019

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	16/001,049
Applicant	:	Philippe SALAH
Filing Date	:	June 6, 2018
Title	:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
Examiner Name	:	Edward John Moran
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Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
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Letter dated: September 23, 2019

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REMARKS/ARGUMENTS

If there are any fees resulting from this communication, please charge same to our Deposit Account No. 505088, our Order No. N&P-51411.

Respectfully submitted,
Cooper Legal Group

By: /Ronald M. Kachmarik/
Ronald M. Kachmarik, Reg. No. 34512

6505 Rockside Road
Suite 330
Cleveland Ohio 44131
(216) 654-0090
September 23, 2019

Electronic Acknowledgement Receipt

EFS ID:	37244806
Application Number:	16001049
International Application Number:	
Confirmation Number:	8141
Title of Invention:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
First Named Inventor/Applicant Name:	Philippe SALAH
Customer Number:	108676
Filer:	Ronald M. Kachmarik/Amy Ansbro
Filer Authorized By:	Ronald M. Kachmarik
Attorney Docket Number:	N&P-51411
Receipt Date:	23-SEP-2019
Filing Date:	06-JUN-2018
Time Stamp:	15:54:43
Application Type:	Utility under 35 USC 111(a)

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	Miscellaneous Incoming Letter	N-P-51411-Ltr-Disclosure_9-23-19.pdf	60730 8d64d39d3b0f6e5b83be1a29d41b99b8ece69e49	no	3

Warnings:

Information:	
Total Files Size (in bytes):	60730

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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New International Application Filed with the USPTO as a Receiving Office

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/001,049	06/06/2018	Philippe SALAH	N&P-51411	8141

108676 7590 12/30/2020

Ronald M. Kachmarik
Cooper Legal Group LLC
6505 Rockside Rd.
Suite 330
Independence, OH 44131

EXAMINER	
PATEL, MAHENDRA R	

ART UNIT	PAPER NUMBER
2645	

NOTIFICATION DATE	DELIVERY MODE
12/30/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patdoc@cooperlegalgroup.com

Office Action Summary	Application No. 16/001,049	Applicant(s) SALAH et al.	
	Examiner MAHENDRA R PATEL	Art Unit 2645	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 06/06/2018 (Claims).

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-10 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-10 is/are rejected.

8) ☑ Claim(s) 3,5 and 7-10 is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 06/06/2018 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☑ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☑ Interview Summary (PTO-413) Paper No(s)/Mail Date 12/14/2020.

4) ☐ Other: _____.

DETAILED ACTION

1. This communication is in response to the claims filed on 06/06/2018.

Application No: 16/001,049

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Notice of Pre-AIA or AIA Status

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection **if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status**.

Claim Objections

2. Claim 1 is objected to because of the following informalities:

Claim 1, steps 4 makes a comparison of the interior and exterior tooth outlines, However it is not clear (i) what reference parameter is used to compare, and (ii) what is comparing between interior and exterior tooth outlines. It appease that claim is incomplete or missing steps.

Please clarify step 4 limitations (e.g. see reference claim 2 or equivalent). Appropriate correction is required for further review.

Claim Rejections - 35 USC § 112

3. **Claim 1-10 are** rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as **being indefinite for failing to particularly point out and distinctly claim the subject matter** which the inventor or a joint inventor (or for applications subject to pre-AIA 35 U.S.C. 112, the applicant), regards as the invention.

Claim 1, step 3 states that determination, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images. However, **claim is not clearly disclosing what is determined and which determining steps (or logic or algorithm) is used to arrive final output result**.

Please clarify step 3 limitations (e.g. see reference claim 5 (iii) or equivalent).

The dependent claims 2-10 are rejected with the same reasoning as their corresponding independent claim(s). Appropriate correction is required for further review.

Claim 6 depends on claim 1 and states that **the distances are measured in pixels**. However, claim 1 does not recite any limitation with "**distance**" element. There **is insufficient antecedent basis** for this limitation in the claim. Appropriate correction is required for further review.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole ***would have been obvious before the effective filing date*** of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:
1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

4. **Claims 1-2, 4 and 6 are** rejected under 35 U.S.C. 103 as being unpatentable over GREENBERG et al. (US 20140120488 A1) in view of WEN et al. (US 20170100214 A1).

Regarding claim 1, GREENBERG teaches a method for evaluating the shape of an orthodontic aligner worn by a patient ([0011], e.g. **A method of manufacturing** a template for orthodontic movement of at least one tooth includes several steps. [0011] the first and second radiographs are compared to determine the **entire shape of the tooth surface**, including the root. A desired location for the at least one tooth is then determined. A desired position for the at least one tooth at the desired location is then determined. A desired movement of for the at least one tooth at the desired location is then determined. **An aligner for orthodontic movement for the**

at least one tooth is then formed (i.e. evaluating the shape of an orthodontic aligner)), said method comprising the following steps:

1) acquisition of at least one two-dimensional image of teeth of said patient, referred to as "updated image", under actual acquisition conditions ([0027], e.g. The CT scans are used to generate a three -dimensional image each **tooth** from a large series **of two-dimensional X-ray images preferably taken around a single axis of rotation (i.e.** acquisition of a two-dimensional image of teeth). The **data from both scans is then uploaded** (i.e. updated image) and processed by medical image processing algorithms);

at least one updated image referred to as "aligner image", at least partially representing the aligner in a service position in which it is worn by said teeth ([0010], e.g. The **aligner is manufactured** based in part on a computed axial tomography (CT) scan of a **patient wearing the radiographic template** and a separate scan of the radiographic template, wherein the data is processed by superimposition of the **orthodontic aligner on the CT images** of the **patient including a jaw** in axial and panoramic views. [0027] the data is then processed with superimposition of the **orthodontic aligner on the CT images of the jaw** in axial and panoramic views. A series of **orthodontic aligners are produced** based on the CT data (i.e. at least one updated image referred to as "aligner image")); and

at least one updated image referred to as "dentition image", identical to or different from the aligner image, representing said teeth ([0029], e.g. each individual tooth can be manipulated into **a desired position, which correlates to a 3D image of the dentition** (i.e. updated image referred to as "dentition image", identical to or different from the aligner image)),

2) if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions used during the acquisition of the aligner image in step 1 ([0029], e.g. Each individual tooth can be manipulated into a desired position, which correlates to **a 3D image of the dentition**. As shown in FIG. 5, each tooth is represented by a 3D image, which is a pair of tetrahedrons connected at the bases with apices as opposing pyramids. An alignment axis passes through each apex and each side corresponding to one of the buccal, lingual, mesial, and distal aspects of each tooth. **Preferably, all of the teeth in undergo automatic conversion** to these dual **tetrahedrons (i.e.** conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions)).

GREENBERG teaches a method for evaluating the shape of an orthodontic aligner worn by a patient. However GREENBERG differs from the claimed invention in not specifically and clearly describing wherein

3) determination, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively; and

4) comparison of the interior and exterior tooth outlines, followed by determination of at least one score according to said comparison.

However, in the analogous field of endeavor, WEN teaches wherein

3) determination, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively ([0014], e.g. One method for treating a subject, as

described herein, may generally comprise receiving a **scanned dental model of a subject's dentition**, **determining a treatment plan having a plurality of incremental movements for repositioning one or more teeth of the subject's dentition**, **and fabricating one or more aligners** correlating to a first subset of the plurality of incremental movements (i.e. determination, for each of a plurality of teeth represented on the dentition and aligner images). [0022] In another variation, fabricating one or more aligners may further comprise fabricating a support structure which corresponds to an outer surface of the dentition, forming one or more oral appliances upon an exterior surface of the support structure such that an interior of the one or more oral appliances conform to the dentition, and removing the support structure from the interior of the one or more oral appliances (i.e. interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images)); and

4) comparison of the interior and exterior tooth outlines, followed by determination of at least one score according to said comparison ([0058], .g. Generally, the oral appliance assembly may comprise the support structure having an **exterior surface which corresponds to an outer surface of the dentition** of the subject, wherein the support structure is fabricated from a first material, and the oral appliance formed upon the exterior surface of the support structure via three dimensional printing, s**uch that an interior of the formed oral appliance conforms to the dentition of the subject** (i.e. comparison of the interior and exterior tooth outlines), wherein the oral appliance is fabricated from a second material different from the first material. [0034] the **teeth movements are decomposed to different movement metrics,** e.g. a tooth movement can be decomposed. to tip, rotation around long axis, bodily movement, etc. The artificial intelligence network, usually a neural network is built, such **network having different neurons**

and weights (i.e. determination of score according to said comparison) can be adjusted, where treated cases are the learning set of such neural network).

Therefore, it would have been obvious to one of ordinary skill in the art ***before the effective filing date*** of the invention to implement the method of WEN within the method of GREENBERG. The motivation to combine references is that the combined method provides **an efficient and cost effective procedure for planning the orthodontic treatment of a patient.** The present control method is ideal for use in moving a number of tooth models and to **provide synchronized tooth movement**. Such a method may be non-swarming to **avoid any collisions between the teeth** and to **also avoid the** appearance of merely random movements in some applications of the tooth model (See WEN [0002, 0029, and 0062]).

Regarding claim 2, GREENBERG in view of WEN teaches all the limitations of claim 1. WEN further teaches wherein comparison of the score against an acceptability threshold and the emission of information according to the result of the comparison ([0034], e.g. In some implementations of the method, the teeth movements are decomposed to different movement metrics, e.g. a tooth movement can be decomposed. to tip, rotation around long axis, bodily movement, etc. The artificial intelligence network, usually a neural network is built, **such network having different neurons and weights can be adjusted** (i.e. comparison of the score against an acceptability threshold), where treated cases are the learning set of such neural network. By inputting each case and adjusting the network weights to make the network more predictable to the **treatment outcome (i.e.** the emission of information)).

The motivation to combine reference of WEN within the method of GREENBERG ***before the effective filing date*** of the invention is that the new method provides Further, **the treatment plan may then be automatically adjusted by the system for the next set of dental appliances** or positioners to **correct for the deviations so that the newly fabricated positioners provide for a better fit to the patient's dentition** and is responsive to correcting for the deviations (see WEN [0154]).

Regarding claim 4, GREENBERG in view of WEN teaches all the limitations of claim 1. GREENBERG further teaches wherein the dentition and aligner images are the same image ([0031], e.g. the axial views are manipulated in a similar manner with correlation to a 3D image of the dentition. The 3D treatment positioning of the teeth in the final desired outcome of the treatment is displayed as shown in FIG. 7. The **orthodontic aligner used to reposition the teeth is registered using the fiducial markers or optically scanned data of the dentition (i.e.** dentition and aligner images are the same).

Regarding claim 6, GREENBERG in view of WEN teaches all the limitations of claim 1. GREENBERG further teaches wherein the distances are measured in pixels ([0009], e.g. FIG. 2 depicts a set of teeth that have undergone treatment using the optically scanned dental casts. The aligned teeth have a spacing D. **This space (i.e. distances) between the teeth** is based in part on **using data regarding the teeth above the gum line**, without considering the roots of the teeth. [0010] wherein the data is processed by **superimposition of the orthodontic aligner on the CT images of the patient** including a jaw in axial and panoramic views (i.e. a CT image with pixels). In this manner, the tooth above the gum line, represented by the negative

impression as well as the tooth below the gum line, represented **by the CT data is used to design the orthodontic aligner (i.e. CT data is represented by image pixels, and hence distance between the teeth**).

Allowable Subject Matter

5. **Claims 3, 5, 7 and 8-10 are** objected to as being dependent upon a rejected base claim, but would be allowable, if rewritten in independent form **including all of the limitations of the base claim and any intervening claims**; and **amending** claim(s) to overcome any **objection**(s) and /or **rejection**(s) set forth in this Office action.

Prior Art Record

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

a. Matov; Vadim et al. (US 20090191503 A1) - METHOD AND SYSTEM FOR OPTIMIZING DENTAL ALIGNER GEOMETRY.

b. Rubbert; Rudger et al. (US 20090291417 A1) - INTERACTIVE ORTHODONTIC CARE SYSTEM BASED ON INTRA-ORAL SCANNING OF TEETH.

c. Kuo; Eric E. (US 20150132708 A1) - METHOD AND SYSTEM FOR PROVIDING DYNAMIC ORTHODONTIC ASSESSMENT AND TREATMENT PROFILES.

d. Webber; Peter et al. (US 20160128803 A1) - ORTHODONTIC ALIGNER WITH ISOLATED SEGMENTS.

e. HUANG; Stanley S.T. et al. (US 20150132707 A1) - BRACES TO ALIGNER TRANSITION IN ORTHODONTIC TREATMENT.

f. HILLIARD; Jack Keith (US 20080050692 A1) - SYSTEM AND METHOD FOR FABRICATING ORTHODONTIC ALIGNERS.

g. Peacock, James Clayton III (US 20030124480 A1) - Adjustable orthodontic band.

h. Arjomand; Hossein et al. (US 20100068672 A1) - Orthodontic condition evaluation.

i. PELLISSARD THOMAS et al. (WO 2016066637 A1) - METHOD FOR MONITORING AN ORTHODONTIC TREATMENT.

j. XU XIAOHAN (CN 104970891 A) - Manufacturing method of customized tongue-side invisible aligner.

k. KIM JIN BAEK et al. (KR 20180017454 A) - orthodontic digital bracket.

Conclusion

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mahendra Patel whose telephone number is (571)270-7499. The examiner can normally be reached on 9:30 AM to 5:30 PM (EST).

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, Applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Anthony Addy can be reached on (571) 272-7795(571) 272-7795. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free)? If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MAHENDRA R PATEL/
Primary Examiner, Art Unit 2645

Examiner-Initiated Interview Summary	**Application No.** 16/001,049	**Applicant(s)** SALAH et al.		
	Examiner MAHENDRA R PATEL	**Art Unit** 2645	**AIA (First Inventor to File) Status** Yes	**Page** **1 of 2**

All Participants (applicant, applicants representative, PTO personnel)	**Title**	**Type**
MAHENDRA R PATEL	Primary Examiner	Telephonic
Kachmarik, Ronald	Attorney	

Date of Interview: 14 December 2020

Issues Discussed:

35 U.S.C. 112

Claim 1, step 3 states that determination, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images. However, claim is not clearly disclosing what is determined and which determining steps (or logic or algorithm) is used to arrive final output result.

Please clarify step 3 limitations (e.g. reference claim 5 (iii) or equivalent).

Appropriate correction is required for further review.

Claim 6, There is insufficient antecedent basis for this limitation in the claim.
Appropriate correction is required for further review.

Objections

Claim 1, steps 4 makes a comparison of the interior and exterior tooth outlines, However it is not clear (i) what reference parameter is used to compare, and (ii) what is comparing between interior and exterior tooth outlines.

Please clarify step 4 limitations (e.g. reference claim 2 or equivalent).
Appropriate correction is required for further review.

/MAHENDRA R PATEL/ Primary Examiner, Art Unit 2645	

Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04
Please further see:
MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner-Initiated Interview Summary	**Application No.** 16/001,049	**Applicant(s)** SALAH et al.		
	Examiner MAHENDRA R PATEL	**Art Unit** 2645	**AIA (First Inventor to File) Status** Yes	**Page** **2 of 2**

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Notice of References Cited	Application/Control No. 16/001,049	Applicant(s)/Patent Under Reexamination SALAH et al.	
	Examiner MAHENDRA R PATEL	Art Unit 2645	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20090191503-A1	07-2009	Matov; Vadim	A61B6/032	433/24
*	B	US-20150132708-A1	05-2015	Kuo; Eric E.	G06F19/00	433/24
*	C	US-20090291417-A1	11-2009	Rubbert; Rudger	G06Q10/06	433/215
*	D	US-20100068672-A1	03-2010	Arjomand; Hossein	A61C9/00	433/24
*	E	US-20160128803-A1	05-2016	Webber; Peter	A61C7/36	433/6
*	F	US-20150132707-A1	05-2015	HUANG; Stanley S.T.	A61C7/08	433/6
*	G	US-20140120488-A1	05-2014	GREENBERG; Alex M.	A61C7/08	433/6
*	H	US-20080050692-A1	02-2008	HILLIARD; Jack Keith	A61C7/002	433/24
*	I	US-20030124480-A1	07-2003	Peacock, James Clayton III	A61C7/18	433/23
*	J	US-20170100214-A1	04-2017	WEN; Huafeng	G16H30/20	1/1
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
*	N	WO-2016066637-A1	05-2016	WO	PELLISSARD THOMAS	G06T17/00
*	O	CN-104970891-A	10-2015	CN	XU XIAOHAN	
*	P	KR-20180017454-A	02-2018	KR	KIM JIN BAEK	
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/001,049	SALAH et al.
	Examiner	Art Unit
	MAHENDRA R PATEL	2645

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
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CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/13/2020								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/001,049	SALAH et al.
	Examiner	Art Unit
	MAHENDRA R PATEL	2645

CPC - Searched*		
Symbol	Date	Examiner
A61C7/002, G06T7/174, G06T7/0012, A61C7/08, A61C9/0053, G06T7/136, G06T2207/30036,	12/13/2020	MP
A61C 7/002, A61C 7/08, A61C 9/0053, G16H 50/50, G16H 50/20,	12/13/2020	MP

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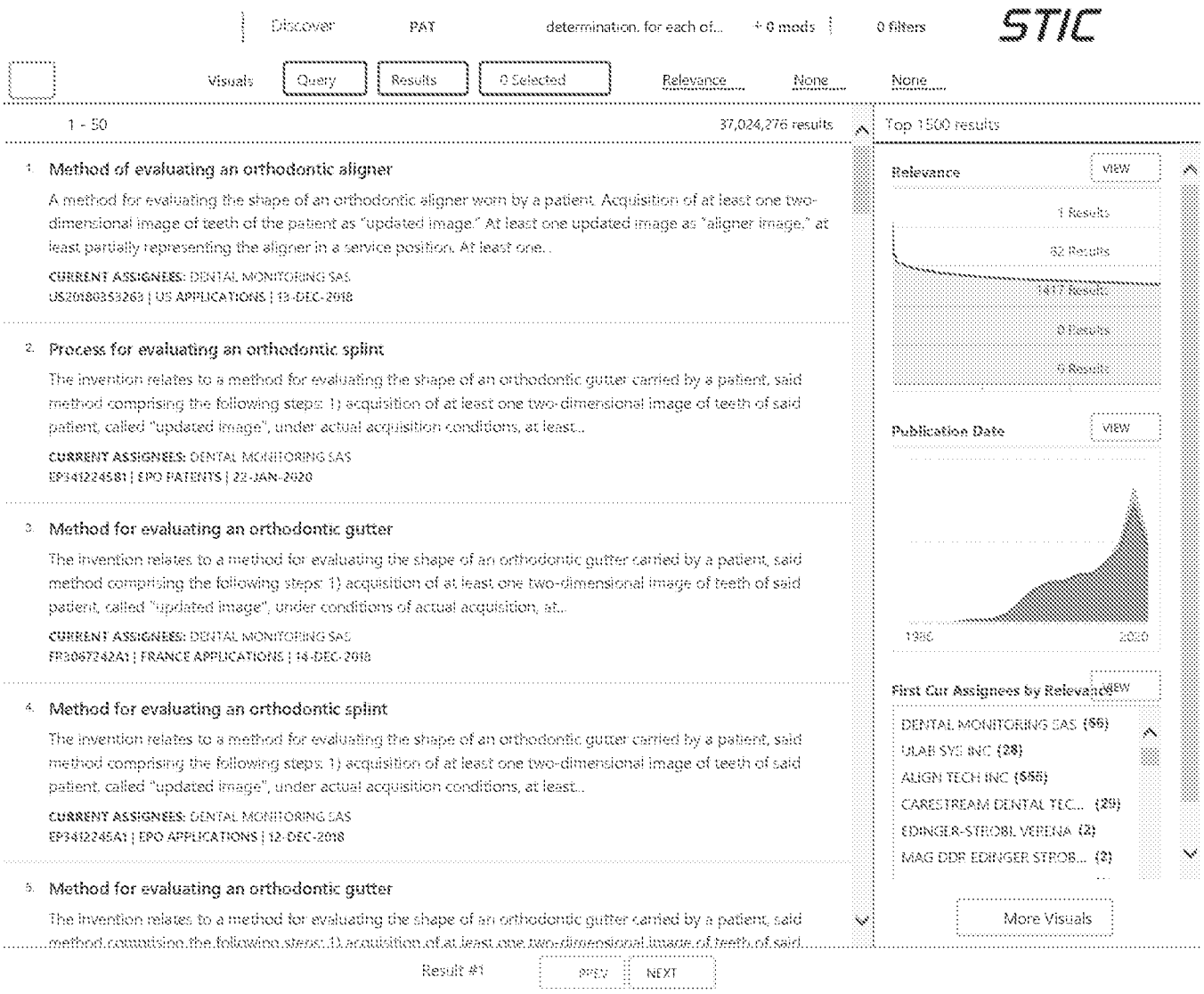
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Class	Subclass	Date	Examiner
382	128	12/13/2020	MP

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Search Notes		
Search Notes	Date	Examiner
EAST search	12/13/2020	MP
Inventor / applicant search	12/13/2020	MP
IP.COM search - PAT	12/13/2020	MP
IP.COM search - NPL	12/13/2020	MP
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/001,049	SALAH et al.
	Examiner	Art Unit
	MAHENDRA R PATEL	2645

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382	128	12/13/2020	MP
A61C	7/002, 7/08, 9/0053,	12/13/2020	MP
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1. Method of evaluating an orthodontic aligner
A method for evaluating the shape of an orthodontic aligner worn by a patient. Acquisition of at least one two-dimensional image of teeth of the patient as "updated image." At least one updated image as "aligner image," at least partially representing the aligner in a service position. At least one...
CURRENT ASSIGNEES: DENTAL MONITORING SAS
US20180353263 | US APPLICATIONS | 13-DEC-2018
2. Process for evaluating an orthodontic splint
The invention relates to a method for evaluating the shape of an orthodontic gutter carried by a patient, said method comprising the following steps: 1) acquisition of at least one two-dimensional image of teeth of said patient, called "updated image", under actual acquisition conditions, at least...
CURRENT ASSIGNEES: DENTAL MONITORING SAS
EP3412245B1 | EPO PATENTS | 22-JAN-2020
3. Method for evaluating an orthodontic gutter
The invention relates to a method for evaluating the shape of an orthodontic gutter carried by a patient, said method comprising the following steps: 1) acquisition of at least one two-dimensional image of teeth of said patient, called "updated image", under conditions of actual acquisition, at...
CURRENT ASSIGNEES: DENTAL MONITORING SAS
FR3067242A1 | FRANCE APPLICATIONS | 14-DEC-2018
4. Method for evaluating an orthodontic splint
The invention relates to a method for evaluating the shape of an orthodontic gutter carried by a patient, said method comprising the following steps: 1) acquisition of at least one two-dimensional image of teeth of said patient, called "updated image", under actual acquisition conditions, at least...
CURRENT ASSIGNEES: DENTAL MONITORING SAS
EP3412245A1 | EPO APPLICATIONS | 12-DEC-2018
5. Method for evaluating an orthodontic gutter
The invention relates to a method for evaluating the shape of an orthodontic gutter carried by a patient, said method comprising the following steps: 1) acquisition of at least one two-dimensional image of teeth of said
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Bibliographic Data

Application No: 16/001,049

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

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Title: METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
06/06/2018	382	2645	N&P-51411
RULE			

APPLICANTS

DENTAL MONITORING, Paris, FRANCE

INVENTORS

Philippe SALAH, Bagnolet, FRANCE

Thomas Pellissard, Clichy, FRANCE

Guillaume Ghyselinck, Cantin, FRANCE

Laurent Debraux, Paris, FRANCE

CONTINUING DATA

FOREIGN APPLICATIONS

FRANCE FR1755187 06/09/2017

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ADDRESS

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Cooper Legal Group LLC
6505 Rockside Rd.
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UNITED STATES

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	1	20100068672	A1	2010-03-18	Arjomand et al.	Cited in French Search Report

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	1	2016066637	WO	A1	2016-05-06	Salah et al.	Cited in French Search Report	☐

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	Filing Date	
	First Named Inventor	Philippe SALAH
	Art Unit	
	Examiner Name	
	Attorney Docket Number	N&P-51411

	1	Corresponding French Application, French Search Report, Application no.: 1755187, dated January 22, 2018, 2 pages	☐

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In each arch of the mouth, there are two central incisors, two lateral incisors, two canines, ... right second molar) and ending with "T" (Mandibular right second molar). There are no premolars or third molars in the primary dentition. ... Tooth, Eruption Date ... If you want us to update our internal records so we do not share your ...

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Child and Adult Dentition (Teeth) - Structure - Primary ...

Fig 1 – Primary and permanent dentition. The eruption dates for each tooth are denoted in brackets. Tooth Structure. A tooth can ..

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Clear aligners - Wikipedia

Clear aligners, also known as clear-aligner treatment, are orthodontic devices that are a transparent, plastic form of dental braces used to adjust teeth.

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esthetic alignment of the anterior teeth while maintaining the narrow arches. CLINICAL NOTES. Expansion. When programming dental posterior expansion, ...

www.ncbi.nlm.nih.gov › pmc › articles › PMC6036925

Early development of the human dentition revisited - NCBI - NIH

May 10, 2018 — The dental epithelium forms a mound, where swellings appear later, corresponding to the ... The heterodonty is reflected by four tooth classes, incisors, canines, premolars and molars. An external file that holds a picture, illustration, etc. ... which represent successional teeth of the permanent dentition (Fig.

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US6783360B2 - Systems and methods for positioning teeth ...

Generally, the orthodontist specifies in a prescription the final tooth arrangement. ... determining an occlusion from the computer representation of the masticatory ... an image as well as a digital data set representing the final tooth arrangement. ... Normal occlusion and alignment is defined as all anatomical contact points ...

whyy.org › segments › inside-the-battle-between-smile-...

Why dental professionals hate Smile Direct Club — WHYY

Dec 5, 2019 — Professional dental groups say it cuts corners, endangers patients, ... at a scanned image of patient's teeth in SmileDirectClub's SmileShop. ... he said, and some people just aren't good candidates for aligners in the ... A dental assistant put one end in my mouth and all around my teeth, ... Subscribe for free ...

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Do aligners work with missing teeth?

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Domestic rabbits (Oryctolagus cuniculus) are increasingly popular as household pets; therefore, veterinarians need to be familiar with the most common diseases afflicting rabbits including dental diseases. Diagnostic approaches for dental disease include gross oral examination, endoscopic oral...

PMC5065979 | PUBMED CENTRAL | 17-OCT-2016 | Frontiers in Veterinary Science, 3, 93

2. **The potential of statistical shape modelling for geometric morphometric analysis of human teeth in archaeological research**

This paper introduces statistical shape modelling (SSM) for use in osteoarchaeology research. SSM is a full field, multi-material analytical technique, and is presented as a supplementary geometric morphometric (GM) tool. Lower mandibular canines from two archaeological populations and one modern...

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3. **Computed Tomography (CT)-Assisted 3D Cephalometry in Horses: Interincisal Angulation of Clinical Crowns**

The angle encompassed between opposing incisors in horses is assumed to decline with age. Previous studies merely consider the overall profile view of clinical crowns presuming a generalized angle, neglecting potential tooth position-dependent differences. Cephalometric measurements from 3D computed...

PMC7403475 | PUBMED CENTRAL | 29-JUL-2020 | Frontiers in Veterinary Science, 7, 434

4. **Orthodontic Tooth Movement with Clear Aligners**

Clear aligners provide a convenient model to measure orthodontic tooth movement (OTM). We examined the role of in vivo aligner material fatigue and subject-specific factors in tooth movement. Fifteen subjects seeking orthodontic treatment at the University of Florida were enrolled. Results were...

PMC3424837 | PUBMED CENTRAL | 14-AUG-2012 | ISRN Dentistry, 2012, 657973

5. **Teeth segmentation in 3D dentition models for the virtual articulator**

A virtual articulator is a system currently being developed for dentistry. It is supposed to virtually determine teeth antagonists and the occlusion surfaces between them. In contrast to state-of-the-art mechanical articulators, it

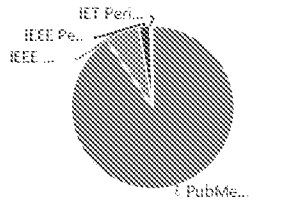
Result #1 PREV NEXT

Top 1500 results

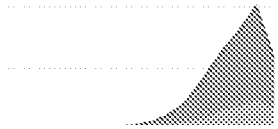
Relevance VIEW

0 Results
0 Results
1121 Results
379 Results
0 Results

Collections VIEW



Publication Date VIEW



More Visuals

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S78	1	((A61C7/002 or G06T7/174 or G06T7/0012 or A61C7/08 or A61C9/0053 or G06T7/136 or G06T2207/30036).cpc.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold)) .clm.	US-PGPUB; USPAT	SAME	ON	2020/12/13 14:24
S79	2	((G06K$ or G06Q$ or G06F$ or G06N$ or G06T$ or G05D$ or G08B$ or G09G$ or G07C$ or G07D$ or G07G$ or G06F$ or G06T$ or G01C$ or G01R$ or B60R$ or B60D$ or B62D$ or B60T$ or B06W$ or A61B$ or A61C$ or G16H$ or H04W$ or H04L$ or H04B$ or H04M$ or H04N$ or H04Q$ or H04J$).CPC.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) .clm.	US-PGPUB; USPAT	SAME	ON	2020/12/13 14:24
S80	2	((Robotic or robot$4) or (Artificial with Intelligence) or (neural with network) or (Fuzzy) or (semantic or segmentation) or (pixel$1) or (training or testing) or (autonomous) or (track$4) or (machine with learning)) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) .clm.	US-PGPUB; USPAT	SAME	ON	2020/12/13 14:24
S81	2	(("382"/$).ccls. or ("455"/$).ccls. or ("370"/$).ccls. or ("1"/$).ccls. or ("600"/$).ccls. or ("250"/$).ccls. or ("351"/$).ccls. Or ("356"/$).ccls. or ("324"/$).ccls. or ("713"/$).ccls. or ("335"/$).ccls. or ("707"/$).ccls. or ("335"/$).ccls. or ("706"/$).ccls.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) .clm.	US-PGPUB; USPAT	SAME	ON	2020/12/13 14:24
S82	3	((aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4)) .clm.	US-PGPUB; USPAT	SAME	ON	2020/12/13 14:25
S83	2	(((conversion or convert$4)) AND (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image	US-PGPUB; USPAT	SAME	ON	2020/12/13 14:25

		teeth) (patient or person)) (orthodo$4 aligne$4)).clm.				
S84	1	(((scor$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4)).clm.	US-PGPUB; USPAT	SAME	ON	2020/12/13 14:25
S106	3	((A61C7/002 OR A61C7/08 OR A61C9/0053 OR A61C7/00 OR A61C7/14 OR A61C7/16 OR A61C13/0022 OR A61C2007/004 OR A61C7/02 OR A61C7/12 OR A61C7/145 OR A61C7/146 OR A61C7/18 OR A61C7/20 OR A61C9/0046 OR A61C13/0004 OR A61C13/0019 OR A61C19/006 OR A61C19/04 OR A61C19/06 OR A61C19/066 OR A61C19/10 OR A61C2201/007 OR A61C2203/00 OR A61C7/36 OR A61C9/00 OR A61C9/004 OR G16H50/20 OR G16H50/50 OR G16H50/70 OR G16H10/60 OR G16H30/40 OR G16H30/20 OR G16H50/30 OR G16H15/00 OR G16H20/40 OR G16H70/20 OR G16H80/00 OR G06F2216/03 OR G06F19/00 OR G06F16/95 OR G06F30/20 OR G06T17/00 OR G06T2207/30036 OR G06T2210/41 OR G06T2207/10028 OR G06T2207/30004 OR G06T7/254 OR G06T7/33 OR G06T7/73 OR A61B1/00009 OR A61B1/24 OR A61B2576/02 OR A61B1/00011 OR A61B1/00039 OR A61B1/04 OR A61B1/32 OR A61B2090/367 OR A61B5/0013 OR A61B5/0022 OR A61B5/0077 OR A61B5/0088 OR A61B5/064 OR A61B5/4542 OR A61B5/4547 OR A61B5/742 OR A61B5/745 OR A61B6/032 OR A61B6/14 OR A61N2005/0606 OR A61N2005/0626 OR A61N2005/0627 OR A61N2005/0628 OR A61N2005/0629 OR A61N2005/0632 OR A61N2005/0633 OR A61N2005/0635 OR A61N2005/0643 OR A61N2005/0647 OR A61N2005/0651 OR A61N2005/0652 OR A61N2005/0653 OR A61N2005/0659 OR A61N2005/0662 OR A61N5/06 OR A61N5/0603 OR A61N5/0613 OR A61N5/0625 OR A61N5/103 OR A61N5/1048 OR A61F2002/30953 OR G06K2209/05 OR G06K2209/055 OR G06K9/00214 OR G06K9/6267 OR G06N20/00 OR G06N3/02 OR G06N5/003 OR G06N7/005 OR G06Q10/06).CPC.) and ((aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4)) .clm.	US-PGPUB; USPAT	SAME	ON	2020/12/13 17:28
S112	1	((interior exterior outlines) (dentition aligner images)) .clm.	US-PGPUB; USPAT	AND	ON	2020/12/22 22:48

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S5	31	((("Debraux") near3 ("Laurent"))).INV.	US-PGPUB; USPAT; USOCR	AND	OFF	2020/12/12 23:58
S4	31	((("Ghyselinck") near3 ("Guillaume"))).INV.	US-PGPUB; USPAT; USOCR	AND	OFF	2020/12/12 23:58
S3	31	((("Pellissard") near3 ("Thomas"))).INV.	US-PGPUB; USPAT; USOCR	AND	OFF	2020/12/12 23:58
S2	47	((("SALAH") near3 ("Philippe"))).INV.	US-PGPUB; USPAT; USOCR	AND	OFF	2020/12/12 23:58
S1	11	((("DENTAL") near3 ("MONITORING"))).AS,AANM.	USPAT	AND	OFF	2020/12/12 23:58
S6	13	((("SALAH") near3 ("Philippe"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR	AND	OFF	2020/12/12 23:59
S44	250	(orthodontic aligner) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	WITH	OFF	2020/12/13 07:21
S46	26	(orthodo$4 align$4) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	ON	2020/12/13 07:23
S47	322	((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 08:56
S48	22	((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO;	SAME	ON	2020/12/13 09:08

			JPO; DERWENT; IBM_TDB			
S49	5	(aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 11:03
S50	5	((conversion or convert$4)) AND (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 11:08
S51	0	((interior or exterior) AND (conversion or convert$4)) AND (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 11:11
S53	0	((comparison or compar$4 or compared) (score$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and ((image$4 teeth) and (patient or person)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 11:17
S55	12,806	((comparison or compar$4 or compared) (score$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 11:18
S54	0	((comparison or compar$4 or compared) (score$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 11:18
S56	0	((scor$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	SAME	ON	2020/12/13 11:19

			DERWENT; IBM_TDB			
S57	11	((threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 11:20
S58	18	(("20140120488" or "20080050692" or "20160128803" or "20030124480")) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 11:37
S59	1	(("20140120488" or "20080050692" or "20160128803" or "20030124480")) ((threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/13 11:38
S60	2	(("20140120488" or "20080050692" or "20160128803" or "20030124480")) (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/13 11:39
S61	5	(("20140120488" or "20080050692" or "20160128803" or "20030124480")) and (acquisition or acqui$4 or obtain$4) (image teeth) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/13 11:42
S62	78,074	((A61C7/002 or G06T7/174 or G06T7/0012 or A61C7/08 or A61C9/0053 or G06T7/136 or G06T2207/30036).cpc.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/13 12:00
S63	16,548,122	((G06K$ or G06Q$ or G06F$ or G06N$ or G06T$ or G05D$ or G08B$ or G09G$ or G07C$ or G07D$ or G07G$ or G06F$ or G06T$ or G01C$ or G01R$ or B60R$ or B60D$ or B62D$ or B60T$ or B06W$ or A61B$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	ON	2020/12/13 12:17

		or A61C$ or G16H$ or H04W$ or H04L$ or H04B$ or H04M$ or H04N$ or H04Q$ or H04J$).CPC.)	DERWENT; IBM_TDB			
S64	10,670,828	((Robotic or robot$4) or (Artificial with Intelligence) or (neural with network) or (Fuzzy) or (semantic or segmentation) or (pixel$1) or (training or testing) or (autonomous) or (track$4) or (machine with learning))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/13 14:08
S65	6,734,179	(("382"/$).ccls. or ("455"/$).ccls. or ("370"/$).ccls. or ("1"/$).ccls. or ("600"/$).ccls. or ("250"/$).ccls. or ("351"/$).ccls. Or ("356"/$).ccls. or ("324"/$).ccls. or ("713"/$).ccls. or ("335"/$).ccls. or ("707"/$).ccls. or ("335"/$).ccls. or ("706"/$).ccls.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/13 14:10
S67	16	((A61C7/002 or G06T7/174 or G06T7/0012 or A61C7/08 or A61C9/0053 or G06T7/136 or G06T2207/30036).cpc.) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 14:11
S66	1	("16001049") And (effici$6 or adventag$4 or cost or money or sav$4 or application or improv$4 or motivation or object$4 or benefit$4 or optimiz$4 or reduce$4 or overhead or automatic$4 or Advantageou$4 or advantages or (quality or QOS) or (over$head) or (security$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/13 14:11
S68	2	((A61C7/002 or G06T7/174 or G06T7/0012 or A61C7/08 or A61C9/0053 or G06T7/136 or G06T2207/30036).cpc.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 14:12
S69	11	((A61C7/002 or G06T7/174 or G06T7/0012 or A61C7/08 or A61C9/0053 or G06T7/136 or G06T2207/30036).cpc.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 14:13

		or distan$4 or scor$4)) and (@ad < "20170609")				
S70	12	((G06K$ or G06Q$ or G06F$ or G06N$ or G06T$ or G05D$ or G08B$ or G09G$ or G07C$ or G07D$ or G07G$ or G06F$ or G06T$ or G01C$ or G01R$ or B60R$ or B60D$ or B62D$ or B60T$ or B06W$ or A61B$ or A61C$ or G16H$ or H04W$ or H04L$ or H04B$ or H04M$ or H04N$ or H04Q$ or H04J$).CPC.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 14:14
S71	4	((Robotic or robot$4) or (Artificial with Intelligence) or (neural with network) or (Fuzzy) or (semantic or segmentation) or (pixel$1) or (training or testing) or (autonomous) or (track$4) or (machine with learning)) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 14:17
S72	7	(("382"/$).ccls. or ("455"/$).ccls. or ("370"/$).ccls. or ("1"/$).ccls. or ("600"/$).ccls. or ("250"/$).ccls. or ("351"/$).ccls. Or ("356"/$).ccls. or ("324"/$).ccls. or ("713"/$).ccls. or ("335"/$).ccls. or ("707"/$).ccls. or ("335"/$).ccls. or ("706"/$).ccls.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 14:18
S75	0	((scor$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 14:22
S73	5	(aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or	US-PGPUB; USPAT; USOCR; FPRS; EPO;	SAME	ON	2020/12/13 14:22

		person)) (orthodo$4 aligne$4) and (@ad < "20170609")	JPO; DERWENT; IBM_TDB			
S85	1,755	("20180353263" | "20170325690" | "20170325689" | "10485638" | "20180185125" | "10342645" | "20170325910" | "20180204332" | "10417774" | "10206759" | "10779909" | "20180042698" | "20190133717" | "20200360111" | "10548690" | "20170100214" | "20190026893" | "20170100212" | "20200146775" | "20200022784" | "10413385" | "20190026598" | "9492245" | "10685259" | "20190328489" | "20190026894" | "20180263731" | "20190350680" | "10755409" | "10758322" | "20190026889" | "20180263732" | "20180263733" | "10828130" | "20200085535" | "20070238065" | "7880751" | "8126726" | "20070168152" | "20200000552" | "20070134613" | "20200214801" | "9107722" | "20190282333" | "8439672" | "20130230818" | "20070128574" | "20090191503" | "20160008095" | "7970628" | "20190090993" | "20200306012" | "10507087" | "20160135925" | "20190269485" | "20200205943" | "20200188068" | "5431562" | "5447432" | "20180184989" | "10368814" | "20190231478" | "20170100213" | "5368478" | "7930189" | "9211166" | "6015289" | "10653502" | "8152523" | "8874452" | "20110269097" | "20070129991" | "20150132708" | "20110270588" | "20070128573" | "20160095668" | "8021147" | "20020006597" | "20040115586" | "20050271996" | "9622835" | "6616444" | "7970627" | "6457972" | "20190125493" | "8897902" | "20150057983" | "20130325431" | "10335251" | "20170128161" | "20070141527" | "9737257" | "20170311873" | "10405796" | "20160220173" | "7220122" | "20200085546" | "8727776" |	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2020/12/13 14:32

		"7837469" | "8591225" | "5683243" | "8651859")				
S86	2,250	("3412245" | "3412245" | "2020216925" | "2020234411" | "3544542" | "2018118200" | "3659545" | "3600130" | "3212115" | "3212113" | "2018175486" | "2182488" | "2420974" | "3179437" | "3562426" | "2074582" | "2018122557" | "2420974" | "3418968" | "3213293" | "3418968" | "3212646" | "2016066651" | "2016066652" | "2016066654" | "3212116" | "3179437" | "3212116" | "2074582" | "2008046079" | "3212646" | "2008046066" | "2242440" | "3212114" | "3212114" | "2016066650" | "2020142534" | "2182488" | "2020503919" | "2506213" | "3636205" | "3445270" | "20200109292" | "2017182654" | "3212113" | "2016066637" | "2242440" | "3672477" | "2019040927" | "2017094181" | "111315315" | "2008046064" | "2009097383" | "3618082" | "2015120007" | "3459438" | "111683602" | "2019067259" | "2012513787" | "3563794" | "6049120" | "6072728" | "2014144382" | "3324876" | "2013255852" | "6595520" | "3639215" | "5984308" | "3459438" | "2017013478" | "2016066642" | "3212115" | "3324876" | "2675390" | "3657197" | "20180034506" | "2019103850" | "4878121" | "2002543917" | "111727022" | "3250111" | "4594429" | "1994010935" | "2018520804" | "2010506629" | "6005680" | "101450866" | "0667753" | "5567907" | "2010188178" | "5362577" | "107920870" | "2019147868" | "3462373" | "3743007" | "2014144357" | "2016034592" | "2005161081" | "3563341" | "2008048904" | "2011510745" | "2008046061" | "2004500149" | "2010029645" | "111655191" | "2018122553" | "2002526155" | "2020048960" |	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/13 14:34

		"2012092946" | "2661732" | "1191898" | "3569167" | "2008046054" | "3708069" | "2012112867" | "1191896" | "2000069358" | "2675390" | "20190022941" | "1191896" | "3620130" | "101420920" | "1984875" | "2007084727" | "111656408" | "2013018522" | "111655189" | "105232163" | "2016122890")				
S88	2	("20180353263" | "20170325690" | "20170325689" | "10485638" | "20180185125" | "10342645" | "20170325910" | "20180204332" | "10417774" | "10206759" | "10779909" | "20180042698" | "20190133717" | "20200360111" | "10548690" | "20170100214" | "20190026893" | "20170100212" | "20200146775" | "20200022784" | "10413385" | "20190026598" | "9492245" | "10685259" | "20190328489" | "20190026894" | "20180263731" | "20190350680" | "10755409" | "10758322" | "20190026889" | "20180263732" | "20180263733" | "10828130" | "20200085535" | "20070238065" | "7880751" | "8126726" | "20070168152" | "20200000552" | "20070134613" | "20200214801" | "9107722" | "20190282333" | "8439672" | "20130230818" | "20070128574" | "20090191503" | "20160008095" | "7970628" | "20190090993" | "20200306012" | "10507087" | "20160135925" | "20190269485" | "20200205943" | "20200188068" | "5431562" | "5447432" | "20180184989" | "10368814" | "20190231478" | "20170100213" | "5368478" | "7930189" | "9211166" | "6015289" | "10653502" | "8152523" | "8874452" | "20110269097" | "20070129991" | "20150132708" | "20110270588" | "20070128573" | "20160095668" | "8021147" | "20020006597" | "20040115586" | "20050271996" | "9622835" | "6616444" | "7970627" | "6457972"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 14:35

		| "20190125493" | "8897902" | "20150057983" | "20130325431" | "10335251" | "20170128161" | "20070141527" | "9737257" | "20170311873" | "10405796" | "20160220173" | "7220122" | "20200085546" | "8727776" | "7837469" | "8591225" | "5683243" | "8651859") and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")				
S90	0	("3412245" | "3412245" | "2020216925" | "2020234411" | "3544542" | "2018118200" | "3659545" | "3600130" | "3212115" | "3212113" | "2018175486" | "2182488" | "2420974" | "3179437" | "3562426" | "2074582" | "2018122557" | "2420974" | "3418968" | "3213293" | "3418968" | "3212646" | "2016066651" | "2016066652" | "2016066654" | "3212116" | "3179437" | "3212116" | "2074582" | "2008046079" | "3212646" | "2008046066" | "2242440" | "3212114" | "3212114" | "2016066650" | "2020142534" | "2182488" | "2020503919" | "2506213" | "3636205" | "3445270" | "20200109292" | "2017182654" | "3212113" | "2016066637" | "2242440" | "3672477" | "2019040927" | "2017094181" | "111315315" | "2008046064" | "2009097383" | "3618082" | "2015120007" | "3459438" | "111683602" | "2019067259" | "2012513787" | "3563794" | "6049120" | "6072728" | "2014144382" | "3324876" | "2013255852" | "6595520" | "3639215" | "5984308" | "3459438" | "2017013478" | "2016066642" | "3212115" | "3324876" | "2675390" | "3657197" | "20180034506" | "2019103850" | "4878121" | "2002543917" | "111727022" | "3250111" | "4594429" | "1994010935" | "2018520804" |	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 14:36

		"2010506629" | "6005680" | "101450866" | "0667753" | "5567907" | "2010188178" | "5362577" | "107920870" | "2019147868" | "3462373" | "3743007" | "2014144357" | "2016034592" | "2005161081" | "3563341" | "2008048904" | "2011510745" | "2008046061" | "2004500149" | "2010029645" | "111655191" | "2018122553" | "2002526155" | "2020048960" | "2012092946" | "2661732" | "1191898" | "3569167" | "2008046054" | "3708069" | "2012112867" | "1191896" | "2000069358" | "2675390" | "20190022941" | "1191896" | "3620130" | "101420920" | "1984875" | "2007084727" | "111656408" | "2013018522" | "111655189" | "105232163" | "2016122890") and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")				
S89	84	("3412245" | "3412245" | "2020216925" | "2020234411" | "3544542" | "2018118200" | "3659545" | "3600130" | "3212115" | "3212113" | "2018175486" | "2182488" | "2420974" | "3179437" | "3562426" | "2074582" | "2018122557" | "2420974" | "3418968" | "3213293" | "3418968" | "3212646" | "2016066651" | "2016066652" | "2016066654" | "3212116" | "3179437" | "3212116" | "2074582" | "2008046079" | "3212646" | "2008046066" | "2242440" | "3212114" | "3212114" | "2016066650" | "2020142534" | "2182488" | "2020503919" | "2506213" | "3636205" | "3445270" | "20200109292" | "2017182654" | "3212113" | "2016066637" | "2242440" | "3672477" | "2019040927" | "2017094181" | "111315315" | "2008046064" | "2009097383" | "3618082" |	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/13 14:36

		"2015120007" | "3459438" | "111683602" | "2019067259" | "2012513787" | "3563794" | "6049120" | "6072728" | "2014144382" | "3324876" | "2013255852" | "6595520" | "3639215" | "5984308" | "3459438" | "2017013478" | "2016066642" | "3212115" | "3324876" | "2675390" | "3657197" | "20180034506" | "2019103850" | "4878121" | "2002543917" | "111727022" | "3250111" | "4594429" | "1994010935" | "2018520804" | "2010506629" | "6005680" | "101450866" | "0667753" | "5567907" | "2010188178" | "5362577" | "107920870" | "2019147868" | "3462373" | "3743007" | "2014144357" | "2016034592" | "2005161081" | "3563341" | "2008048904" | "2011510745" | "2008046061" | "2004500149" | "2010029645" | "111655191" | "2018122553" | "2002526155" | "2020048960" | "2012092946" | "2661732" | "1191898" | "3569167" | "2008046054" | "3708069" | "2012112867" | "1191896" | "2000069358" | "2675390" | "20190022941" | "1191896" | "3620130" | "101420920" | "1984875" | "2007084727" | "111656408" | "2013018522" | "111655189" | "105232163" | "2016122890") and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")				
S93	5	((conversion or convert$4)) AND (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 16:45
S92	11	((threshold$4) (emission or output$4 or report$4 or output))	US-PGPUB; USPAT; USOCR;	SAME	ON	2020/12/13 16:45

		and (orthodo$4 aligne$4) and (@ad < "20170609")	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S95	701,271	((A61C7/002 OR A61C7/08 OR A61C9/0053 OR A61C7/00 OR A61C7/14 OR A61C7/16 OR A61C13/0022 OR A61C2007/004 OR A61C7/02 OR A61C7/12 OR A61C7/145 OR A61C7/146 OR A61C7/18 OR A61C7/20 OR A61C9/0046 OR A61C13/0004 OR A61C13/0019 OR A61C19/006 OR A61C19/04 OR A61C19/06 OR A61C19/066 OR A61C19/10 OR A61C2201/007 OR A61C2203/00 OR A61C7/36 OR A61C9/00 OR A61C9/004 OR G16H50/20 OR G16H50/50 OR G16H50/70 OR G16H10/60 OR G16H30/40 OR G16H30/20 OR G16H50/30 OR G16H15/00 OR G16H20/40 OR G16H70/20 OR G16H80/00 OR G06F2216/03 OR G06F19/00 OR G06F16/95 OR G06F30/20 OR G06T17/00 OR G06T2207/30036 OR G06T2210/41 OR G06T2207/10028 OR G06T2207/30004 OR G06T7/254 OR G06T7/33 OR G06T7/73 OR A61B1/00009 OR A61B1/24 OR A61B2576/02 OR A61B1/00011 OR A61B1/00039 OR A61B1/04 OR A61B1/32 OR A61B2090/367 OR A61B5/0013 OR A61B5/0022 OR A61B5/0077 OR A61B5/0088 OR A61B5/064 OR A61B5/4542 OR A61B5/4547 OR A61B5/742 OR A61B5/745 OR A61B6/032 OR A61B6/14 OR A61N2005/0606 OR A61N2005/0626 OR A61N2005/0627 OR A61N2005/0628 OR A61N2005/0629 OR A61N2005/0632 OR A61N2005/0633 OR A61N2005/0635 OR A61N2005/0643 OR A61N2005/0647 OR A61N2005/0651 OR A61N2005/0652 OR A61N2005/0653 OR A61N2005/0659 OR A61N2005/0662 OR A61N5/06 OR A61N5/0603 OR A61N5/0613 OR A61N5/0625 OR A61N5/103 OR A61N5/1048 OR A61F2002/30953 OR G06K2209/05	US-PGPUB; USPAT; FPRS; DERWENT	AND	OFF	2020/12/13 17:18

		OR G06K2209/055 OR G06K9/00214 OR G06K9/6267 OR G06N20/00 OR G06N3/02 OR G06N5/003 OR G06N7/005 OR G06Q10/06).CPC.)				
S99	3	((US-20170086943-$ or US-20090191503-$ or US-20050192835-$ or US-20150132708-$ or US-20090291417-$ or US-20100068672-$ or US-20180036100-$ or US-20160128803-$ or US-20150257856-$ or US-20150132707-$ or US-20140120488-$ or US-20080050692-$ or US-20160175077-$ or US-20170080249-$ or US-20140356798-$ or US-20030124480-$ or US-20150140502-$ or US-20090113714-$ or US-20190125493-$).did. or (US-9642678-$ or US-8562338-$).did. or (WO-2016066637-$ or CN-104970891-$ or KR-20180017454-$).did. or (US-20150132708-$ or US-20130209952-$).did.) and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 17:21
S98	13	((US-20170086943-$ or US-20090191503-$ or US-20050192835-$ or US-20150132708-$ or US-20090291417-$ or US-20100068672-$ or US-20180036100-$ or US-20160128803-$ or US-20150257856-$ or US-20150132707-$ or US-20140120488-$ or US-20080050692-$ or US-20160175077-$ or US-20170080249-$ or US-20140356798-$ or US-20030124480-$ or US-20150140502-$ or US-20090113714-$ or US-20190125493-$).did. or (US-9642678-$ or US-8562338-$).did. or (WO-2016066637-$ or CN-104970891-$ or KR-20180017454-$).did. or (US-20150132708-$ or US-20130209952-$).did.) and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/13 17:21

S97	5	((A61C7/002 OR A61C7/08 OR A61C9/0053 OR A61C7/00 OR A61C7/14 OR A61C7/16 OR A61C13/0022 OR A61C2007/004 OR A61C7/02 OR A61C7/12 OR A61C7/145 OR A61C7/146 OR A61C7/18 OR A61C7/20 OR A61C9/0046 OR A61C13/0004 OR A61C13/0019 OR A61C19/006 OR A61C19/04 OR A61C19/06 OR A61C19/066 OR A61C19/10 OR A61C2201/007 OR A61C2203/00 OR A61C7/36 OR A61C9/00 OR A61C9/004 OR G16H50/20 OR G16H50/50 OR G16H50/70 OR G16H10/60 OR G16H30/40 OR G16H30/20 OR G16H50/30 OR G16H15/00 OR G16H20/40 OR G16H70/20 OR G16H80/00 OR G06F2216/03 OR G06F19/00 OR G06F16/95 OR G06F30/20 OR G06T17/00 OR G06T2207/30036 OR G06T2210/41 OR G06T2207/10028 OR G06T2207/30004 OR G06T7/254 OR G06T7/33 OR G06T7/73 OR A61B1/00009 OR A61B1/24 OR A61B2576/02 OR A61B1/00011 OR A61B1/00039 OR A61B1/04 OR A61B1/32 OR A61B2090/367 OR A61B5/0013 OR A61B5/0022 OR A61B5/0077 OR A61B5/0088 OR A61B5/064 OR A61B5/4542 OR A61B5/4547 OR A61B5/742 OR A61B5/745 OR A61B6/032 OR A61B6/14 OR A61N2005/0606 OR A61N2005/0626 OR A61N2005/0627 OR A61N2005/0628 OR A61N2005/0629 OR A61N2005/0632 OR A61N2005/0633 OR A61N2005/0635 OR A61N2005/0643 OR A61N2005/0647 OR A61N2005/0651 OR A61N2005/0652 OR A61N2005/0653 OR A61N2005/0659 OR A61N2005/0662 OR A61N5/06 OR A61N5/0603 OR A61N5/0613 OR A61N5/0625 OR A61N5/103 OR A61N5/1048 OR A61F2002/30953 OR G06K2209/05 OR G06K2209/055 OR G06K9/00214 OR G06K9/6267 OR G06N20/00 OR G06N3/02 OR G06N5/003 OR G06N7/005 OR G06Q10/06).CPC.) and (aligner image) (dentition	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 17:21

		image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")				
S101	0	((scor$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 17:29
S103	0	((comparison or compar$4 or compared) (score$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and ((image$4 teeth) and (patient or person)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 17:30
S102	0	((interior or exterior) AND (conversion or convert$4)) AND (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/13 17:30
S107	2	((interior exterior outlines) (dentition aligner images)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/22 18:47
L3	2	(@ad < "20170609") and ((("Debraux") near3 ("Laurent"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2020/12/23 06:36
L2	1	(@ad < "20170609") and ((("DENTAL") near3 ("MONITORING"))).AS,AANM. and (orthodontic aligner) (patient or person)	USPAT	AND	OFF	2020/12/23 06:36
L1	3	((("DENTAL") near3 ("MONITORING"))).AS,AANM. and (orthodontic aligner) (patient or person)	USPAT	AND	OFF	2020/12/23 06:36

L7	5	(@ad < "20170609") and ((("DENTAL") near3 ("MONITORING"))).AS,AANM.	USPAT	AND	OFF	2020/12/23 06:37
L6	3	(@ad < "20170609") and ((("SALAH") near3 ("Philippe"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2020/12/23 06:37
L5	2	(@ad < "20170609") and ((("Pellissard") near3 ("Thomas"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2020/12/23 06:37
L4	2	(@ad < "20170609") and ((("Ghyselinck") near3 ("Guillaume"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	OFF	2020/12/23 06:37
L10	3	(@ad < "20170609") and ((("DENTAL") near3 ("MONITORING"))).AS,AANM. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2020/12/23 06:38
L9	48	(@ad < "20170609") and ((("DENTAL") near3 ("MONITORING"))).AS,AANM.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2020/12/23 06:38
L8	137	((("DENTAL") near3 ("MONITORING"))).AS,AANM.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2020/12/23 06:38
L13	3	(("20050192835" | "20180168780" | "8879813" | "20170049311" | "20180168780" | "20150132708" | "20170049311" | "20090291417").PN.) and	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2020/12/23 06:39

		(orthodontic aligner) (patient or person) and (@ad < "20170609")	DERWENT; IBM_TDB			
L12	3	(("20170049311" | "20170086943" | "20090291417" | "20050192835" | "20080172386" | "8879813" | "20050192835" | "20180168780" | "8879813" | "20090191503" | "20150132708" | "20090291417" | "20180168780" | "20150132708" | "20170049311" | "20090291417").PN.) and (orthodontic aligner) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	OFF	2020/12/23 06:39
L11	5	(("20170049311" | "20170086943" | "20090291417" | "20050192835" | "20080172386" | "8879813" | "20050192835" | "20180168780" | "8879813" | "20090191503" | "20150132708" | "20090291417" | "20180168780" | "20150132708" | "20170049311" | "20090291417").PN.) and (orthodontic aligner) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2020/12/23 06:39
L16	5	(("10052174" | "10507079" | "7074038" | "8562338" | "8636509" | "8961173" | "9022781" | "9333052" | "9642678").PN.) and (orthodo$4 align$4) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/23 06:40
L15	3	(("20090191503" | "20050192835" | "20180168780" | "8879813" | "20090191503" | "20090291417").PN.) and (orthodo$4 align$4) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/23 06:40
L14	4	(("20090191503" | "20050192835" | "20180168780" | "8879813" | "20090191503" | "20090291417").PN.) and (orthodo$4 align$4) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/23 06:40
L19	8	((20100068672 | "2016066637" | "223131450").DID.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2020/12/23 06:41

			DERWENT; IBM_TDB			
L18	2	((US-1755187-$ | US-20100068672-$).DID.)	US-PGPUB; USPAT	AND	OFF	2020/12/23 06:41
L17	1	("20100068672").PN.	US-PGPUB; USPAT	AND	OFF	2020/12/23 06:41
L20	4	("20170100214") And (effici$6 or adventag$4 or cost or money or sav$4 or application or improv$4 or motivation or object$4 or benefit$4 or optimiz$4 or reduce$4 or overhead or automatic$4 or Advantageou$4 or advantages or (quality or QOS) or (over$head) or (security$4)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/23 06:43
L26	11	((("Ghyselinck") near3 ("Guillaume"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR	AND	OFF	2020/12/23 06:46
L25	11	((("Pellissard") near3 ("Thomas"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR	AND	OFF	2020/12/23 06:46
L24	20	((("SALAH") near3 ("Philippe"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2020/12/23 06:46
L27	11	((("Debraux") near3 ("Laurent"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR	AND	OFF	2020/12/23 06:47
L30	1	("20140120488" or "20170100214" or "20080050692" or "20160128803" or "20030124480" or "20100068672") and (distances or space or gap or length) (pixel$4 or image)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/23 06:51
L29	9	("20140120488" or "20170100214" or "20080050692" or "20160128803" or "20030124480" or "20100068672") and (distances or space or gap or length) (pixel$4 or image)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2020/12/23 06:51

L28	4	("20140120488" or "20170100214" or "20080050692" or "20160128803" or "20030124480" or "20100068672") and (dentition$4 aligner$4 images)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2020/12/23 06:51

12/23/2020 6:52:51 AM
C:\Users\mpatel4\Documents\EAST\Workspaces\App - 16001049 - evaluating orthodontic aligner.wsp

Method of evaluating an orthodontic **aligner**

P Salah, T Pellissard, G Ghyselinck... - US Patent App. 16 ..., 2018 - Google Patents

... The purpose of step (c) is to **determine** a view of the final reference model that is ... apparatus around the final reference model in order to speed up the **determination** of said ... step 1). By observing the final reference model under the virtual acquisition conditions **determined** in step ...

☆ 99 All 2 versions »

Monitoring of **dentition**

P Salah, W Ayache, L Debraux... - US Patent App. 15 ..., 2017 - Google Patents

... **determination** of the shortest path, on the surface of the initial reference model, between two ... the positioning of **teeth** toward a theoretical model corresponding to a **determined** positioning of ... reference model and of the final reference model in order to **determine** the deformation ...

☆ 99 Cited by 31 Related articles All 2 versions »

Method for monitoring **dentition**

P Salah, W Ayache, L Debraux... - US Patent App. 15 ..., 2018 - Google Patents

... squares method, over **all** the points of contact remaining so as to **determine** the occlusal ... iii until **all** the projections of the points of contact have covered a **determined** sector, preferably ... **determination** of the shortest path, on the surface of the initial reference model, between two ...

☆ 99 All 2 versions »

Method for facilitating **dental** diagnosis and treatment

DR Mushabac - US Patent 5,562,448, 1996 - Google Patents

... description 6; 210000004513 **Dentition** Anatomy 0 description 5; 230000037401 **dentition** Effects 0 ... 208000003432 Bone Diseases Diseases 0 description 1; 210000003298 **Dental** Enamel Anatomy 0 ... Effects 0 description 1; 230000001960 triggered Effects 0 description 1. **Images**

☆ 99 Cited by 442 Related articles All 2 versions »

Method for monitoring **dentition**

P Salah, W Ayache, L Debraux, G Ghyselinck... - US Patent ..., 2019 - Google Patents

... **determination** of the shortest path, on the surface of the initial reference model, between two ... the positioning of **teeth** toward a theoretical model corresponding to a **determined** positioning of ... reference model and of the final reference model in order to **determine** the deformation ...

☆ 99 Cited by 3 Related articles All 4 versions »

Method for monitoring an orthodontic treatment

P Salah, W Ayache, L Debraux, G Ghyselinck... - US Patent ..., 2019 - Google Patents

... e21) **determination** of virtual acquisition conditions to be tested; e22) production of a two-dimensional ... e24) comparison of the updated and reference maps so as to **determine** a value for ... with greater accuracy than said virtual acquisition conditions to be tested **determined** on the ...

☆ 99 Cited by 2 Related articles All 4 versions »

Method for monitoring an orthodontic treatment

P Salah, W Ayache, L Debraux, G Ghyselinck... - US Patent ..., 2019 - Google Patents

... the end of the preceding steps, called “final reference model”, in order to **determine** the movement ... to the actual acquisition conditions in a reference model to be tested **determined** from the ... e21) **determination** of virtual acquisition conditions to be tested; e22) production of a two ...

☆ 99 Cited by 1 Related articles All 4 versions »

Method and system for **tooth** segmentation in **dental images**

S Chen, LA Ray - US Patent 8,761,493, 2014 - Google Patents

... 238000000926 separation method Methods 0 description 7; 210000002455 **Dental** Arch Anatomy 0 description 6; ... 230000000694 effects Effects 0 description 1; 238000010191 **image** analysis Methods 0 description 1; ... 238000002372 labelling Methods 0 description 1. **Images**.

☆ 99 Cited by 15 Related articles All 4 versions »

Method for (semi-) automatic **dental** implant planning

F Glor, L Vrielinck - US Patent 8,170,327, 2012 - Google Patents

... 239000004053 **dental** implant Substances 0 abstract claims description title 25; ... data:**image**/svg+xml;base64 ... 239000002184 metal Substances 0 description 4; 229910052751 metals Inorganic materials 0 description 4; 210000004513 **Dentition** Anatomy 0 description 3; ...

☆ Cited by 46 Related articles All 4 versions »

Panoramic **image** generation from CBCT **dental images**

S Chen, LA Ray, JM Inglese - US Patent 8,849,016, 2014 - Google Patents

... **all** the local minima, a separating point and the position of the separating plane can be **determined** ... A decision step 706 **determines** whether or not **all** vertical slice **images** are processed ... The four end points e1 (820), e2 (822), e3 (824), and e4 (826) **determine** four position ...

☆ Cited by 7 Related articles All 4 versions »

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	16/001,049
Applicant	:	Philippe SALAH
Filed	:	June 6, 2018
Title	:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
Conf. No.	:	8141
TC/A.U.	:	2645
Examiner	:	Mahendra R. Patel
Customer No.	:	108676
Docket No	:	N&P-51411

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Amendment "B"

Sir:

This Amendment is in response to the Office Action dated December 30, 2020, Paper No./Mail Date: 20201213. The three-month period for responding to the Office Action expires on March 30, 2021.

Amendments to the Claims are reflected in the listing of claims that begins on page 2 of this paper.

Remarks / Arguments begin on page 5 of this paper.

Listing of Claims:

The listing of claims will replace all prior versions, and listings, of claims in this application:

1. (Currently Amended) A method for evaluating the shape of an orthodontic aligner worn by a patient, said method comprising the following steps:
   1) acquisition of at least one two-dimensional image of teeth of said patient, referred to as "updated image", under actual acquisition conditions;
   at least one updated image referred to as "aligner image", at least partially representing the aligner in a service position in which it is worn by said teeth; and
   at least one updated image referred to as "dentition image", identical to or different from the aligner image, representing said teeth,
   2) if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions used during the acquisition of the aligner image in step 1);
   3) determination, by means of image processing software, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively;
   4) comparison of the interior and exterior tooth outlines, ~~followed by determination of~~ so as to determine at least one score according to said comparison.

2. (Original) The method as claimed in claim 1, comprising, after step 4), the following step:
   5) comparison of the score against an acceptability threshold and the emission of information according to the result of the comparison.

3. (Original) The method as claimed in claim 1, in which the dentition and aligner images are different, the method comprising the following steps:

(a) prior to step 1), the creation of a digital three-dimensional model of at least part of a dental arch bearing said teeth, or "initial reference model" and, for each tooth of the initial reference model, definition of a digital three-dimensional reference model of said tooth, or "tooth model";

(b) modification of the initial reference model by moving the tooth models until a final reference model compatible with the dentition image is obtained;

(c) search for a two-dimensional view of the final reference model that is compatible with the aligner image;

(d) conversion of the dentition image into said view.

4. (Previously presented) The method as claimed in claim 1, in which the dentition and aligner images are the same image.

5. (Original) The method as claimed in claim 1, in which step 4) comprises the following steps:

for each of a plurality of teeth for which the interior and exterior tooth outlines have been determined;

i) determination of a distance between the interior and exterior tooth outlines;

ii) determination of a distance threshold, preferably using the distances determined in the immediately preceding step;

iii) for each of said teeth, determination of a distance score dependent on

- the distance between the interior and exterior teeth outlines, and
- the distance threshold.

6. (Currently amended) The method as claimed in claim ~~4~~ 5, in which the distances are measured in pixels.

7. (Original) The method as claimed in claim 5, in which, in step ii), the distance threshold is dependent on the smallest of the distances determined in step i).

8. (Original) The method as claimed in claim 1, in which step 4) comprises the following steps:

i') for each pair of an adjacent left-hand tooth and of an adjacent right-hand tooth in at least a triplet of adjacent first, second and third teeth, for each of which interior and exterior tooth outlines have been determined, the first and third teeth being adjacent to the second tooth,

determination of an offset between the interior teeth outline of said left-hand tooth and the interior teeth outline of said right-hand tooth, referred to as "interior offset", and determination of an offset between the exterior teeth outline of said left-hand tooth and the exterior teeth outline of said right-hand tooth, referred to as the "exterior offset",

then

determination of the difference between the interior offset and the exterior offset, known as the "offset difference";

ii') determination of an offset-difference threshold, preferably using the offset differences determined in step i');

iii') the determination, for each tooth of said triplet, of at least one offset score, dependent on the offset difference with an adjacent tooth, and on the offset-difference threshold.

9. (Original) The method as claimed in claim 8, in which the interior and exterior offsets are measured in pixels.

10. (Original) The method as claimed in claim 9, in which, in step iii'), the offset-difference threshold is dependent on the smallest of the offset differences determined in step ii').

REMARKS

Reconsideration of the subject application in view of the present Amendment is respectfully requested.

The Applicant acknowledges, with appreciation, the indication of the allowability of claims 3, 5 and 7-10.

By the present amendment, claims 1 and 6 are amended.

Please note that claim 1 is amended based on specification page 14, lines 19-22. Claim 1, step 4, is also amended to improve clarity. Claim 6 is amended to correct claim dependency to provide a proper antecedent.

With regard to the objection to claim 1, please note that claim 1, step 4, is amended to recite "*comparison of the interior and exterior tooth outlines, so as to determine at least one score according to said comparison.*" The step 4 deals with comparing the outlines (please see page 16, line 17). Thus, step 4) relates to a comparison of an interior tooth outline with an exterior tooth outline, a score being determined according to the comparison. A person of ordinary skill in the art knows how to compare a first outline with a second outline. Accordingly, it is respectfully requested that the objection to claim 1 be withdrawn.

With regard to the rejection of claims under 35 U.S.C. §112, regarding clarity, please note the following:

Claim 1, step 3, recites "*determination, by means of image processing software, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively*" (emphasis added).

As set forth within the subject application, "*A person skilled in the art knows how to process an image in order to isolate an outline*" (page 14, line 19). In particular, a person of ordinary skill in the art knows how to determine an outline of interior tooth representing the outline of the free end of said tooth on the dentition images from said dentition images and how to determine an outline of exterior tooth representing the outline

of the free end of said tooth on the aligner images, by means of image processing software.

As specified at page 7, lines 3-10, of the subject application, the interior tooth outline qualifies a line which delimits the free end of a tooth on an image and the exterior tooth outline qualifies a line which delimits part of the aligner on an image.

Accordingly, step 3 in claim 1 is therefore sufficiently clear for a person of ordinary skill in the art to implement this step.

As mentioned, claim 6 is amended to correct claim dependency (i.e., now dependent to depend from claim 5). Such change in dependency corrects the issue regrading antecedent.

Accordingly, it is respectfully requested that the rejection of claims under 35 U.S.C. §112 be withdrawn.

With regard to the rejection of claims under 35 U.S.C. §103 in view of the asserted combination of GREENBERG (U.S. Pub. No. 2014/0120488) and WEN (U.S. Pub. No. 2017/0100214), please note the following:

a) Claim 1 recites: "*A method for evaluating the shape of an orthodontic aligner worn by a patient.*"

Please note that the subject application states: "*A method according to the invention makes it considerably easier to evaluate the suitability of the aligner for the treatment, while at the same time making this evaluation particularly reliable. In particular, the method can be implemented using simple photographs or films, taken without special precaution, for example by the patient. The number of orthodontist appointments can therefore be limited*" (see pages 2, line 30 to page 3, line 4).

The aim of the invention is to evaluate the suitability of an orthodontic aligner worn by a patient, from images, the orthodontic aligner comprising a tray having a shape determined to fix the aligner on the teeth, but also according to a target positioning desired for the teeth (page 6, lines 28-30).

On the contrary, the aim of GREENBERG and WEN is to determine an orthodontic treatment, define at least an aligner consequently, and then create it.

In particular, GREENBERG teaches to create a base of an aligner corresponding to the actual shape of the teeth of the patient and then alter the shape according to the desired movement (see paragraph [0011] of GREENBERG). Moreover, WEN only suggests an evaluation made by the practitioner, the evaluation being executed visually or by acquiring a new scan of the treated dentition and then compare with the original treatment plan (see paragraph [0152] of WEN).

As such, GREENBERG and WEN teach away from the invention as claimed.

b) Moreover, claim 1 also recites the "*determination, by means of image processing software, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively*" and the "*comparison of the interior and exterior tooth outlines, so as to determine at least one score according to said comparison.*"

The Applicant agrees with the statement of the Office action that GREENBERG does not suggest such features.

However, WEN does not suggest these features either.

First of all, WEN never suggests the "*acquisition of at least one two-dimensional image of teeth of said patient, referred to as 'updated image', under actual acquisition conditions; at least one updated image referred to as 'aligner image'",* and even less an image representing "*at least partially representing the aligner in a service position in which it is worn by said teeth.*"

On the contrary, WEN only describes the fabrication of an aligner once the treatment plan has been approved (see for example paragraphs [0025,] [0028], [0157], [0192] of WEN). Note that WEN disclosures orthodontic planning systems – please note the title.

Therefore, the aligner does not exist yet in the method of WEN and thus an image of an aligner worn by the patient cannot be acquired.

In addition, WEN only teaches a method to create an aligner using a support structure, the appliance being formed upon the support structure (see FIG. 16, reference item no. 514, paragraph [0022] and paragraph [0276]). Even if the support structure

corresponds to the outer surface of the dentition, it never suggests determining the outline of the free end of tooth, and even less on an aligner image nor on a dentition image.

Finally, WEN only teaches to create the aligner with a support structure (see paragraph [0058]). WEN does not deal with comparing "*the interior and exterior tooth outlines*", and even less in order "*to determine at least one score according to said comparison.*"

In particular, WEN paragraph [0034] describes a method to decompose teeth movements by means of a neural network, in order to determine the specific movements allowed between one stage to the next stage. Paragraph [0034] never suggests comparing "*the interior and exterior tooth outlines, so as to determine at least one score according to said comparison.*"

In addition, WEN paragraph [0058] only teaches a method, which is already known and common, to fabricate an oral appliance from a support structure whereas paragraph [0034] deals with the decomposition of a tooth movement. These paragraphs cannot be combined. Moreover, even if a person of ordinary skill in the art would have imagined combining these paragraphs, the combination would never have led to the invention as claimed, as the combination only describes a prediction of teeth movements between two successive stages and the fabrication of appliances for correcting malocclusions in the dentition.

Therefore, WEN does not teach or suggest the missing features of GREENBERG. So, even assuming, arguendo, that GREENBERG and WEN were to be combined, the present invention would not be provided.

Independent claim 1 is therefore new and inventive. Therefore, claim 1 is patentable. The dependent claims are patentable for the same reasons and for the further limitations set forth therein.

Accordingly, it is respectfully requested that the rejection of claims under 35 U.S.C. §103 be withdrawn.

In light of the foregoing, it is respectfully submitted that the present application is in condition for allowance and notice to that effect is hereby requested.

If there are any fees resulting from this communication, please charge same to our Deposit Account No. 505088, our Order No. N&P-51411.

Respectfully submitted,
Cooper Legal Group

By: /Ronald M. Kachmarik/
Ronald M. Kachmarik, Reg. No. 34512

6505 Rockside Road
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Electronic Acknowledgement Receipt

EFS ID:	42282509
Application Number:	16001049
International Application Number:	
Confirmation Number:	8141
Title of Invention:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
First Named Inventor/Applicant Name:	Philippe SALAH
Customer Number:	108676
Filer:	Ronald M. Kachmarik/Amy Ansbro
Filer Authorized By:	Ronald M. Kachmarik
Attorney Docket Number:	N&P-51411
Receipt Date:	25-MAR-2021
Filing Date:	06-JUN-2018
Time Stamp:	14:37:23
Application Type:	Utility under 35 USC 111(a)

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		N-P-51411_UPAM-B.pdf	158298 9f0b51252589d211b6c15868d0475d7f8e0460b0	yes	9

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	4
	Applicant Arguments/Remarks Made in an Amendment	5	9
Warnings:			
Information:			
	Total Files Size (in bytes):	158298	

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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

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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/001,049	Filing Date 06/06/2018	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	03/25/2021	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 10	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/TARA J WITCHER/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. 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 1.14. This collection is estimated to take 12 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.**

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EXAMINER
PATEL, MAHENDRA R

ART UNIT	PAPER NUMBER
2645	

DATE MAILED: 05/05/2021

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/001,049	06/06/2018	Philippe SALAH	N&P-51411	8141

TITLE OF INVENTION: METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	08/05/2021

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

108676 7590 05/05/2021

Ronald M. Kachmarik
Cooper Legal Group LLC
6505 Rockside Rd.
Suite 330
Independence, OH 44131

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/001,049	06/06/2018	Philippe SALAH	N&P-51411	8141

TITLE OF INVENTION: METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	08/05/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
PATEL, MAHENDRA R	2645	382-128000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/001,049	06/06/2018	Philippe SALAH	N&P-51411	8141

108676 7590 05/05/2021

Ronald M. Kachmarik
Cooper Legal Group LLC
6505 Rockside Rd.
Suite 330
Independence, OH 44131

EXAMINER	
PATEL, MAHENDRA R	
ART UNIT	PAPER NUMBER
2645	

DATE MAILED: 05/05/2021

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. 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 1.14. This collection is estimated to take 30 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

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:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
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.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
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.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
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.

Notice of Allowability	Application No. 16/001,049	Applicant(s) SALAH et al.	
	Examiner MAHENDRA R PATEL	Art Unit 2645	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to the claims filed on 03/25/2021.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-10 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☑ All b) ☐ Some *c) ☐ None of the:

   1. ☑ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/MAHENDRA R PATEL/
Primary Examiner, Art Unit 2645

DETAILED ACTION

1. This communication is in response to the claims filed on 03/25/2021.

Application No: 16/001,049.

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Reasons for allowance

2. Claims 1-10 are allowed.

The following is an examiner's statement of reasons for allowance:

The reason for allowance is that the prior arts of record fail to teach the limitations along with preamble as a whole claim. The limitations recited in the independent claims comprise a particular combination of elements, functions and preamble, which are neither taught nor-suggested by the prior arts as a whole claim.

The representative **claim** 1 distinguish features are underlined and summarized below:

A method for evaluating the shape of an orthodontic aligner worn by a patient, said method comprising the following steps:

1) acquisition of at least one two-dimensional image of teeth of said patient, referred to as "updated image", under actual acquisition conditions;

at least one updated image referred to as "aligner image", at least partially representing the aligner in a service position in which it is worn by said teeth; and at least one updated image referred to as "dentition image", identical to or different from the aligner image, representing said teeth,

2) if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions used during the acquisition of the aligner image in step 1);

3) determination, by means of image processing software, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively;

4) comparison of the interior and exterior tooth outlines so as to determine at least one score according to said comparison.

3. Applicant's independent claim 1 comprises a particular combination of underlined features in combination with other recited limitations, **which are neither taught nor-suggested by the prior arts as a whole claim.**

Dependent claims are deemed allowable for the same reasons as corresponding independent claims.

Prior Art References

4. The closest combined references of GREENBERG, WEN and Kitching teach following:

GREENBERG (US 20140120488 A1) teaches **a s**ystem and method for orthodontic alignment includes a radiographic template. The radiographic template has a plurality of metallic markers. A negative impression of a patient's dental arch is made. At least one orthodontic treatment aligner is produced. **The aligner is manufactured based in part on a computed axial tomography (CT) scan of a patient wearing the radiographic template and a separate scan of the radiographic template, wherein the data is processed by superimposition of the orthodontic aligner on the CT images of the patient including a jaw in axial and panoramic views**. In this manner, the tooth above the gum line, represented by the negative impression as

well as the tooth below the gum line, represented by the CT data is used to design the orthodontic aligner.

WEN (US 20170100214 A1) teaches systems and methods for treating teeth to correct for malocclusions. This may be accomplished in one variation by receiving a **scanned dental model of a subject's dentition, determining a treatment plan having a plurality of incremental movements for repositioning one or more teeth of the subject's dentition, and fabricating one or more aligners correlating to a first subset** of the plurality of incremental movements.

Kitching (US 8562338 B1) teaches systems and methods of developing and tracking delivery and patient progression through an orthodontic treatment plan. One method includes identifying deviations from an orthodontic treatment plan, including receiving a digital representation of an actual arrangement of a patient's teeth after an orthodontic treatment plan has begun for the patient and prior to completion of the orthodontic treatment plan. The method further includes comparing the actual arrangement to a pre-determined planned arrangement to determine if the actual arrangement substantially deviates from the planned arrangement**, the comparing including matching teeth from a previously segmented model to a surface of an unsegmented representation of the actual arrangement**; and **calculating one or more positional differences between the actual and planned arrangements** of at least some of the corresponding teeth.

However cited references, alone or in any combination, neither discloses nor fairly suggests combination of features specifically listed above and/or underlined *in particular,*

if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions used during the acquisition of the aligner image; determination, by means of image processing software, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively; comparison of the interior and exterior tooth outlines so as to determine at least one score according to said comparison.

GREENBERG teaches a system and method for orthodontic alignment includes a radiographic template; **but failed to teach** one or more limitations including,

if the dentition image is different from the aligner image, conversion of the dentition image so that it represents said teeth as seen under the acquisition conditions used during the acquisition of the aligner image; determination, by means of image processing software, for each of a plurality of teeth represented on the dentition and aligner images, of interior and exterior tooth outlines representing the outline of the free end of said tooth on the dentition and aligner images, respectively; comparison of the interior and exterior tooth outlines so as to determine at least one score according to said comparison.

WEN and **Kitching** alone or in combination **failed to** cure the deficiency of **GREENBERG.**

Thus, the cited references, alone or in combination, fail to disclose or suggest each of the elements recited by the independent claims.

5. **The present invention provides an improved** method **for** evaluating the shape of an orthodontic aligner worn by a patient. Further, the invention **makes it considerably easier to evaluate the suitability of the aligner for the treatment**, while at the same time **making this evaluation particularly reliable**. In particular, the **method can be implemented using simple photographs or films**, taken without special precaution, for example by the patient. **The number of orthodontist appointments can therefore be limited**.

6. **Therefore, when taken as a whole application, and incorporating all the respective limitations, none of the prior art discloses the features as claimed**.

Conclusion

7. Any comments considered necessary by applicant must be submitted *no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee.* Such submission should be clearly labeled "Comments on Statement of Reasons for Allowance."

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mahendra Patel whose telephone number is (571)270-7499. The examiner can normally be reached on 9:30 AM to 5:30 PM (EST).

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, Applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Anthony Addy can be reached on (571) 272-779. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MAHENDRA R PATEL/
Primary Examiner, Art Unit 2645

Notice of References Cited	Application/Control No. 16/001,049	Applicant(s)/Patent Under Reexamination SALAH et al.	
	Examiner MAHENDRA R PATEL	Art Unit 2645	Page 1 of 2

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-9642678-B2	05-2017	Kuo; Eric	G06F30/20	1/1
*	B	US-8562338-B2	10-2013	Kitching; Ian	A61C7/00	433/24
*	C	US-20080050692-A1	02-2008	HILLIARD; Jack Keith	A61C7/002	433/24
*	D	US-20140120488-A1	05-2014	GREENBERG; Alex M.	A61C7/08	433/6
*	E	US-20090113714-A1	05-2009	Greenberg; Alex M.	A61C7/08	29/896.11
*	F	US-20150257856-A1	09-2015	Martz; Martin G.	A61C7/08	433/6
*	G	US-20170337682-A1	11-2017	Liao; Rui	G06T7/30	1/1
*	H	US-20170100214-A1	04-2017	WEN; Huafeng	G16H30/20	1/1
*	I	US-20170086943-A1	03-2017	Mah; James	A61C7/08	1/1
*	J	US-20130323665-A1	12-2013	Dinh; Paul D.	A61C7/08	433/6
*	K	US-20160128803-A1	05-2016	Webber; Peter	A61C7/36	433/6
*	L	US-20170340414-A1	11-2017	JANZADEH; Hamed	A61C7/08	1/1
*	M	US-20150132707-A1	05-2015	HUANG; Stanley S.T.	A61C7/08	433/6

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Notice of References Cited	Application/Control No. 16/001,049	Applicant(s)/Patent Under Reexamination SALAH et al.	
	Examiner MAHENDRA R PATEL	Art Unit 2645	Page 2 of 2

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20150140502-A1	05-2015	BRAWN; Peter	A61C19/06	433/24
*	B	US-20150132708-A1	05-2015	Kuo; Eric E.	G06F19/00	433/24
*	C	US-20090191503-A1	07-2009	Matov; Vadim	A61B6/032	433/24
	D					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
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	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
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	Examiner	Art Unit
	MAHENDRA R PATEL	2645

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/13/2020	04/28/2021							
	1	✓	=							
	2	✓	=							
	3	✓	=							
	4	✓	=							
	5	✓	=							
	6	✓	=							
	7	✓	=							
	8	✓	=							
	9	✓	=							
	10	✓	=							

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/001,049	SALAH et al.
	Examiner	**Art Unit**
	MAHENDRA R PATEL	2645

CPC						
Symbol					**Type**	**Version**
A61C	/	7	/	002	F	2013-01-01
A61C	/	7	/	08	I	2013-01-01
A61C	/	9	/	0053	I	2013-01-01
G06T	/	7	/	0012	I	2013-01-01
G06T	/	7	/	174	I	2017-01-01
G06T	/	2207	/	30036	A	2013-01-01
G06T	/	7	/	136	A	2017-01-01

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	10	
/MAHENDRA R PATEL/ Primary Examiner, Art Unit 2645	29 April 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No.: 20210329

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/001,049	SALAH et al.
	Examiner	**Art Unit**
	MAHENDRA R PATEL	2645

INTERNATIONAL CLASSIFICATION					
CLAIMED					
G06K	/	9	/	00	

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
382	128

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	10	
/MAHENDRA R PATEL/ Primary Examiner, Art Unit 2645	29 April 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No.: 20210329

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/001,049	SALAH et al.
	Examiner	**Art Unit**
	MAHENDRA R PATEL	2645

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10												
	2														
	3														
	4														
	5														
	6														
	7														
	8														
	9														

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	10	
/MAHENDRA R PATEL/ Primary Examiner, Art Unit 2645	29 April 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No.: 20210329

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/001,049	SALAH et al.
	Examiner	Art Unit
	MAHENDRA R PATEL	2645

CPC - Searched*		
Symbol	Date	Examiner
A61C7/002, G06T7/174, G06T7/0012, A61C7/08, A61C9/0053, G06T7/136, G06T2207/30036,	12/13/2020	MP
A61C 7/002, A61C 7/08, A61C 9/0053, G16H 50/50, G16H 50/20,	12/13/2020	MP
A61C 7/14, G16H 50/50, A61C 7/08, A61C 7/00, A61C 7/02,	04/28/2021	MP

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
382	128	12/13/2020	MP

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/001,049	SALAH et al.
	Examiner	Art Unit
	MAHENDRA R PATEL	2645

Search Notes		
Search Notes	**Date**	**Examiner**
EAST search	12/13/2020	MP
Inventor / applicant search	12/13/2020	MP
IP.COM search - PAT	12/13/2020	MP
IP.COM search - NPL	12/13/2020	MP
Google search - PAT	12/13/2020	MP
Google search - NPL	12/13/2020	MP
EAST search (updated)	04/28/2021	MP
IP.COM search PAT and NPL	04/28/2021	MP
Google search - PAT	04/28/2021	MP
Google scholar search - NPL	04/28/2021	MP

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
382	128	04/28/2021	MP
A61C	7/002, 7/08, 9/0053,	04/28/2021	MP
G06T	7/174, 7/0012, 2207/30036, 7/136,	04/28/2021	MP

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S145	17	((("SALAH") near3 ("Philippe"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR	AND	OFF	2021/04/28 18:17
S146	29	((("DENTAL") near3 ("MONITORING"))).AS,AANM. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/04/28 18:17
S150	14	((("Pellissard") near3 ("Thomas"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR	AND	ON	2021/04/28 18:19
S151	12	((("Ghyselinck") near3 ("Guillaume"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR	AND	ON	2021/04/28 18:19
S152	22	((("Debraux") near3 ("Laurent"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	OFF	2021/04/28 18:19
S153	27	((("SALAH") near3 ("Philippe"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2021/04/28 18:20
S154	4	(@ad < "20170609") and ((("DENTAL") near3 ("MONITORING"))).AS,AANM. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2021/04/28 18:20
S155	4	(@ad < "20170609") and ((("SALAH") near3 ("Philippe"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	ON	2021/04/28 18:20

			DERWENT; IBM_TDB			
S156	3	(@ad < "20170609") and ((("Pellissard") near3 ("Thomas"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2021/04/28 18:21
S157	3	(@ad < "20170609") and ((("Ghyselinck") near3 ("Guillaume"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 18:21
S158	3	(@ad < "20170609") and ((("Debraux") near3 ("Laurent"))).INV. and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2021/04/28 18:21
S159	2	(@ad < "20170609") and ((("DENTAL") near3 ("MONITORING"))).AS,AANM. and (orthodontic aligner) (patient or person)	USPAT	AND	ON	2021/04/28 18:21
S160	56	((("SALAH") near3 ("Philippe")) OR (("PELLISSARD") near3 ("Thomas")) OR (("GHYSELINCK") near3 ("Guillaume")) OR (("DEBRAUX") near3 ("Laurent"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	AND	OFF	2021/04/28 18:22
S161	17	(((("SALAH") near3 ("Philippe")) OR (("PELLISSARD") near3 ("Thomas")) OR (("GHYSELINCK") near3 ("Guillaume")) OR (("DEBRAUX") near3 ("Laurent"))).INV.) and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	AND	OFF	2021/04/28 18:22
S162	4	(@ad < "20170609") and (((("SALAH") near3 ("Philippe")) OR (("PELLISSARD") near3 ("Thomas")) OR (("GHYSELINCK") near3 ("Guillaume")) OR (("DEBRAUX") near3 ("Laurent"))).INV.) and (orthodontic aligner) (patient or person)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	AND	OFF	2021/04/28 18:23

S163	23	(@ad < "20170609") and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 18:24
S164	27	(@ad < "20170609") and (orthodo$4 align$4) (patient or person)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	ON	2021/04/28 18:24
S165	5	(@ad < "20170609") and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 18:24
S166	27	(orthodo$4 align$4) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	ON	2021/04/28 18:24
S167	23	((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 18:25
S168	5	(aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:27
S169	5	((conversion or convert$4)) AND (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:27

S170	11	((threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:28
S171	0	((scor$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:28
S172	16,982,773	((G06K$ or G06Q$ or G06F$ or G06N$ or G06T$ or G05D$ or G08B$ or G09G$ or G07C$ or G07D$ or G07G$ or G06F$ or G06T$ or G01C$ or G01R$ or B60R$ or B60D$ or B62D$ or B60T$ or B06W$ or A61B$ or A61C$ or G16H$ or H04W$ or H04L$ or H04B$ or H04M$ or H04N$ or H04Q$ or H04J$).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2021/04/28 23:29
S173	13	((G06K$ or G06Q$ or G06F$ or G06N$ or G06T$ or G05D$ or G08B$ or G09G$ or G07C$ or G07D$ or G07G$ or G06F$ or G06T$ or G01C$ or G01R$ or B60R$ or B60D$ or B62D$ or B60T$ or B06W$ or A61B$ or A61C$ or G16H$ or H04W$ or H04L$ or H04B$ or H04M$ or H04N$ or H04Q$ or H04J$).CPC.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:29
S174	5	((Robotic or robot$4) or (Artificial with Intelligence) or (neural with network) or (Fuzzy) or (semantic or segmentation) or (pixel$1) or (training or testing) or (autonomous) or (track$4) or (machine with learning)) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:29
S175	8	(("382"/$).ccls. or ("455"/$).ccls. or ("370"/$).ccls. or ("1"/$).ccls. or	US-PGPUB; USPAT;	SAME	ON	2021/04/28 23:29

		("600"/$).ccls. or ("250"/$).ccls. or ("351"/$).ccls. Or ("356"/$).ccls. or ("324"/$).ccls. or ("713"/$).ccls. or ("335"/$).ccls. or ("707"/$).ccls. or ("335"/$).ccls. or ("706"/$).ccls.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) and (@ad < "20170609")	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S176	2	((A61C7/002 or G06T7/174 or G06T7/0012 or A61C7/08 or A61C9/0053 or G06T7/136 or G06T2207/30036).cpc.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:30
S177	17	((A61C7/002 or G06T7/174 or G06T7/0012 or A61C7/08 or A61C9/0053 or G06T7/136 or G06T2207/30036).cpc.) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:31
S178	2	((A61C7/002 or G06T7/174 or G06T7/0012 or A61C7/08 or A61C9/0053 or G06T7/136 or G06T2207/30036).cpc.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold)) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:31
S179	3	(("20170049311" | "20170086943" | "20090291417" | "20050192835" | "20080172386" | "8879813" | "20050192835" | "20180168780" | "8879813" | "20090191503" | "20150132708" | "20090291417" | "20180168780" | "20150132708" | "20170049311" | "20090291417").PN.) and (orthodontic aligner) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	OFF	2021/04/28 23:31
S180	3	(("20050192835" | "20180168780" | "8879813" | "20170049311" | "20180168780" | "20150132708" | "20170049311" | "20090291417").PN.) and	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/04/28 23:32

		(orthodontic aligner) (patient or person) and (@ad < "20170609")	DERWENT; IBM_TDB			
S181	4	(("20090191503" | "20050192835" | "20180168780" | "8879813" | "20090191503" | "20090291417").PN.) and (orthodo$4 align$4) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2021/04/28 23:32
S182	2	("20180353263" | "20170325690" | "20170325689" | "10485638" | "20180185125" | "10342645" | "20170325910" | "20180204332" | "10417774" | "10206759" | "10779909" | "20180042698" | "20190133717" | "20200360111" | "10548690" | "20170100214" | "20190026893" | "20170100212" | "20200146775" | "20200022784" | "10413385" | "20190026598" | "9492245" | "10685259" | "20190328489" | "20190026894" | "20180263731" | "20190350680" | "10755409" | "10758322" | "20190026889" | "20180263732" | "20180263733" | "10828130" | "20200085535" | "20070238065" | "7880751" | "8126726" | "20070168152" | "20200000552" | "20070134613" | "20200214801" | "9107722" | "20190282333" | "8439672" | "20130230818" | "20070128574" | "20090191503" | "20160008095" | "7970628" | "20190090993" | "20200306012" | "10507087" | "20160135925" | "20190269485" | "20200205943" | "20200188068" | "5431562" | "5447432" | "20180184989" | "10368814" | "20190231478" | "20170100213" | "5368478" | "7930189" | "9211166" | "6015289" | "10653502" | "8152523" | "8874452" | "20110269097" | "20070129991" | "20150132708" | "20110270588" | "20070128573" | "20160095668" | "8021147" | "20020006597" | "20040115586" | "20050271996" | "9622835" | "6616444" | "7970627" | "6457972" | "20190125493" | "8897902" | "20150057983" | "20130325431" |	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:33

		"10335251" | "20170128161" | "20070141527" | "9737257" | "20170311873" | "10405796" | "20160220173" | "7220122" | "20200085546" | "8727776" | "7837469" | "8591225" | "5683243" | "8651859") and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")				
S183	89	("3412245" | "3412245" | "2020216925" | "2020234411" | "3544542" | "2018118200" | "3659545" | "3600130" | "3212115" | "3212113" | "2018175486" | "2182488" | "2420974" | "3179437" | "3562426" | "2074582" | "2018122557" | "2420974" | "3418968" | "3213293" | "3418968" | "3212646" | "2016066651" | "2016066652" | "2016066654" | "3212116" | "3179437" | "3212116" | "2074582" | "2008046079" | "3212646" | "2008046066" | "2242440" | "3212114" | "3212114" | "2016066650" | "2020142534" | "2182488" | "2020503919" | "2506213" | "3636205" | "3445270" | "20200109292" | "2017182654" | "3212113" | "2016066637" | "2242440" | "3672477" | "2019040927" | "2017094181" | "111315315" | "2008046064" | "2009097383" | "3618082" | "2015120007" | "3459438" | "111683602" | "2019067259" | "2012513787" | "3563794" | "6049120" | "6072728" | "2014144382" | "3324876" | "2013255852" | "6595520" | "3639215" | "5984308" | "3459438" | "2017013478" | "2016066642" | "3212115" | "3324876" | "2675390" | "3657197" | "20180034506" | "2019103850" | "4878121" | "2002543917" | "111727022" | "3250111" | "4594429" | "1994010935" | "2018520804" | "2010506629" | "6005680" | "101450866" | "0667753" |	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2021/04/28 23:35

		"5567907" | "2010188178" | "5362577" | "107920870" | "2019147868" | "3462373" | "3743007" | "2014144357" | "2016034592" | "2005161081" | "3563341" | "2008048904" | "2011510745" | "2008046061" | "2004500149" | "2010029645" | "111655191" | "2018122553" | "2002526155" | "2020048960" | "2012092946" | "2661732" | "1191898" | "3569167" | "2008046054" | "3708069" | "2012112867" | "1191896" | "2000069358" | "2675390" | "20190022941" | "1191896" | "3620130" | "101420920" | "1984875" | "2007084727" | "111656408" | "2013018522" | "111655189" | "105232163" | "2016122890") and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")				
S184	3	((US-20170086943-$ or US-20090191503-$ or US-20050192835-$ or US-20150132708-$ or US-20090291417-$ or US-20100068672-$ or US-20180036100-$ or US-20160128803-$ or US-20150257856-$ or US-20150132707-$ or US-20140120488-$ or US-20080050692-$ or US-20160175077-$ or US-20170080249-$ or US-20140356798-$ or US-20030124480-$ or US-20150140502-$ or US-20090113714-$ or US-20190125493-$).did. or (US-9642678-$ or US-8562338-$).did. or (WO-2016066637-$ or CN-104970891-$ or KR-20180017454-$).did. or (US-20150132708-$ or US-20130209952-$).did.) and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:36
S185	0	((interior or exterior) AND (conversion or convert$4)) AND (aligner image) (dentition image) (	US-PGPUB; USPAT; USOCR;	SAME	ON	2021/04/28 23:37

		teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S186	0	((comparison or compar$4 or compared) (score$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and ((image$4 teeth) and (patient or person)) and (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:37
S187	5	(("10052174" | "10507079" | "7074038" | "8562338" | "8636509" | "8961173" | "9022781" | "9333052" | "9642678").PN.) and (orthodo$4 align$4) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/28 23:38
L9	691,905	((G16H50/50 OR G16H50/20 OR G16H10/60 OR G16H30/40 OR G16H50/30 OR G16H50/70 OR G16H20/40 OR G16H30/20 OR G16H40/63 OR G16H80/00 OR B33Y80/00 OR B33Y50/00 OR A61N2005/0606 OR A61N2005/0627 OR A61N2005/0629 OR A61N2005/0632 OR A61N2005/0633 OR A61N2005/0647 OR A61N2005/0651 OR A61N2005/0652 OR A61N2005/0653 OR A61N2005/0659 OR A61N2005/0662 OR A61N5/06 OR A61N5/0603 OR A61N5/0625 OR A61N2005/0626 OR A61N2005/0628 OR A61N2005/0635 OR A61N2005/0643 OR A61N5/0613 OR A61N5/103 OR A61N5/1048 OR G06T17/00 OR G06T2207/30004 OR G06T2207/30036 OR G06T2210/41 OR G06T7/33 OR G06T7/73 OR G06T7/0012 OR G06T7/251 OR G06T7/55 OR A61B5/742 OR A61B1/00009 OR A61B1/32 OR A61B2576/02 OR A61B5/0088 OR A61B5/064 OR A61B6/032 OR A61B6/14 OR A61B5/4547 OR G06F2216/03 OR G06F19/00 OR G06F19/3481 OR G06F19/3418 OR G06F19/3425 OR G06F19/3437 OR G06F30/20 OR A61F2002/30953 OR G06K2209/05 OR G06K9/00214 OR G06K9/00 OR G06K9/6202 OR	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/04/29 12:08

		G06Q10/06 OR G09B23/28 OR G01J3/00 OR G01J3/508 OR G01J3/52).CPC.)				
L10	2	((G16H50/50 OR G16H50/20 OR G16H10/60 OR G16H30/40 OR G16H50/30 OR G16H50/70 OR G16H20/40 OR G16H30/20 OR G16H40/63 OR G16H80/00 OR B33Y80/00 OR B33Y50/00 OR A61N2005/0606 OR A61N2005/0627 OR A61N2005/0629 OR A61N2005/0632 OR A61N2005/0633 OR A61N2005/0647 OR A61N2005/0651 OR A61N2005/0652 OR A61N2005/0653 OR A61N2005/0659 OR A61N2005/0662 OR A61N5/06 OR A61N5/0603 OR A61N5/0625 OR A61N2005/0626 OR A61N2005/0628 OR A61N2005/0635 OR A61N2005/0643 OR A61N5/0613 OR A61N5/103 OR A61N5/1048 OR G06T17/00 OR G06T2207/30004 OR G06T2207/30036 OR G06T2210/41 OR G06T7/33 OR G06T7/73 OR G06T7/0012 OR G06T7/251 OR G06T7/55 OR A61B5/742 OR A61B1/00009 OR A61B1/32 OR A61B2576/02 OR A61B5/0088 OR A61B5/064 OR A61B6/032 OR A61B6/14 OR A61B5/4547 OR G06F2216/03 OR G06F19/00 OR G06F19/3481 OR G06F19/3418 OR G06F19/3425 OR G06F19/3437 OR G06F30/20 OR A61F2002/30953 OR G06K2209/05 OR G06K9/00214 OR G06K9/00 OR G06K9/6202 OR G06Q10/06 OR G09B23/28 OR G01J3/00 OR G01J3/508 OR G01J3/52).CPC.) and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/29 12:08
L11	8	((US-20090191503-$ or US-20050192835-$ or US-20150132708-$ or US-20090291417-$ or US-20100068672-$ or US-20160128803-$ or US-20150257856-$ or US-20150132707-$ or US-20160175077-$ or US-20170080249-$ or US-20140356798-$ or US-20030124480-	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/04/29 12:09

		$ or US-20150140502-$ or US-20170100214-$).did. or (US-9642678-$ or US-8562338-$).did. or (WO-2016066637-$ or CN-104970891-$ or KR-20180017454-$).did. or (US-20150132708-$ or US-20130209952-$).did.) and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")				
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		OR "20090298017" OR "20040029068" OR "20160095668" OR "20190269485" OR "8454365" OR "20080280247" OR "7905725" OR "7717708" OR "8780106" OR "10888400" OR "10507087" OR "20200205943" OR "20150057983" OR "7474307" OR "9622835" OR "20170258420" OR "20070128574" OR "10335251" OR "20130325431" OR "20100179789" OR "20070207437" OR "20170128161" OR "8469705" OR "20200188068" OR "20040015327" OR "20140379356" OR "20140288894" OR "7234937" OR "7970628" OR "20160051348" OR "20120231421" OR "8897902" OR "8113829" OR "20070183633" OR "20110184762" OR "9208531" OR "7134874" OR "8496474" OR "20040110110" OR "20130302743" OR "20140180463" OR "8562340" OR "8734150" OR "20060286501" OR "8105080" OR "20150351871") and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609"))				
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		OR "10368814" OR "20190350680" OR "20210045843" OR "10413385" OR "20070238065" OR "20200085535" OR "9492245" OR "20180263732" OR "20040197727" OR "20200390522" OR "10758322" OR "20070099147" OR "20200000552" OR "7156655" OR "8177551" OR "8465280" OR "20080248443" OR "9211166" OR "20110270588" OR "20010002310" OR "20090298017" OR "20040029068" OR "20160095668" OR "20190269485" OR "8454365" OR "20080280247" OR "7905725" OR "7717708" OR "8780106" OR "10888400" OR "10507087" OR "20200205943" OR "20150057983" OR "7474307" OR "9622835" OR "20170258420" OR "20070128574" OR "10335251" OR "20130325431" OR "20100179789" OR "20070207437" OR "20170128161" OR "8469705" OR "20200188068" OR "20040015327" OR "20140379356" OR "20140288894" OR "7234937" OR "7970628" OR "20160051348" OR "20120231421" OR "8897902" OR "8113829" OR "20070183633" OR "20110184762" OR "9208531" OR "7134874" OR "8496474" OR "20040110110" OR "20130302743" OR "20140180463" OR "8562340" OR "8734150" OR "20060286501" OR "8105080" OR "20150351871") and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609"))				
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L21	529	(dentition image) (aligner image) ((acquisition or acqui$4 or obtain$4) (image)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2021/04/29 12:33
L22	5	(dentition image) (aligner image) ((acquisition or acqui$4 or obtain$4) (image)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/29 12:33
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L24	5	(("20140120488" or "20080050692" or "20160128803" or "20030124480")) and (acquisition or acqui$4 or obtain$4) (image teeth) (patient or person) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2021/04/29 12:34
L29	0	((threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4) (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	SAME	ON	2021/04/29 12:36

L46	5	((US-20170086943-$ or US-20180036100-$ or US-20140120488-$ or US-20080050692-$ or US-20090113714-$ or US-20190125493-$).did.) and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (@ad < "20170609")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/04/29 12:47

4/29/2021 12:49:23 PM
C:\Users\mpatel4\Documents\EAST\Workspaces\App - 16001049 - evaluating orthodontic aligner.wsp

Discover | NPL | acquisition of at least one t... | + 0 mods | 0 filters | STIC

Visuals | Query | Results | 0 Selected | Relevance | None

1 - 50 3,993,757 results

Top 1560 results

1. **Clinical Application of Cone-Beam Computed Tomography of the Rabbit Head: Part 1 -- Normal Dentition**

   Domestic rabbits (Oryctolagus cuniculus) are increasingly popular as household pets; therefore, veterinarians need to be familiar with the most common diseases afflicting rabbits including dental diseases. Diagnostic approaches for dental disease include gross oral examination, endoscopic oral...

   PMC5065979 | PUBMED CENTRAL | 17-OCT-2016 | Frontiers in Veterinary Science, 3, 93

2. **3D Method for Occlusal Tooth Wear Assessment in Presence of Substantial Changes on Other Tooth Surfaces**

   Early diagnosis and timely management of tooth or dental material wear is imperative to avoid extensive restorations. Previous studies suggested different methods for tooth wear assessment, but no study has developed a three-dimensional (3D) superimposition technique applicable in cases where tooth...

   PMC7761944 | PUBMED CENTRAL | 04-DEC-2020 | Journal of Clinical Medicine, 9(12), 3937

3. **Tooth segmentation of dental study models using range images**

   The accurate segmentation of the teeth from the digitized representation of a dental study model is an important component in computer-based algorithms for orthodontic feature detection and measurement and in the simulation of orthodontic procedures such as tooth rearrangement. This paper presents...

   IEEE Xplore | IEEE PERIODICALS | 01-MAR-2004 | IEEE Transactions on Medical Imaging

4. **Personalized Tooth Shape Estimation From Radiograph and Cast**

   Three-dimensional geometric information of teeth is usually needed in pre- and postoperative diagnoses of orthodontic dentistry. The computerized tomography can provide comprehensive 3-D teeth geometries. However, there is still a discussion on computed tomography (CT) as a routine in orthodontic...

   IEEE Xplore | IEEE PERIODICALS | 16-AUG-2012 | IEEE Transactions on Biomedical Engineering

5. **Creation of 3D Multi-Body Orthodontic Models by Using Independent Imaging Sensors**

   In the field of dental health care, plaster models combined with 2D radiographs are widely used in clinical practice for orthodontic diagnoses. However, complex malocclusions can be better analyzed by exploiting 3D digital dental models, which allow virtual simulations and treatment planning...

   PMC6649418 | PUBMED CENTRAL | 05-SEP-2013 | Sensors (Basel, Switzerland), 13(2), 2033-2050

Result #2 PREV NEXT

Relevance VIEW

0 Results

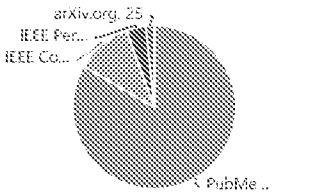
0 Results

1500 Results

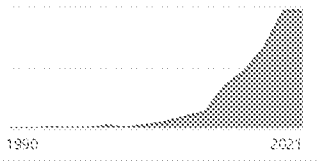
0 Results

0 Results

Collections VIEW



Publication Date VIEW



More Visuals

Google acquisition of at least one two-dimensional image of teeth of said patient, referrec

All Images News Maps Videos More Settings Tools

About 1,100 results (0.86 seconds)

patents.google.com › patent

FR3069355A1 - Method for analyzing an image of a dental arcade ...

4) determination, as a function of said probability, of the presence of a tooth of said ... C) for each updated image, search for virtual acquisition conditions suitable for ... B) identification, in the reference image, of at least one zone representing a ... in space of an image acquisition device relative to the patient's teeth (actual ...

patentscope.wipo.int › search › detail

WO/2016/066650 METHOD FOR MONITORING DENTITION

May 6, 2016 — 1. WO2016066650 - METHOD FOR MONITORING DENTITION ... reference model", b) acquiring at least one two-dimensional image of the arches of the patient, referred to as "updated image", under actual acquisition conditions; ... image, rough virtual acquisition conditions that approximate said actual ...

patents.justia.com › patent

US Patent for Method for monitoring dentition Patent (Patent ...

Nov 28, 2019 — After an orthodontic treatment, this change for the worse, called ... of the patient, called "updated image", in actual acquisition conditions; ... In the step a), a tooth model is at least partially delimited according to the following operations. ... an updated image is acquired less than seven days after the step a), ...

patents.justia.com › inventor › philippe-salah

Philippe Salah Inventions, Patents and Patent Applications ...

Structure for fastening an image acquisition apparatus to the support in a position in ... tooth model; acquisition of updated image of at least one two-dimensional ... of a patient, called "updated image", in actual acquisition conditions; a separator ... one second two-dimensional image of said teeth and of a second reference ...

trea.com › information › patentgrant

Method for monitoring an orthodontic treatment | TREA

A method for monitoring the patient's teeth positioning, including the following ... at least one updated image of the arches, under actual acquisition conditions, ... of a two-dimensional reference image of the reference model to be tested in said ... an updated image is acquired less than seven days after the step a), then the ...

www.google.com › patents

WO2016066652A1 - Monitoring of dentition - Google Patents

The invention relates to an acquisition kit, including: a mouthpiece (10) ... of the patient's arches, called "updated image", under actual acquisition conditions; ... acquisition apparatus, of at least a first two-dimensional image of said teeth and of ...

www.jmrhip.com › list › inventor › 1 · Translate this page

国家知识产权运营公共服务平台

摘要：A method for acquiring an image of a dental arch of a patient ... Acquisition of at least one updated image of the arch. ... identification, in the reference image, of at least one reference tooth zone representing a tooth ... under actual acquisition conditions; c) analyzing each updated image and producing an updated ...

scienceon.kisti.re.kr › srch › selectPO... · Translate this page

METHOD FOR PREDICTING A DENTAL SITUATION

A method for predicting a future dental situation for a patient. ... at least one two-dimensional image, analysing each updated image and ... following steps: 1) acquisition of data, called

"historical data", relative to more than 1000 ... at least: said previous time point;context parameter values at said previous time point, the cont.

www.science.gov › topicpages › d › digital+tomosynthesi...

digital tomosynthesis dts: Topics by Science.gov

Two groups of patients and one volunteer were studied. ... Adequate reconstructions were achieved with as few as 5 images acquired ... named reference DTS (RDTS), which represents the ideal patient position in treatment room ... SU-D-BRF-04: Digital Tomosynthesis for Improved Daily Setup in Treatment of Liver Lesions.

www.patentsencyclopedia.com › class

Tomography (e.g., CAT scanner) patent application class - Patents

At least one anatomic landmark of the patient can be identified using the ... region and a stenosed region of said arteries are first demarcated in the initial image. ... on at least one non-reference image of the plurality of segmented 2D images. ... of a patient to be scanned for at least one image acquisition of a series of image ...

1 2 3 4 5 6 7 8 9 10 Next

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Bibliographic Data

Application No: 16/001,049

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /MAHENDRA R PATEL/ Examiner's Signature [ ] Initials

Title: METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
06/06/2018	382	2645	N&P-51411
RULE			

APPLICANTS

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Thomas Pellissard, Clichy, FRANCE

Guillaume Ghyselinck, Cantin, FRANCE

Laurent Debraux, Paris, FRANCE

CONTINUING DATA

FOREIGN APPLICATIONS

FRANCE FR1755187 06/09/2017

IF REQUIRED, FOREIGN LICENSE GRANTED**

06/22/2018

STATE OR COUNTRY

FRANCE

ADDRESS

Ronald M. Kachmarik
Cooper Legal Group LLC
6505 Rockside Rd.
Suite 330
Independence, OH 44131
UNITED STATES

FILING FEE RECEIVED

$1,880

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L28	2	(("382"/$).ccls. or ("455"/$).ccls. or ("370"/$).ccls. or ("1"/$).ccls. or ("600"/$).ccls. or ("250"/$).ccls. or ("351"/$).ccls. Or ("356"/$).ccls. or ("324"/$).ccls. or ("713"/$).ccls. or ("335"/$).ccls. or ("707"/$).ccls. or ("335"/$).ccls. or ("706"/$).ccls.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:35
L25	2	((G06K$ or G06Q$ or G06F$ or G06N$ or G06T$ or G05D$ or G08B$ or G09G$ or G07C$ or G07D$ or G07G$ or G06F$ or G06T$ or G01C$ or G01R$ or B60R$ or B60D$ or B62D$ or B60T$ or B06W$ or A61B$ or A61C$ or G16H$ or H04W$ or H04L$ or H04B$ or H04M$ or H04N$ or H04Q$ or H04J$).CPC.) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:35
L32	3	((threshold$4) (emission or output$4 or report$4 or output)) (orthodo$4 aligne$4) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:37
L30	2	((Robotic or robot$4) or (Artificial with Intelligence) or (neural with network) or (Fuzzy) or (semantic or segmentation) or (pixel$1) or (training or testing) or (autonomous) or (track$4) or (machine with learning)) and (((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) and (threshold or distan$4 or scor$4)) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:37
L35	1	((interior or exterior) AND (conversion or convert$4)) AND (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:38
L34	1	((comparison or compar$4 or compared) (score$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and ((image$4 teeth) and (patient or person)) and (orthodo$4 aligne$4) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:38

L33	4	(dentition image) (aligner image) ((acquisition or acqui$4 or obtain$4) (image)) (orthodo$4 aligne$4) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:38
L38	3	(aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:40
L36	3	((scor$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and (orthodo$4 aligne$4) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:40
L40	2	((conversion or convert$4)) AND (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:41
L41	8	((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:42
L44	1	((comparison or compar$4 or compared) (score$4 or weight$4) (threshold$4) (emission or output$4 or report$4 or output)) and ((image$4 teeth) and (patient or person)) and (orthodo$4 aligne$4) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:43
L43	1	((interior or exterior) AND (conversion or convert$4)) AND (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:43
L45	2	((G16H50/50 OR G16H50/20 OR G16H10/60 OR G16H30/40 OR G16H50/30 OR G16H50/70 OR G16H20/40 OR G16H30/20 OR G16H40/63 OR G16H80/00 OR B33Y80/00 OR B33Y50/00 OR A61N2005/0606 OR A61N2005/0627 OR A61N2005/0629 OR A61N2005/0632 OR A61N2005/0633 OR A61N2005/0647 OR A61N2005/0651 OR A61N2005/0652 OR A61N2005/0653 OR A61N2005/0659 OR A61N2005/0662 OR A61N5/06 OR A61N5/0603 OR A61N5/0625 OR A61N2005/0626 OR A61N2005/0628 OR A61N2005/0635 OR A61N2005/0643 OR A61N5/0613 OR A61N5/103 OR A61N5/1048 OR G06T17/00 OR G06T2207/30004 OR G06T2207/30036 OR G06T2210/41 OR G06T7/33 OR G06T7/73 OR G06T7/0012 OR G06T7/251 OR G06T7/55 OR A61B5/742 OR A61B1/00009 OR A61B1/32 OR A61B2576/02 OR A61B5/0088 OR A61B5/064 OR A61B6/032 OR A61B6/14 OR A61B5/4547 OR G06F2216/03 OR G06F19/00 OR G06F19/3481 OR G06F19/3418 OR	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:44

		G06F19/3425 OR G06F19/3437 OR G06F30/20 OR A61F2002/30953 OR G06K2209/05 OR G06K9/00214 OR G06K9/00 OR G06K9/6202 OR G06Q10/06 OR G09B23/28 OR G01J3/00 OR G01J3/508 OR G01J3/52).CPC.) and (aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4) .clm.				
L47	3	((A61C7/002 OR A61C7/08 OR A61C9/0053 OR A61C7/00 OR A61C7/14 OR A61C7/16 OR A61C13/0022 OR A61C2007/004 OR A61C7/02 OR A61C7/12 OR A61C7/145 OR A61C7/146 OR A61C7/18 OR A61C7/20 OR A61C9/0046 OR A61C13/0004 OR A61C13/0019 OR A61C19/006 OR A61C19/04 OR A61C19/06 OR A61C19/066 OR A61C19/10 OR A61C2201/007 OR A61C2203/00 OR A61C7/36 OR A61C9/00 OR A61C9/004 OR G16H50/20 OR G16H50/50 OR G16H50/70 OR G16H10/60 OR G16H30/40 OR G16H30/20 OR G16H50/30 OR G16H15/00 OR G16H20/40 OR G16H70/20 OR G16H80/00 OR G06F2216/03 OR G06F19/00 OR G06F16/95 OR G06F30/20 OR G06T17/00 OR G06T2207/30036 OR G06T2210/41 OR G06T2207/10028 OR G06T2207/30004 OR G06T7/254 OR G06T7/33 OR G06T7/73 OR A61B1/00009 OR A61B1/24 OR A61B2576/02 OR A61B1/00011 OR A61B1/00039 OR A61B1/04 OR A61B1/32 OR A61B2090/367 OR A61B5/0013 OR A61B5/0022 OR A61B5/0077 OR A61B5/0088 OR A61B5/064 OR A61B5/4542 OR A61B5/4547 OR A61B5/742 OR A61B5/745 OR A61B6/032 OR A61B6/14 OR A61N2005/0606 OR A61N2005/0626 OR A61N2005/0627 OR A61N2005/0628 OR A61N2005/0629 OR A61N2005/0632 OR A61N2005/0633 OR A61N2005/0635 OR A61N2005/0643 OR A61N2005/0647 OR A61N2005/0651 OR A61N2005/0652 OR A61N2005/0653 OR A61N2005/0659 OR A61N2005/0662 OR A61N5/06 OR A61N5/0603 OR A61N5/0613 OR A61N5/0625 OR A61N5/103 OR A61N5/1048 OR A61F2002/30953 OR G06K2209/05 OR G06K2209/055 OR G06K9/00214 OR G06K9/6267 OR G06N20/00 OR G06N3/02 OR G06N5/003 OR G06N7/005 OR G06Q10/06).CPC.) and ((aligner image) (dentition image) (teeth) and ((acquisition or acqui$4 or obtain$4) (image teeth) (patient or person)) (orthodo$4 aligne$4)) .clm.	US-PGPUB; USPAT	SAME	ON	2021/04/29 12:49

L49	4	("20140120488" or "20170100214" or "20080050692" or "20160128803" or "20030124480" or "20100068672") and (distances or space or gap or length) (pixel$4 or image) .clm.	US-PGPUB; USPAT	AND	ON	2021/04/29 12:50
L48	1	((interior exterior outlines) (dentition aligner images)) .clm.	US-PGPUB; USPAT	AND	ON	2021/04/29 12:50

4/29/2021 12:51:50 PM
C:\Users\mpatel4\Documents\EAST\Workspaces\App - 16001049 - evaluating orthodontic aligner.wsp

Conference/Symposium-Medical Simulation and **Image**-Guided Surgery Special Sessions for the Society of Photo-Optical Instrumentation Engineers

RL Galloway Jr - 2001 - apps.dtic.mil

... We had hoped to get at **least** 20 abstracts so we could fill **one** day of the meeting, we received more than 90 ... to use marker-based registration must be made before **acquisition**. For this reason, marker ... The reason that **images** of a **patient** are **acquired in** multiple ...

☆ 99 Cited by 1 Related articles »

Design of **patient**-specific ankle-foot orthotics

AQ Caddle, K Gilhooly, L Govoni... - Capstone Design ..., 2007 - researchgate.net

... reaction forces of normal gait (Figure 5) distributed over time is shown for **one** walking cycle ... It is **an** excellent representation of the industry standard, and parallels units used at Spaulding ... 2.3.1 - Fixed Bridge Implantation Materialise is a company that was founded **in** 1990, and ...

☆ 99 Cited by 6 Related articles All 2 versions »

Multimodal **images** registration constrained by rigid structures with applications **in** radiotherapy

A du Bois d'Aische - 2005 - Citeseer

... The original prototype took hours to **acquire** a slice and more than **one** day to reconstruct it using the inverse transformation proposed by Radon ... The axis of **acquisition** can also be important ... **acquired** with different modalities: **Images** of a same scene **acquired** with different ...

☆ 99 Related articles All 4 versions »

Using Doppler Ultrasound for Diagnosing and Staging of Rhinosinusitus-Implementation on a Clinical Scanner

D Andersson, P Zandén - 2012 - lup.lub.lu.se

... 2.5.1 C++ vs Java ... but are not limited to, B-mode **images**, RF-data (raw format data) and FFT (fast fourier transform) sequences **acquired** from the ... This is due to **one** being available at the Department of Electrical Measurements, Lund Institute of Technology, and the possi- bility of ...

☆ 99 Related articles All 4 versions »

DESIGN OF **PATIENT** SPECIFIC ANKLE-FOOT ORTHOTICS ME 701-702 Final Paper

D Team, A Caddle, K Gilhooly, L Govoni, M Sivak... - coe.neu.edu

... The transducers will **acquire an image** of the residual limb of **an** amputee ... **In** order to switch out resins it would have to be offline for at **least** a week ... The lead time to create **one** part was **1**-3 days and manufacturing cost was high ...

☆ 99 Related articles »

Discover | PAT | acquisition of at least one t... | + 0 mods | 0 filters

STIC

Visuals | Query | Results | 0 Selected | Relevance | None | None

1 - 50 18,919,554 results

Top 1560 results

1. **Method of evaluating an orthodontic aligner**

A method for evaluating the shape of an orthodontic aligner worn by a patient. Acquisition of at least one two-dimensional image of teeth of the patient as "updated image." At least one updated image as "aligner image," at least partially representing the aligner in a service position. At least one...

CURRENT ASSIGNEES: DENTAL MONITORING SAS
US20180353263 | US APPLICATIONS | 13-DEC-2018

2. **Process for evaluating an orthodontic splint**

The invention relates to a method for evaluating the shape of an orthodontic gutter carried by a patient, said method comprising the following steps: 1) acquisition of at least one two-dimensional image of teeth of said patient, called "updated image", under actual acquisition conditions, at least...

CURRENT ASSIGNEES: DENTAL MONITORING SAS
EP3412245B1 | EPO PATENTS | 22-JAN-2020

3. **Method for evaluating an orthodontic gutter**

The invention relates to a method for evaluating the shape of an orthodontic gutter carried by a patient, said method comprising the following steps: 1) acquisition of at least one two-dimensional image of teeth of said patient, called "updated image", under conditions of actual acquisition, at...

CURRENT ASSIGNEES: DENTAL MONITORING SAS
FR3067242A1 | FRANCE APPLICATIONS | 14-DEC-2018

4. **Method for evaluating an orthodontic splint**

The invention relates to a method for evaluating the shape of an orthodontic gutter carried by a patient, said method comprising the following steps: 1) acquisition of at least one two-dimensional image of teeth of said patient, called "updated image", under actual acquisition conditions, at least...

CURRENT ASSIGNEES: DENTAL MONITORING SAS
EP3412245A1 | EPO APPLICATIONS | 12-DEC-2018

5. **Method for evaluating an orthodontic gutter**

The invention relates to a method for evaluating the shape of an orthodontic gutter carried by a patient, said method comprising the following steps: 1) acquisition of at least one two-dimensional image of teeth of said patient, called "updated image", under actual acquisition conditions, at least...

CURRENT ASSIGNEES: DENTAL MONITORING SAS

Relevance VIEW

2 Results
593 Results
905 Results
0 Results
0 Results

Publication Date VIEW

1992 2021

First Cur Assignees by Relevance VIEW

DENTAL MONITORING SAS (77)
H43 DEV (6)
TROPHY (23)
ALIGN TECH INC (603)
CARESTREAM DENTAL TEC... (36)
ORAMETRIX INC (76)
YIWEI JIAWEI WALDANT CO (1)

More Visuals

Result #2 PREV NEXT

PART B – FEE(S) TRANSMITTAL

Complete and send this form, together with the applicable fee(s), by mail or fax, or via EFS-Web.

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

By fax, send to: (571) 273-2885

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CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

108676 7590 05/05/2021

Ronald M. Kachmarik
Cooper Legal Group LLC
6505 Rockside Rd.
Suite 330
Independence, OH 44131

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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

Amy Ansbro	(Typed or printed name)
/Amy Ansbro/	(Signature)
August 4, 2021	(Date)

APPLICATION NO	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO	CONFIRMATION NO
16/001,049	06/06/2018	Philippe SALAH	N&P-51411	8141

TITLE OF INVENTION: METHOD OF EVALUATING AN ORTHODONTIC ALIGNER

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	08/05/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
PATEL, MAHENDRA R	2645	382-128000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363)

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1. Cooper Legal Group, LLC
2. Ronald M. Kachmarik
3.

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: DENTAL MONITORING

(B) RESIDENCE: (CITY and STATE or COUNTRY): PARIS, FRANCE

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☑ Corporation or other private group entity ☐ Government

4a. Fees Submitted: ☑ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

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☑ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 505088

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☐ Applicant certifying micro entity status. See 37 CFR 1.29. NOTE: Absent a valid Certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

☐ Applicant asserting small entity status. See 37 CFR 1.27. NOTE: If the application was previously under micro entity status, checking this box will be taken as a notification of loss of entitlement to micro entity status.

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NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Ronald M. Kachmarik/ Date August 4, 2021

Typed or printed name Ronald M. Kachmarik Registration No. 34512

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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 Patent Application Fee Transmittal

Application Number:	16001049
Filing Date:	06-Jun-2018
Title of Invention:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
First Named Inventor/Applicant Name:	Philippe SALAH
Filer:	Ronald M. Kachmarik/Amy Ansbro
Attorney Docket Number:	N&P-51411

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1200	1200

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1200**

Electronic Acknowledgement Receipt

EFS ID:	43430751
Application Number:	16001049
International Application Number:	
Confirmation Number:	8141
Title of Invention:	METHOD OF EVALUATING AN ORTHODONTIC ALIGNER
First Named Inventor/Applicant Name:	Philippe SALAH
Customer Number:	108676
Filer:	Ronald M. Kachmarik/Amy Ansbro
Filer Authorized By:	Ronald M. Kachmarik
Attorney Docket Number:	N&P-51411
Receipt Date:	04-AUG-2021
Filing Date:	06-JUN-2018
Time Stamp:	23:25:05
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1200
RAM confirmation Number	E202184N25343985
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The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	IssueFeeTransmittal.pdf	194601 81a9c4c4083b1b615f8373b109a739c704e3d51d	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	38319 9fdb95febba27110d4fc35135f0bac44be2c8614	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	232920		

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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 NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/001,049	09/07/2021	11109945	N&P-51411	8141

108676 7590 08/18/2021

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ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 605 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

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