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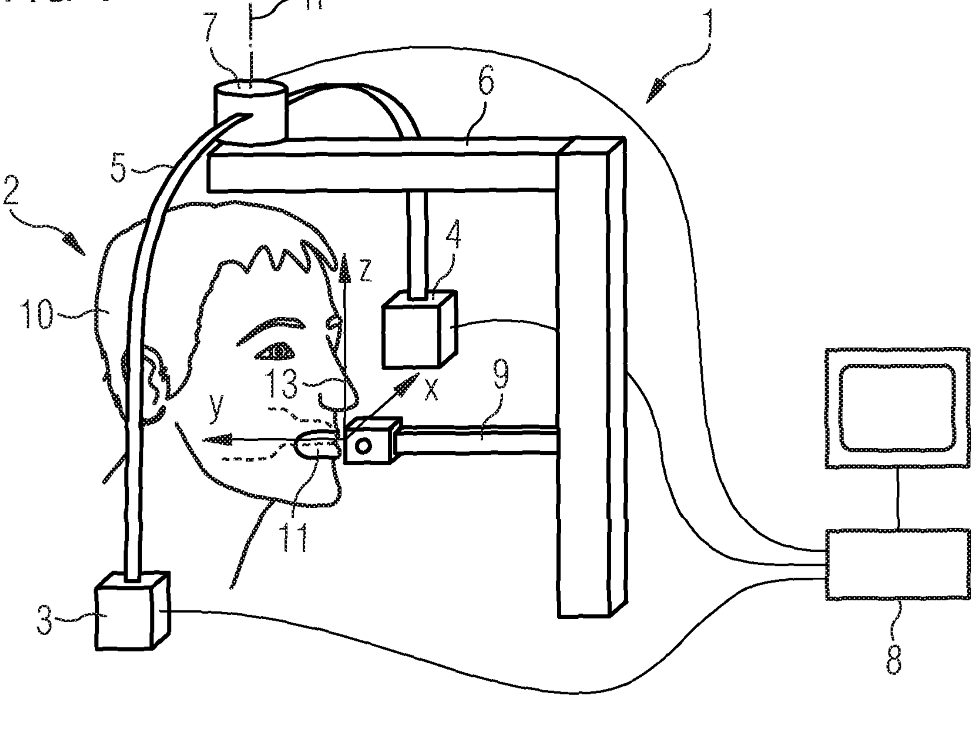
(54) **Method and Apparatus for Simplified Patient Positioning in Dental Tomographic X-Ray Imaging**

(57) An apparatus and a method is proposed which allow for a simplified patient positioning based on the selection of a region of interest for the tomographic image of the dentition of a patient. The region of interest is selected on a previously acquired panoramic image of the dentition of the patient.

FIG 1



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Description

[0001] The invention relates to a method for dental tomographic X-ray imaging, the method comprising the steps of:

- selecting a region of interest for a local tomographic imaging process;
- positioning a patient in an X-ray apparatus; and
- performing an imaging process by the X-ray apparatus under the control of a control unit by moving an imaging system along a trajectory.

[0002] The invention further relates to an apparatus for implementing the method.

[0003] Such a method and such an apparatus is known from US 59 21 927 A. In a first step of the known method an imprint of the mouth of the patient is taken first. Afterwards, the imprint is attached to the radiographic apparatus through a specific holder. The imprint and the holder form together a bite unit. The holder is then moved manually by the clinical operator, to bring it in the desired position. According to the known method an optical adjustment device is used to align the bite unit of the apparatus such that a local tomographic image can be taken from a particular region of dentition of the patient. The optical adjustment device is provided with a laser whose beam can be used to mark the region of tomographic imaging on the imprint in the bite unit. For adjusting the patient, the operator moves the bite unit until the point of interest on the imprint matches with the mark of the laser beam on the imprint.

[0004] US 64 24 694 B1 discloses a bite support that is translated and oriented by an external off-line alignment accessory device, so that the center of the volume of interest falls under the reference marking of a transparent plexiglass template. The device is then repositioned on the system to perform the tomographic examination.

[0005] In both cases, the operator has to modify position and orientation of the bite support manually in order to adapt it to the patient and to the desired volume of interest. This procedure is time consuming and it may introduce substantial errors in patient positioning.

[0006] Local tomographic analysis is a widely used examination in the field of dental surgery, in particular in the field of implantology. Conventional tomography, tomosynthesis, and local cone beam computerized tomography (= CB-CT) are well known techniques, which generate a volumetric reconstruction of the analyzed anatomical districts, delivering a low radiation dose in the patient tissues.

[0007] To achieve the maximum efficiency, patient positioning is critical. In particular the patient's position with respect to the radiographic apparatus has to be set such that the center of the volume of interest coincides with the center of the volume which will be reconstructed. This problem is common to conventional tomography, tomosynthesis and CB-CT.

[0008] Conventional tomography and tomosynthesis are limited angle of view tomographic methods that generate a set of parallel slices orthogonal to main direction of projection, where resolution is minimum along the direction orthogonal to the slices, and maximum along the slices. Therefore, conventional tomography and tomosynthesis also require that the patient is adequately oriented in the three-dimensional space, with respect to the radiographic apparatus. Incorrect orientation of the acquired volume may introduce blurring of the interesting anatomical structures, making structure identification difficult and measurements inaccurate.

[0009] For instance, volume orientation is critical when measurements have to be taken along a preferential direction. This is common to different dental applications like implantology, where the knowledge of the lower or upper jaw cross-section and of the nerve canal position is fundamental to plan an accurate, risk free, implant. In this situation, the slices acquired with conventional tomography or tomosynthesis should be orthogonal to the lower or upper jaw profile, to allow the maximum resolution of the anatomical structures and accurate measurements of the dimension of the anatomical structures of interest.

[0010] For CB-CT the orientation of the volume is also important, especially if the reconstructed volume has an anisotropic shape, or if a limited angle of view acquisition scheme is adopted.

[0011] US 54 25 065 A discloses a method and an apparatus for taking panoramic images of the dentition of a patient. The panoramic radiography is based on the theory of orthopantomography, which has been established for a long time. The basic principle of orthopantomography is a coordinated movement of the X-ray source and detector pair, which allows focusing on the structures lying on a predefined surface, blurring out at the same time structures outside the focal plane. This approach is also used in panoramic radiography to focus on the patient dental arch, blurring all the other anatomical structures of the skull.

[0012] BRAUN, S. et al., The shape of the human dental arch, The Angle Orthodontist, Vol. 68, No. 1, p. 29-36, 1998 contains data on a template of the human dental arch.

[0013] SAHIWAL, I. G. et al., Radiographic identification of nonthreated endoseous dental implants, J. Prosthet. Dent. 87, 552-562 (2002) and LEHMANN, T. et al. IDEFIX - Identification of dental fixtures in intraoral X-rays, Proc. SPIE 2710, p. 584-595 (1996) disclose methods for the identification of fixtures within the dental arch such as dental implants.

[0014] Proceeding from this related art, the present invention seeks to provide a method and an apparatus for dental tomographic X-ray imaging with simplified patient positioning and improved image quality.

[0015] This object is achieved by a method having the features of the independent claim. Advantageous embodiments and refinements are specified in claims dependent thereon.

[0016] In the method and in the apparatus the region of interest is selected based on a panoramic image of the dental arch of the patient. Furthermore, the parameters for the trajectory applicable for the local tomographic imaging process are calculated by the control unit based on the selection of the region of interest. The localization of the region of interest is based on a actual panoramic image of the dentition of the patient. Since the spatial relation between the panoramic image and the actual position of the dentition of the patient is known a accurate spatial relation between the region of interest and the actual position of the dentition can be established after the region of interest has been selected by the operator. Since the actual position of the dentition is known the operational parameters of the imaging system can be chosen appropriately resulting in a high image quality of the recorded tomographic images.

[0017] In one preferred embodiment, the panoramic image is acquired in real-time prior to the selecting step. Thus a particularly accurate relationship between the actual position of the dentition in three-dimensional space and the panoramic image can be established.

[0018] Preferably, a template dental arch is used instead of the actual dental arch for establishing a relation between the image points on the panoramic image and the three-dimensional space. In most cases using the template dental arch will be sufficient, since the actual dental arch can be accurately reproduced by the template dental arch.

[0019] The template dental arch, can also be corrected for the lower or upper jaw taking into account the inclination of the dentition with respect to the vertical direction in order to improve the spatial relation between the actual dentition and the image points of the panoramic image.

[0020] The selection of the region of interest preferably includes a selection of the position and orientation of the region of interest in the three-dimensional space. Since the spatial resolution is not isotropic for tomographic imaging with a limited angle of view the orientation of the region of interest is important for the usability of the tomographic images.

[0021] In an embodiment of the method, a repositioning of the patient is performed prior to the step of moving the imaging system along the trajectory taking into account cinematic constraints of the system. In this case it will be possible to perform a tomographic imaging process even if the mechanical structure of the imaging system does not allow to take a tomographic image at any point of the dentition of the patient.

[0022] The repositioning is preferably made by a roto-translation of the head support system, based on displacement data calculated and provided by the control unit.

[0023] The repositioning can also be automatically made by the head support system upon user command, performing the roto-translation of the head support system by controlling particular actuators of the head support system. Thus, the operator can give the patient a warning before the head of the patient is repositioned.

[0024] The extent of the repositioning is preferably calculated by the system based on optimization criteria such as dose minimization, maximum angle of view, minimum time of acquisition, maximum distance between patient and moving components of the radiographic apparatus resulting in an low dose for the patient in combination with high quality of the tomographic images.

[0025] The quality of the tomographic images can be further increased if a local analysis of the panoramic image is performed for identifying fixtures or other metallic objects, and if the operational parameters including X-ray dose and angle of view are varied in dependency of the output of the local analysis.

[0026] The dose to which the patient is exposed can particularly be reduced if, based on the vertical position and extension of the selected region of interest, at least one vertical X-ray collimator is automatically or manually operated avoiding unnecessary exposure of the patient tissues lying outside of the region of interest.

[0027] If the radiographic apparatus is equipped with a limited number of acquisition trajectories for the tomographic imaging process a movable positioning device is used to get the proper position and orientation of the patient. In some cases also a roto-translational motion of the patient is needed to bring the region of interest to the correct position and orientation if the radiographic apparatus is equipped with a limited set of trajectories that do not allow performing the tomographic reconstruction of any point of the dental arch.

[0028] However, if the radiographic apparatus is capable of acquiring a set of radiographic images for the tomographic examination in any point of the dentition a fixed positioning device might be used.

[0029] For increasing the quality of the reconstructed volume, the data of the panoramic radiography can be used as an additional projection from a different point of view added to the data set of the projection images, thus improving the quality of the tomographic reconstruction. The reconstructed volume and the panoramic image can also be displayed together in a three-dimensional representation.

[0030] Further advantages and properties of the present invention are disclosed in the following description, in which exemplary embodiments of the present invention are explained in detail on the basis of the drawings:

Figure 1 shows a patient who bites the bite unit of a radio-graphic apparatus to get the correct positioning;

Figure 2 shows a dental arch of a patient together with five projections;

Figure 3 shows the dental arch of Figure 2 displaced at another position;

Figure 4 depicts a typical panoramic radiography in panel, on which a local tomographic reconstruction of the root of the second upper molar is set up; and

Figure 5 shows a three-dimensional representation of the panoramic radiography form Figure 4 mapped on a template arch.

[0031] Figure 1 shows an apparatus 1 used for taking tomographic X-ray images from the dentition of a patient 2. According to Figure 1 the apparatus 1 comprises an X-ray imaging system including an X-ray tube 3 and a X-ray detector 4, held by a pivotable support 5. The pivotable support 5 is mounted on a stand 6 via a drive unit 7 and can be pivoted around a rotational axis R. The rotational axis R can be moved along a transversal plane extended by the X-axis and the Y-axis.

[0032] The source 3, the detector 4 and the drive unit 7 are connected to a control unit 8, which controls the movement and the operation of the tube 3 and the detector 4 during the imaging process. In the following the assembly formed by the tube 3 and the detector 4 is also called imaging system.

[0033] The control unit 8 is provided with a display for displaying images taken by the apparatus 1 and may also be provided with various input devices such as a keyboard or a mouse for inputting data or commands to the apparatus 1.

[0034] The apparatus 1 further comprises a head support 9 for positioning a head 10 of the patient 2 in a predefined position with respect to the apparatus 1. The head support 9 can be formed by a bite unit 11. During the imaging process, the patient 2 bites on the bite unit 11 of the apparatus 1 to get the correct positioning of a dental arch 12 of the patient 2.

[0035] In Figure 1 an absolute reference system 13 with a vertically aligned Z-axis is shown to be located in the center of the bite unit 11 in the region of the incisors. The Y-axis extends towards the spine of the patient 2 whereas the X-axis extends in a lateral direction.

[0036] Figure 2 shows a typical acquisition scheme, in which the tube 3 and detector 4 approximately rotate around the interesting anatomical structure. According to Figure 2 the dental arch 12 extends in the XY-plane of the reference system 13. The dental arch 12 is shown as a continuous thick curve. A set of five projections 14 is also shown. The origin of the five projection 14 lies in the tube 3, which follows a preset trajectory for taking a tomographic image of a region of interest of the dental arch 12. The motion of the tube 3 is coupled to a corresponding motion of the detector 4 on the opposite side of the head 10. Radiographic images of the head 10 of the patient 2 are generated on the detector 4 by the projections 14. From the radiographic images a three-dimensional image of a target volume 15 can be reconstructed by the control unit 8. The target volume 15 generally corresponds to a region of interest 16 selected by the operator. The resolution within the target volume 15 is best in a focal plane 17, which corresponds to a common intersection plane of the projections. In a direction orthogonal to the focal plane 17 along the main direction of projection the resolution is lowest.

[0037] The apparatus 1, in particular the control unit 8, is also provided with means for selecting the region of interest 16 for a local tomography or tomosynthesis. It should be noticed that, given a certain trajectory of the tube 3 and the detector 4, the local target volume 15 which can be reconstructed is uniquely determined. Furthermore, the dental radiographic apparatus, such as the apparatus 1, have strong kinematics constraints that do not allow performing tomographic reconstruction at any desired target volume 15 along the dental arch 12. Thus, a limited number of trajectories are typically available, allowing tomographic reconstruction only on a subset of predefined oriented target volumes in the three-dimensional space. The patient 2 has therefore to be moved in order to position and orient the head 10 such that the desired local region of interest 16 falls inside one of these predefined target volumes 15.

[0038] In Figure 3 the dental arch 12 from Figure 2 has been moved, since a different position and orientation are required to bring the anatomical structures of the region of interest 16 within an allowable target volume 15. In Figure 3, the reference position is depicted by a solid line and the patient 2 has been moved to the position by a dashed line by moving the bite unit 11 in the correct orientation and position. The arrows indicate the tangential directions to the dental arch 12.

[0039] Positioning is generally a time consuming and complex process, requiring iterative steps of positioning of the patient 2, alignment of dedicated accessories and verifications by the operator with substantial risk of positioning errors.

[0040] In the method described herein, a panoramic radiography 18 as shown in Figure 4 is used for positioning the target volume 15 with respect to the imaging system. To obtain a panoramic radiography 18 of high quality, the patient 2 shall always be accurately positioned with respect to the system, as shown in Figure 3, so that during the image acquisition the imaging system focuses exactly on the dental arch 12. For these purposes, the following procedure is adopted: The patient 2 bites the bite unit 11, which is rigidly connected to the radiographic apparatus 1. As a consequence, the central point of the dental arch 12 lies in a known position. Then, a clinical operator adjusts the orientation of the patient 2 such that the dental arch 12 is horizontal and no tilt in the dental arch is present. Once the positioning procedure is terminated, the dental arch 12 in the XY-plane is well superimposed to a template dental arch 19 as will be outlined in detail in connection with Figure 4 and 5.

[0041] For establishing a spatial relation between the target volume 15 and the radiographic image, the shape of the dental arch 12 has advantageously to be known a priori, such that the coordinated movement of the X-ray tube 3 and the detector 4 focuses on the region of interest 16 of the dental arch 12. The mean shape of the jaw in the XY-plane has been accurately estimated by many authors: it is well approximated by a piecewise polynomial function which can be adapted to the size of the patient 2. In the following, we will refer to it as the template dental arch 19. The template dental arch 19 is also used for controlling the motion of the imaging system while taking the panoramic radiography 18 depicted in Figure 4. On this panoramic radiography 18 a local tomographic reconstruction of the root of the second upper molar is setup. The pixel p(u, v) in the center of the interesting area is identified by its row index u and column index v of the panoramic radiography 18.

[0042] The same panoramic radiography 18 mapped onto a template dental arch 19 is shown in Figure 5. As can be seen from Figure 5, the surface of the panoramic radiography follows the curve Y = f(X) and it is parallel to the vertical Z-axis. For controlling the motion of the imaging system the coordinates of the point p(u,v) in the reference system 13 have to be known. The three-dimensional coordinates of the point P = (X, Y, Z), corresponding to p(u,v) in the panoramic radiography 18, can then be computed as follows:

[0043] It is assumed that the panoramic radiography 18 of the patient 2 has been previously acquired as depicted in Figure 4. Each pixel p = (u, v) of the panoramic image can be associated to a single three-dimensional point, P = (X, Y, Z), lying on a vertical surface passing through the template dental arch, [X, f(X), Z]. Therefore a biunivocal correspondence can be written between the points on the panoramic radiography 18 and the points of the panoramic radiography 18 positioned in three-dimensional space following the template dental arch 19.

[0044] The coordinates X, Y, Z can be computed from u, v as follows: The vertical position, that is the Z coordinate, is computed by considering that the surface focused in the panoramic radiography 18 is perpendicular to the horizontal XY-plane; therefore the height of point P above the horizontal XY-plane is linearly proportional to the row index u of the panoramic radiography 18 as:

$$Z = k\,u + Z_0 \qquad (1)$$

where k depends on the vertical pixel size and Z_0 is the height of the first line of the panoramic image.

[0045] The position of P on the horizontal plane, [X, Y], is associated with the column index v on the panoramic radiography 18. Such relationship can be computed from the trajectory used to acquire the panoramic radiography 18; the focused surface corresponds to the template dental arch 19, therefore:

$$X = X(v) + X_0 \qquad (2a)$$

$$Y = Y(v) + Y_0 \qquad (2b)$$

[0046] This correspondence can be stored in a look-up table as the number of column indexes is finite. All the constants and parameters can be derived from factory specifications.

[0047] We explicitly note that the tangential direction to the template dental arch 19, in the following the versor f'(X), can be computed for each point of f(X). This versor indicates the local orientation of the mandible. Given the position XY onto the template dental arch 19, the tangential direction to the template dental arch 19 is easily derived, for instance analytically, using the expression of f(X) for the template arch, or numerically, given a set of points belonging to the template arch. These data can also be pre-computed and stored.

[0048] Therefore, we can assume that the orientation and the position of the volume of interest 16 is completely determined with respect to the position used when the panoramic radiography 18 of the patient 2 was acquired (reference position).

[0049] For implementing the method described herein the apparatus 1 is provided with extended kinematic capability, which avoids in most cases the need to correct the alignment of the head 10 when local tomography is performed.

[0050] In a first preferred embodiment, no motion of the head support 9 and correction of alignment of the head 10 of the patient 2 is required for any tomographic examination. Only appropriate movements, in particular translations and rotations of the components of the imaging system are involved, thus leading to a simplified solution for the positioning problem. In particular, the drive unit 7 and the stand 6 are arranged such that the rotational axis R can perform an extended movement along a transversal plane extended by the X-axis and the Y-axis. The rotational axis R can be shifted by more than +/-50 millimeter, preferably by more than +/-60 millimeter or even by more than +/-70 millimeter with respect to a neutral position of the rotational axis.

[0051] It should be emphasized that, in this embodiment, the patient 2 is kept fixed in the same positioning as for the panoramic radiography 18, and that there is no need of a movable head support system dedicated for tomographic examinations.

[0052] After the acquisition of the panoramic radiography 18, the clinical operator selects the pixel of interest p in the panoramic radiography, and eventually the required angle of view, which is typically transversal or longitudinal: The corresponding point P and versor TP, describing the center and the orientation of the volume of interest 16, are then automatically computed.

[0053] Then the operator starts the execution of the tomographic trajectory, the patient 2 is held by the same head support 9, which has been used during the acquisition of the panoramic radiography 18, so avoiding unnecessary repositioning. During the trajectory, the tube 3 and the detector 4 is driven such that a set of projections, aimed to the reconstruction of a target volume 15 centered in P and oriented along TP, is executed.

[0054] In a second alternative embodiment, a motion of the head support 9 and a correction of the alignment of the head 10 is required only for limited volume positions corresponding to specific kinematic constraints of the tomographic apparatus 1. In such cases adjustment movements of the head support 9 can be automatically accomplished by the system, based on the numeric data output available by the method.

[0055] This alternative embodiment is required when, for at least one position of the volume of interest, the kinematic constraints of the imaging system do not allow execution of the tomographic trajectory without movement of the head support 9 and of the patient 2.

[0056] Therefore, after the acquisition of the panoramic radiography 18, the clinical operator selects the pixel of interest p in the panoramic radiography 18, and eventually the required angle of view, typically transversal or longitudinal: The corresponding point P and versor TP, describing the center and the orientation of the region of interest 16, are then automatically computed.

[0057] If the selected volume lies in a forbidden territory, where the trajectory cannot be executed due to the kinematic constraints of the system, the need arises to move the patient 2 and hence the region of interest 16 in a permitted region, where the trajectory can be executed.

[0058] The radiographic apparatus 1 according to the second embodiment can coordinately move the tube 3 and the detector 4, such that a trajectory related to the volume centered in C_0 with orientation T_0 can be executed.

[0059] The patient 2 has to be roto-translated with respect to the position and orientation assumed during the acquisition of the panoramic radiography 18, such that the forbidden region of interest 16 at position C' with orientation T' reaches the permitted position C_0 with orientation T_0 by a roto-translation.

[0060] This roto-translation has to be performed using the degrees of freedom allowed by the head support system. The parameters which define it, $Q_0 = Q(C', C_0, T', T_0)$, can be derived taking into account the condition $C' = C_0$ and $T' = T_0$ at the end of the motion.

[0061] The movable head support system of the radiographic apparatus 1 is then automatically relocated according to the parameters Q_0. Lastly, the patient 2 is repositioned by the head support system and the acquisition can start.

[0062] Typically, orthopantomographs provide tomographic trajectories that allow volume reconstruction in predefined positions C_n and orientation T_n in the three-dimensional space, where n = 1 ... N and N is the number of possible trajectories. Therefore, before implementing the roto-translation described by Q_n, the system may decide or ask the user for a choice of the most adequate trajectory based on optimization criteria such as for instance the comfort of the patient 2 or the minimization of the path.

[0063] The method described so far apply to tomographic machines which comprise a limited range of acquisition angles. However, if a CB-CT machine with a 180° or 360° acquisition angle is considered, the volume orientation is less important, since the resolution of the reconstructed volume is generally isotropic. In this case, the proposed method could still be used to automatically position the patient with respect to the radiographic apparatus with high accuracy, discarding his orientation.

[0064] The knowledge on the orientation of the patient 2 can also be used to optimize the acquired radiographic images with respect to the reconstruction algorithm or to the dose released into the patient tissue. For instance, for a CB-CT machine acquiring data with a 180° acquisition angle, the patient can be oriented such that the dose released to some important tissues, such as the brain or the spine, is limited.

[0065] The methods described herein can also be modified with respect to the usage of the panoramic and tomographic data:

As previously stated, the reconstruction of a local volume from a set of projections taken from a limited angle of view suffers of a limited resolution along the main direction of projection. The local data provided by the panoramic radiography 18 can be integrated with the reconstructed volume to increase the resolution.

This integration can be done numerically; in this case, a specific algorithm has to be adopted. For instance, the panoramic radiography 18 can be included in the set of projections adopted for the tomographic reconstruction of the volume.

A more simple integration of the data can be performed by simultaneous visualization of the reconstructed volume and the panoramic radiography 18 in the three-dimensional space. This solution requires only the adoption of a three-dimensional graphic interface.

[0066] The method can also be used to design particular acquisition trajectories, for instance, aimed at the optimization of the projections if metallic objects (fixtures) are present in the reconstructed volume. Once the clinical operator selects the pixel of interest p on the panoramic radiography 18, a local analysis of the radiography 18 an be performed, aimed at the individuation of fixtures. If some fixture is present, the control unit 8 can automatically increase the X-ray radiation, enlarge the acquisition angle to limit the effect of the metallic objects in reconstruction, or change the weight of the different images in the reconstruction process.

[0067] Further modifications relate to operational conditions of the imaging process.

[0068] For example, a vertical collimator can be used to irradiate only the upper or lower jaw, thus limiting the dose released into the patient tissue.

[0069] Moreover, the user could select onto the panoramic radiography 18 not only a point of interest p, but an entire region of interest 16. The control unit 8 can then generate the acquisition trajectory to reconstruct the entire region of interest 16 selected by the user.

[0070] The method used for recording the panoramic radiography 18 can be a standard panoramic, or partial panoramic, or improved orthogonality, or any other panoramic image provided by the apparatus 1. The panoramic image can finally also be a template panoramic image which is usable for various patients.

[0071] The method used for recording tomographic images can be based on various kinds of tomographic examinations such as linear tomography, narrow beam tomography, tomosynthesis, local CB-CT, and other similar methods wherein a trajectory for tomography or tomosynthesis by roto-translation of the imaging system around the head 10 of the patient 2 is executed.

[0072] Finally, it should be noted that throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

[0073] Features, integers, characteristics, compounds or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith.

Claims

1. A method for dental tomographic X-ray imaging, the method comprising the steps of:

- selecting a region of interest (16) for a local tomographic imaging process;
- positioning a patient (2) in an X-ray apparatus (1); and
- performing an imaging process by the X-ray apparatus (1) under the control of a control unit (8) by moving an imaging system (3, 4) along a trajectory

characterized in that
the region of interest (16) is selected based on a panoramic image (18) of the dental arch (12, 19) of the patient (2) and that the parameters for the trajectory applicable for the local tomographic imaging process are calculated by the control unit (8) based on the selection of the region of interest (16).

2. The method according to Claim 1,
wherein the panoramic image (18) is acquired in real-time prior to the selecting step.

3. The method according to Claim 1 or 2,
wherein a template dental arch (19) is used for establishing a spatial relation between the image points on the panoramic image (18) and the three-dimensional space.

4. The method according to Claim 3,
wherein the template dental arch (19) is corrected for the lower or upper jaw taking into account the inclination of the dentition with respect to the vertical direction.

5. The method according to any one of Claims 1 to 4,
wherein the selection of the region of interest (16) includes a selection of the position and orientation of the region of interest (16) in the three-dimensional space.

6. The method according to any one of Claims 1 to 5,
wherein, prior to the step of moving the imaging system (3, 4) along the trajectory, a repositioning of the patient (2) is performed taking into account cinematic constraints of the apparatus (1).

7. The method according to Claim 6,
wherein the repositioning is made by roto-translation of the head support system (9), based on displacement data calculated and provided by the control unit (8).

8. The method according to Claim 7,
wherein the repositioning is automatically made by the head support system (9) upon user command, performing the roto-translation of the head support system (9) by controlling actuators (7) of the head support system (9).

9. The method according to any one of Claims 6 to 8,
wherein the extent of the repositioning is calculated by the control unit (8) based on at least one optimization criterion selected from the group containing the group members dose minimization, maximum angle of view, minimum time of acquisition, image quality and maximum distance between patient and moving components of the radiographic apparatus.

10. The method according to any one of Claims 1 to 9,
wherein a local analysis of the panoramic image (18) is performed by the control unit (8) for identifying fixtures or other metallic objects, and wherein the operational parameters including X-ray dose and angle of view are varied in dependency of the output of the local analysis.

11. The method according to any one of Claims 1 to 10,
wherein, based on the selected region of interest (16), at least one vertical X-ray collimator is automatically or manually operated avoiding unnecessary exposure of the patient tissues lying outside of the region of interest (16).

12. The method according to any one of the Claims 1 to 11,
wherein a movable positioning unit (11) is used to get the proper position and orientation of the patient (2), and the radiographic apparatus (1) is equipped with one ore more acquisition trajectories for the tomographic reconstruction.

13. The method according to any one of the Claims 3 to 12,
wherein a fixed positioning unit (11) is used and wherein a cinematic unit (5, 7) of the radiographic apparatus (1) performs an extended movement for the tomographic examination in any point of the template dental arch (19).

14. The method according to any one of the Claims 1 to 13,
wherein the data of the panoramic radiography (18) are integrated with the data set of radiographic images acquired for the tomography to increase the quality of the reconstructed volume.

15. The method according to any one of the Claims 1 to 14,
wherein the reconstructed volume and the panoramic image are displayed together in a three-dimensional representation.

16. The method according to any one of the Claims 1 to 15,
wherein the tomographic imaging process is a linear tomography, narrow beam tomography, tomosynthesis or a cone beam computer tomography and the panoramic image is a standard panoramic, a partial panoramic image or a panoramic image with improved orthogonality.

17. A apparatus for dental tomographic X-ray imaging comprising:

- an imaging system comprising an X-ray source (3) and an X-ray detector (4);
- a head support system (9) to position a head (10) of a patient (2) in a predefined position with respect to the imaging system; and
- a control unit (8) arranged for selecting a region of interest (16) for a local tomographic imaging process and for controlling the movement of the imaging system during an imaging process

characterized in that
the control unit (8) is arranged for performing a method according to any one of the Claims 1 to 16.

FIG 1

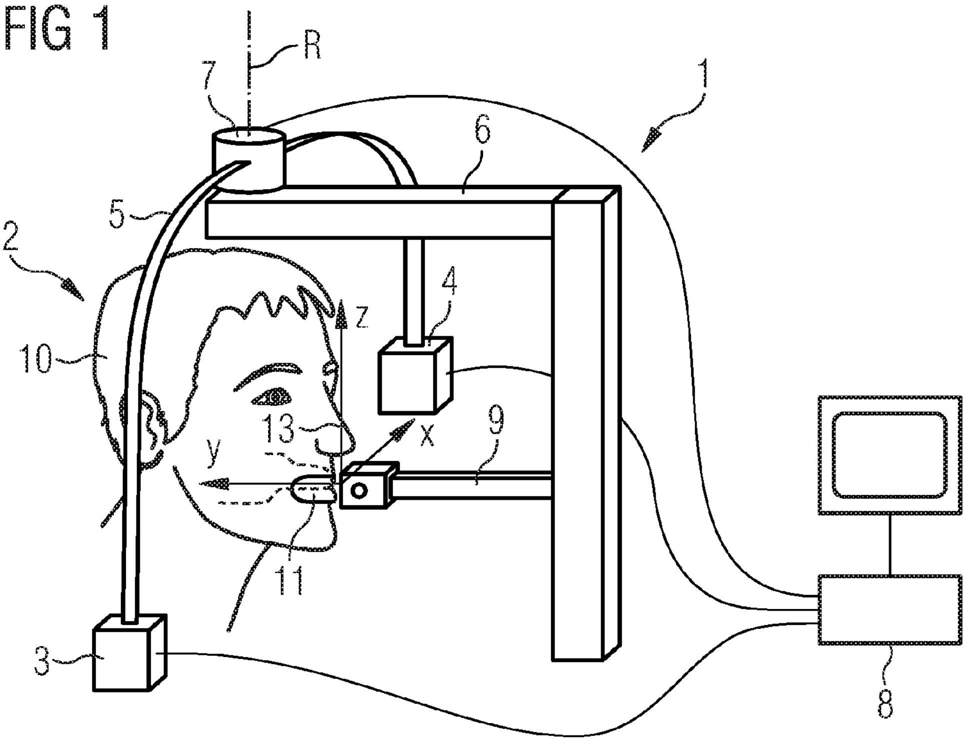

R
7
1
6
5
2
4
z
10
13
x
9
y
11
3
8

FIG 2

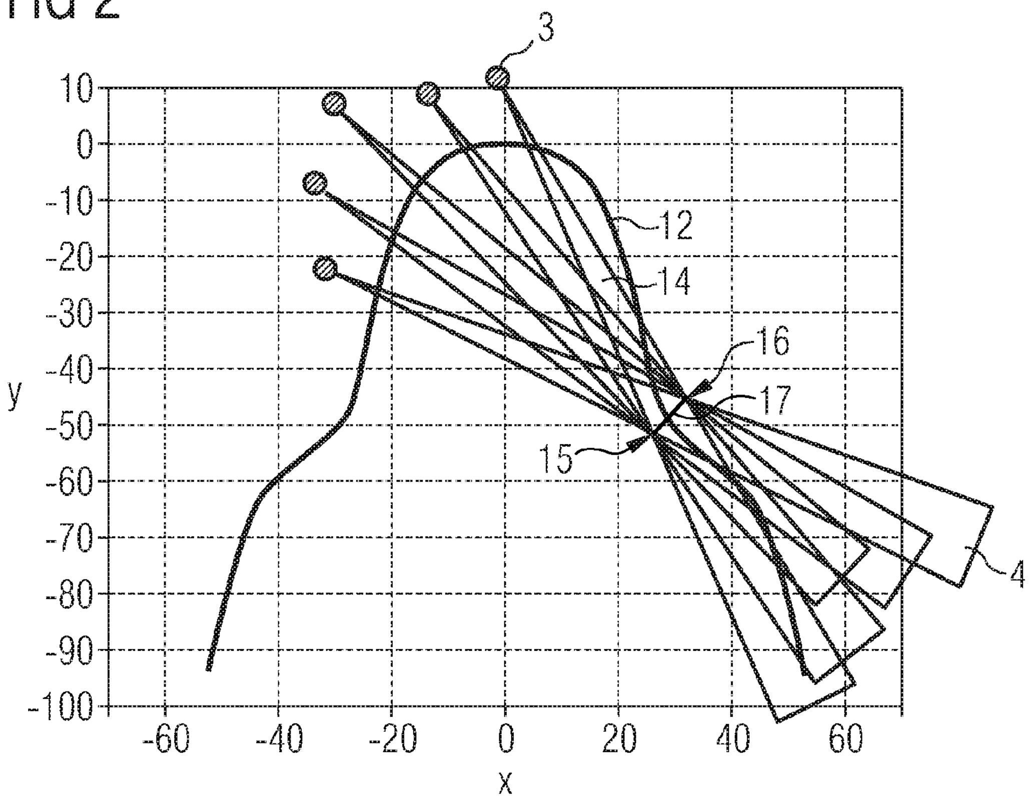

3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
12
14
16
17
15
4
y
-60
-40
-20
0
20
40
60
x

FIG 3

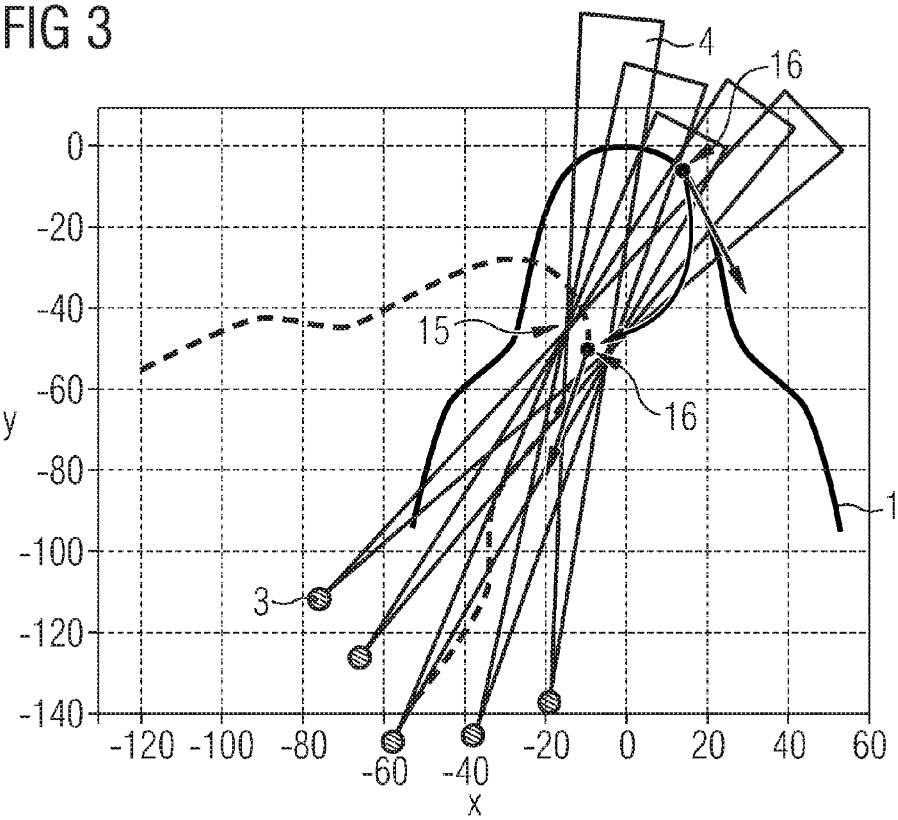


FIG 4

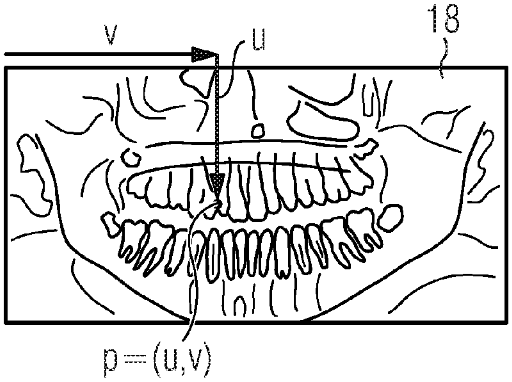
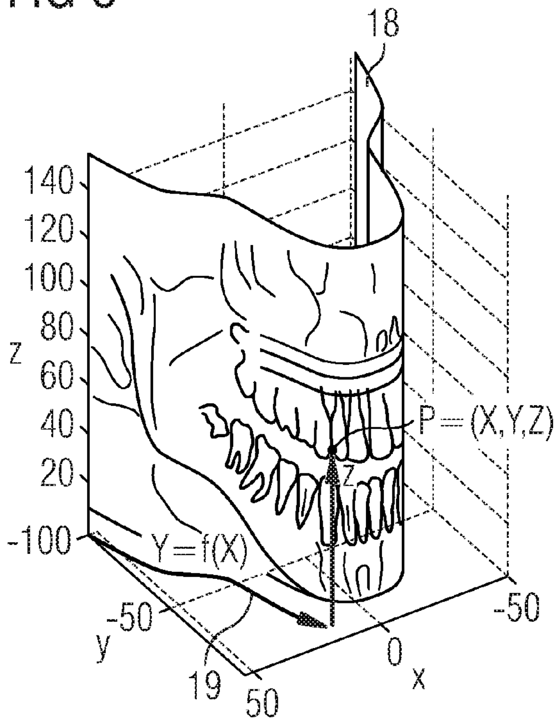


FIG 5



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Application Number
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