(19) DANMARK

(10) DK/EP 2531110 T3

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: *A 61 B 6/14 (2006.01)* *A 61 B 6/03 (2006.01)* *G 06 T 15/04 (2011.01)*

(45) Oversættelsen bekendtgjort den: **2022-04-19**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2022-01-12**

(86) Europæisk ansøgning nr.: **11739451.0**

(86) Europæisk indleveringsdag: **2011-02-02**

(87) Den europæiske ansøgnings publiceringsdag: **2012-12-12**

(86) International ansøgning nr.: **FI2011050091**

(87) Internationalt publikationsnr.: **WO2011095695**

(30) Prioritet: **2010-02-02 FI 20100036** **2010-02-02 FI 20100037**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

(73) Patenthaver: **Planmeca OY, Asentajankatu 6, 00880 Helsinki, Finland**

(72) Opfinder: **KOIVISTO, Juha, Kulosaaren Puistotie 46 I 49, FI-00570 Helsinki, Finland**
NYHOLM, Kustaa, Lauklammenpolku 40, Myllykylä, FI-02570 Siuntio, Finland
DE GODZINSKY, Christian, Honkamäentie 3, FI-01260 Vantaa, Finland

(74) Fuldmægtig i Danmark: **Patrade A/S, Ceresbyen 75, 6., 8000 Århus C, Danmark**

(54) Benævnelse: **APPARAT TIL DENTAL COMPUTERTOMOGRAFI**

(56) Fremdragne publikationer:
EP-A1- 2 130 491
WO-A1-2008/072398
WO-A2-2004/098378
JP-A- 2006 204 329
JP-A- 2006 204 330
US-A- 6 081 739
US-A1- 2004 254 456
US-A1- 2008 056 439

DESCRIPTION

FIELD OF INVENTION

[0001] The invention relates to a dental computed tomography apparatus according to claim 1.

BACKGROUND OF INVENTION

[0002] The history of medical x-ray imaging originates approximately to the time of inventing x-radiation. For more advanced ways of imaging, e.g. the development of panoramic x-ray imaging in the dental field started for over a half century ago. The development of digital imaging especially in the 1990s brought digital x-ray imaging devices also to dental practices. The latest development step in the dental field has been the generalisation of the cone-beam computed tomography apparatus designed for three-dimensional imaging of skeletal structures of the cranial area. Concerning new possibilities offered by them, worth mentioning is e.g. applications related to implant attachment and other treatment planning.

[0003] Along with the development of cameras and information technology, such as that of computing power of computers, it has become possible to create virtual three-dimensional surface models of different surfaces. In the dental field, facial surface models can be utilised e.g. in connection with orthodontic treatment, as orthodontic treatment can also have an effect on facial shapes. Such surface models have sometimes been combined with information on surface texture, i.e. that of details of the surface / surface structure.

[0004] The prior art also includes techniques to create a virtual three-dimensional texture model without a separately created model of the three-dimensional shape of the surface.

[0005] Among others, the need for acquiring a separate device for a particular imaging purpose has been limiting utilisation of facial texture models in the dental field. Acquiring a separate device is not only a question of costs but also of space, as each device always requires a space to be installed and/or stored in and/or where it can be used. On the other hand, each separate imaging always takes a certain amount of time, too. Furthermore, as far as data processing is concerned, there are certain challenges in the arrangements in which creating the model requires combining image information acquired at different times, image information acquired by different imaging devices and/or image information acquired of an anatomy Insert having been positioned in different ways for imaging.

[0006] US6081739 discloses an idea to develop a medical x-ray apparatus capable of also measuring superficial contours. JP2006204329A and WO 2008/072398 A1 disclose apparatuses for both X-ray and optical imaging.

BRIEF DESCRIPTION OF INVENTION

[0007] The object of the invention is a versatile dental computed tomography apparatus, by means of which it is possible to create for the virtual three-dimensional modelling of a patient's skull at least x-ray image information on the patient's cranial skeletal structure and, further, information on the colours, scars, hair, moles etc. of the patient's face. The apparatus according to the invention includes means for producing not only computed tomography images but also three-dimensional images comprising a facial surface texture. Preferably, the apparatus is arranged to enable creating 3D images on the cranial skeletal structure and/or teeth and, with the same patient positioning and imaging event, information on facial soft-tissue surface shapes and surface texture. Essential characteristics of the invention are defined in more detail in the accompanying patent claims.

[0008] The invention introduces a new arrangement for versatile modelling of the patient's cranial anatomy. The invention enables, among others, using existing imaging devices and avoiding the need to use prior-art special arrangements, which lowers the dentists' threshold to employ the possibilities offered by virtual 3D models.

[0009] Next, the invention and its preferable embodiments will be described in more detail also with reference to the enclosed figures.

BRIEF DESCRIPTION OF FIGURES

[0010]

Fig. 1 shows one computed tomography apparatus according to the invention, the basic structure of which includes a base construction and an arm part supporting imaging means.

Fig. 2 shows a receiver module of image information applicable for use in the apparatus according to Fig. 1.

Fig. 3 shows directing of laser beams from the module according to Fig. 2 towards a patient positioned at an imaging station.

Fig. 4 shows operation principle of a laser scanning used in an apparatus according to the invention.

Figs. 5a and 5b show signal paths according to one preferable embodiment of the invention from an x-ray detector and at least one colour camera via a frame grabber to a computer.

Figs. 6a - 6c show examples on various virtual three-dimensional facial models.

Fig. 7 shows a principle according to one preferable embodiment of the invention for

controlling certain operations of the apparatus.

DETAILED DESCRIPTION OF INVENTION

[0011] Fig. 1 shows one computed tomography apparatus according to the invention. The apparatus includes a vertical support construction (11) from which horizontally extends an arm (12) supporting a patient support means and an arm part (13) which supports a structure supporting imaging means of the apparatus, an arm part (14). The arm part supporting the imaging means (14) is arranged rotatable. To the arm part supporting the imaging means (14) are arranged at a distance from each other an x-ray source (15) and a receiver of x-ray image information (21), which are located at the apparatus with respect to a patient support means (17) such that an imaging station (18) is created to the apparatus which is located between the x-ray source (15) and the receiver means of x-ray image information (21) such that a beam produced by the x-ray source (15) can be directed to go through said imaging station (18) towards the receiver means of x-ray image information (21). The apparatus includes control means, of which Fig. 1 shows a control panel (16) arranged to the support construction (11) and operating mode selection means (19) pertaining in it. In the apparatus according to Fig. 1, the receiver means of x-ray image information (21) are arranged as part of a receiver module of image information (20) which is arranged into connection with a computer (30) via a cable. A means for processing image information is arranged to the computer, and a display (31) to present images created by the computer.

[0012] Fig. 2 shows a receiver module of image information (20) applicable for use in the apparatus according to Fig. 1. The module includes two colour cameras (22) arranged horizontally on opposite sides of the x-ray detector (21) and aligned at the imaging station (18). Further, light sources (23) preferably producing white light to illuminate the imaging station (18) and two lasers (24) are arranged to the module (20). These lasers are positioned substantially in the middle of the module (20) to the substantial proximity of its upper and lower edges. The lasers (24) are arranged to emit and direct at the imaging station (18) a narrow vertical planar fan beam which casts a laser light pattern on the patient's face. Fig. 3 shows how the laser fan beams produced by the two lasers (24) shown in Fig. 2 can be directed at the imaging station (18) to cover the patient's face in the vertical direction without shadow areas.

[0013] The invention can employ two lasers (24) of the same colour or they may be of different colour, i.e., the first can be arranged to produce laser light of a first and the other of a second colour. When using lasers of the same colour, it can be challenging to implement the structure in practice such that the lasers (24) produce exactly overlapping beams. This can already be difficult from the viewpoint of manufacturing techniques and, further, alignment problems may also occur later on when using the device. As regards to lasers of different colours, they can be arranged to point at different directions and can be identified in the image e.g. by machine vision based on searching the image for the hues in question. If the mutual alignment of the

lasers of different colours changes during use, instead of realigning the lasers (which could require service at the factory), it is possible to fix the situation by recalibration.

[0014] The light sources (23) arranged to the apparatus can be arranged to produce lights of other colour or colours than white, too. Diffusing foils may be arranged in front of the light sources (23) (cf. surface (23) in Fig. 2), whereby light is emitted from a larger area and substantially evenly and illumination in the target area will be even. Furthermore, the light sources (23) may be provided with polarizers (cf. surface (23) in Fig. 2) which can eliminate mirror reflection from the skin surface possibly otherwise visible in the image of the second camera, caused by the light source located in connection with the first camera, and vice versa. It is also possible to arrange to the apparatus more than two or only one colour camera (22), and the cameras or camera (22) can be arranged to operate not only as a photographic camera but also as a continuously-operating video camera. The light pattern to be directed on the patient's face can be produced by some other light source than a laser and the colour of this light pattern, too, can be arranged changeable and, even when produced by a laser, its colour can be some other than the conventional red, such as preferably particularly green.

[0015] When the structure supporting the imaging means (14) of the apparatus according to Fig. 1 is arranged rotatable, it is possible for the one or more colour cameras (22) arranged to the receiver module of image information (20) to shoot images from the patient's face positioned at the imaging station (18) from different directions. Then, it is also possible to make the laser light pattern to scan the patient's face. When using e.g. the arrangement according to Fig. 2, in which the camera (22) and the laser (24) are positioned at a distance from each other, it is possible to scan the patient's face positioned at the imaging station (18) with the laser line and, at the same time, to shoot images of the face at an angle (at an angle of less than 90 degrees) with respect to the direction of the laser beam. Of the image information acquired this way, it is possible to produce a three-dimensional surface model of the patient's facial shape in a way to be presented in more detail below. In one preferable embodiment of the invention, the control system of the apparatus is provided with a control function to always momentarily switch off the laser for a desired duration during a scan, during which periods it is possible to shoot colour images of the patient's face without the laser light pattern and to produce from the hence acquired image information a texture model of the patient's face. However, it is in principle possible to operate also such that the laser is not switched off at all but the laser line is removed from the texture model being formed during processing of the image information produced in the imaging programmatically.

[0016] Fig. 4 shows the principle of the laser scanning used in an apparatus according to the invention. A fan-like beam is directed at the face of a patient positioned at the imaging station (18) to form a narrow vertical laser light pattern on the face, which will be imaged at an angle between 0 and 90 degrees with respect to direction of the laser fan beam by a two-dimensional camera (22). The laser line is identified from the image taken with the camera (22), whereby each point (x, y) in the image lying on the laser line is a projection of a point P of the laser line directed on the patient's face on the sensor. When position of the camera (22) with respect to the imaging station (18) as well as the optical properties of the camera are known, it is possible

to determine the location of point P' corresponding to each pixel (point x, y) of the camera (22) in this three-dimensional set of coordinates. The three-dimensional location of point P in space is discovered by resolving the intersection point T of the plane of the laser fan beam and the beam going through the centre O of the objective of the camera (22) and the point P'. A virtual three-dimensional model of the shape of the facial surface can be constructed by transferring the laser (24) and the camera (22) from one side of the patient's face to the other and by shooting images of the laser line while it lies at different locations on the face.

[0017] Fig. 5a shows a signal path from the receiver module of image information (20) to the computer (30) used in one preferable embodiment of the invention. The signal path of image information detected by the colour camera or cameras (22) and the x-ray detector (21) to the computer (30) can be arranged shared such that the image information acquired from them is directed to the computer (30) via the same one frame grabber. Preferably, a signal path is also arranged in the apparatus at least between the control means of the movements of the imaging means and/or the control means of the x-ray source and the computer via the same Ethernet cable as the signal path from the camera to the computer. This can be implemented e.g. by means of an Ethernet-HUB component or an Ethernet switch component arrangeable to the apparatus. Fig. 4b shows another preferable embodiment for arranging signal paths to the apparatus which also requires only one Ethernet cable between the imaging means and the computer.

[0018] The means arranged to the computer (30) to process image information acquired when imaging the patient's face arranged at the imaging station (18) comprise, according to the invention, an algorithm for processing at least image information acquired from the x-ray detector (21) and for processing image information acquired from the colour camera or cameras (22) to create a virtual three-dimensional texture model of the patient's face. A means included in the image processing means for creating a facial surface model from the image information of the laser line directed on the patient's face is utilised in producing the texture model. Preferably, the image processing means includes a means which can produce models which simultaneously show three-dimensionally both the facial texture and at least parts of the teeth and/or skeletal structure of the patient's cranial area.

[0019] Fig. 6a shows an example of a facial three-dimensional model implementable with the apparatus according to the invention in which to the facial texture model is integrated information on the skeletal structure and teeth of the cranial area of the patient. Fig. 6b again shows an example of a facial surface model produceable with the above-described apparatus according to the invention, and Fig. 6c a different projection of the model according to Fig. 6b, which is produced only of information acquirable from the laser line patterns on the patient's face. Comparing Figs. 6b and 6c illustrates how the facial texture model produceable with the apparatus according to the invention differs from a mere facial surface model.

[0020] Fig. 7 shows a diagram which illustrates a principle according to which certain operations of the apparatus according to the above-described embodiment can be controlled. In the figure, the imaging of the patient's face is assumed to be implemented - simultaneously

with x-ray exposure or as its own imaging - such that the arm part supporting the imaging means (14) is made to rotate such that the receiver module of image information (20) moves from one side of the patient's face to the other for at least 180 degrees, such as for at least 200 degrees, such as for about 260 degrees. During this motion, the patient's face is illuminated by regularly pulsing the light sources (23) of the receiver module of image information (20), whereas the laser light is otherwise kept continuously on but, during the scan, it is momentarily switched off in order to be able to shoot images from the face of the patient positioned at the imaging station (18) also without the laser light pattern. The operations of the apparatus are synchronised to comprise two kinds of periods, during the first of which the laser light is switched off and images are shot of the face during such sequences of the light pulses whereby the patient's face is illuminated, and during the second periods the laser light is again kept on whereby the laser line, when the arm part supporting the imaging means (14) rotates, moves along the patient's face and images are shot of the face during such periods of the light pulses whereby the patient's face is not illuminated. When the imaging employs two colour cameras (22) according to the embodiment of the invention described above, concerning the operation mode shown in Fig. 7, the control as described above is implemented such that the first and the second camera (22) shoot images always during successive light pulses. The image information integrated by the cameras (22) can be read out always during those periods of the light pulsing when image information is not being integrated.

[0021] According to one preferable embodiment of the invention, the apparatus includes a means for realizing the imaging such that the computed tomography imaging is realized by a turning angle of about 200 degrees and the photographing by a turning angle of about 260 degrees. Thus, this may be realized in practise by making one manoeuvre of 260 degrees, during which the x-ray imaging is started only after movement of 30 degrees and correspondingly ended earlier than the photographing, or such that x-ray image information is first picked up during a manoeuvre of 200 degrees in the first direction, the movement is continued in this first direction to the starting position of photographing, which is then realized during a manoeuvre of 260 degrees in the opposite direction. An advantage offered by the latter alternative is that the manoeuvre of mere photographing can be realized as fast (i.e. by a higher angular velocity than the x-ray imaging) without the velocity needed in computed tomography imaging limiting the angular velocity, which reduces the risk for the facial expression of the patient changing or for other movements during exposure.

[0022] The diagram of Fig. 7 thus shows one principle applicable for use in the invention. However, if desiring to prevent the patient positioned at the imaging station from sensing the flickering of lights caused by the pulsing of facial illumination, the pulse frequency of the illumination must be arranged to be at least 50-60 Hz. Such pulsing would lead, when operating exactly the way shown in Fig. 6, to an unnecessarily large amount of image information for practical implementation of the invention. The above principle can indeed be applied e.g. such that, during the above-described periods, the first and the second camera do not shoot images during each light pulse but only e.g. at times of the order of every tenth pulse, whereby there also is more time for reading the image information from the camera. Thus, in one preferable embodiment of the invention, the means for illuminating the patient's

face is controlled to illuminate the patient's face in short pulses, preferably at least at the frequency of 50-60 Hz, the laser or lasers are controlled to produce a laser light pattern on the patient's face otherwise continuously but such that there are periods during the rotation of the arm part, such as less than 10 periods, during which no laser light pattern is produced and the colour camera or cameras are controlled to shoot images at the first pulse steps when the laser light pattern is directed on the face and when the means for illuminating the patient's face do not illuminate the face, and at the second pulse steps whereby no laser light pattern is directed on the face and when the means for illuminating the patient's face do illuminate the face.

[0023] One practical way to implement sequencing of shooting images according to the practical mode of operation described above comprises implementing the first and the last period during movement of the imaging means as periods during which the face is imaged without a laser line and for the duration of the movement in question, this kind of periods are arranged for the total of five at even intervals. According to such an embodiment of the invention, for the total of ten colour images of the patient's face would thus be shot from different directions without the laser light pattern, and the angular velocity of the motion of the imaging means from one side of the patient's face to the other can be arranged such that during the four periods falling between these periods, images of the order of 300 are shot of the laser light line directed on the face. It is still evident to those skilled in the art that it is e.g. not necessary to shoot images of the laser light pattern at even intervals and that their number, and the positions from which images of the laser line are shot, may be varied e.g. according to the desired horizontal resolution of the surface construction. It is also not necessary to shoot photographs without the laser line at even intervals and their number and position can be varied according to any particular need as well so that suitable joining points and adequate coverage are achieved for creating a three-dimensional texture model from the partial facial images shot from different directions.

[0024] The apparatus according to the invention and its operation mode selection switch (19) can be arranged to enable x-ray imaging and imaging of the patient's face to occur either separately or, in one preferable embodiment of the invention, to be implemented in connection with the same imaging event, even simultaneously. Photographing the face from different directions simultaneously with the x-ray imaging eliminates a need for a separate imaging whereby, among other things, there is no need to calibrate some other imaging device and to position the patient to this other device for a separate facial imaging. Thus, trouble and time are saved when the facial imaging can be performed simultaneously with the x-ray imaging. Also, if one wishes to integrate image information acquired in different ways of imaging, e.g. to be presented in the same three-dimensional model, the combining is then easier as the imaged anatomy has been in the same position and in the set of coordinates according to the same imaging device when imaged. The apparatus enables the use of the laser line to enhance bringing out the facial shapes in more detail by transferring the location of the laser line on the face, by shooting profiles produced by the laser line on the facial surface and by calculating the shape of the facial surface from these profiles.

[0025] Above, the invention has been described predominantly with reference to the enclosed figures, but all of the above-described details of the embodiments of the invention are not necessary or the only ones possible considering implementing the invention. The number of colour cameras used in the apparatus can be some other than two and, if the apparatus enables changing the camera location with respect to the imaging station, it is possible to shoot images of the patient's face from different directions even with one camera. In a preferable embodiment of the invention, the apparatus is arranged with a lighting arrangement emitting white light to illuminate the patient's face, which is advantageous considering imaging the facial hues, but it is possible to consider the invention being also utilisable without one or several sources of white light integrated in the apparatus and also with lights of other colours.

[0026] The receiver module of image information applicable for use in the apparatus can according to the embodiment of above comprise the receiver of x-ray image information (21) arranged substantially in the middle of the module, seen from the horizontal direction, and two lasers (24), and arranged substantially at opposite ends of the module (20) on the one hand a first and a second colour camera (22), on the other hand a first and a second lighting structure (23). When viewing the module (20) in the vertical direction, it may comprise an arrangement in which said lasers (24) are arranged substantially at the edges of the receiver module of image information (20), and said lighting structures (23) to direct light at the imaging station (18) from above and from below said colour cameras (22). The functionality according to the invention for modelling at least part of the face can nevertheless be considered to be achieved with other kinds of arrangements as well, such as with an arrangement which uses two light lines and only one camera.

[0027] The colour camera pertaining to the apparatus according to the invention can also be used for other purposes than those described above. The camera or cameras can be arranged to operate as a video camera, whereby it is possible to e.g. monitor and/or save the patient's expressions and possible movements before the x-ray imaging and/or during exposure, with suitable arrangements also in 3D. In the above embodiments, the colour camera or cameras are located to the arm part supporting the imaging means to the substantial proximity of the x-ray detector Generally, it is advantageous to position the colour camera or cameras, as well as the laser or lasers pertaining to the apparatus, to such structure of the apparatus which is already arranged movable with respect to the imaging station for the purposes of x-ray imaging by the apparatus.

[0028] The computer pertaining to the apparatus does not have to be a physically separate device from the imaging means but it can also be integrated as part of the actual imaging device.

[0029] The x-ray imaging means of the apparatus enable computed tomography imaging, especially cone-beam computed tomography imaging known to be used in the dental field, the paths of the arm part supporting the x-ray imaging means used in which apparatus are typically arranged to enable rotation of the arm part with respect to a stationary, virtual vertical axis going through the imaging station, which motion is also directly utilisable for producing

image information for creating a three-dimensional facial texture model. This property of the imaging apparatus makes implementation of the facial laser scanning quite simple, as the x-ray imaging apparatus already includes means to implement movements applicable for use in laser scanning. The laser scanning can in many cases significantly facilitate detection of three-dimensional surface shapes of the patient's face as compared to using information acquired solely from colour photography of the face. In a preferable embodiment of the invention, there is then e.g. an arrangement in which said receiver means of x-ray image information (21) comprise a detector, the dimensions of the area receiving image information of which are at least of the order of centimetres, said structure supporting the imaging means (14) being arranged to be rotatable with respect to a vertical, virtual rotation axis going through a stationary imaging station (18) such that the x-ray source (15) and the receiver means of x-ray image information (21) move on opposite sides of the imaging station (18), in which the control system of the apparatus comprises a control routine, which on the one hand controls the rotating motion of the structure supporting said imaging means (14), the x-ray source (15) and the receiver means of x-ray image information (21) to produce image information, of which with said means for processing information (30) detected by the receiver of x-ray image information (21) can be reconstructed a three-dimensional x-ray image, and on the other hand, controls at least said colour camera (22) to shoot colour images of the face of a patient positioned at the imaging station (18) during said rotating motion, and in which the image information processing means (30) functionally pertaining to the apparatus are arranged to create a three-dimensional model presentable on the display (31) of the patient positioned at the imaging station (18), which model shows at least a portion of the skeletal construction and/or teeth of the patient' s cranial area and at least a portion of the texture of the patient's facial area.

REFERENCES CITED IN THE DESCRIPTION

Cited references

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US6081739A [0006]
- JP2006204329A [0006]
- WO2008072398A1 [0006]

Patentkrav

1. Apparat til dental computertomografi, hvilket apparat indbefatter:
- en støttekonstruktion (11, 13) til understøtning af en konstruktion (14), der er anbragt drejeligt, og som understøtter billeddannelsesmidler,
- mindst én billeddannelsesstation (18) til anbringelse af en patient i apparatet med henblik på billeddannelse,
- i hvilket apparatur billeddannelsesmidlerne mindst indbefatter en røntgenkilde (15) og et middel til modtagelse af røntgenbilledinformation (21), som er indrettet i apparatet på en sådan måde i forhold til nævnte billeddannelsesstation (18), at røntgenkilden (15) og midlerne til modtagelse af røntgenbilledinformation (21) kan positioneres på modstående sider af billeddannelsesstationen (18), således at en stråle, der genereres af røntgenkilden (15), kan justeres til at gå gennem nævnte billeddannelsesstation (18) og mod nævnte midler til modtagelse af røntgenbilledinformation (21),
- et styresystem til styring af apparatets operationer, og
- et middel, der er integreret i apparatet eller anbragt i funktionel forbindelse med det til behandling af information, der er detekteret ved modtageren af røntgenbilledinformation (21),
- og hvor konstruktioner, komponenter og styremidler af apparatet i forbindelse med røntgenbilleddannelse er indrettet til at muliggøre dental panoramisk billeddannelse, dental computertomografibilleddannelse og/eller dental keglestrålecomputertomografibilleddannelse,
hvor
apparatet indbefatter et middel til fotografering (22) af en patients ansigt og/eller til frembringelse af et bevægeligt billede af patientens ansigt fra mindst to retninger, mens patienten er positioneret ved nævnte billeddannelsesstation (18), hvilket middel omfatter mindst ét farvekamera (22), hvis placering i forhold til nævnte billeddannelsesstation er anbragt foranderligt, og/eller mindst to farvekameraer, der er arrangeret med henblik på at afbilde patientens ansigt, som er positioneret ved patientunderstøtningsstationen (18), fra forskellige retninger, mindst én laser eller andet belysningsarrangement (24), der er monteret med henblik på at rette et lysmønster mod forskellige steder på ansigtet af den patient, som er positioneret ved billeddannelsesstationen (18), hvor
apparatet indbefatter mindst én belysningskonstruktion (23) til belysning af patientens ansigt, der er positioneret ved billeddannelsesstationen (18), idet nævnte mindst ene belysningskonstruktion (23) er indrettet til at omfatte en konstruktion, der retter lys mod ansigtet af en patient, som er anbragt ved billeddannelsesstа-

tionen (18), i det væsentlige fra et sted ovenover og nedenunder nævnte mindst ene farvekamera (22), hvor nævnte belysningskonstruktion (23) og nævnte mindst ene farvekamera (22) er anbragt i det væsentlige i nærheden af nævnte modtager af røntgenbilledinformation (21), og nævnte belysningskonstruktion (23) og nævnte mindst ene farvekamera (22) er anbragt i forbindelse med nævnte konstruktion (14), der understøtter billeddannelsesmidlerne, et middel, der er anbragt i funktionel forbindelse med nævnte mindst ene farvekamera (22) med henblik på at skabe en virtuel tredimensionel overflademodel af den lysmønsterinformation, der er rettet mod forskellige steder på ansigtet af patienten, som er positioneret ved billeddannelsesstationen (18), og et middel til at kombinere den ansigtsbilledinformation, der detekteres af nævnte mindst ene farvekamera (22), med nævnte overflademodel af patientens ansigt med henblik på at skabe en virtuel tredimensionel teksturmodel af patientens ansigt, hvor der på nævnte konstruktion, der understøtter billeddannelsesmidlerne (14), er anbragt et modtagermodul for billedinformation (20), på hvilket der er anbragt: modtageren af røntgenbilledinformation (21), mindst ét farvekamera (22), midlerne til frembringelse af en laser eller et andet lysmønster (24) og eventuelt midlerne til belysning af ansigtet (23).

2. Apparat ifølge krav 1, hvor:
apparatet indbefatter et middel til at skabe en virtuel model, der omfatter røntgenbilledinformation i det mindste fra en del af knoglerne og/eller tænderne af patientens kranieområde, integreret med nævnte virtuelle tredimensionelle teksturmodel, som er frembragt af patientens ansigt.

3. Apparat ifølge krav 1 eller 2, hvor:
apparatets styresystem omfatter et middel til implementering af røntgenbilleddannelsen og billeddannelsen af patientens ansigt på samme tid og/eller som en kombineret billeddannelse, der finder sted under én billeddannelseshændelse, og/eller apparatets styresystem omfatter et udvælgelsesmiddel til implementering af røntgenstrålebilleddannelsen og billeddannelsen af patientens ansigt enten med mindst én af ovennævnte måder eller til implementering af mindst én af nævnte billeddannelsesmetoder som en separat billeddannelse.

4. Apparat ifølge krav 3, hvor:
nævnte mindst ene lyskonstruktion (23) og/eller mindst ene farvekamera (22) er anbragt på apparatet, således at patientens ansigt kan belyses og afbildes fra forskellige retninger, når patienten er positioneret ved nævnte billeddannelsesstation (18), der er indrettet til røntgenbilleddannelse.

5. Apparat ifølge et hvilket som helst af kravene 1-4,
hvor apparatet indbefatter mindst to farvekameraer (22), og de er indrettet til at blive anbragt vandret i en afstand fra hinanden.

6. Apparat ifølge et hvilket som helst af kravene 1-5,
hvor apparatets kontrolsystem omfatter et middel til styring af nævnte mindst ene belysningskonstruktion (23) med henblik på at frembringe hvidt lys, frembringe pulserende hvidt lys og/eller frembringe lys af forskellige farver.

7. Apparat ifølge et hvilket som helst af kravene 1-6,
hvor apparatet omfatter mindst to farvekameraer (22), i forbindelse med hvilke belysningskonstruktionen (23), er anbragt, der retter lys mod ansigtet af en patient, som er positioneret ved billeddannelsesstationen (18), i det væsentlige fra et sted ovenover og nedenunder mindst to farvekameraer (22), hvilke mindst to farvekameraer (22) og de belysningskonstruktioner (23), der er anbragt i forbindelse med dem, er anbragt vandret i en afstand fra hinanden på de modstående sider af nævnte modtager af røntgenbilledinformation (21).

8. Apparat ifølge et hvilket som helst af kravene 1-7,
hvor nævnte konstruktion (14), der understøtter billeddannelsesmidlerne, er anbragt roterbart i forhold til en lodret virtuel akse, der går gennem patientunderstøtningsstationen, eller en anden virtuel lodret akse.

9. Apparat ifølge et hvilket som helst af kravene 1-8,
hvor nævnte konstruktion (14), der understøtter billeddannelsesmidlerne, er anbragt roterbart i forhold til billeddannelsesstationen (18) i mindst 180 grader, og idet apparatets styresystem skal styre nævnte mindst ene farvekamera (22) til at optage mindst to farvebilleder af patientens ansigt, der er positioneret ved billeddannelsesstationen (18) inden for det pågældende vinkelområde.

10. Apparat ifølge et hvilket som helst af kravene 1-9,
hvor information, der detekteres af nævnte modtager af røntgenbilledinformation (21) og mindst ene farvekamera (22), er indrettet til at blive sendt til samme ene billedregistreringsindretning og/eller via det samme ene Ethernet-kabel fra billeddannelsesindretningen til fysisk adskilte midler til behandling af billedinformation (30).

11. Apparat ifølge et hvilket som helst af kravene 1-10,
hvor nævnte mindst ene laser eller andet belysningsarrangement (24) er indrettet til at kaste et smalt lodret lysmønster på patientens ansigt, der er positioneret ved billeddannelsesstationen (18), hvilken mindst ene laser eller andet belysningsarrangement (24) er anbragt på nævnte konstruktion, der understøtter billeddannelsesmidlerne (14), og idet nævnte konstruktion (14), der understøtter billeddannelsesmidlerne, og nævnte billeddannelsesstation (18) er anbragt bevægeligt i forhold til hinanden, således at nævnte lysmønster kan rettes i det væsentlige omfattende mod forskellige steder inden for patientens ansigtsareal, og/eller at nævnte belysningsarrangement (24) indbefatter to lasere eller tilsvarende lyskilder, der frembringer et lysmønster arrangeret i det væsentlige på samme lodrette virtuelle akse, og som er anbragt på apparatet i forhold til billeddannelsesstationen (18), således at den øverste af dem belyser patientens ansigt i det mindste en smule skråt ovenfra og den nederste i det mindste lidt skråt nedefra.

12. Apparat ifølge et hvilket som helst af kravene 1-11,
hvor nævnte konstruktion (14), der understøtter billeddannelsesmidlerne, er anbragt roterbart i forhold til billeddannelsesstationen (18), idet nævnte lysmønster skal bevæge sig i henhold til bevægelsen af nævnte konstruktion (14), der understøtter billeddannelsesmidlerne, og idet apparatets styresystem skal optage fra ti til flere hundrede billeder af lysmønsteret med nævnte mindst ene farvekamera (22) fra forskellige retninger inden for bevægelsesområdet for nævnte konstruktion (14), der understøtter billeddannelsesmidlerne.

13. Apparat ifølge krav 12, hvor:
- set i vandret retning er der på modtagermodulet for billedinformation (20), i det væsentlige midt på det, anbragt modtageren af røntgenbilledinformation (21) og nævnte to lasere eller andet belysningsarrangement (24), og i det væsentlige i modstående ender af modulet (20) er der anbragt på den ene side det første og det andet farvekamera (22), på den anden side den første og den anden belysningskonstruktion (23) til belysning af ansigtet, og
- set i lodret retning er nævnte lasere eller andet belysningsarrangement (24) anbragt på nævnte modtagermodul for billedinformation (20) i det væsentlige ved dets kanter, og nævnte belysningskonstruktioner (23) skal rette lys mod billeddannelsesstationen (18) fra et sted ovenover og nedenunder nævnte farvekameraer (22).

14. Apparat ifølge et hvilket som helst af kravene 1-13,
hvor apparatets styresystem omfatter en styrerutine, som omfatter følgende trin:
- konstruktionen (14), der understøtter billeddannelsesmidlerne, roterer i forhold til billeddannelsesstationen (18), under hvilken rotation
- belysningskonstruktionen (23) til belysning af patientens ansigt styres med henblik på at belyse patientens ansigt, der er positioneret ved billeddannelsesstationen (18), i korte impulser, fortrinsvis mindst ved en frekvens på 50 Hz,
- den mindst ene laser eller andet belysningsarrangement (24) styres med henblik på at frembringe et lysmønster på patientens ansigt ellers kontinuerligt, men således, at der under rotationen af konstruktionen (14), der understøtter billeddannelsesmidlerne, er øjeblikke, hvor lysmønsteret ikke frembringes, og
- farvekameraet eller -kameraerne (22) styres med henblik på at optage billeder i løbet af første trin, hvor lysmønsteret er rettet mod ansigtet, og hvor belysningskonstruktionen (23) til belysning af patientens ansigt ikke belyser ansigtet, og på den anden side under anden trin, hvor der ikke er rettet noget lysmønster mod ansigtet, og hvor belysningskonstruktionen (23) til belysning af patientens ansigt belyser ansigtet.

15. Apparat ifølge krav 14, hvor:
nævnte konstruktion (14), der understøtter billeddannelsesmidlerne, er indrettet til at rotere i forhold til billeddannelsesstationen (18) i mindst 180 grader, og idet der ifølge nævnte styrerutine er korte perioder under rotationen, såsom færre end 10 perioder, i løbet af hvilke intet lysmønster er rettet mod patientens ansigt, og i løbet af hvilke farvekameraet eller -kameraerne (22) styres med henblik på at optage billeder i faser, hvor midlerne til belysning af patientens ansigt frembringer en lysimpuls.

16. Apparat ifølge et hvilket som helst af kravene 1-15,
hvor nævnte modtagermidler for røntgenbilledinformation (21) omfatter en detektor, hvis dimensioner af det areal, der modtager billedinformation, mindst er af størrelsesordenen centimeter, idet nævnte konstruktion (14), der understøtter billeddannelsesmidlerne, er indrettet til at være roterbar i forhold til en lodret, virtuel rotationsakse, der går gennem den stationære billeddannelsesstation (18), således at røntgenkilden (15) og modtagermidlerne for røntgenbilledinformation (21) bevæger sig på modstående sider af billeddannelsesstationen (18), hvor apparatets styresystem omfatter styrerutinen, som på den ene side styrer rotationsbevægelsen for konstruktionen (14), der understøtter nævnte billeddannelsesmidler, røntgenkilden (15) og modtagermidlerne for røntgenbilledinformation (21) med henblik

på at frembringe billedinformation, ud fra hvilken nævnte midler til behandling af information (30), der er detekteret af modtageren af røntgenbilledinformation (21), kan rekonstruere et tredimensionelt røntgenbillede, og på den anden side styrer i det mindste nævnte farvekamera (22) med henblik på at optage farvebilleder af patientens ansigt, der er positioneret ved billeddannelsesstationen (18) under nævnte rotationsbevægelse, og idet billedinformationsbehandlingsmidlerne (30), der funktionelt vedrører apparatet, er indrettet til at skabe en tredimensionel model af patienten, som er positioneret ved billeddannelsesstationen (18), hvilken model kan præsenteres på en skærm (31) og viser i det mindste en del af knoglerne og/eller tænderne i patientens kranieområde og i det mindste en del af teksturen af patientens ansigtsareal.

17. Apparat ifølge et hvilket som helst af kravene 1-16,
hvor nævnte mindst ene laser eller andet belysningsarrangement (24), der skal rette et lysmønster mod et ansigt af en patient, indbefatter et middel til at frembringe en grøn laser eller anden lysvifte og rette den mod patientens ansigt, der er positioneret ved billeddannelsesstationen, med henblik på at skabe en i det væsentlige lodret smal lyslinje på ansigtet, og/eller to lasere (24), hvoraf den første er indrettet til at frembringe laserlys af en første farve, og den anden af en anden farve.

18. Apparat ifølge et hvilket som helst af kravene 1-17,
hvor nævnte mindst ene lyskonstruktion (23) indbefatter mindst to lyskilder til belysning af patientens ansigt, og foran hvilke er anbragt en diffusionsfolie og/eller en polarisator.

19. Apparat ifølge et hvilket som helst af kravene 1-18,
hvor apparatet indbefatter et middel til realisering af billeddannelsen, således at computertomografibilleddannelsen realiseres ved en drejningsvinkel på ca. 200 grader og fotograferingen ved en drejningsvinkel på ca. 260 grader, eller et middel til realisering af billeddannelsen ved først at indsamle røntgenbilledeinformation under en manøvrere over en vinkel på ca. 200 grader i en første retning, ved at fortsætte bevægelsen i denne første retning til en startposition for fotografering, og ved at realisere fotograferingen under en manøvre på 260 grader i den modsatte retning med en vinkelhastighed, der er højere end vinkelhastigheden for den første manøvre.

DRAWINGS

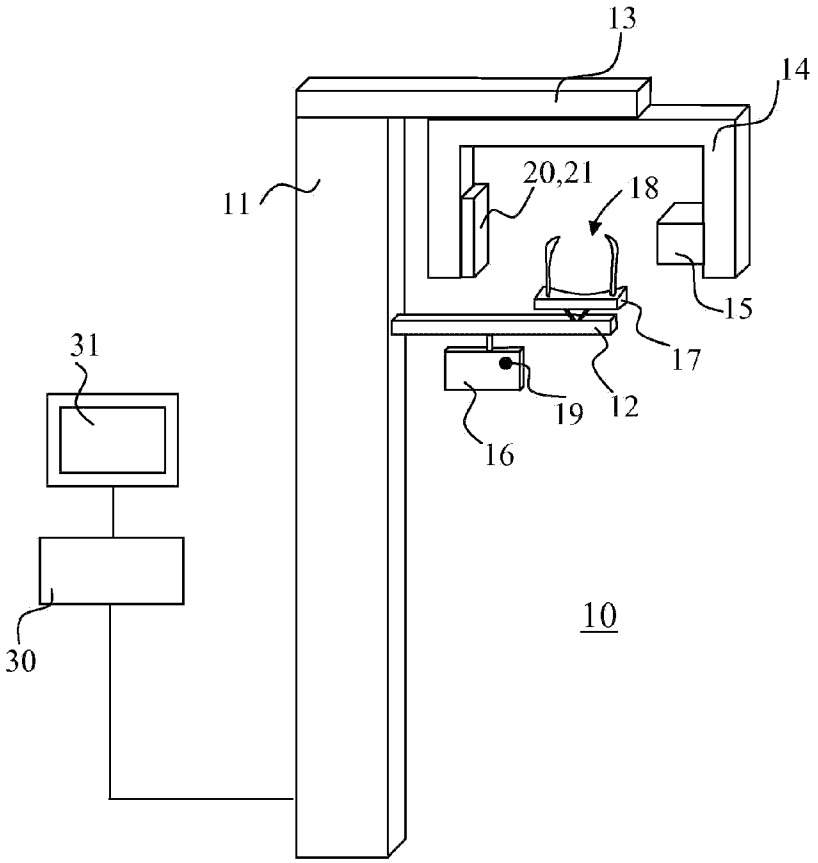

Fig. 1

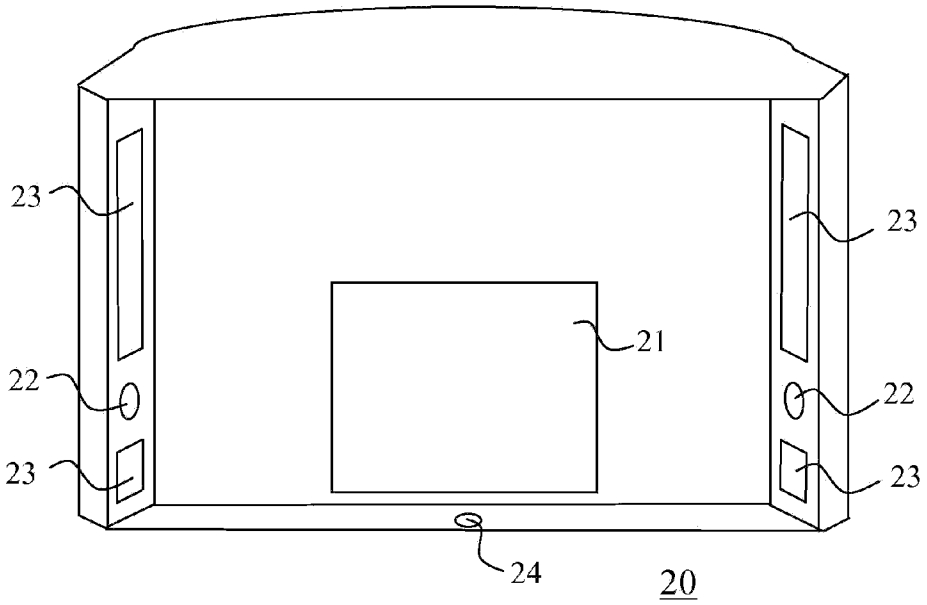

Fig. 2

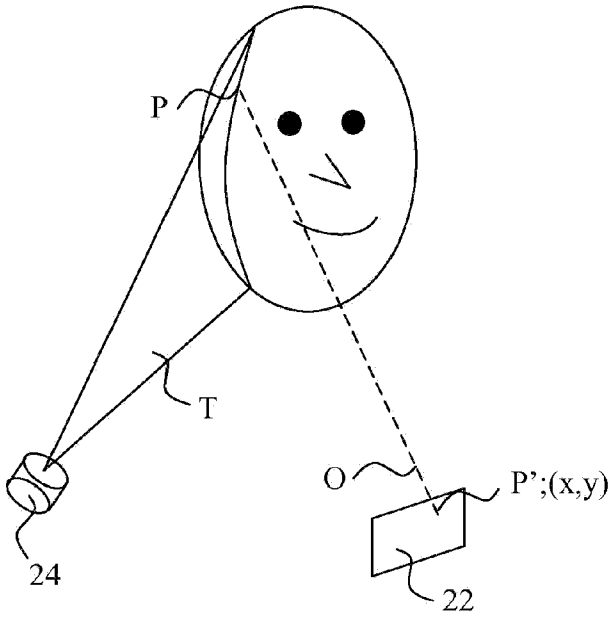

FIG. 4

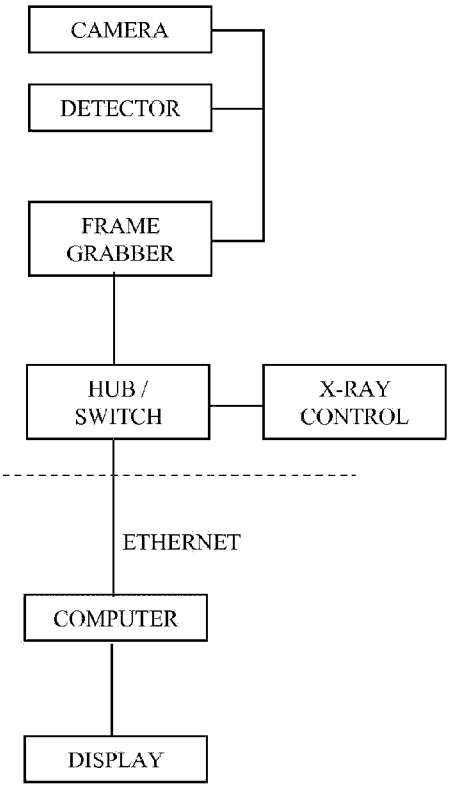
CAMERA
DETECTOR
FRAME GRABBER
HUB / SWITCH
X-RAY CONTROL
ETHERNET
COMPUTER
DISPLAY

Fig. 5a

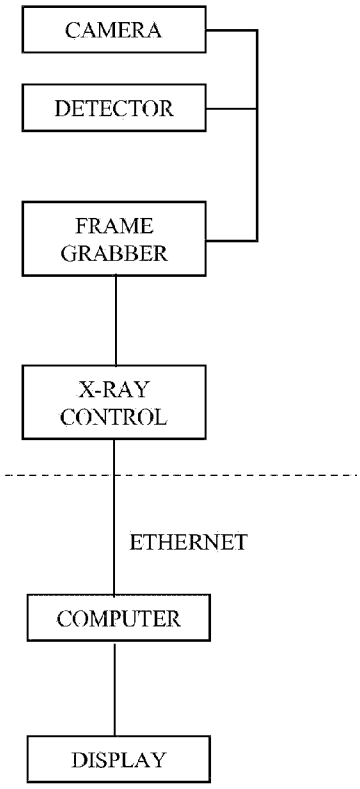
CAMERA
DETECTOR
FRAME GRABBER
X-RAY CONTROL
ETHERNET
COMPUTER
DISPLAY

Fig. 5b

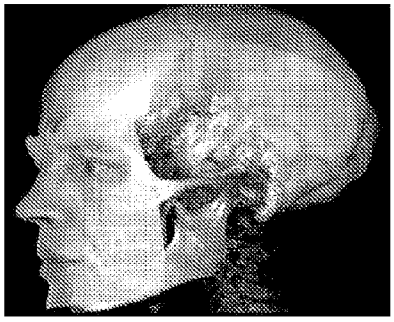

Fig. 6a

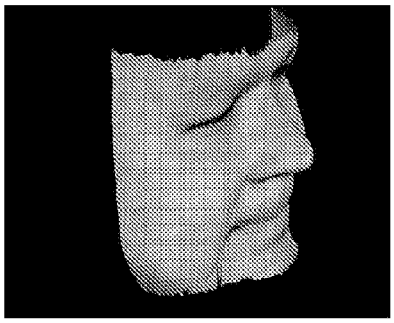

Fig. 6b

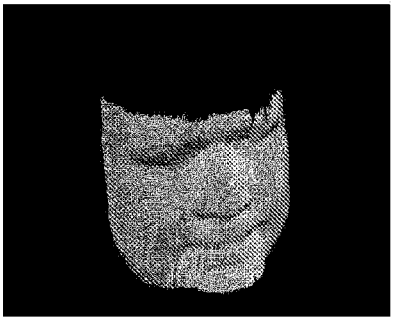

Fig. 6c

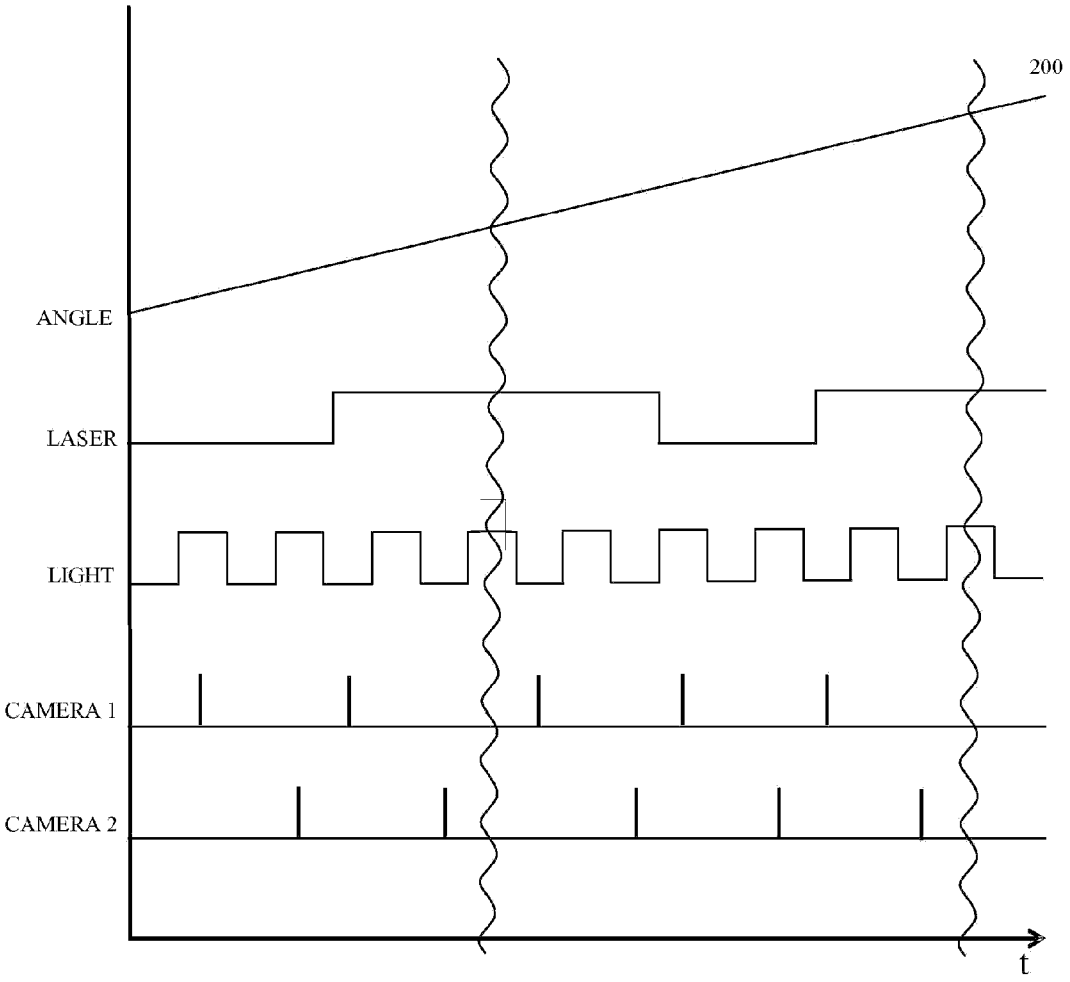

Fig. 7