PORM 2

THE PATENT ACT 1970

(39 of 1970)

The Patents Rules, 2003

PROVISIONAL/COUPLETE SPECIFICATION

(See section 10 and njt•13)

*1. TITLE **OF THE INVENTION A system for aligning bone fracture based on radiation imaging and method thereof**

2. APPLICANT (S)

(a) NAME: Adimatics Healthcare Private Limited

(b) NATIONALITY: India

(a) ADDRESS: #16, SLV Layout Roopena Agrahara, Bengaluru, Karnataka, India,560 068

3. PREAMBLE TO THE DESCRIPTION (Complete specification)

PROVISIO5IAL	COMPLETE
The following specification describes the invention.	**The following specification particuiañy describes the invention and the manner in which it is to be performed.**

4. DESCRIPTION (Description shall start from next page.)

Please refer to annexure 1

5. CLAIMS (not applicable for provisional specification. Claims should start with the preamble — "I/we claIM" on separate page)

Please refer to annexure 1

6. DATE AND SIQNATU RE (to be given at the end of last page of specification) 17.12.2020

7. ABSTRACT OF TNE INVENTION (lobe given along with complete specification on separate page)

Please refer to annexure 1

*Repeat boxes In case of more than one entry.

***To be signed by the applicant(s) or by authorized registered** patent agent.

'Name **of the applicant should** be given In full , family name In the beginning .

'Con.plete **address of the applicant should** be given stating the postal Index no./code, ctate and **country.**

'Strike out the column which Is/are not **applicable**

F O R M 2

THE PATENTS ACT, 1970

(39 of 1970)

The patent Rule, 2003

COMPLETE SPECIFICATION

(See section 10 and rule 13)

TITLE OF THE INVENTION

A system for aligning bone fracture based on radiation imaging and method thereof

NAME AND ADDRESS OF THE APPLICANT:

(a) Name: Adimatics Healthcare Private Limited.

(b) Nationality: Indian

(c) Address: 16, SLV Layout, Roopena Agrahara, Bengaluru 560068, Karnataka, India.

PREAMBLE TO THE DESCRIPTION:

[0001] The following specification particularly describes the invention and the manner in which it is to be performed:

DESCRIPTION OF THE INVENTION

TECHNICAL FIELD OF THE INVENTION

[0002] The present invention is related to a system and method for providing assistance in aligning bone fractures. The system has the potential to detect possible misalignment while fixing the fractured bones and provide suggestions for best alignment. One of fundamental steps of the invention is to detect the misalignment even if it is minute using radiation based medical imaging such as X-rays and CT scans and provide suggestions using mathematical parameters to align in the best possible manner.

BACKGROUND OF THE INVENTION

[0003] According to one of the bone health organization, 1 in 3 women and 1 in 5 men over the age of 50 will experience an osteoporotic fracture. Worldwide bone fracture due to osteoporosis happens every three seconds. In Europe, India, Japan and the USA alone, there are an estimated 125 million people with osteoporosis. A study predicts that the total cost of care associated with osteoporotic fractures will be $95 billion in 2040. Nearly 20% of Medicare beneficiaries died within a year of suffering an additional fracture as per Health leader media.

[0004] A fracture is a broken or discontinued bone. A bone may be completely fractured or partially fractured in any number of ways including crosswise, lengthwise and in multiple pieces. The severity of a fracture usually depends on the force that caused the break or discontinuation. If the bone's breaking point has been exceeded only slightly, then the bone may crack rather than break all the way. As per Stanford Healthcare, a list of the common types of fracture includes Greenstick, an Incomplete fracture where the broken bone is not completely separated,

transverse where the break is in a straight line across the bone, Spiral where the break spirals around the bone; common in a twisting injury, Oblique where diagonally it breaks across the bone, Compression where the bone is crushed, causing the broken bone to be wider or flatter in appearance, Comminuted where the break is in three or more pieces and fragments are present at the fracture site, Stable fracture where an injury causes the bone to break clean, with its parts in alignment, Compound or open fracture where the bone pierces the skin when it breaks, a hairline fracture where it results of repetitive movement an avulsion fracture where it breaks at the site and the bone attaches to a tendon or ligament, Pathological fractures where a patient has an illness that has weakened their bones, and Segmental where the same bone is fractured in two places, so there is a "floating" segment of bone.

[0005] Displacement of fractures is defined in terms of the abnormal position of the distal fracture fragment in relation to the proximal bone. Types of fracture displacement include - angulation, rotation, change of bone length, and loss of alignment.

[0006] According to the invention described in DE000010057023 titled method and appliance for identifying correct alignment of fractured bones by superimposition of templates on images of those bones, with the aid of an X-ray source and a radiation detector, a series of 2-D projections taken from different directions are recorded from which a computer generates a 3-D volume data set of the fracture. In the computer are stored templates which can be superimposed on a screen image generated from the data to indicate e.g., the healthy position of a bone fracture. Though the patent appears to be close, it finds only whether the alignment is correct or not and does not provide any suggestion for correction. Additionally, there is no need for 3D model always for detecting and correcting misalignments as specified in our invention.

[0007] According to one other invention described in US20170281392 titled shirt for correcting bone alignment, the present invention is to provide a shirt for correcting bone alignment that has a capability to correct the alignment of the sternum and the ribs and reduce burden on user's body. The shirt for correcting bone

alignment includes a shirt that is formed from a stretch fabric; a first restraint that is formed on the right or the left side in the upper-half of the front body of the shirt, the first restraint being less stretch than the fabric of the shirt; and a second restraint that is formed on the different side from the first restraint in the upper-half of the back body of the shirt, the second restraint part being less stretch than the fabric of the shirt. Although the title of the patent matches with our invention, the core concept is very different. There is no need of an external item such as the short explained in the patent. Our invention provides suggestion for best possible alignment while fixing itself.

[0008] According to a recent invention described in US2020205844 (A1) titled Fetal pattern fuzzification processing platform, devices and techniques for performing an osteotomy procedure on a first metatarsal to correct a bone misalignment is described. The devices and techniques for adjusting an alignment for a first metatarsal may include making a plurality of cuts along the length of the first metatarsal. In different applications of the technique, a plurality of transverse cuts may or may not be made intersecting the longitudinal cuts. In either case, the cuts can separate the first metatarsal into two individual portions and release a removable wedge of bone. The different portions of the metatarsal can be moved relative to each other to adjust an anatomical alignment of one portion relative to another portion, for example in multiple planes. After suitably adjusting the alignment of the different bone portions, the portions can be fixed together. The patent is specific to only one type of bone structure and cannot be extended to other bones like in our invention which is general in nature which can be applied to most of the bone fractures.

[0009] According to another invention described in RU2015142885 (A) titled method of intramedullary fixation of bone and guide tool for precision alignment of axes of symmetry of instrument guides with axes of symmetry of intramedullary rod holes, group of inventions relates to traumatology and orthopaedics can be used for intramedullary fixation of bone with bone-marrow canal. Guide tool for precision alignment of axes of symmetry of holes of instrument guides with axes of symmetry of intramedullary nail holes in intramedullary fixation

of bone with bone-marrow canal includes shoulder for implantation of rod into a longitudinal bone canal, releasably connected to the proximal end of the shaft such that it is continuously directed relative to the distal portion of the intramedullary nail; mounted on arm of guiding tool guides having cylindrical shape and installed in many planes; guide device also includes a threaded end having a support surface and a mounting probe connecting the position of the cylindrical guides relative to the holes in the distal portion of the rod; a bushing installed with the possibility of blocking onto the setting connection probe. Mounting connecting probe, placed in hole of one of cylindrical guides guide tool, is screwed into appropriate hole of rod to support surface of probe. Sleeve installed at appropriate height relative to guide tool is blocked. Probe is removed from guide tool. After the rod is inserted into the medullary canal, a hole is made in the bone, which coincides with the corresponding opening in the distal portion of the intramedullary nail. Probe is placed in appropriate holes of guides and through hole made in bone is screwed to support surface into corresponding hole of rod, locking guiding tool at certain height, and performing the remaining holes in the bone for locking screws passing through the corresponding holes in the rod. The patent uses guides essentially which are not required in our inventions. Additionally, no radiation basedmedical imaging such as X-rays and/or CT scans are used for correcting misalignment.

[0010] According to an expired invention described in US 5,249,581 titled Precision bone alignment, an apparatus and method for precision bone alignment includes a plurality of markers secured to bone portions prior to an orthopaedic/surgical procedure. Light emitting LED's are provided on said markers and are sensed by an optical three-dimensional sensor which provides respective positional electric signals to a computer, the computer in turn being connected to a monitor to provide a three-dimensional display. The signals prior to the orthopaedic/surgical procedure are stored in the computer. The sensor also provides signals following the orthopaedic/surgical procedure for comparison with the signals before the procedure to insure proper alignment. In this patent

external sensors to provide positional electric signals are used which are absolutely not required in our invention which uses no radiation basedmedical imaging such as X-rays and/or CT scans for correcting misalignment.

[0011] According to another invention described in US6,582,435 titled Bone alignment and fixation device and installation method, using guide tab, a clip to inter-connect primary and secondary bone zones having edges, comprising in combination a first tab to extend over a surface of the secondary bone zone, above a level defined by that surface; a first projection carried by the tab and configured to penetrate the primary bone zone at the edge thereof, and below the first level; and an auxiliary tab associated with the first tab positioned to extend over a top surface of the primary bone zone to guide movement of the clip as the first projection penetrates the primary bone zone. The patent uses another item such as clip which is not required in our invention. Additionally, no radiation basedmedical imaging such as X-rays and/or CT scans are used for correcting misalignment.

[0012] Accordingly, there is a need for a system and method for providing assistance in aligning bone fractures using radiation based medical imaging such as X-rays and CT scans for correcting misalignments, additionally with artificial neural networks, machine learning and deep learning.

SUMMARY OF THE INVENTION:

[0013] It is an object of the invention to detect possible misalignment while fixing the fractured bones and provide suggestions for best alignment.

[0014] One of the methods of the invention is to detect the misalignment even if it is minute using radiation based medical imaging such as X-rays and CT scans and provide suggestions using mathematical parameters to align in the best possible alignment.

[0015] In an embodiment of the invention, the following subsystem such as at least one image analysis subsystem, at least one image registration subsystem and at least one body part alignment subsystem are used.

[0016] In one of the embodiments of the invention, detection of misalignment automatically uses artificial intelligence methods including artificial neural networks, machine learning and deep learning.

[0017] In another embodiment of the invention, the suggestions for corrections are provided on a display unit such a screen, console or a computer monitor.

[0018] In yet another embodiments of the invention, the object of the invention is to correct the misalignment even after the previous correction is made.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0019] As the figures are only for the illustrating purpose and not to be construed as limiting cases of the invention or implementation of the invention. It should be remembered that for appropriate variants of the embodiments corresponding to different independent claims figures have been provided accordingly.

[0020] Fig.1 describes an overview of one of the embodiments of system of the invention with the three subsystems.

[0021] Fig.2 explains one of the embodiments of system of the invention further explaining image analysis subsystem in detail.

[0022] Fig.3 narrates another embodiment of the system of the invention further explaining image registration subsystem in detail.

[0023] Fig.4 portraits one other embodiments of the system of the invention further explaining body part alignment subsystem in detail.

[0024] Fig.5. corresponds to the method adapted to the embodiment in Fig.1.

[0025] Fig.6. corresponds to the method adapted to the embodiment in Fig.2.

[0026] Fig.7 corresponds to the method adapted to the embodiment in Fig.3.

[0027] Fig.8 corresponds to the method adapted to the embodiment in Fig.4.

[0028] Fig.9 narrates another method used to detect the misalignment at the time of review or follow-up.

[0029] Fig.10 portrays the parameters used to detect and correct misalignment of the body part, mostly the bone fractures.

DETAILED DESCRIPTION OF THE INVENTION:

[0030] Fig.1 describes an overview of one of the embodiments of the system (100) for body part alignment using an imaging system (110) especially correcting the bone fracture misalignment using X-ray and/or radiation based medical imaging devices. The system (100) comprises three subsystems namely image analysis subsystem (120), image registration subsystem (130) and body part alignment subsystem (140).

[0031] Fig. 2 explains the embodiment of the image analysis subsystem (120) as a part of the system (100) for body part alignment using an imaging system (110) as described in Fig.1. The image analysis subsystem (120) comprises at least one processing means (200) to process at least one or more images (115) from the imaging system (110) to detect the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) automatically, at least one first electronic storage means (300) to store the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180), and at least one first communication means (400) optionally to communicate the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) to relevant healthcare authorities including inter and intra hospitals.

[0032] Fig. 3 describes the embodiment of the image registration subsystem (130) as a part of the system (100) for body part alignment using an imaging system (110) as described in Fig.1. The image registration subsystem (130) comprises at least

one second electronic storage means (310) to store the standard details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics, operably coupled with processing means (200) and at least one second communication means (410) to communicate at least the details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics, operably coupled with processing means (200) which receives the communication.

[0033] Fig. 4 deals with the embodiment of the body part alignment subsystem (140) as a part of the system (100) for body part alignment using an imaging system (110) as described in Fig.1. The body part alignment subsystem (140) comprises at least one display means (500) including screen, console and computer monitor to indicate the alignment changes to be made to minimize or eliminate the misalignment.

[0034] Fig.5 corresponds to the method (1000) adapted to the embodiment in Fig.1 which deals with the processes involved in three subsystems namely image analysis subsystem (120), image registration subsystem (130) and body part alignment subsystem (140) of the system (100) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180). The steps include processing (1100) one or more images (115) from the imaging system (110) to detect the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) automatically, registering (1200) the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics, and indicating (1300) the possible correction to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180). It is clarified that the registration should not be misconstrued as patient registration in hospital management system. But registration here in the invention explains the standard method of registering objects or parts as defined in computer vision domain. The

registration of images is defined as an image processing technique used to align multiple scenarios (at least two) into a single integrated image.

[0035] Fig.6. corresponds to the method (1000) adapted to the embodiment in Fig.2 to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) which deals with the processing (1100) one or more images (115) from the imaging system (110) to detect the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) automatically of the system (100). The steps involved in processing (1100) one or more images (115) from the imaging system (110) detecting (1110) the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) from one or more images (115) from the imaging system (110) using computer vision algorithms optionally with artificial neural networks, machine learning and/or deep learning algorithms, deriving (1120) the image parameters (1121), anatomical parameters (1122), functional parameters (1123), mathematical parameters (1124) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) using computer vision algorithms optionally with artificial neural networks, machine learning and deep learning algorithms, storing (1130) the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) from one or more images (115) from the imaging system (110) and the image parameters (1121), anatomical parameters (1122), functional parameters (1123), mathematical parameters (1124) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) in the first electronic storage means (300), and Communicating (1140) the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) from one or more images (115) from the imaging system (110) and the image parameters (1121), anatomical parameters (1122), functional parameters (1123), mathematical parameters (1124) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) optionally.

[0036] Fig.7. corresponds to the method adapted to the embodiment in Fig.3 to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) which deals with the registering (1200) the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics. The steps involved includes combining (1210) the results of at least one standard image registration algorithm or volume registration algorithm to optimally register the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics and displaying (1220) the registration of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics on the display means (500) with selectable choice of 2D, 3D and 4D representations. It is emphasized that the registration is not restricted only to 2D images or 3D volumes, it is presumed it refers to any n D (n dimensional) including 4D, 5D, 6D and 7D.

[0037] Fig.8. corresponds to the method adapted to the embodiment in Fig.4 to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) which deals with indicating (1300) the possible correction to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180). The steps involved includes processing (1310) at least one or more images (115) from the imaging system (110) using at least one processing means (200) to detect the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) till perfect alignment is achieved, registering (1320) the images (115) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy with 2D, 3D and 4D representations, and indicating (1330) the direction (1331), amount (1332), position (1333), orientation (1334) on the display means

(500) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the indication of perfect alignment (1335).

[0038] Fig. 9 narrates another method (2000) used to detect the misalignment at the time of review to minimize or eliminate the misalignment after fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180). It includes two steps namely, comparing (2100) at least two images (116) from the imaging system (110) to detect the extent of misalignment (117) automatically and indicating (2200) the possible correction to minimize or eliminate the misalignment after fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180). The two images (116) consist of at least one image taken at the end of fixing discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) and the another image taken after fixing discontinuity (160) of the body part including bone or cartilage (170) of the organism (180).

[0039] Fig.10 portrays the parameters used to detect and correct misalignment of the body part, mostly the bone fractures which includes the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) includes but not limited to shape (191), size (192), orientation(193), anatomical properties (194) of the body part including bone or cartilage (170) of the organism (180) and discontinuity related properties (195). The parameters also include mathematical parameters (196) such as parallelism of surface normal (197), coplanarity of surface tangents(198). collinearity of points from either side of the fractured bone (199), minimal distance constraint metrics, gap between bones at fracture site and such other parameters which provides indication of optimal alignment.

[0040] For the sake of better understanding of the invention, two example scenarios have been mentioned. It should not be construed that the claimed invention of the patent application works only in these scenarios or restricted to the scenarios mentioned in the examples.

Example 1:

[0041] In the first sample of body part alignment system (100) based on an imaging system (110) such as X-ray or CT scan comprising an image analysis subsystem (120), an image registration subsystem (130) and a body part alignment subsystem (140) is explained in detail which minimizes or eliminates the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180). First by processing (1100) one or more images (115) from the imaging system (110) for detecting (1110) the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) from one or more images (115) from the imaging system (110) using computer vision algorithms optionally with artificial neural networks, machine learning and deep learning algorithms with the processing means (200), it is aimed to get the extent of alignment or misalignment. Subsequently, by deriving (1120) the image parameters (1121), anatomical parameters (1122), functional parameters (1123), mathematical parameters (1124) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180), the extent of alignment or misalignment is estimated. Finally, by storing (1130) the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) from one or more images (115) from the imaging system (110) and the image parameters (1121), anatomical parameters (1122), functional parameters (1123), mathematical parameters (1124) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) in the first electronic storage means (300), it can used for comparison while visiting next time for review or follow-up. The registering (1200) of the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics is carried out next. Subsequently, by combining (1210) the results of at least one standard image registration algorithm or volume registration algorithm to optimally register the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the details (195) of the body part including bone or cartilage

(170) of the organism (180) as per the anatomy including specifics, corrections required for the best possible alignment can be found. Finally, by displaying (1220) the registration of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics on the display means (500) with selectable choice of 2D, 3D and 4D representations, the medical practitioner gets the suggestions to modify the course of action in such a way that the misalignment can be minimized or eliminated.

Example 2.

[0042] In this example a different scenario of case at the time review or follow-up is considered. The method (2000) to minimize or eliminate the misalignment after fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) is used here. Firstly, by comparing (2100) at least two images (116) from the imaging system (110), the extent of misalignment (117) automatically is detected. Then, by indicating (2200) the possible correction to minimize or eliminate the misalignment after fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) by the medical practitioner is made. The two images (116) consist of at least one image taken at the end of fixing discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) and the another image taken after fixing discontinuity (160) of the body part including bone or cartilage (170) of the organism (180). By comparing them, the extent of alignment or misalignment can also be estimated. It may be recalled for detecting and estimating the alignment or misalignment, artificial intelligence method (600) such as machine learning (610), deep learning (620), artificial neural networks (630) or any combination of them (640) can be used effectively.

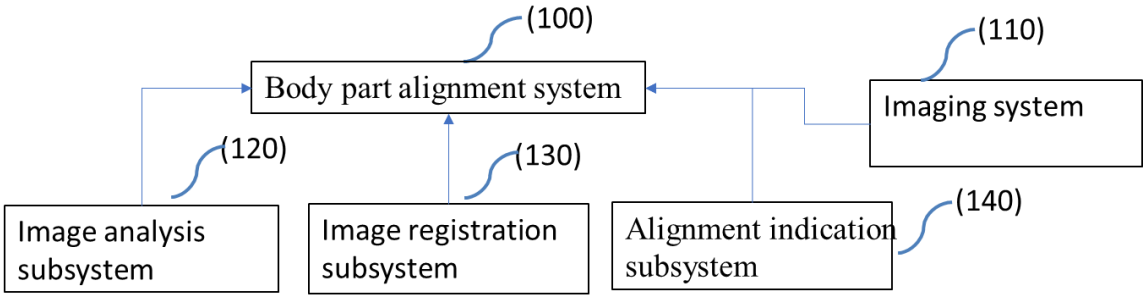

Fig 1. Three subsystems of the invention.

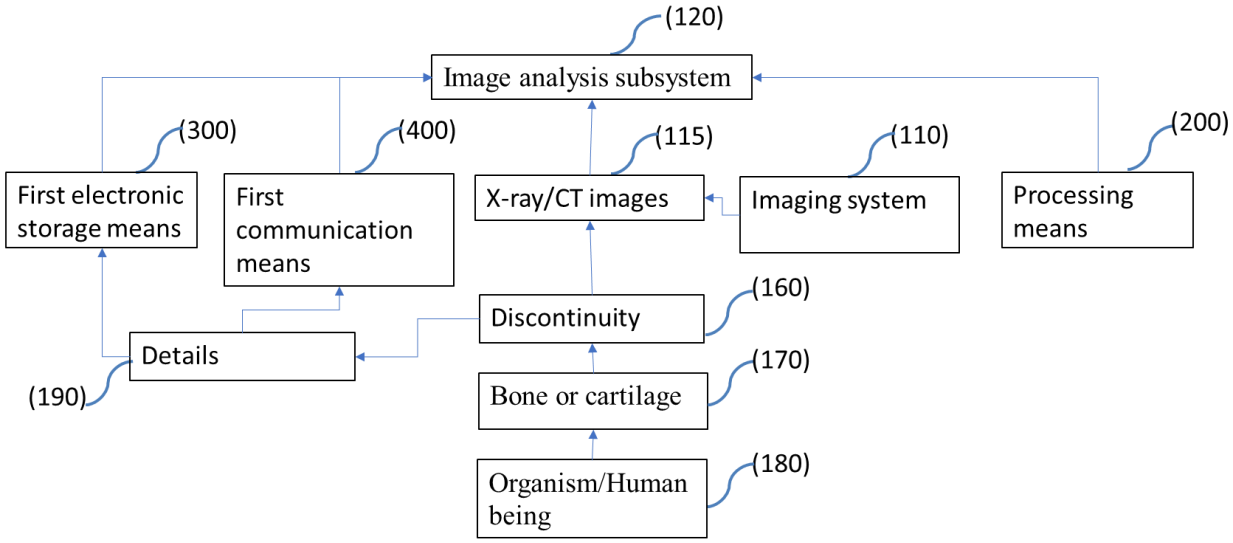

Fig 2. An overview of Image analysis subsystem of our invention.

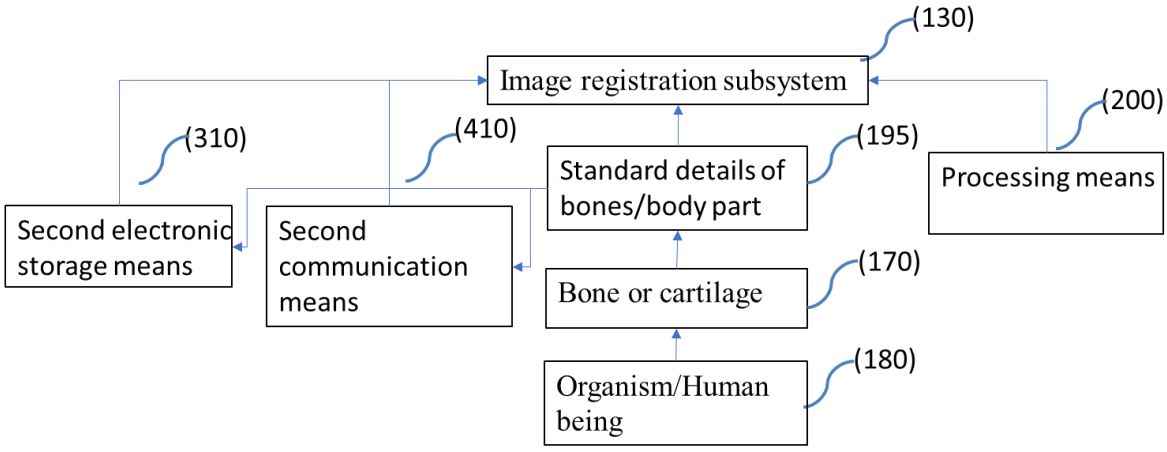

Fig. 3. An overview of image registration subsystem

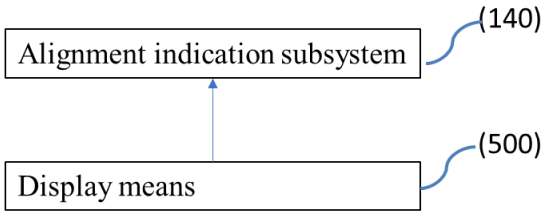

Fig. 4. An overview of display system

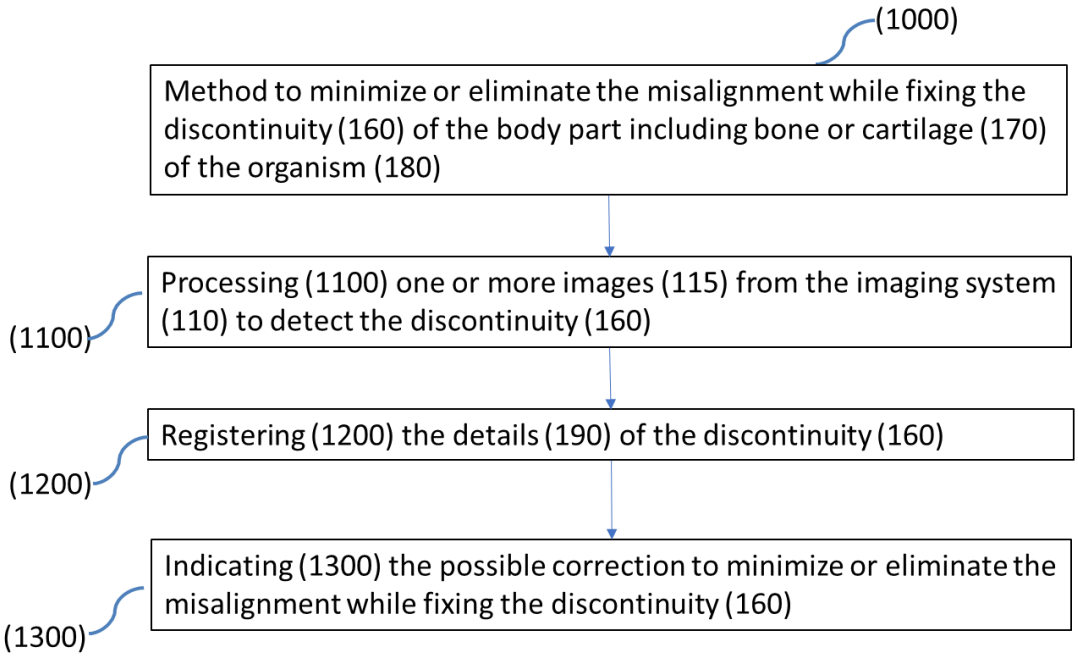

Fig. 5. The key steps of one of the embodiments of the method for the invention.

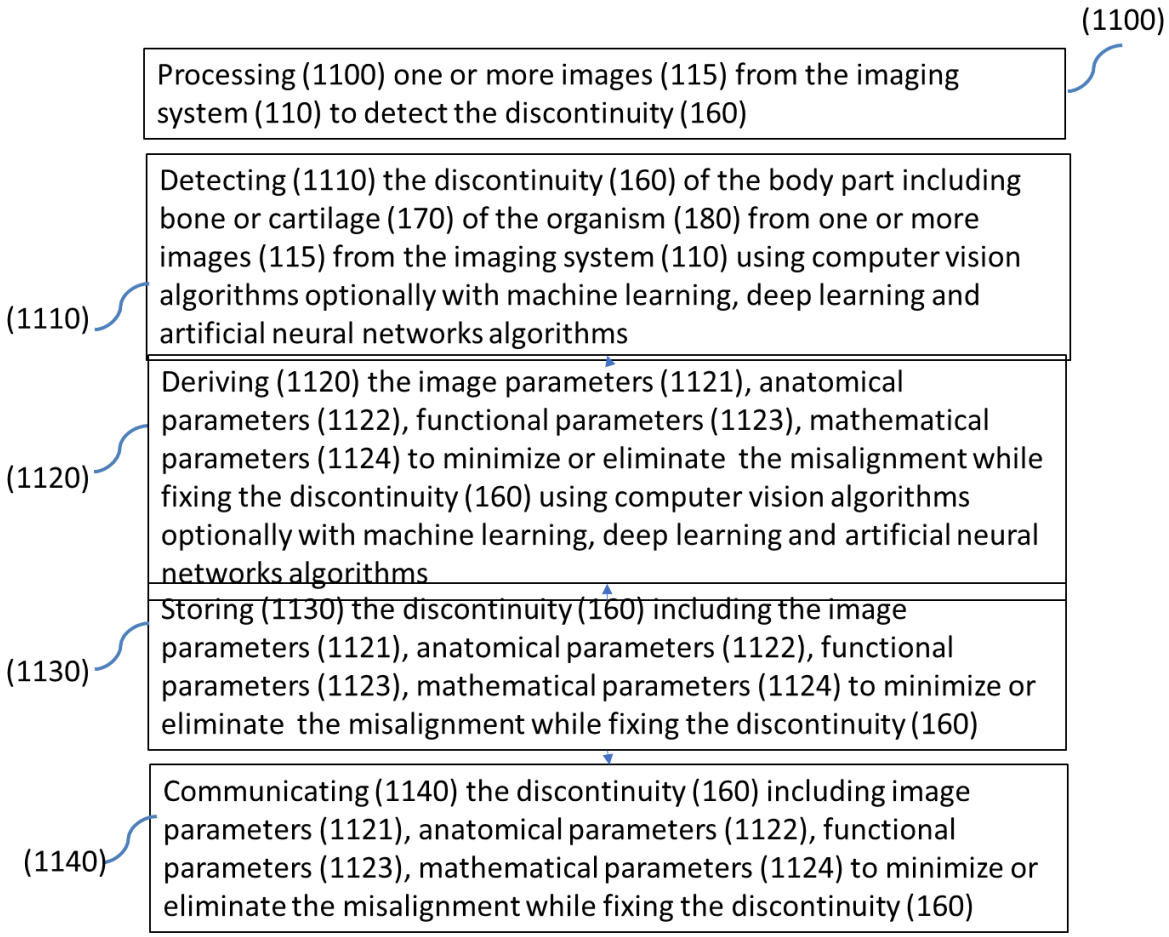

Fig. 6. The key steps involved in processing images from the imaging system to detect the discontinuity

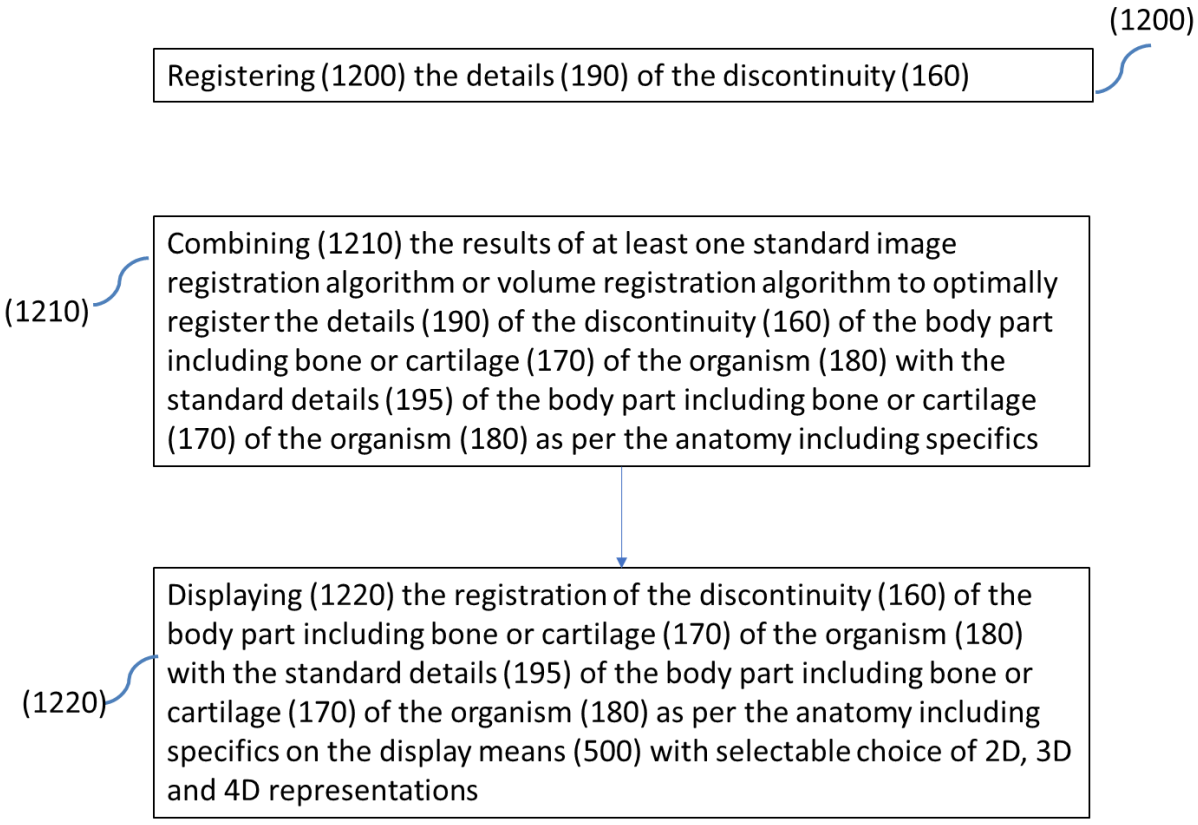

Fig.7. The key steps involved in registering the details of the discontinuity

5

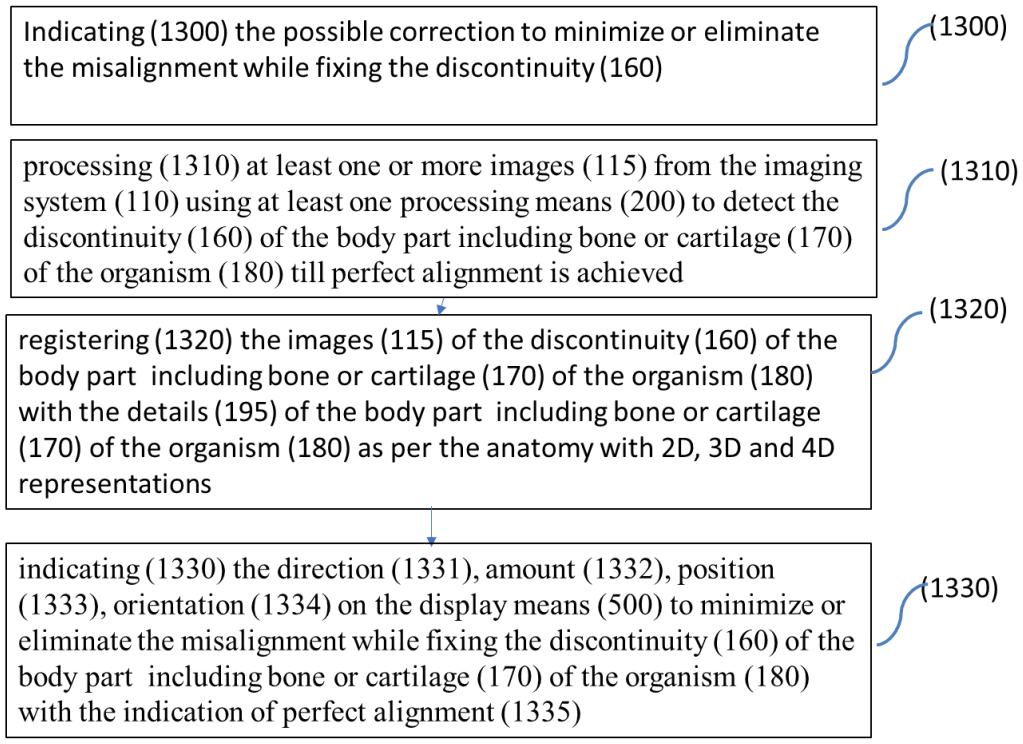

Fig. 8. The key steps involved in indicating the possible correction to minimize or eliminate the misalignment while fixing the discontinuity

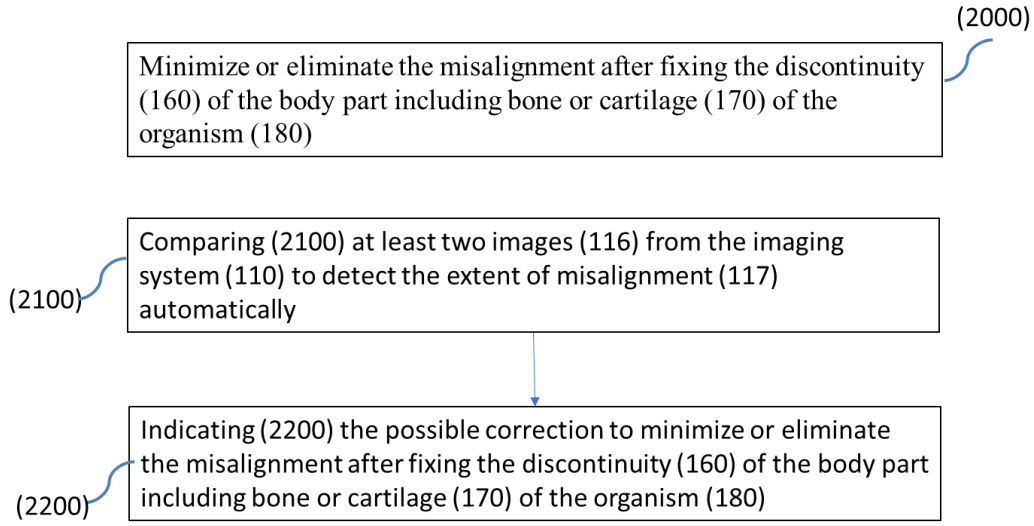

Fig. 9. The key steps involved correction to minimize or eliminate the misalignment after fixing the discontinuity at the time of review

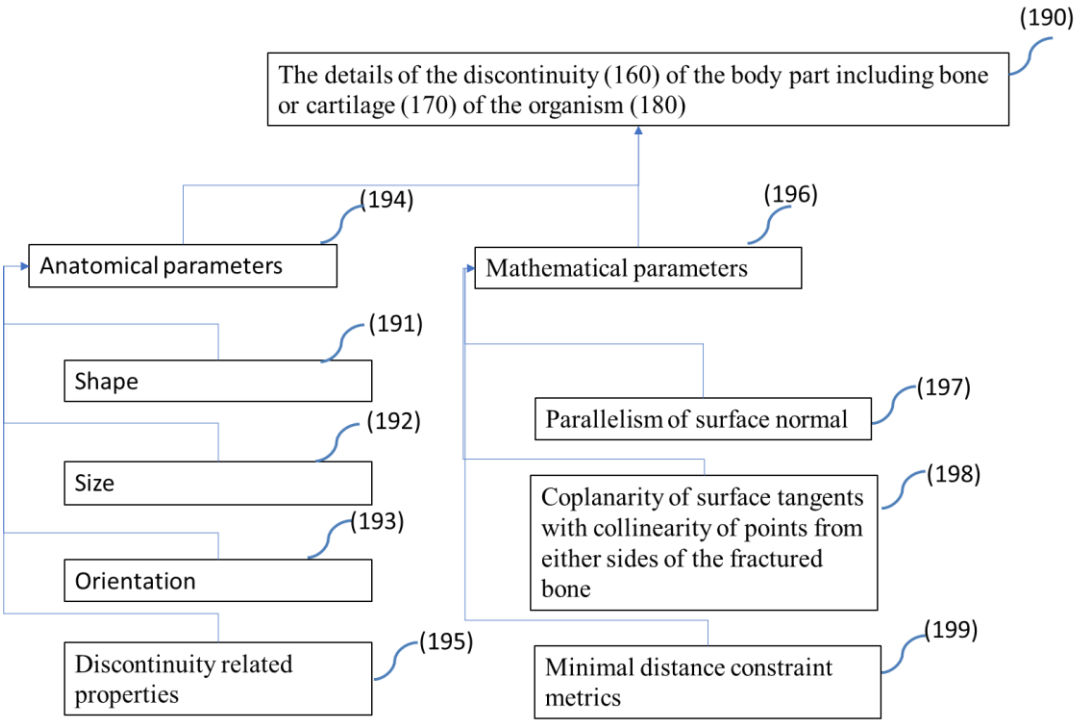

Fig. 10. The details of the discontinuity of the body part including bone or cartilage of the organism

CLAIMS:

We claim,

1. A body part alignment system (100) based on at least one imaging system (110) further comprising:
    a. At least one image analysis subsystem (120);
    b. At least one image registration subsystem (130), and
    c. At least one alignment indication subsystem (140).

2. The body part alignment system (100) based on at least one imaging system (110) as claimed in claim 1, wherein the image analysis subsystem (120) comprising:
    a. At least one processing means (200) to process at least one or more images (115) from the imaging system (110) to detect the discontinuity (160) of a part of the body including bone or cartilage (170) of the organism (180) automatically;
    b. At least one first electronic storage means (300) to store the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180), and
    c. At least one first communication means (400) optionally to communicate the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180).

3. The body part alignment system (100) based on at least one imaging system (110) as claimed in claim 1, wherein the image registration subsystem (130) comprising:

    a. At least one second electronic storage means (310) to store the standard details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics, operably coupled with processing means (200), and

    b. At least one second communication means (410) to communicate at least the details (195) of the body part including bone or cartilage (170)

of the organism (180) as per the anatomy including specifics, operably coupled with processing means (200).

4. The body part alignment system (100) based on at least one imaging system (110) as claimed in claim 1, wherein the alignment indication subsystem (140) comprising:
    a. At least one display means (500) to indicate the alignment changes to be made to minimize or eliminate the misalignment.

5. A method (1000) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) comprising:
    a. processing (1100) one or more images (115) from the imaging system (110) to detect the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) automatically;
    b. registering (1200) the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics, and
    c. indicating (1300) the possible correction to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180).

6. The method (1000) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) as claimed in claim 5, wherein processing (1100) one or more images (115) from the imaging system (110) to detect the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) automatically comprising:
    a. detecting (1110) the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) from one or more

images (115) from the imaging system (110) using computer vision algorithms optionally with deep learning algorithms;

b. deriving (1120) the image parameters (1121), anatomical parameters (1122), functional parameters (1123), mathematical parameters (1124) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) using computer vision algorithms optionally with deep learning algorithms;

c. Storing (1130) the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) from one or more images (115) from the imaging system (110) and the image parameters (1121), anatomical parameters (1122), functional parameters (1123), mathematical parameters (1124) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) in the first electronic storage means (300), and

d. Communicating (1140) the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) from one or more images (115) from the imaging system (110) and the image parameters (1121), anatomical parameters (1122), functional parameters (1123), mathematical parameters (1124) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) optionally.

7. The method (1000) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) as claimed in claim 5, wherein registering (1200) the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics comprising:

a. Combining (1210) the results of at least one standard image registration algorithm or volume registration algorithm to optimally

register the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the standard details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics, and

b. Displaying (1220) the registration of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the standard details (195) of the body part including bone or cartilage (170) of the organism (180) as per the anatomy including specifics on the display means (500) with selectable choice of 2D, 3D and 4D representations.

8. The method (1000) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) as claimed in claim 5, wherein indicating (1300) the possible correction to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) comprising:

a. indicating (1310) the direction (1311), amount (1312), position (1313), orientation (1314) on the display means (500) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) with the indication of perfect alignment (1315).

9. The method (1000) to minimize or eliminate the misalignment while fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) as claimed in claim 5, wherein processing (1100) one or more images (115) from the imaging system (110) to detect the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) automatically using the first processing means (200) involves at least one artificial intelligent method (600) such as machine learning (610), deep learning (620), artificial neural networks (630) or any combination of them (640).

10. The body part alignment system (100) based on at least one imaging system (110) as claimed in any of the claims above, wherein the imaging system (110) is a x-ray based machine including CT (computed tomography), CR (computed radiography) and DR (digital radiography) systems.

11. The body part alignment system (100) based on at least one imaging system (110) as claimed in any of the claims above, wherein the part of the body including bone or cartilage (170) of the organism (180) is confined to bone or cartilage.

12. The body part alignment system (100) based on at least one imaging system (110) as claimed in any of the claims above, wherein the discontinuity (160) of a part of the body including bone or cartilage (170) of the organism (180) includes bone fracture.

13. The body part alignment system (100) based on at least one imaging system (110) as claimed in any of the claims above, wherein the organism (180) is any mammal including human beings.

14. A method (2000) to minimize or eliminate the misalignment after fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) comprising:

    a. comparing (2100) at least two images (116) from the imaging system (110) to detect the extent of misalignment (117) automatically, and

    b. indicating (2200) the possible correction to minimize or eliminate the misalignment after fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180).

15. The method (2000) to minimize or eliminate the misalignment after fixing the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) as claimed in claim 14, wherein the two images (116) consist of at least one image taken at the end of fixing discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) and the another image taken after fixing discontinuity (160) of the body part including bone or cartilage (170) of the organism (180).

16. The body part alignment system (100) based on at least one imaging system (110) as claimed in any of the claims above, wherein the processing means

(200) include multiple processing units with or without additional processing units such as graphical processing units (GPU), coprocessors such as digital signal processors (DSP), Application specific integrated circuits (ASIC), field programmable gate array (FPGA) and such other parallel and distributed processing units.

17. The body part alignment system (100) based on at least one imaging system (110) as claimed in any of the claims above, wherein the first electronic storage means (300) and the second electronic storage means (310) include any electronic storage but not limited to hard disks, magnetic and video tapes, compact discs, DVD, Flash drive and other higher storage capacity electronic storage devices.

18. The body part alignment system (100) based on at least one imaging system (110) as claimed in any of the claims above, wherein first communication means (400) or second communication means (410) include but not limited to both wired and wireless communication such as Transmission Control Protocol (TCP), Internet Protocol (IP), User Datagram Protocol (UDP), Simple mail transport Protocol (SMTP), File Transfer Protocol (FTP), Hyper Text Transfer Protocol Secure (HTTPS), Telnet, Global system for mobile communication (GSM) and general packet radio system (GPRS).

19. The body part alignment system (100) based on at least one imaging system (110) as claimed in any of the claims above, wherein the details (190) of the discontinuity (160) of the body part including bone or cartilage (170) of the organism (180) includes but not limited to shape (191), size (192), orientation(193), anatomical properties (194) of the body part including bone or cartilage (170) of the organism (180) and discontinuity related properties (195) and mathematical parameters (196) such as parallelism of surface normal (197), coplanarity of surface tangents with collinearity of points from either sides of the fractured bone (198), minimal distance constraint metrics (199) and such other parameters which provides indication of optimal alignment.

ABSTRACT

A system for aligning bone fracture based on radiation imaging and method thereof

[0045] For aligning bone fractures by detecting possible misalignment while correcting fractured bones, suggestions are provided for best alignment in the invention. The body part alignment system (100) using imaging system (110) especially correcting the bone fracture misalignment using X-ray or CT scans comprises three subsystems namely image analysis subsystem (120), image registration subsystem (130) and body part alignment subsystem (140). The method involves processing (1100) images (115) from the imaging system (110) to detect discontinuity (160) of the body part including bone or cartilage (170) of the organism (180), registering (1200) details (190) of discontinuity (160) as per anatomy including specifics and indicating (1300) possible corrections to minimize or eliminate misalignment while fixing the discontinuity (160). Using the invention, ample number of misalignments can be minimized making the lives of many people better.

(Figure 1)

Dated this 17th Day of December 2020

Signature:

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For ADIMATICS HEALTHCARE PVT. LTD.

Chairman