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(54) **METHOD AND DEVICE FOR 3D ACQUISITION, 3D VISUALIZATION AND COMPUTER GUIDED SURGERY USING NUCLEAR PROBES**

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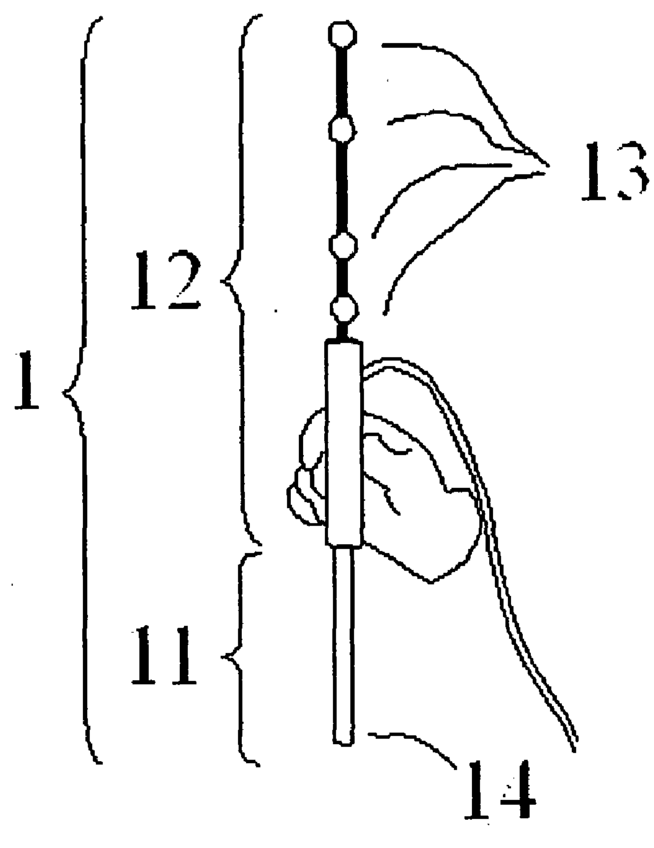
(57) **ABSTRACT**

A device for 3D acquisition, 3D visualization and computer guided surgery with a tracking system, which can be for example an external optical tracking system (**4**), a tracked nuclear probe (**1**) having a nuclear probe (**11**) and a tip of nuclear probe (**14**), which measures a radioactivity, is achieved by providing a time synchronized recording of the spatial position and orientation of the tip of nuclear probes (**14**) and its measured counts of radioactivity. Thus a 3D radioactive surface distribution (**8**) is generated and may be visualized spatially registered with the viewing geometry of any in a superimposed image (**81**). Moreover using the said device, a method for 3D acquisition, 3D visualization and computer guided surgery is introduced for invasive or minimally invasive interventions. A further introduced method is the spatial localization of any surgical instrument in the same coordinate system as the said tracked nuclear probe (**1**) and the guidance of it to the said 3D radioactive surface distribution (**8**) during the surgical procedure. This is achieved by visualizing a simulated radioactivity measurement or feeding it backs in an acoustic signal. The said simulated radioactivity measurement is calculated based on the 3D radioactive surface distribution (**8**) and the position and orientation of the tip of the surgical instrument. The invention compromises also an integrated system that implements all or some of the said methods. Finally the invention includes a tracked combination of nuclear probe with camera (**9**).



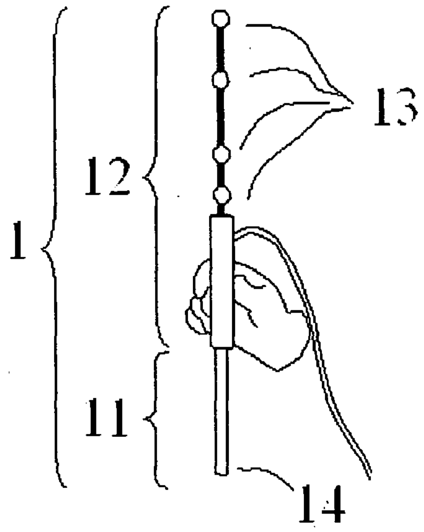


Fig. 1

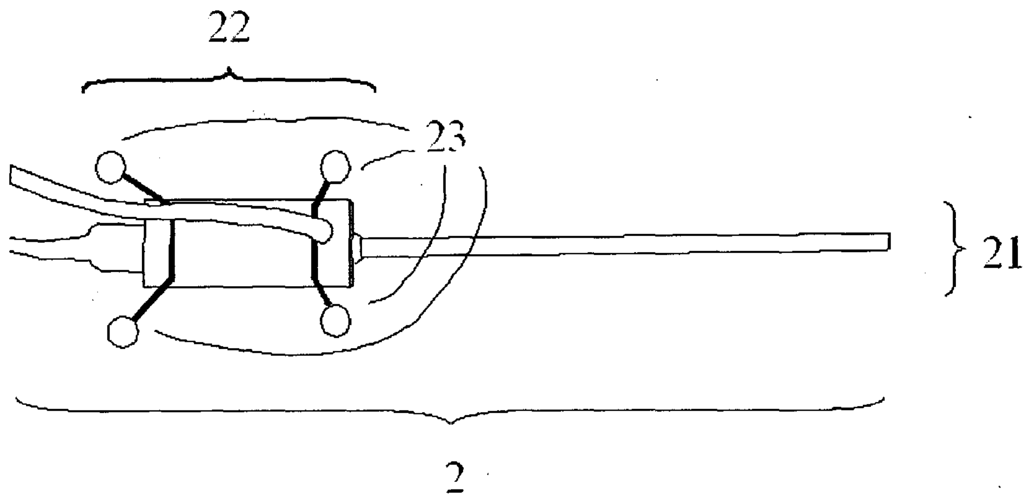


Fig. 2

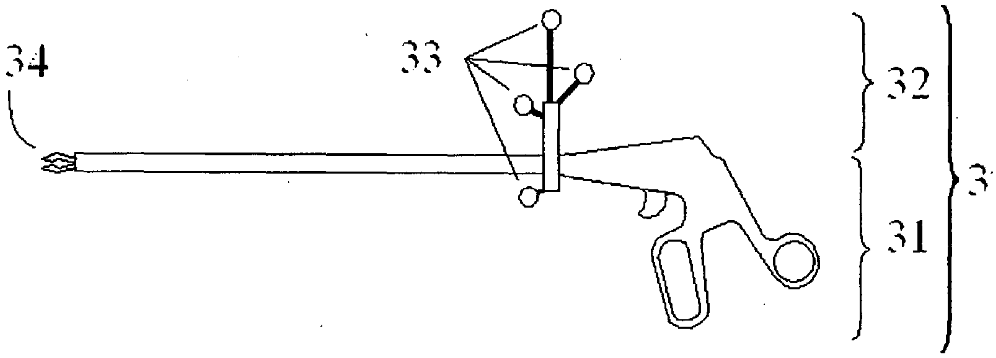


Fig. 3

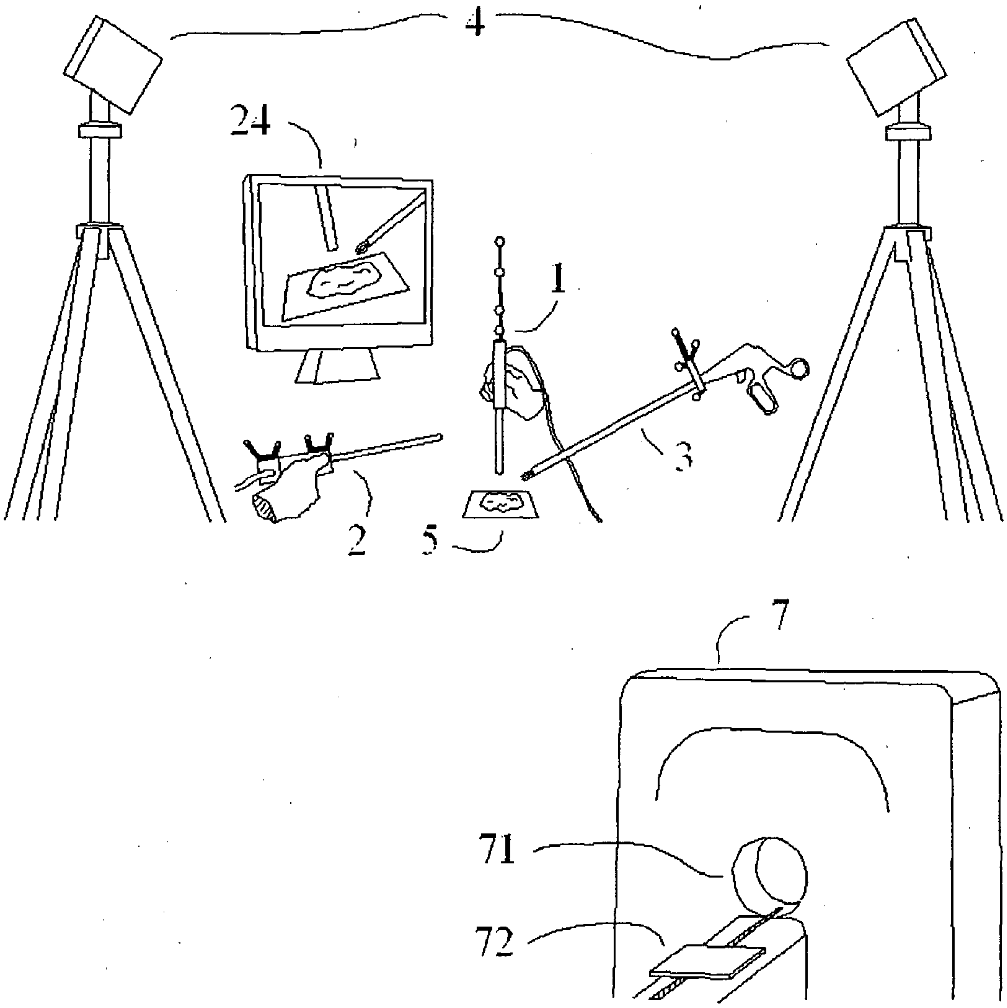


Fig. 4

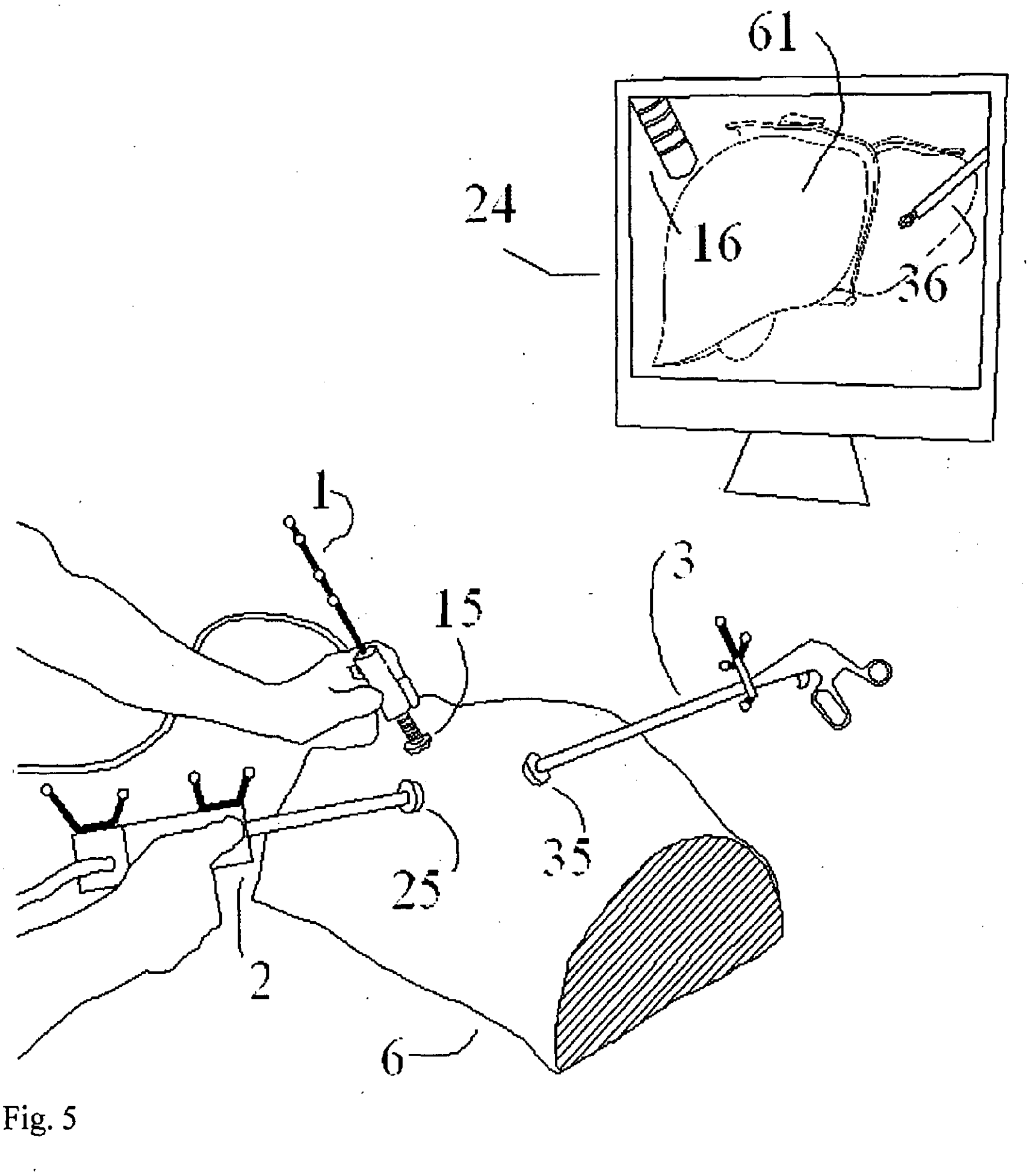


Fig. 5

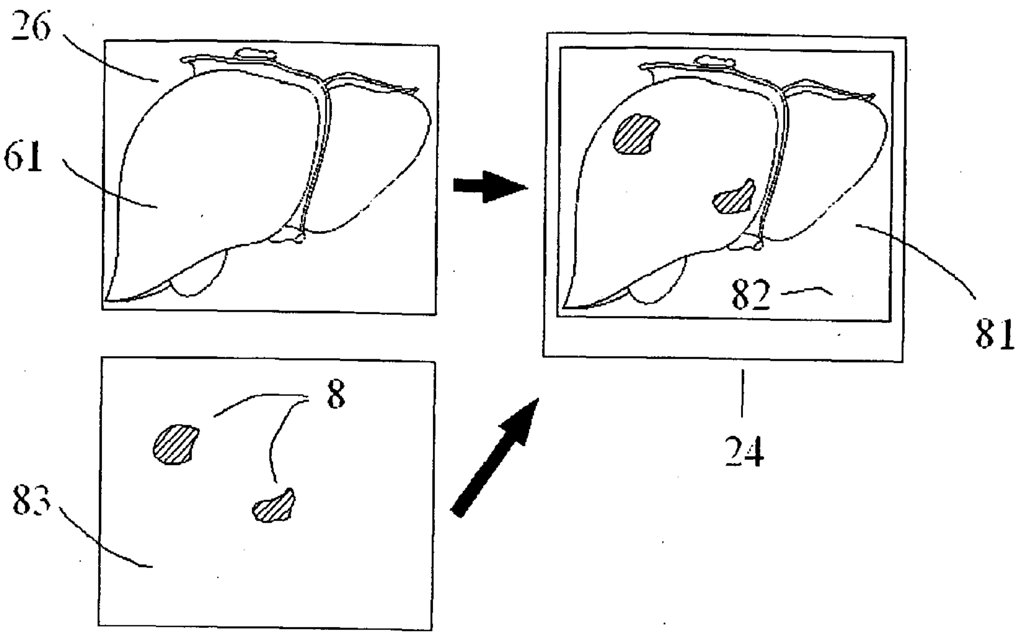

26
61
8
83
82
81
24

Fig. 6

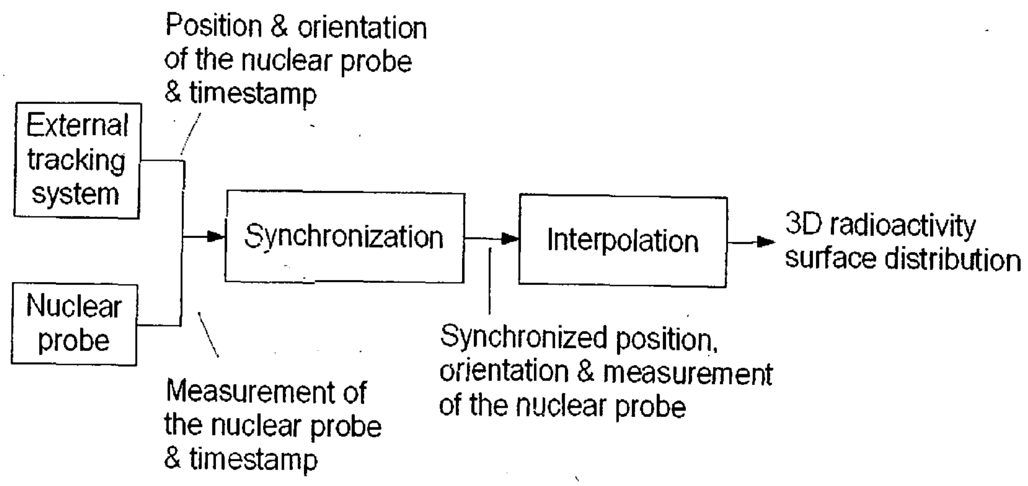

Position & orientation
of the nuclear probe
& timestamp
External
tracking
system
Nuclear
probe
Synchronization
Interpolation
3D radioactivity
surface distribution
Synchronized position,
orientation & measurement
of the nuclear probe
Measurement of
the nuclear probe
& timestamp

Fig. 7

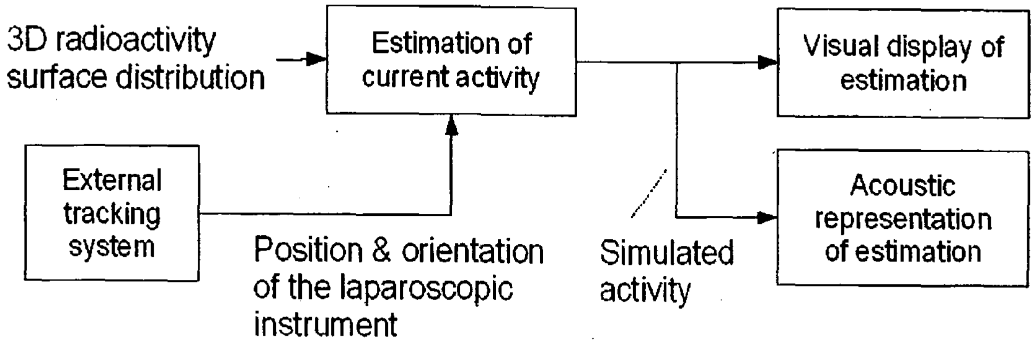

3D radioactivity surface distribution
Estimation of current activity
Visual display of estimation
External tracking system
Acoustic representation of estimation
Position & orientation of the laparoscopic instrument
Simulated activity

Fig. 8

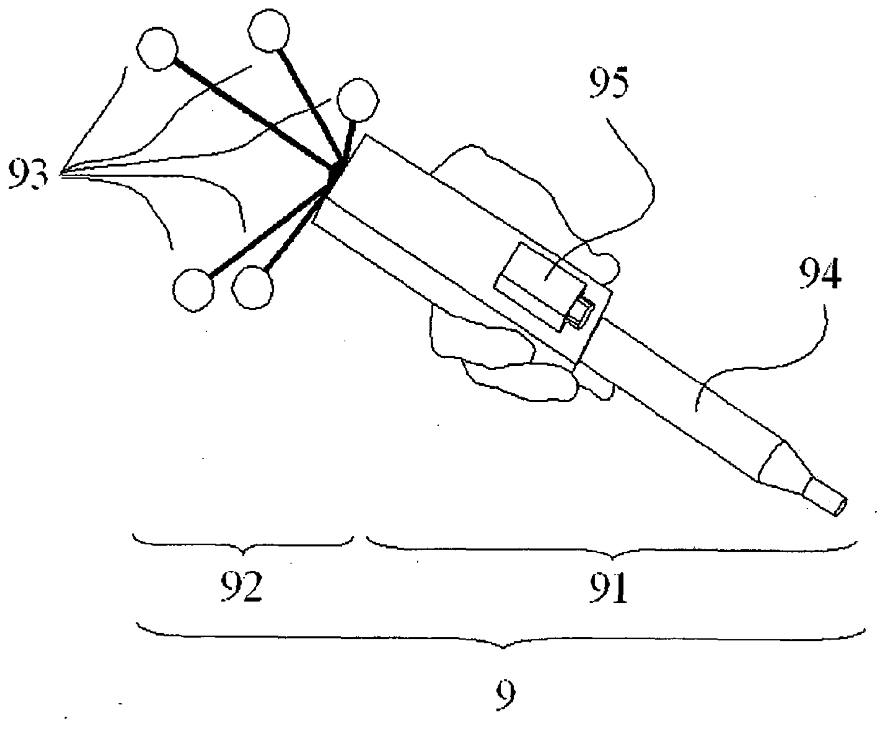

93
95
94
92
91
9

Fig. 9

METHOD AND DEVICE FOR 3D ACQUISITION, 3D VISUALIZATION AND COMPUTER GUIDED SURGERY USING NUCLEAR PROBES

[0001] The present invention relates to a method and to an device for 3D acquisition, 3D visualization and computer guided surgery using Nuclear Probes with a tracking system and a to localize malign tumorous cells of a human body or animal and a surgical instrument to remove the said diseased cells in both invasive and minimally invasive surgery.

[0002] The prior art related to the present invention are disclosed for example in U.S. Pat. No. 6,602,488, U.S. Pat. No. 6,456,869, U.S. Pat. No. 6,317,622 or U.S. Pat. No. 6,167,296 and allow trailing of the hand held probes as common diagnostic devices especially during surgery, as well as tracking systems for determination of position and orientation of surgical instruments. and imaging devices. Furthermore surface reconstruction is known as part of the state of the art.

[0003] The idea of tracking nuclear probes was mentioned in the past by several groups for example as disclosed in U.S. Pat. No. 6,510,336 and U.S. Pat. No. 6,021,341. However, these patents did not provide neither theory nor implementation nor application.

[0004] As further disclosed in U.S. Pat. No. 6,643,538 nuclear probes can be integrated per construction with a camera. However, this patent does not consider any kind of spatial localization.

[0005] Intraoperative probes have been used in the localization of tumors for 60 years. Lately beta emitting labeling has improved drastically their detection accuracy enabling a minimal, but complete resection of malignant cells and thus avoiding recurrence.

[0006] The output of nuclear probes is just a one dimensional signal usually not constant in time. The main advantages of such devices lie in the portability, simplicity, and the possibility of miniaturizing them for the investigation of cavities for instance mounted on endoscopes.

[0007] Moreover since each measurement is not restricted to be at a certain position with respect to the previous one, probes allow the scan of arbitrary surfaces with a spatial accuracy only limited by the size of the sensor.

[0008] Nuclear probes such as gamma- and beta-probes are capable of measuring radioactive decay of nuclides in tracers that are injected to the patient before the intervention.

[0009] The combination of nuclear probes with a camera in one device allows them further not only the determination of the radioactivity emitted by a certain region, but also the simultaneous visualization of the anatomy. This even allows the use of these nuclear probes to detect lesions through smaller incisions where the point of emission is only partially visible or completely occluded to the surgeon.

[0010] The disadvantage of these nuclear probes is that they are just point measurements. This makes the appreciation of the physical value on a surface difficult if it changes considerably with position. One additional problem in this matter is the fluctuation of the measurement results which is based on the statistical nature of the decay process which makes the interpretation of the measurement data even more difficult and unreliable. A further disadvantage is the need for many observations in order to get an idea of a valid measurement map in big areas, which is not the best solution for detection of hot spots in scans of big body sections.

[0011] Moreover, the sequential process of measuring and then performing the surgical action limits the accuracy to the surgeon's ability of navigating the instrument back to the detected locations.

[0012] Finally, in the specific case of the combination of nuclear probes with a camera one has a further disadvantage that the correlation of the measurement of the radioactivity to the anatomy seen in the video image is not given hence it has to be done in the mind of the surgeon.

[0013] The advantageous extending of the use of probes for combining position and orientation tracking with surface reconstruction, measurement and advanced visualization is not mentioned in the past.

[0014] The object of the present invention is to improve a computer guided surgery using Nuclear Probes of the above type such that the said disadvantages of the known arrangements are avoided and that in particular the disadvantage of nuclear probes performing point measurements, the difficulty of the interpretation of the measurement data due to its fluctuation, the further disadvantage namely the need for many observations in order to get an idea of a valid measurement map in big areas and finally the disadvantage of the sequential process of measuring and then performing the surgical action are compensated and thus a more reliable operation is guaranteed.

[0015] This invention also compensates the particular disadvantage of the combination of nuclear probes with a camera related to the lack of the correlation of the measurement of the radioactivity to the anatomy by including tracking systems and a proper visualization.

[0016] The advantageous extending of the use of probes for combining position and orientation tracking with surface reconstruction, measurement and advanced visualization is also to be implemented.

[0017] The invention achieves this object for a computer guided surgery using Nuclear Probes of the above type and tracking systems and in particular by first generating an activity surface in three dimensions by synchronized recording of the radioactivity and the position and orientation of a nuclear probe and thus making possible the interpretation of the measurements as a composite result; second visualizing this composite result which allows the operator to get a smooth impression of the activity distribution and thus to compensate the fluctuation; third calculating a mesh by using the measured positions and the a priori knowledge that they lie on a surface and further generating a proper interpolation of the results based on the said mesh; and finally presenting the generated surface activity distribution to the surgeon when applying the therapeutic actions and thus allowing the bridging of the time gap between measurement and action.

[0018] In a preferred embodiment of the invention the generated surface activity distribution is presented using an augmented reality system. In it, firstly, a visual, colour encoded surface model is superimposed on the real image of an external camera or a laparoscope; secondly, based on the recorded activity and the position and orientation of any tracked therapeutic device in the same coordinate system as the one in which the nuclear probe is tracked, a radioactivity measurement is simulated turning the surgical instrument into a virtual probe, and allowing the guidance of the surgeon to the areas of interest during surgical procedures.

[0019] The new technology can be used in both invasive and minimally invasive surgery and provides an end-to-end solution for minimal resection of malign tumorous cells reducing the remaining residual and therefore the risks of reoccurrence. It also results in more precise detection and treatment of afflicted lymph nodes.

[0020] A further improvement is the generating the same auditory feedback one gets during the nuclear probe examination, while approaching the same tissue with surgical instruments during surgical procedures.

[0021] In addition this invention solves the additional disadvantage of the combination of nuclear probes with a camera related to the lack of the correlation of the measurement of the radioactivity to the anatomy by the synchronized recording of the radioactivity, the camera image and the position and orientation of a nuclear probe. Based on the said synchronized recording, an activity surface in three dimensions is generated and it is projected onto the real image of the camera as a colour-encoded surface. Thus the correlation of the measurement of the radioactivity to the anatomy is given in a proper visualization.

[0022] The invention will now be elucidated by reference to the embodiment partially illustrated schematically in the drawings.

[0023] FIG. **1**: a schematic view of a tracked nuclear probe

[0024] FIG. **2**: a schematic view of a tracked laparoscope

[0025] FIG. **3**: a schematic view of a tracked surgical instrument

[0026] FIG. **4**: a schematic view of an exemplary hardware set up for an experimental laparoscopic scan

[0027] FIG. **5**: a schematic view of a laparoscopic scan on a human body with a laparoscope, a nuclear probe and a monitor

[0028] FIG. **6**: schematic views of a body tissue, radioactive areas and a semi-transparent superposition of the radioactive areas to the body tissue

[0029] FIG. **7**: a block diagram of a synchronized recording of the position and orientation measurement device

[0030] FIG. **8**: presentation of a recorded activity by means of a tracked instrument

[0031] FIG. **9**: schematic view of tracked combination of nuclear probe with camera

[0032] FIG. **1** shows a schematic of a tracked nuclear probe **1** which has essentially two parts, the first part is a nuclear probe **11** with a tip of nuclear probe **14** and the second part is an optical tracking target of nuclear probe **12** with an optical markers of nuclear probe **13**. Based on the relative positions of the markers of nuclear probe **13**, the position of the tip of the nuclear probe **14** and the probe axis can be estimated with a high precision in real time. The rotation around the axis of the nuclear probe **1** is not tracked, but it is also of no interest for the applications, since the measurement value is independent of this rotation. The readings of the nuclear probe **1** are sent to a proper data acquisition system for example a proper computer (not shown) using a data transfer means (not shown).

[0033] FIG. **2** shows a schematic view of a tracked instrument which is a tracked laparoscope **2** which has essentially two parts, the first part is a laparoscope **21** and the second part is an optical tracking target of laparoscope **22** which has optical markers of laparoscope **23**. Based on the relative positions of the optical markers of laparoscope **23** the position and the orientation of laparoscope **21** can be estimated with a high precision in real time. Both the position and the orientation of laparoscope **21** are necessary to determine the correct view port of a laparoscopic video image **26**, which is shown in FIG. **4**.

[0034] FIG. **3** shows a schematic view of a tracked laparoscopic instrument **3** which is a tracked surgical instrument and has essentially two parts, the fist part is a laparoscopic instrument **31** with a tip of laparoscopic instrument **34** and the second part is an optical tracking target of laparoscopic instrument **32** with optical markers of laparoscopic instrument **33**. Based on the relative positions of the markers of laparoscopic instrument **33**, the position and orientation of the tip of the laparoscopic instrument **34** and axis of the laparoscopic instrument **31** can be estimated with a high precision in real time. In order to simulate the readings of the tracked nuclear probe **1** on the tip of laparoscopic instrument **34**, both the position and the orientation of laparoscopic instrument **31** are necessary.

[0035] FIG. **4** shows an embodiment of a Device for 3D acquisition, 3D visualization and computer guided surgery using Nuclear Probes in an experimental case for a laparoscopic scan. A tracked nuclear probe **1** is used to acquire the 3D radioactive surface distribution **8** (shown in FIG. **6**) of a phantom **5**. An tracking system which can be for example an external optical tracking system **4** or an electro magnetic device (not shown) is used to track the tracked nuclear probe **1** as well as the tracked laparoscope **2** and the tracked laparoscopic instrument **3**. The tracked laparoscope **2** acquires simultaneously a laparoscopic video image **26** (shown in FIG. **6**). In order to visualized the acquired information a screen for image of laparoscope **24** is used. The said laparoscopic video image **26** is augmented with additional data like the 3D radioactive surface distribution **8**. In case of the use of many cameras the video images of each of them can be augmented separately. A special case for that is for example a Head-Mounted Display where one image for each eye is augmented and thus a 3D impression is achieved. The tracked laparoscopic instrument **3** can also be tracked and the readings of the tracked nuclear probe **1** can be simulated on the tip of laparoscopic instrument **34**. The simulated activity can be either displayed in the screen for image of laparoscope **24** or be fed back in form of acoustic signals that encode the 3D radioactive surface distribution **8**. The encoding can be such that for a high radioactivity a high beep frequency and for a low radioactivity a low beep frequency is generated. A PET scanner **7** (Positron Emission Tomography) is used to validate the 3D radioactive surface distribution **8** in the phantom **5**. Therefore the phantom **5** is positioned on a Phantom holder of PET scanner **72** and is to be moved into a gantry of PET scanner **71** to perform the imaging.

[0036] FIG. **5** shows a schematic view of a scan on a human body **6** with a tracked laparoscope **2**, a tracked nuclear probe **1** and a screen for image of laparoscope **24** for scanning a body tissue **61**. The tracked nuclear probe **1** is introduced through a proper trocar for tracked nuclear probe **15** into a human body **6** of a patient. The image of the inside is acquired using a tracked laparoscope **2** introduced by trocar for tracked laparoscope **25**. Moreover the tracked laparoscopic instrument **3** can be introduced through a trocar for tracked laparoscopic instrument **35**. A data acquisition system, for example a proper computer (not shown), integrates the laparoscopic video image **26** (shown in FIG. **6**), the position and the orientation of laparoscope **21** and the position and orientation of the tip of the laparoscopic instrument **34** and axis of the laparoscopic instrument **31**, where they are also synchronized with the readings of the tracked nuclear probe **1** and with the position and orientation of the tip of the nuclear probe **14**. An image of the tip of nuclear probe on screen **16** as well as the body tissue **61** and an image of the tip of laparoscopic instrument **36** can be seen in the screen for image of laparoscope **24**.

[0037] FIG. **6** shows schematic views of a body tissue **61**, the laparoscopic video image **26**, the 3D radioactive surface distribution **8**, a projection of the said generated 3D radioactive surface distribution as a color encoded surface **83** and a semi-transparent superposition of 3D radioactive surface distribution **8** onto the body tissue **61** indicated as superimposed image **81**. Additional information for example simulated radioactivity measurement **82** can be also shown on the screen for image of laparoscope **24**. The simulated radioactivity measurement is calculated based on the 3D radioactive surface distribution **8** and the position and orientation of the tip of laparoscopic instrument **34**. The simulated radioactivity measurement is to be equivalent to the one displayed by a nuclear probe **11** when detecting radioactivity.

[0038] FIG. **7** shows a block diagram of a synchronized recording of the position and orientation measurement device and the activity measures resulting in the generation of the three dimensional surface map that is presented to the surgeon. The external tracking system **4** feeds the data acquisition system with the position and orientation of the tip of the nuclear probe **14** as well as the timestamp of that measurement. Simultaneously the measurement of the nuclear probe **11** is also acquired with the timestamp of that measurement. Both the position and the orientation of the tip of the nuclear probe **14** and the measurement of the nuclear probe **11** are stored and synchronized. The synchronized position, orientation and measurement of the nuclear probe **11** are further interpolated to generate a 3D radioactive surface distribution **8**.

[0039] FIG. **8** shows a presentation of a recorded activity by means of a tracked laparoscopic instrument **3**. This could result either in a visual presentation such as an augmented reality view for example as a superimposed image **81** or in an acoustic representation simulating the real sound or count visualization of the nuclear probe **11**. The optical external tracking system **4** feeds the data acquisition system with the position and orientation of the tip of laparoscopic instrument **34**. The 3D radioactive surface distribution **8** calculated as described in FIG. **7** can then be integrated to generate a simulated activity on the tip of laparoscopic instrument **34**. Based on the simulated activity the proper visualization or acoustic feedback can be calculated.

[0040] FIG. **9** shows a preferred embodiment of a tracked combination of a nuclear probe with a camera **9** which has essentially two parts. The fist part is a combination of a nuclear probe with a camera **91** with a nuclear probe of combination of a nuclear probe with a camera **94** and an optical camera system, which can be for example only one camera of combination of a nuclear probe with a camera **95** or a light guide that transmits the optical image to a camera connected to the device (not shown). The second part is an optical tracking target of combination of a nuclear probe with a camera **92** with optical markers of combination of a nuclear probe with a camera **93**. Based on the relative positions of the markers of combination of a nuclear probe with a camera **93**, the position and orientation of the nuclear probe of combination of a nuclear probe with a camera **94** and the position and orientation of the optical camera system can be estimated with a high precision in real time. Based on the synchronized radioactivity measurements of the nuclear probe of combination of a nuclear probe with a camera **94** and the position and orientation of the nuclear probe of combination of a nuclear probe with a camera **94**, a 3D radioactive surface distribution **8** can be also generated. With the 3D radioactive surface distribution **8** a projection of the generated 3D radioactive surface distribution as a colour encoded surface **83** can be generated using the viewing geometry of the optical camera system and shown also as a superimposed image **81**.

Reference List of Drawings

[0041] **1** tracked nuclear probe (modified beta-probe)
[0042] **11** nuclear probe
[0043] **12** optical tracking target of nuclear probe
[0044] **13** optical markers of nuclear probe
[0045] **14** tip of nuclear probe
[0046] **15** trocar for tracked nuclear probe
[0047] **16** image of the tip of nuclear probe on screen
[0048] **2** tracked laparoscope
[0049] **21** laparoscope
[0050] **22** optical tracking target of laparoscope
[0051] **23** optical markers of laparoscope
[0052] **24** screen for image of laparoscope
[0053] **25** trocar for tracked laparoscope
[0054] **26** laparoscopic video image
[0055] **3** tracked laparoscopic instrument
[0056] **31** laparoscopic instrument
[0057] **32** optical tracking target of laparoscopic instrument
[0058] **33** optical markers of laparoscopic instrument
[0059] **34** tip of laparoscopic instrument
[0060] **35** trocar for tracked laparoscopic instrument
[0061] **36** image of the tip of laparoscopic instrument
[0062] **4** external optical tracking system
[0063] **5** phantom
[0064] **6** Human body
[0065] **61** body tissue
[0066] **7** PET scanner
[0067] **71** Gantry of PET scanner
[0068] **72** Phantom holder of PET scanner
[0069] **8** 3D radioactive surface distribution
[0070] **81** superimposed image
[0071] **82** additional information for example simulated radioactivity measurement
[0072] **83** projection of the generated 3D radioactive surface distribution as a color encoded surface
[0073] **9** tracked combination of a nuclear probe with a camera
[0074] **91** combination of a nuclear probe with a camera
[0075] **92** optical tracking target of nuclear probe of combination of a nuclear probe with a camera
[0076] **93** optical tracking markers of nuclear probe of combination of a nuclear probe with a camera
[0077] **94** nuclear probe of combination of a nuclear probe with a camera
[0078] **95** camera of combination of a nuclear probe with a camera

1. A device for 3D acquisition, 3D visualization and computer guided surgery with an tracking system **4**, a tracked nuclear probe **1** having a nuclear probe **11** and a tip of nuclear probe **14**, which measures a radioactivity,

characterized in that a time synchronized recording of the spatial position and orientation of the tip of nuclear probe **14** and its measured counts of radioactivity is provided.

2. The device for 3D acquisition, 3D visualization and computer guided surgery according to claim **1**,

characterized in that a 3D radioactive surface distribution **8**, which can be a colour encoded surface **83**, is generated using the said time synchronized spatial position and orientation of the tip of nuclear probe **14** with the said associated radioactivity measurements.

3. The device for 3D acquisition, 3D visualization and computer guided surgery according to claim **2**,

characterized in that a projection of the generated 3D radioactive surface distribution as a colour encoded surface **83** is visualized spatially registered with the viewing geometry of any camera or set of cameras for example a laparoscope **21** or Head-Mounted Display in a superimposed image **81** or a set of superimposed images **81**.

4. A method for 3D acquisition, 3D visualization and computer guided surgery using the device according to any of the preceding claims,

characterized in that the 3D radioactive surface distribution **8** or the superimposed image **81** or the projection of the generated 3D radioactive surface distribution as a colour encoded surface **83** or any combination of them are visualized and used for invasive or minimally invasive interventions.

5. A method for 3D acquisition, 3D visualization and computer guided surgery using the device according to any of the preceding claims,

characterized in that intraoperative measured counts of radioactivity of the nuclear probe **11** are directly augmented onto a camera video image for example a laparoscopic video image **26**.

6. A method for 3D acquisition, 3D visualization and computer guided surgery using the device according to any of the preceding claims,

characterized in that any surgical instrument, for example a laparoscopic instrument **31**, is spatially localized in the same coordinate system as the said tracked nuclear probe **1** and the said surgical instrument is guided to the said 3D radioactive surface distribution **8** during the surgical procedure.

7. A method for 3D acquisition, 3D visualization and computer guided surgery using the device according to any of the preceding claims,

characterized in that a simulated radioactivity measurement is calculated based on the 3D radioactive surface distribution **8** and the position and orientation of the tip of a surgical instrument for example the tip of laparoscopic instrument **34** and displayed, while navigating any tracked surgical instruments, for example a tracked laparoscopic instrument **3**, over the previously generated 3D radioactive surface distribution **8**.

8. A method for 3D acquisition, 3D visualization and computer guided surgery using the device according to any of the preceding claims,

characterized in that a simulated radioactivity measurement is calculated based on the 3D radioactive surface distribution **8** and the position and orientation of the tip of a surgical instrument for example the tip of laparoscopic instrument **34** and be fed back in form of acoustic signals, while navigating any tracked surgical instruments, for example a tracked laparoscopic instrument **3**, over the previously generated 3D radioactive surface distribution **8**.

9. The device for 3D acquisition, 3D visualization and computer guided surgery according to any of preceding claims,

characterized in that a system is provided which integrates

a module for the visualization of the 3D radioactive surface distribution **8** or the superimposed image **81** or the projection of the generated 3D radioactive surface distribution as a colour encoded surface **83** or any combination of them for invasive or minimally invasive interventions,

a module for the direct augmentation of intraoperative measured counts of radioactivity of the nuclear probe **11** onto a camera video image for example a laparoscopic video image **26**,

a module for the spatial localization of any surgical instrument, for example a laparoscopic instrument **31**, in the same coordinate system as the said tracked nuclear probe **1** and the guidance of the said surgical instrument to the said 3D radioactive surface distribution **8** during the surgical procedure,

a module for the calculation and display of a simulated radioactivity measurement is calculated based on the 3D radioactive surface distribution **8** and the position and orientation of the tip of a surgical instrument for example the tip of laparoscopic instrument **34**, while navigating any tracked surgical instruments, for example a tracked laparoscopic instrument **3**, over the previously generated 3D radioactive surface distribution **8** and

a module for the calculation and feedback in form of acoustic signals of a simulated radioactivity measurement is calculated based on the 3D radioactive surface distribution **8** and the position and orientation of the tip of a surgical instrument for example the tip of laparoscopic instrument **34**, while navigating any tracked surgical instruments, for example a tracked laparoscopic instrument **3**, over the previously generated 3D radioactive surface distribution **8**,

or any combination of any of the modules in a software framework that provides a unified user interface for visualization of intraoperative measured counts of radioactivity.

10. The device for 3D acquisition, 3D visualization and computer guided surgery according to any of preceding claims,

characterized in that a tracked combination of nuclear probe with camera **9** having a combination of nuclear probe with camera **91**, which has a nuclear probe of combination of a nuclear probe with a camera **94** and an optical camera system is provided.

* * * * *

patsnap

专利名称(译)	使用核探针进行3D采集，3D可视化和计算机引导手术的方法和装置		
公开(公告)号	US20090259123A1	公开(公告)日	2009-10-15
申请号	US12/300758	申请日	2007-02-27
[标]申请(专利权)人(译)	SURGICEYE		
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当前申请(专利权)人(译)	SURGICEYE GMBH		
[标]发明人	NAVAB NASSIR ZIEGLER SIBYLLE TRAUB JORG WENDLER THOMAS		
发明人	NAVAB, NASSIR ZIEGLER, SIBYLLE TRAUB, JORG WENDLER, THOMAS		
IPC分类号	A61B6/00		
CPC分类号	A61B6/4258 G01T1/161		
优先权	2006010052 2006-05-16 EP		
外部链接	Espacenet USPTO		

摘要(译)

一种用于3D采集，3D可视化和具有跟踪系统的计算机引导手术的设备，其可以是例如外部光学跟踪系统（4），具有核探针（11）和核尖端的跟踪核探针（1）通过提供核探针尖端（14）的空间位置和取向的时间同步记录及其测量的放射性计数来实现测量放射性的探针（14）。因此，生成3D放射性表面分布（8），并且可以在空间上与叠加图像（81）中的任何一个的观察几何形状配准。此外，使用所述装置，引入了用于3D获取，3D可视化和计算机引导手术的方法，用于侵入性或微创干预。进一步引入的方法是在与外科手术过程中所述跟踪的核探针（1）相同的坐标系中的任何外科器械的空间定位及其对所述3D放射性表面分布（8）的引导。这是通过可视化模拟放射性测量或将其反馈到声学信号中来实现的。基于3D放射性表面分布（8）以及手术器械的尖端的位置和取向来计算所述模拟放射性测量值。本发明还折衷了实现所有或一些所述方法的集成系统。最后，本发明包括核探针与相机（9）的跟踪组合。