

What is claimed is:

1. A system for planning one or more surgical trajectory paths to one or more targets in tissue within a patient's body, comprising:

a) a storage memory device configured to store therein one or more pre-operative imaging data sets from one or more imaging modalities of an anatomical portion of the patient's body, at least one of the one or more imaging data sets being one or more diffusion MRI data sets; and

b) a computer processor in communication with the storage memory device programmed for

i) producing, from the one or more pre-operative imaging data sets, images and related data of a volume of the anatomical portion of the patient's body containing one or more entry points into the tissue and one or more targets to be approached, at least one of the related data being tractography of the volume of the anatomical portion produced from the one or more diffusion MRI data sets, and

ii) storing the images and related data of the volume; and

c) a computer user interface in communication with the computer processor for

i) receiving a user selection of the one or more targets to be approached during a surgical procedure and storing locations of the one or more targets;

ii) displaying the images and related data of the volume;

iii) receiving a user selection of the one or more entry points into the patient's tissue;

- iv) producing and displaying one or more potential surgical trajectory paths from the one or more entry points to the one or more targets, and their interaction with the tractography and other selected anatomical features in the volume of the anatomical portion;
 - v) accepting a user selection of one or more surgical trajectory paths from the one or more potential surgical trajectory paths; and
 - vi) storing on the memory device the one or more surgical trajectory paths.
2. The system of claim 1 wherein the one or more surgical trajectory paths that satisfies a surgical intent.
 3. The system of claim 1 wherein the diffusion MRI data sets is selected from a group consisting of diffusion tensor imaging (DTI), and diffusion weighted imaging (DWI).
 4. The system of claim 1 wherein displaying the volume and related data further comprises displaying tractography and the images of the volume of the anatomical portion along with the locations of the one or more targets.
 5. The system of claim 1 wherein at least one of the one or more images and related data of a volume being produced provides a visualization of the vasculature of the anatomical portion.
 6. The system of claim 1 wherein the anatomical portion is a brain of a human patient.
 7. The system of claim 6 wherein at least one of the one or more images of the volume being produced provides a visualization of the sulci of the brain.
 8. The system of claim 1 wherein two or more images and related data of the volume are overlaid atop one another to produce a virtual representation.
 9. The system of claim 1 wherein the representation of the tractography is modulated.

10. The system of claim 9 wherein the modulation of the tractography implemented is a visual modulation and can take the form of any one or combination of transparency, coloration, outlining, and color gradation.

11. The system of claim 9 wherein the modulation is performed in accordance with a surgical intent.

12. The system of claim 1 wherein the storage memory device is further configured to store a database of one or more virtual medical instruments and the computer processor in communication with the storage device is further programmed to produce from the database of virtual medical instruments a visualization of the medical instrument along said potential surgical trajectory paths.

13. The system of claim 12 wherein the surgical intent can be any or combination of an intersection with the virtual medical instrument, a vicinity of the virtual medical instrument, a cut-off angle between the virtual medical instrument and a tract, a length of a tract, a distance of the virtual medical instrument from the end of a tract, a distance from the end of the virtual medical instrument, a relative density of a tract, a location of a tract along the length of the virtual medical instrument, a location of the tract within the anatomical portion, a location of the virtual medical instrument within the anatomical portion, and a direction of a tract relative to the anatomical portion.

14. A system for planning one or more surgical trajectory paths to one or more targets in tissue within a patient's body, comprising:

a) a storage memory device configured to store therein one or more pre-operative imaging data sets from one or more imaging modalities of an anatomical portion of the patient's body, at least one of the one or more imaging data sets being one or more diffusion MRI data sets; and

b) a computer processor in communication with the storage memory device programmed for

i) producing, from the one or more pre-operative imaging data sets, images and related data of a volume of the anatomical portion of the patient's body containing one or more entry points into the tissue and one or more targets to be approached, at least one of the related data being tractography of the volume of the anatomical portion produced from the one or more diffusion MRI data sets, and

ii) storing the images and related data of the volume; and

c) a computer user interface in communication with the computer processor for

i) receiving from the processor the one or more targets to be approached during a surgical procedure and storing locations of the one or more targets;

ii) displaying tractography and the other images of the volume of the anatomical portion along with the locations of the one or more targets;

iii) receiving from the processor the one or more entry points into the patient's tissue;

iv) producing and displaying one or more potential surgical trajectory paths from the one or more entry points to the one or more targets, and their interaction with the tractography and other selected anatomical features in the volume of the anatomical portion;

v) accepting a user selection of one or more surgical trajectory paths from the one or more potential surgical trajectory paths; and

- vi) storing on the memory device one or more surgical trajectory paths.
15. The system of claim 14 wherein the one or more surgical trajectory paths that satisfies a surgical intent.
16. The system of claim 14 wherein the diffusion MRI data sets is selected from a group consisting of diffusion tensor imaging (DTI), and diffusion weighted imaging (DWI).
17. The system of claim 14 wherein displaying the volume and related data further comprises displaying tractography and the images of the volume of the anatomical portion along with the locations of the one or more targets.
18. The system of claim 14 wherein at least one of the one or more images and related data of a volume being produced provides a visualization of the vasculature of the anatomical portion.
19. The system of claim 14 wherein the anatomical portion is a brain of a human patient.
20. A method executed on a computer for planning one or more surgical trajectory paths to one or more targets in tissue within a patient's body, comprising
- a) storing in a storage memory device one or more pre-operative imaging data sets from one or more imaging modalities of an anatomical portion of the patient's body, at least one of the one or more imaging data sets being one or more diffusion MRI data sets; and
 - b) processing the one or more imaging data sets, using a computer processor, for producing from the one or more pre-operative imaging data sets, one or more images and related data of a volume of the anatomical portion of the patient's body containing one or more entry points into the tissue and one or more targets to be approached, at least one of the related data being tractography of the volume of the anatomical portion produced from the one or more diffusion MRI data sets, and

- c) storing in a storage memory device the images and related data of the volume,
- d) receiving through a computer user interface a user selection of the one or more target locations to be approached during a surgical procedure and storing the one or more target locations in the storage memory device,
- e) displaying the images and related data volume
- f) receiving through a computer user interface a user selection of the one or more entry points into the patient's tissue;
- g) displaying one or more potential surgical trajectory paths from the one or more entry points to the one or more targets, and their interaction with the tractography and other selected anatomical features in the volume of the anatomical portions;
- h) accepting through a computer user interface a user selection of one or more surgical trajectory paths from the one or more potential surgical trajectory paths; and
- i) storing in the storage memory device the one or more surgical trajectory paths.

21. The method of claim 20 wherein the one or more surgical trajectory paths satisfies a surgical intent.

22. The method of claim 20 wherein the diffusion MRI data sets is selected from a group consisting of diffusion tensor imaging (DTI), and diffusion weighted imaging (DWI).

23. The method of claim 20 wherein displaying the volume and related data further comprises displaying tractography and the other images of the volume of the anatomical portion along with the locations of the one or more targets.

24. The method of claim 23 wherein at least one of the one or more images and related data

of a volume being produced provides a visualization of the vasculature of the anatomical portion.

25. The method of claim 20 wherein the anatomical portion is a brain of a human patient.

26. The method of claim 25 wherein at least one of the one or more images and related data of a volume being produced provides a visualization of the sulci of the brain.

27. The method of claim 20 wherein two or more images and related data of a volume are overlaid atop one another to produce a virtual representation.

28. The method of claim 20 wherein visualization of the tractography is modulated.

29. The method of claim 28 wherein the type modulation of the tractography implemented is a visual modulation and can take the form of any one or combination of transparency, coloration, outlining, and color gradation.

30. The method of claim 28 wherein the modulation is performed in accordance with a surgical intent.

31. The method of claim 20 wherein the storage memory device is further configured to store a database of one or more virtual medical instruments and the computer processor in communication with the storage device is further programmed to produce from the database of virtual medical instruments a visualization of the medical instrument along said point-wise surgical trajectory path.

32. The method of claim 31 wherein the surgical intent can be any or combination of an intersection with the virtual medical instrument, a vicinity of the virtual medical instrument, a cut-off angle between the virtual medical instrument and a tract, a length of a tract, a distance of the virtual medical instrument from the end of a tract, a distance from the end of the virtual medical instrument, a relative density of a tract, a location of a tract along the length of the virtual medical instrument, a location of the tract within the anatomical portion, a location of the virtual medical instrument within the anatomical portion, and a direction of a tract relative to the anatomical portion.

33. A computer readable storage medium having stored therein a computer program for planning one or more surgical trajectory paths to one or more targets in tissue within a patient's body, the computer program being programmed with steps, which, when executed on a computer, comprises:

a) storing in a storage memory device one or more pre-operative imaging data sets from one or more imaging modalities of an anatomical portion of the patient's body, at least one of the one or more imaging data sets being one or more diffusion MRI data sets; and

b) processing the one or more imaging data sets, using a computer processor, for producing from the one or more pre-operative imaging data sets, one or more images and related data of a volume of the anatomical portion of the patient's body containing one or more entry points into the tissue and one or more targets to be approached, at least one of the related data being tractography of the volume of the anatomical portion produced from the one or more diffusion MRI data sets, and

c) storing in a storage memory device the images and related data of the volume,

d) receiving through a computer user interface a user selection of the one or more target locations to be approached during a surgical procedure and storing the one or more target locations in the storage memory device,

e) displaying the images and related data volume

f) receiving through a computer user interface a user selection of the one or more entry points into the patient's tissue;

g) displaying one or more potential surgical trajectory paths from the one or more entry points to the one or more targets, and their interaction with the tractography and other selected anatomical features in the volume of the anatomical portions;

h) accepting through a computer user interface a user selection of one or more surgical trajectory paths from the one or more potential surgical trajectory paths; and

i) storing in the storage memory device the one or more surgical trajectory paths.