CLAIMS:

1. A method of scanning for vascular irregularities in at least one in vivo image acquired in the absence of contrast agent, the method including:

applying a multi-scale shape-based filter to the in vivo image to provide a probability field and a scale field;

performing vessel segmentation on the probability field to extract a vasculature tree from the probability field;

mapping the scale field to the segmented vasculature tree to quantify the geometry of the vasculature tree; and

performing an automated geometric analysis on the quantified geometry to detect irregularities in the vasculature.

2. The method of claim 1, wherein the step of providing a probability field and a scale field includes:

applying the multi-scale filter to the in vivo image to provide multiple probability fields, one for each scale;

creating an overall probability field from the multiple probability fields by performing a voxel-by-voxel comparison on each of the multiple probability fields and selecting the highest probability for each voxel; and

creating a corresponding overall scale field by recording the scale at which the highest probability occurs for each voxel.

3. The method of claim 1 or claim 2, wherein the step of applying the multi-scale filter includes inverting the in vivo image or using a filter that effectively inverts the in vivo image.

4. The method of any one of claims 1 to 3, wherein the step of applying the multi-scale filter includes two stages, namely applying a first coarse scale and a second fine scale.

5. The method of any one of claims 1 to 4, wherein the step of segmenting the vasculature includes performing a region growing operation on the probability field.

6. The method of any one of claims 1 to 5, ~~wherein the step of applying a multi-scale filter to the in vivo image includes applying a multi-scale shape filter, and~~ wherein the shape used in the shape filter is a tube.

7. The method of claim 6, wherein the multi-scale shape filter is a Hessian-based filter.

8. The method of any one of claims 1 to 7, including acquiring a three-dimensional in vivo image in the absence of contrast agent.

9. The method of claim 8, including acquiring a three-dimensional in vivo image of the lungs.

10. The method of any one of claims 1 to 9, wherein the step of applying a multi-scale filter involves applying a multi-scale filter to a three-dimensional in vivo image in the absence of contrast agent.

11. The method of claim 10, ~~wherein the step of applying a multi-scale filter includes applying a shape filter,~~ wherein the shape used in the shape filter is a tube, and the probability field represents the probability that a voxel in the in vivo image is a part of a tubular structure and the scale field represents the filter size that yields the greatest probability that the voxel belongs to a tubular structure.

12. The method of any one of claims 1 to 11, wherein the step of applying a multi-scale filter includes using a Hessian-based filter.

13. The method of any one of claims 1 to 12, wherein the step of performing the automated geometric analysis includes comparing the scale at a first position in the vasculature tree to the scale at a second position in the vasculature tree.

14. The method of any one of claims 1 to 13, wherein the step of performing the automated geometric analysis includes calculating the change in scale along a length of a branch in the vasculature tree.

15. The method of any one of claims 1 to 14, including performing automated geometric analysis throughout the entire segmented vasculature tree.

16. The method of any one of claims 1 to 15, including scanning for an embolism.

17. The method of any one of claims 1 to 16, including scanning for a vascular irregularity in the lung vasculature.

18. The method of any one of claims 1 to 17, including analysing the geometry to classify segments of the vasculature as normal or irregular.

19. The method of any one of claims 1 to 18, including inverting the image before the filtering step.

20. A method of scanning for vascular irregularities in at least one in vivo image acquired in the absence of contrast agent, the method including:

applying a shape-based filter to the in vivo image to provide a probability field data and a scale field data;

performing an automated analysis on the probability field data and/or the scale field data to detect irregularities in the vasculature.

21. The method according to claim 20, wherein the shape-based filter is a Hessian-based filter ~~including applying a multi-scale shape filter to the in vivo image~~.

22. The method according to claim 20 or claim 21, wherein the step of performing the automated analysis includes comparing the scale at a first position to the scale at a second position.

23. The method according to any one of claims 20 to 22, including performing vessel segmentation on the probability field to extract a vasculature tree from the in vivo image.

24. The method according to claim 23, including mapping the scale field to the segmented vasculature tree to quantify the geometry of the vasculature tree.

25. A method of scanning for a pulmonary embolism in at least one in vivo image acquired in the absence of contrast agent, the method including:

applying a multi-scale shape filter to the in vivo image to provide a probability field and a scale field;

performing vessel segmentation on the probability field to extract a vasculature tree;

mapping the scale field to the segmented vasculature tree to quantify the geometry of the vasculature tree; and

calculating the change in scale along a length of a branch in the vasculature tree to detect irregularities in the vasculature.

26. A method of scanning for a pulmonary embolism in the lung vasculature in at least one in vivo image acquired in the absence of contrast agent, the method including:

applying a Hessian-based multi-scale shape filter as per Frangi 1998 to provide a probability field and a scale field;

segmenting a vascular tree from the probability field by performing a region growing operation on the probability field;

skeletonising the vasculature tree by extracting the centreline of each branch in the vasculature tree;

mapping the scale field to the skeletonised vasculature tree to provide the scale of the vessel at each point in the skeletonised vasculature tree; and

calculating the change in scale along the centreline in a length of a branch in the vasculature tree to detect a pulmonary embolism.

27. A method of detecting an irregularity in lung vasculature, the method comprising the steps of:

(i) providing at least one image of a lung vasculature comprising one or more vessels, the image having been captured *in vivo* in the absence of contrast agent,

(ii) applying a shape-based filter to the image to create an output including a probability field and scale field for the lung vasculature, and using ~~one or two forms of~~ the output to segment and quantify the geometry of the lung vasculature,

(iii) analysing the ~~output in conjunction with~~ quantified geometr~~yic analysis~~ to detect irregularities in the one or more vessels of the ~~lung~~ vasculature.

28. The method according to claim 27, wherein step (ii) comprises one or more of the following sub-steps:

(ii)(a) performing a Hessian-based multi-scale shape filter (as per Frangi 1998) on the image from step (i) to provide a probability field for the lung vasculature,

(ii)(b) carrying out flood-fill selection of the probability field for the lung vasculature to yield a binary image,

(ii)(c) carrying out binary segmentations of the binary image,

(ii)(d) performing vessel centreline extraction from the binary segmentation, and

(ii)(e) associating the scale from the shape filter (filter size which yields greatest probability that any given point on the image belongs to a tubular structure) to each point along the centreline of the vasculature tree to obtain local geometry data.

29. The method according to claim 27 or claim 28, wherein the step of analysing the output includes calculating a change in vessel diameter.

30. The method according to any one of claims 27 to 29, wherein the irregularity comprises one or more pulmonary embolisms.