

wherein forming a counterpart of the colour image comprises determining distributions of the skin-characterizing variables to form the vein patterns.

14. The method as claimed in claim 13, wherein determining distributions of the skin-characterizing variables comprises applying an inverse of the functional relationship on the colour components obtained from the colour image.

15. The method as claimed in claim 14, wherein the colour components comprise a red (R) component, a green (G) component, and a blue (B) component.

~~16. The method as claimed in any one of claims 13 to 15, wherein the skin-characterizing variables comprise a volume fraction of an epidermis occupied by melanosomes, a volume fraction of a dermis occupied by blood and a depth of the dermis.~~

~~17.~~16. The method as claimed in any one of claims 13 to ~~16~~15, wherein forming the counterpart of the colour image further comprises training the neural network by back-propagation.

~~18. The method as claimed in any one of claims 13 to 17, wherein the functional relationship is formulated using at least a reflectance and a transmittance of a skin.~~

~~19. The method as claimed in claim 18, wherein the reflectance and the transmittance of the skin are dependent on reflectances and transmittances of a plurality of layers of the skin.~~

~~20. The method as claimed in claim 19, wherein each of the plurality of layers of the skin is selected from the group consisting of a stratum corneum, an epidermis and a dermis.~~

~~21. The method as claimed in any one of claims 18 to 20, wherein the functional relationship is formulated further using a spectral response function of a camera used for capturing the modelling colour image or the colour image.~~

~~22. The method as claimed in any one of claims 18 to 21, wherein the functional relationship is formulated further using a measure of an illuminant, the illuminant corresponding to a type of light source used in capturing the modelling colour image or the colour image.~~

~~23-17.~~ The method as claimed in any one of claims 1 to ~~22~~16, further comprising removing blocking artifacts in the colour image, wherein the colour image is a compressed colour image.

~~24-18.~~ The method as claimed in claim ~~23~~17, wherein removing blocking artifacts comprises using a knowledge-based approach or a one-pass algorithm.

~~25-19.~~ The method as claimed in any one of claims 1 to ~~24~~18, further comprising extracting vein patterns from an image, wherein the image comprises a plurality of pixels.

~~26-20.~~ The method as claimed in claim ~~25~~19, wherein the image is selected from the group consisting of an infrared (IR) image, a colour image, a black-and-white image and a greyscale image.

~~27-21.~~ The method as claimed in claim ~~25~~19 or ~~26~~20, wherein extracting vein patterns comprises

generating a feature map from the plurality of pixels of the image;

determining for each of the plurality of pixels the likelihood of a pixel representing a vein or a part thereof based on the feature map to form a classified output; and

binarizing the classified output into two types of pixels such that one type of pixels represents the veins while the other type of pixels represents the skin.

~~28.22.~~ The method as claimed in claim ~~2721~~, wherein the feature map comprises a scale map, or an orientation map, or a response map.

~~29.23.~~ The method as claimed in claim ~~2721~~ or ~~2822~~, wherein generating the feature map further comprises grouping the plurality of pixels; and wherein determining the likelihood of a pixel representing a vein or a part thereof comprises determining for each of the groups, the likelihood of a pixel therein representing a vein or a part thereof and to subsequently apply the likelihood outcome of that pixel to all pixels in that group.

~~30.24.~~ The method as claimed in claim ~~2923~~, wherein the plurality of pixels is grouped based on the orientation map.

~~31. — A method of extracting vein patterns from an image comprising a plurality of pixels for personal identification, the method comprising:~~

- ~~—— generating an orientation map for the plurality of pixels of the image; and~~
- ~~—— determining for each of the plurality of pixels whether a pixel represents a vein or a part thereof based on the orientation map.~~

~~32. — The method as claimed in claim 31, wherein the image is selected from the group consisting of an infrared (IR) image, a colour image, a black and white image and a greyscale image.~~

~~33.25.~~ The method as claimed in any one of claims ~~2721~~ to ~~3224~~, wherein binarizing the classified output comprises utilizing a threshold applicable to a skin area of the image to determine the veins.

34.26. The method as claimed in any one of claims 2721 to 3325, wherein extracting vein patterns further comprises representing the vein patterns with a set of points.

35.27. The method as claimed in any one of claims 2721 to 3426, wherein extracting vein patterns further comprises obtaining a skeleton of the veins using a thinning algorithm.

36.28. The method as claimed in claim 3527, wherein when the image is a colour image, the method further comprises prior to generating the feature map ~~or the orientation map~~, preconditioning the colour image.

37.29. The method as claimed in claim 3628, wherein preconditioning the colour image comprises

adaptively mapping a part of the colour image to a desired distribution such that the vein patterns become optimally visible and image contrast of the colour image is increased; and

capturing local information from the colour image such that veins are detectable from the colour image.

38.30. The method as claimed in claim 3628 or 3729, wherein preconditioning the colour image further comprises forming an objective function for the colour image.

39.31. The method as claimed in any one of claims 3628 to 3830, wherein determining the likelihood of a pixel representing a vein or a part thereof comprises allowing for manual correction of the colour image.

40.32. An apparatus for determining vein patterns from a colour image for personal identification, the apparatus comprising:

a determining unit configured to form a counterpart of the colour image by applying a functional relationship obtained from optimization on the colour image, wherein the counterpart of the colour image comprises the vein patterns.

41.33. The apparatus as claimed in claim 4032, wherein the determining unit configured to form the counterpart of the colour image by applying the functional relationship on the colour image is configured to form the counterpart of the colour image by applying a neural network on the colour image.

42.34. The apparatus as claimed in claim 4032 or 4133, wherein the functional relationship is formulated using a modelling colour image and a counterpart of the modelling colour image, wherein the counterpart of the modelling colour image comprises modelling vein patterns.

43.35. The apparatus as claimed in any one of claims 4032 to 4234, wherein the functional relationship obtained from optimization is formulated using an approximate regression comprising a least squares-error energy function with an optimal weight.

44.36. The apparatus as claimed in any one of claims 4032 to 4335, wherein the functional relationship comprises a plurality of functional relationships between modelling colour images and counterparts of the modelling colour images.

45.37. The apparatus as claimed in claim 4436, further comprising a selection unit configured to select a functional relationship from the plurality of functional relationships such that the determining unit is configured to apply the selected functional relationship on the colour image to form the counterpart of the colour image.

46.38. The apparatus as claimed in any one of claims 4032 to 4537, further comprising a grouping unit configured to group parts of the counterpart of the colour image.

~~47.39.~~ The apparatus as claimed in any one of claims ~~4032~~ to ~~4638~~, wherein the colour image is represented by a greyscale version.

~~48.40.~~ The apparatus as claimed in any one of claims ~~4032~~ to ~~4739~~, wherein the counterpart of the modelling colour image comprises an infrared (IR) image or a near-infrared (NIR) image.

~~49.41.~~ The apparatus as claimed in claim ~~4840~~, wherein the functional relationship comprises a plurality of functional relationships between modelling colour images and IR images of the modelling colour images, wherein each modelling colour image and the respective IR image thereof forms an image pair; and wherein for at least one of the modelling colour images, an IR image of the at least one of the modelling colour images is captured simultaneously by a camera.

~~50.42.~~ The apparatus as claimed in claim ~~4941~~, wherein the determining unit is configured to be trained with a set of image pairs formed by the modelling colour images and the respective IR images thereof.

~~51.43.~~ The apparatus as claimed in any one of claims ~~4840~~ to ~~5042~~, wherein the determining unit applies the functional relationship comprising a parametric vector for predicating the IR image from the colour image.

~~52.44.~~ The apparatus as claimed in any one of claims ~~4739~~ to ~~5143~~, wherein the grouping unit is configured to assign pixels in the IR image having substantially the same colour to a same group.

~~53.45.~~ The apparatus as claimed in any one of claims ~~4032~~ to ~~4739~~, wherein the colour image comprises colour components;

wherein the counterpart of the colour image comprises skin-characterizing variables; and

wherein the determining unit is configured to determine distributions of the skin-characterizing variables to form the vein patterns.

54.46. The apparatus as claimed in claim 5345, wherein the determining unit is configured to apply an inverse of the functional relationship on the colour components obtained from the colour image.

55.47. The apparatus as claimed in claim 5345 or 5446 wherein the colour components comprise a red (R) component, a green (G) component, and a blue (B) component.

~~56. The apparatus as claimed in any one of claims 53 to 55, wherein the skin-characterizing variables comprise a volume fraction of an epidermis occupied by melanosomes, a volume fraction of a dermis occupied by blood and a depth of the dermis.~~

57.48. The apparatus as claimed in any one of claims 5345 to 5647, wherein the determining unit comprises at least one neural network.

58.49. The apparatus as claimed in claim 5748, wherein the at least one neural network comprises a feed-forward neural network.

59.50. The apparatus as claimed in claim 5849, wherein the feed-forward neural network comprises a three-layered feed-forward neural network.

60.51. The apparatus as claimed in any one of claims 5345 to 5950, wherein the determining unit comprises a network trainer configured to train the at least one neural network by back-propagation.

~~61.52.~~ The apparatus as claimed in claim ~~60~~51, wherein the network trainer uses an infrared (IR) image for training the at least one neural network.

~~62.53.~~ The apparatus as claimed in any one of claims ~~57~~48 to ~~61~~52, wherein the at least one neural network is dependent on spectral response functions of a camera used for capturing the colour image.

~~63.54.~~ The apparatus as claimed in any one of claims ~~57~~48 to ~~62~~53, wherein the at least one neural network is dependent on a measure of an illuminant corresponding to a type of light source used in capturing the colour image.

~~64.55.~~ The apparatus as claimed in claim ~~62~~53 or ~~63~~54, wherein the at least one neural network comprises different neural networks dependent on different spectral response functions and different illuminants.

~~65.~~ ~~The apparatus as claimed in any one of claims 53 to 64, wherein the functional relationship is formulated using at least a reflectance and a transmittance of a skin.~~

~~66.~~ ~~The apparatus as claimed in claim 65, wherein the reflectance and the transmittance of the skin are dependent on reflectances and transmittances of a plurality of layers of the skin.~~

~~67.~~ ~~The apparatus as claimed in claim 66, wherein each of the plurality of layers of the skin is selected from the group consisting of a stratum corneum, an epidermis and a dermis.~~

~~68.56.~~ The apparatus as claimed in any one of claims ~~53~~45 to ~~67~~55, wherein the functional relationship is formulated further using a spectral response function of a camera used for capturing the modelling colour image or the colour image.

~~69.57.~~ The apparatus as claimed in claim ~~68~~56, wherein the spectral response function of the camera comprises a plurality of spectral response functions of the camera comprising a R spectral response function, a G spectral response function, and a B spectral response function.

~~70.58.~~ The apparatus as claimed in any one of claims ~~53~~45 to ~~69~~57, wherein the functional relationship is formulated further using a measure of an illuminant, the illuminant corresponding to a type of light source used in capturing the modelling colour image or the colour image.

~~71.59.~~ The apparatus as claimed in claim ~~70~~58, wherein the type of light source is selected from the group consisting of daylight, an incandescent lamp and a fluorescent lamp.

~~72.60.~~ The apparatus as claimed in claim ~~70~~58 or ~~71~~59, wherein the illuminant is selected from the group consisting of an illuminant D65, an illuminant A and an illuminant F.

~~73.61.~~ The apparatus as claimed in any one of claims ~~40~~32 to ~~72~~60, further comprising an image pre-processor configured to remove blocking artifacts in the colour image, wherein the colour image is a compressed colour image.

~~74.62.~~ The apparatus as claimed in claim ~~73~~61, wherein the image pre-processor uses a knowledge-based approach or a one-pass algorithm.

~~75.63.~~ The apparatus as claimed in claim ~~73~~61 or ~~74~~62, wherein the image pre-processor comprises an indexing mechanism.

76.64. The apparatus as claimed in any one of claims 4032 to 7563, further comprising a vein pattern extraction unit configured to extract vein patterns from an image, the image comprising a plurality of pixels.

77.65. The apparatus as claimed in claim 7664, wherein the image is selected from the group consisting of an infrared (IR) image, a colour image, a black-and-white image and a greyscale image.

78.66. The apparatus as claimed in claim 7664 or 7765, wherein the vein pattern extraction unit comprises

a map generating unit configured to generate a feature map for the plurality of pixels of the image;

a classifier configured to determine for each of the plurality of pixels the likelihood of a pixel representing a vein or a part thereof based on the feature map to form a classified output; and

a thresholding scheme unit configured to binarize the classified output into two types of pixels such that one type of pixels represents the veins while the other type of pixels represents the skin.

79.67. The apparatus as claimed in claim 7866, wherein the map generating unit comprises a multi-scale directional filter.

80.68. The apparatus as claimed in claim 7866 or 7967, wherein the feature map comprises a scale map, or an orientation map, or a response map.

81.69. The apparatus as claimed in any one of claims 7866 to 8068, wherein the map generating unit is further configured to group the plurality of pixels; and wherein the classifier is configured to determine for each of the groups, the likelihood of a pixel therein representing a vein or a part thereof and to subsequently apply the likelihood outcome of that pixel to all pixels in that group.

~~82.70.~~ The apparatus as claimed in claim ~~8169~~, wherein the plurality of pixels is grouped based on the orientation map.

~~83.——An apparatus for extracting vein patterns from an image comprising a plurality of pixels for personal identification, the apparatus comprising a vein pattern extraction unit comprising:~~

~~a map generating unit configured to generate an orientation map for the plurality of pixels of the image; and~~

~~a classifier configured to determine for each of the plurality of pixels whether a pixel represents a vein or a part thereof based on the orientation map.~~

~~84.——The apparatus as claimed in claim 83, wherein the image is selected from the group consisting of an infrared (IR) image, a colour image, a black and white image and a greyscale image.~~

~~85.71.~~ The apparatus as claimed in any one of claims ~~7866~~ to ~~8470~~, wherein the thresholding scheme unit utilizes a threshold applicable to a skin area of the image to determine the veins.

~~86.72.~~ The apparatus as claimed in any one of claims ~~7866~~ to ~~8571~~, wherein the vein pattern extraction unit further comprises a representation unit configured to represent the vein patterns with a set of points.

~~87.73.~~ The apparatus as claimed in any one of claims ~~7866~~ to ~~8672~~, wherein the vein pattern extraction unit further comprises a thinning unit configured to obtain a skeleton of the veins using a thinning algorithm.

~~88.74.~~ The apparatus as claimed in claim ~~8773~~, wherein when the image is a colour image, the apparatus further comprises an optimization unit configured to precondition the colour image for the map generating unit.

~~89.75.~~ The apparatus as claimed in claim ~~8874~~, wherein the optimization unit comprises

an intensity adjustment unit configured to explore a searching space formed by images generated from colour images and

a filter configured to capture local information from the colour image such that veins are detectable from the colour image.

~~90.76.~~ The apparatus as claimed in claim ~~8874~~ or ~~8975~~, wherein the optimization unit further comprises

an objective function evaluator configured to form an objective function for the colour image.

~~91.77.~~ The apparatus as claimed in any one of claims ~~8874~~ to ~~9076~~, wherein an output of the classifier allows for manual correction of the colour image.

~~92.78.~~ The method as claimed in any one of claims 1 to ~~3931~~ or the apparatus as claimed in any one of claims ~~4032~~ to ~~9177~~ for use in forensic identification.

CLAIMS

1. A method of determining vein patterns from a colour image for personal identification, the method comprising:

forming a counterpart of the colour image by applying a functional relationship obtained from optimization on the colour image, wherein the counterpart of the colour image comprises the vein patterns.

2. The method as claimed in claim 1, wherein in forming the counterpart of the colour image, applying the functional relationship on the colour image is applying a neural network on the colour image.

3. The method as claimed in claim 1 or 2, wherein the functional relationship is formulated using a modelling colour image and a counterpart of the modelling colour image, wherein the counterpart of the modelling colour image comprises modelling vein patterns.

4. The method as claimed in any one of claims 1 to 3, wherein the functional relationship obtained from optimization is formulated using an approximate regression comprising a least-squares-error energy function with an optimal weight.

5. The method as claimed in any one of claims 1 to 4, wherein forming the counterpart of the colour image further comprises selecting the functional relationship from a plurality of functional relationships between modelling colour images and counterparts of the modelling colour images.

6. The method as claimed in claim 5, further comprising grouping parts of the counterpart of the colour image.

7. The method as claimed in any one of claims 1 to 6, wherein the colour image is represented by a greyscale version.

8. The method as claimed in any one of claims 1 to 7, wherein the counterpart of the modelling colour image comprises an infrared (IR) image or a near-infrared (NIR) image.

9. The method as claimed in claim 8, wherein the functional relationship comprises a plurality of functional relationships between colour images and IR images wherein each colour image and the respective IR image thereof forms an image pair; and wherein for at least one of the colour images, an IR image of the at least one of the colour images is captured simultaneously by a camera.

10. The method as claimed in claim 9, wherein forming the counterpart of the colour image further comprises training with a set of image pairs formed by the modelling colour images and the IR images thereof.

11. The method as claimed in any one of claims 8 to 10, wherein the functional relationship comprises a parametric vector for predicating the IR image from the colour image.

12. The method as claimed in any one of claims 8 to 11, wherein grouping parts of the counterpart of the colour image comprises assigning pixels in the IR image having substantially the same colour to a same group.

13. The method as claimed in any one of claims 1 to 7,
wherein the colour image comprises colour components;
wherein the counterpart of the colour image comprises skin-characterizing variables; and

wherein forming a counterpart of the colour image comprises determining distributions of the skin-characterizing variables to form the vein patterns.

14. The method as claimed in claim 13, wherein determining distributions of the skin-characterizing variables comprises applying an inverse of the functional relationship on the colour components obtained from the colour image.

15. The method as claimed in claim 14, wherein the colour components comprise a red (R) component, a green (G) component, and a blue (B) component.

16. The method as claimed in any one of claims 13 to 15, wherein forming the counterpart of the colour image further comprises training the neural network by back-propagation.

17. The method as claimed in any one of claims 1 to 16, further comprising removing blocking artifacts in the colour image, wherein the colour image is a compressed colour image.

18. The method as claimed in claim 17, wherein removing blocking artifacts comprises using a knowledge-based approach or a one-pass algorithm.

19. The method as claimed in any one of claims 1 to 18, further comprising extracting vein patterns from an image, wherein the image comprises a plurality of pixels.

20. The method as claimed in claim 19, wherein the image is selected from the group consisting of an infrared (IR) image, a colour image, a black-and-white image and a greyscale image.

21. The method as claimed in claim 19 or 20, wherein extracting vein patterns comprises

generating a feature map from the plurality of pixels of the image;
determining for each of the plurality of pixels the likelihood of a pixel representing a vein or a part thereof based on the feature map to form a classified output;
and
binarizing the classified output into two types of pixels such that one type of pixels represents the veins while the other type of pixels represents the skin.

22. The method as claimed in claim 21, wherein the feature map comprises a scale map, or an orientation map, or a response map.

23. The method as claimed in claim 21 or 22, wherein generating the feature map further comprises grouping the plurality of pixels; and wherein determining the likelihood of a pixel representing a vein or a part thereof comprises determining for each of the groups, the likelihood of a pixel therein representing a vein or a part thereof and to subsequently apply the likelihood outcome of that pixel to all pixels in that group.

24. The method as claimed in claim 23, wherein the plurality of pixels is grouped based on the orientation map.

25. The method as claimed in any one of claims 21 to 24, wherein binarizing the classified output comprises utilizing a threshold applicable to a skin area of the image to determine the veins.

26. The method as claimed in any one of claims 21 to 25, wherein extracting vein patterns further comprises representing the vein patterns with a set of points.

27. The method as claimed in any one of claims 21 to 26, wherein extracting vein patterns further comprises obtaining a skeleton of the veins using a thinning algorithm.

28. The method as claimed in claim 27, wherein when the image is a colour image, the method further comprises prior to generating the feature map, preconditioning the colour image.

29. The method as claimed in claim 28, wherein preconditioning the colour image comprises

adaptively mapping a part of the colour image to a desired distribution such that the vein patterns become optimally visible and image contrast of the colour image is increased; and

capturing local information from the colour image such that veins are detectable from the colour image.

30. The method as claimed in claim 28 or 29, wherein preconditioning the colour image further comprises forming an objective function for the colour image.

31. The method as claimed in any one of claims 28 to 30, wherein determining the likelihood of a pixel representing a vein or a part thereof comprises allowing for manual correction of the colour image.

32. An apparatus for determining vein patterns from a colour image for personal identification, the apparatus comprising:

a determining unit configured to form a counterpart of the colour image by applying a functional relationship obtained from optimization on the colour image, wherein the counterpart of the colour image comprises the vein patterns.

33. The apparatus as claimed in claim 32, wherein the determining unit configured to form the counterpart of the colour image by applying the functional relationship on the colour image is configured to form the counterpart of the colour image by applying a neural network on the colour image.

34. The apparatus as claimed in claim 32 or 33, wherein the functional relationship is formulated using a modelling colour image and a counterpart of the modelling colour image, wherein the counterpart of the modelling colour image comprises modelling vein patterns.

35. The apparatus as claimed in any one of claims 32 to 34, wherein the functional relationship obtained from optimization is formulated using an approximate regression comprising a least squares-error energy function with an optimal weight.

36. The apparatus as claimed in any one of claims 32 to 35, wherein the functional relationship comprises a plurality of functional relationships between modelling colour images and counterparts of the modelling colour images.

37. The apparatus as claimed in claim 36, further comprising a selection unit configured to select a functional relationship from the plurality of functional relationships such that the determining unit is configured to apply the selected functional relationship on the colour image to form the counterpart of the colour image.

38. The apparatus as claimed in any one of claims 32 to 37, further comprising a grouping unit configured to group parts of the counterpart of the colour image.

39. The apparatus as claimed in any one of claims 32 to 38, wherein the colour image is represented by a greyscale version.

40. The apparatus as claimed in any one of claims 32 to 39, wherein the counterpart of the modelling colour image comprises an infrared (IR) image or a near-infrared (NIR) image.

41. The apparatus as claimed in claim 40, wherein the functional relationship comprises a plurality of functional relationships between modelling colour images and IR

images of the modelling colour images, wherein each modelling colour image and the respective IR image thereof forms an image pair; and wherein for at least one of the modelling colour images, an IR image of the at least one of the modelling colour images is captured simultaneously by a camera.

42. The apparatus as claimed in claim 41, wherein the determining unit is configured to be trained with a set of image pairs formed by the modelling colour images and the respective IR images thereof.

43. The apparatus as claimed in any one of claims 40 to 42, wherein the determining unit applies the functional relationship comprising a parametric vector for predicating the IR image from the colour image.

44. The apparatus as claimed in any one of claims 39 to 43, wherein the grouping unit is configured to assign pixels in the IR image having substantially the same colour to a same group.

45. The apparatus as claimed in any one of claims 32 to 39,
wherein the colour image comprises colour components;
wherein the counterpart of the colour image comprises skin-characterizing variables; and
wherein the determining unit is configured to determine distributions of the skin-characterizing variables to form the vein patterns.

46. The apparatus as claimed in claim 45, wherein the determining unit is configured to apply an inverse of the functional relationship on the colour components obtained from the colour image.

47. The apparatus as claimed in claim 45 or 46 wherein the colour components comprise a red (R) component, a green (G) component, and a blue (B) component.

48. The apparatus as claimed in any one of claims 45 to 47, wherein the determining unit comprises at least one neural network.

49. The apparatus as claimed in claim 48, wherein the at least one neural network comprises a feed-forward neural network.

50. The apparatus as claimed in claim 49, wherein the feed-forward neural network comprises a three-layered feed-forward neural network.

51. The apparatus as claimed in any one of claims 45 to 50, wherein the determining unit comprises a network trainer configured to train the at least one neural network by back-propagation.

52. The apparatus as claimed in claim 51, wherein the network trainer uses an infrared (IR) image for training the at least one neural network.

53. The apparatus as claimed in any one of claims 48 to 52, wherein the at least one neural network is dependent on spectral response functions of a camera used for capturing the colour image.

54. The apparatus as claimed in any one of claims 48 to 53, wherein the at least one neural network is dependent on a measure of an illuminant corresponding to a type of light source used in capturing the colour image.

55. The apparatus as claimed in claim 53 or 54, wherein the at least one neural network comprises different neural networks dependent on different spectral response functions and different illuminants.

56. The apparatus as claimed in any one of claims 45 to 55, wherein the functional relationship is formulated further using a spectral response function of a camera used for capturing the modelling colour image or the colour image.

57. The apparatus as claimed in claim 56, wherein the spectral response function of the camera comprises a plurality of spectral response functions of the camera comprising a R spectral response function, a G spectral response function, and a B spectral response function.

58. The apparatus as claimed in any one of claims 45 to 57, wherein the functional relationship is formulated further using a measure of an illuminant, the illuminant corresponding to a type of light source used in capturing the modelling colour image or the colour image.

59. The apparatus as claimed in claim 58, wherein the type of light source is selected from the group consisting of daylight, an incandescent lamp and a fluorescent lamp.

60. The apparatus as claimed in claim 58 or 59, wherein the illuminant is selected from the group consisting of an illuminant D65, an illuminant A and an illuminant F.

61. The apparatus as claimed in any one of claims 32 to 60, further comprising an image pre-processor configured to remove blocking artifacts in the colour image, wherein the colour image is a compressed colour image.

62. The apparatus as claimed in claim 61, wherein the image pre-processor uses a knowledge-based approach or a one-pass algorithm.

63. The apparatus as claimed in claim 61 or 62, wherein the image pre-processor comprises an indexing mechanism.

64. The apparatus as claimed in any one of claims 32 to 63, further comprising a vein pattern extraction unit configured to extract vein patterns from an image, the image comprising a plurality of pixels.

65. The apparatus as claimed in claim 64, wherein the image is selected from the group consisting of an infrared (IR) image, a colour image, a black-and-white image and a greyscale image.

66. The apparatus as claimed in claim 64 or 65, wherein the vein pattern extraction unit comprises

a map generating unit configured to generate a feature map for the plurality of pixels of the image;

a classifier configured to determine for each of the plurality of pixels the likelihood of a pixel representing a vein or a part thereof based on the feature map to form a classified output; and

a thresholding scheme unit configured to binarize the classified output into two types of pixels such that one type of pixels represents the veins while the other type of pixels represents the skin.

67. The apparatus as claimed in claim 66, wherein the map generating unit comprises a multi-scale directional filter.

68. The apparatus as claimed in claim 66 or 67, wherein the feature map comprises a scale map, or an orientation map, or a response map.

69. The apparatus as claimed in any one of claims 66 to 68, wherein the map generating unit is further configured to group the plurality of pixels; and wherein the classifier is configured to determine for each of the groups, the likelihood of a pixel therein representing a vein or a part thereof and to subsequently apply the likelihood outcome of that pixel to all pixels in that group.

70. The apparatus as claimed in claim 69, wherein the plurality of pixels is grouped based on the orientation map.

71. The apparatus as claimed in any one of claims 66 to 70, wherein the thresholding scheme unit utilizes a threshold applicable to a skin area of the image to determine the veins.

72. The apparatus as claimed in any one of claims 66 to 71, wherein the vein pattern extraction unit further comprises a representation unit configured to represent the vein patterns with a set of points.

73. The apparatus as claimed in any one of claims 66 to 72, wherein the vein pattern extraction unit further comprises a thinning unit configured to obtain a skeleton of the veins using a thinning algorithm.

74. The apparatus as claimed in claim 73, wherein when the image is a colour image, the apparatus further comprises an optimization unit configured to precondition the colour image for the map generating unit.

75. The apparatus as claimed in claim 74, wherein the optimization unit comprises

an intensity adjustment unit configured to explore a searching space formed by images generated from colour images and

a filter configured to capture local information from the colour image such that veins are detectable from the colour image.

76. The apparatus as claimed in claim 74 or 75, wherein the optimization unit further comprises

an objective function evaluator configured to form an objective function for the colour image.

77. The apparatus as claimed in any one of claims 74 to 76, wherein an output of the classifier allows for manual correction of the colour image.

78. The method as claimed in any one of claims 1 to 31 or the apparatus as claimed in any one of claims 32 to 77 for use in forensic identification.