FORM 2

THE PATENTS ACT, 1970

(39 of 1970)

& The Patent Rules, 2003

COMPLETE SPECIFICATION

1. TITLE OF THE INVENTION:

THREE DIMENSIONAL CAMERA AND PROJECTOR FOR SAME

2. APPLICANT:

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3. PREAMBLE TO THE DESCRIPTION:

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

We Claim:

1. A 3D imaging apparatus comprising:

 a projector, comprising:

 a laser array comprising a plurality of individual emitters;

 a mask for providing a structured light pattern,

 wherein a distance between the laser array and the mask is such that, according to a non-uniformity profile of the plurality of individual emitters, a uniformity criterion related to the light intensity distribution across the mask plane is met;

 projection optics to image the structured light pattern onto an object;

 an imaging sensor adapted to capture an image of the object with the structured light pattern projected thereon; and

 a processing unit adapted to process the image to determine range parameters.

2. The apparatus according to claim 1, wherein the mask is positioned at a minimal distance from the laser array, where the minimal distance is a shortest relative distance where the uniformity criterion is met.

3. The apparatus according to claim 1, position of the mask relative to the laser array is determined further according to a maximal relative distance between the mask and the laser array.

4. The apparatus according to claim 3, wherein the maximal relative distance between the mask and the laser array is associated with a predetermined minimum power transfer of the laser array through the mask.

5. The apparatus according to claim 3, wherein the maximal relative distance between the mask and the laser array is associated with a predetermined light intensity across the mask surface.

6. The apparatus according to claim 3, wherein the position of the mask relative to the laser array is determined further according a minimal relative distance between the mask and

the laser array, where the minimal distance is a minimal relative distance where the uniformity criterion is met.

7. The apparatus according to claim 6, wherein the minimal relative distance and the maximal relative distance define a relative range, and the mask is positioned relative to the laser array such that the distance between the mask and the laser is within the relative range.

8. The apparatus according to claim 1, wherein the position of the mask relative to the laser array is determined further according to a tolerance specification.

9. The apparatus according to claim 8, wherein the tolerance specification is associated with a characteristic of the mask and/or of the structured light pattern which the mask provides.

10. The apparatus according to claim 1, wherein the position of the mask relative to the laser array is determined further according to a constraint specification.

11. The apparatus according to claim 10, wherein the constraint specification is associated with a relation among a density of a light intensity distribution pattern of light that impinges upon the mask and a density of the mask's pattern.

12. The apparatus according to claim 1, wherein the plurality of individual emitters are characterized by substantially identical emitter size, substantially identical light divergence output, substantially identical light power output, substantially equal mutual spacing, and wherein the non-uniformity profile is related to the light divergence output, and light power output of the individual emitters and to mutual spacing among the individual emitters.

13. The apparatus according to claim 1, wherein the uniformity criterion is related to a target dynamic range.

14. The apparatus according to claim 1, wherein the uniformity criterion is associated with a relation between a density of the individual emitters in the laser array and a density of feature types in the structured light pattern.

15. The apparatus according to claim 1, wherein the mask is sized according to a spatial intensity profile of the light emitted by the laser array.

16. The apparatus according to claim 15, wherein the spatial intensity profile defines an area of uniform light of the laser array at the distance where the mask is positioned relative to the laser array.

17. The apparatus according to claim 15, wherein the mask is sized further according to the uniformity criterion.

18. The apparatus according to claim 15, wherein the mask is sized further according to a light power transfer criterion.

19. The apparatus according to claim 1, wherein the laser array is a VCSEL array.

20. The apparatus according to claim 1, wherein the laser array meets a defective emitter criterion that is associated with a distribution and a ratio of individual defective emitters among the plurality of individual emitters.

21. The apparatus according to claim 1, wherein the laser array and the mask are positioned with respect to one another at a distance that is less than 5mm.

22. The apparatus according to claim 1, wherein the laser array and the mask are positioned with respect to one another at a distance that is less than 2mm.

23. A method of enabling 3D imaging, comprising:

positioning a mask for providing a structured light pattern relative to a laser array that includes a plurality of individual emitters at a distance where, according to a non-

uniformity profile of the plurality of individual emitters, a uniformity criterion related to the light intensity distribution across the mask plane is met;

positioning projection optics in the optical path of light from individual emitters passing through the mask, to enable imaging of the structured light pattern onto an object; and

positioning an imaging sensor in the optical path of reflected projected light to enable capturing of an image of the object with the structured light pattern projected thereon to further enable determining range parameters.

24. The method according to claim 23, wherein said positioning the mask comprises positioning the mask at a minimal distance from the laser array, where the minimal distance is a shortest relative distance where the uniformity criterion is met.

25. The method according to claim 23, wherein the position of the mask relative to the laser array is determined further according to a maximal relative distance between the mask and the laser array.

26. The method according to claim 25, wherein the maximal relative distance between the mask and the laser array is associated with a predetermined minimum power transfer of the laser array through the mask.

27. The method according to claim 25, wherein the maximal relative distance between the mask and the laser array is associated with a predetermined light intensity across the mask surface.

28. The method according to claim 25, wherein the position of the mask relative to the laser array is determined further according a minimal relative distance between the mask and the laser array, where the minimal distance is a minimal relative distance where the uniformity criterion is met.

29. The method according to claim 28, wherein the minimal relative distance and the maximal relative distance define a relative range, and the mask is positioned relative to the laser array such that the distance between the mask and the laser is within the relative range.

30. The method according to claim 23, wherein the position of the mask relative to the laser array is determined further according to a tolerance specification.

31. The method according to claim 30, wherein the tolerance specification is associated with a characteristic of the mask and/or of the structured light pattern which the mask provides.

32. The method according to claim 23, wherein the position of the mask relative to the laser array is determined further according to a constraint specification.

33. The method according to claim 32, wherein the constraint specification is associated with a relation among a density of a light intensity distribution pattern of light that impinges upon the mask and a density of the mask's pattern.

34. The method according to claim 23, wherein the plurality of individual emitters are characterized by substantially identical emitter size, substantially identical light divergence output, substantially identical light power output, substantially equal mutual spacing, and wherein the non-uniformity profile is related to the light divergence output, and light power output of the individual emitters and to mutual spacing among the individual emitters.

35. The method according to claim 23, wherein the uniformity criterion is related to a target dynamic range.

36. The method according to claim 23, wherein the uniformity criterion is associated with a relation between a density of the individual emitters in the laser array and a density of feature types in the structured light pattern.

37. The method according to claim 23, wherein the mask is sized according to a spatial intensity profile of the light emitted by the laser array.

38. The method according to claim 37, wherein the spatial intensity profile defines an area of uniform light of the laser array at the distance where the mask is positioned relative to the laser array.

39. The method according to claim 37, wherein the mask is sized further according to the uniformity criterion.

40. The method according to claim 37, wherein the mask is sized further according to a light power transfer criterion.

41. The method according to claim 23, wherein the laser array and the mask are positioned with respect to one another at a distance that is less than 5mm.

42. The method according to claim 23, wherein the laser array and the mask are positioned with respect to one another at a distance that is less than 2mm.

43. A projector for three dimensional range finding, comprising:

a laser array comprising a plurality of individual emitters;

a mask for providing a structured light pattern,

wherein the mask is positioned relative to the laser array at a distance where, according to a non-uniformity profile of the plurality of individual emitters, a uniformity criterion related to the light intensity distribution across the mask plane is met;

projection optics to image the structured light pattern on an object.

44. The apparatus according to claim 43, wherein the mask is positioned at a minimal distance from the laser array, where the minimal distance is a shortest relative distance where the uniformity criterion is met.

45. The apparatus according to claim 43, wherein the position of the mask relative to the laser array is determined further according to a maximal relative distance between the mask and the laser array.

46. The apparatus according to claim 45, wherein the maximal relative distance between the mask and the laser array is associated with a predetermined minimum power transfer of the laser array through the mask.

47. The apparatus according to claim 45, wherein the maximal relative distance between the mask and the laser array is associated with a predetermined light intensity across the mask surface.

48. The apparatus according to claim 45, wherein the position of the mask relative to the laser array is determined further according a minimal relative distance between the mask and the laser array, where the minimal distance is a minimal relative distance where the uniformity criterion is met.

49. The apparatus according to claim 48, wherein the minimal relative distance and the maximal relative distance define a relative range, and the mask is positioned relative to the laser array such that the distance between the mask and the laser is within the relative range.

50. The apparatus according to claim 43, wherein the position of the mask relative to the laser array is determined further according to a tolerance specification.

51. The apparatus according to claim 50, wherein the tolerance specification is associated with a characteristic of the mask and/or of the structured light pattern which the mask provides.

52. The apparatus according to claim 43, wherein the position of the mask relative to the laser array is determined further according to a constraint specification.

53. The apparatus according to claim 52, wherein the constraint specification is associated with a relation among a density of a light intensity distribution pattern of light that impinges upon the mask and a density of the mask's pattern.

54. The apparatus according to claim 43, wherein the plurality of individual emitters are characterized by substantially identical emitter size, substantially identical light divergence output, substantially identical light power output, substantially equal mutual spacing, and wherein the non-uniformity profile is related to the light divergence output, and light power output of the individual emitters and to mutual spacing among the individual emitters.

55. The apparatus according to claim 43, wherein the uniformity criterion is related to a target dynamic range.

56. The apparatus according to claim 43, wherein the uniformity criterion is associated with a relation between a density of the individual emitters in the laser array and a density of feature types in the structured light pattern.

57. The apparatus according to claim 43, wherein the mask is sized according to a spatial intensity profile of the light emitted by the laser array.

58. The apparatus according to claim 57, wherein the spatial intensity profile defines an area of uniform light of the laser array at the distance where the mask is positioned relative to the laser array.

59. The apparatus according to claim 57, wherein the mask is sized further according to the uniformity criterion.

60. The apparatus according to claim 57, wherein the mask is sized further according to a light power transfer criterion.

61. The apparatus according to claim 43, wherein the laser array is a VCSEL array.

62. The apparatus according to claim 43, wherein the laser array meets a defective emitter criterion that is associated with a distribution and a ratio of individual defective emitters among the plurality of individual emitters.

63. The apparatus according to claim 43, wherein the laser array and the mask are positioned with respect to one another at a distance that is less than 5mm.

64. The apparatus according to claim 43, wherein the laser array and the mask are positioned with respect to one another at a distance that is less than 2mm.

65. A method of enabling 3D range finding, comprising:

positioning a mask for providing a structured light pattern relative to a laser array that includes a plurality of individual emitters at a distance where, according to a non-uniformity profile of the plurality of individual emitters, a uniformity criterion related to the light intensity distribution across the mask plane is met; and

positioning projection optics in the optical path of light from individual emitters passing through the mask, to enable imaging of the structured light pattern onto an object.

66. The method according to claim 65, wherein said positioning the mask comprises positioning the mask at a minimal distance from the laser array, where the minimal distance is a shortest relative distance where the uniformity criterion is met.

67. The method according to claim 65, wherein the position of the mask relative to the laser array is determined further according to a maximal relative distance between the mask and the laser array.

68. The method according to claim 67, wherein the maximal relative distance between the mask and the laser array is associated with a predetermined minimum power transfer of the laser array through the mask.

69. The method according to claim 67, wherein the maximal relative distance between the mask and the laser array is associated with a predetermined light intensity across the mask surface.

70. The method according to claim 67, wherein the position of the mask relative to the laser array is determined further according a minimal relative distance between the mask and the laser array, where the minimal distance is a minimal relative distance where the uniformity criterion is met.

71. The method according to claim 70, wherein the minimal relative distance and the maximal relative distance define a relative range, and the mask is positioned relative to the laser array such that the distance between the mask and the laser is within the relative range.

72. The method according to claim 65, wherein the position of the mask relative to the laser array is determined further according to a tolerance specification.

73. The method according to claim 72, wherein the tolerance specification is associated with a characteristic of the mask and/or of the structured light pattern which the mask provides.

74. The method according to claim 65, wherein the position of the mask relative to the laser array is determined further according to a constraint specification.

75. The method according to claim 74, wherein the constraint specification is associated with a relation among a density of a light intensity distribution pattern of light that impinges upon the mask and a density of the mask's pattern.

76. The method according to claim 65, wherein the plurality of individual emitters are characterized by substantially identical emitter size, substantially identical light divergence output, substantially identical light power output, substantially equal mutual spacing, and wherein the non-uniformity profile is related to the light divergence output, and light power output of the individual emitters and to mutual spacing among the individual emitters.

77. The method according to claim 65, wherein the uniformity criterion is related to a target dynamic range.

78. The method according to claim 65, wherein the uniformity criterion is associated with a relation between a density of the individual emitters in the laser array and a density of feature types in the structured light pattern.

79. The method according to claim 65, wherein the mask is sized according to a spatial intensity profile of the light emitted by the laser array.

80. The method according to claim 79, wherein the spatial intensity profile defines an area of uniform light of the laser array at the distance where the mask is positioned relative to the laser array.

81. The method according to claim 79, wherein the mask is sized further according to the uniformity criterion.

82. The method according to claim 79, wherein the mask is sized further according to a light power transfer criterion.

83. The method according to claim 65, wherein the laser array and the mask are positioned with respect to one another at a distance that is less than 5mm.

84. The method according to claim 65, wherein the laser array and the mask are positioned with respect to one another at a distance that is less than 2mm.

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