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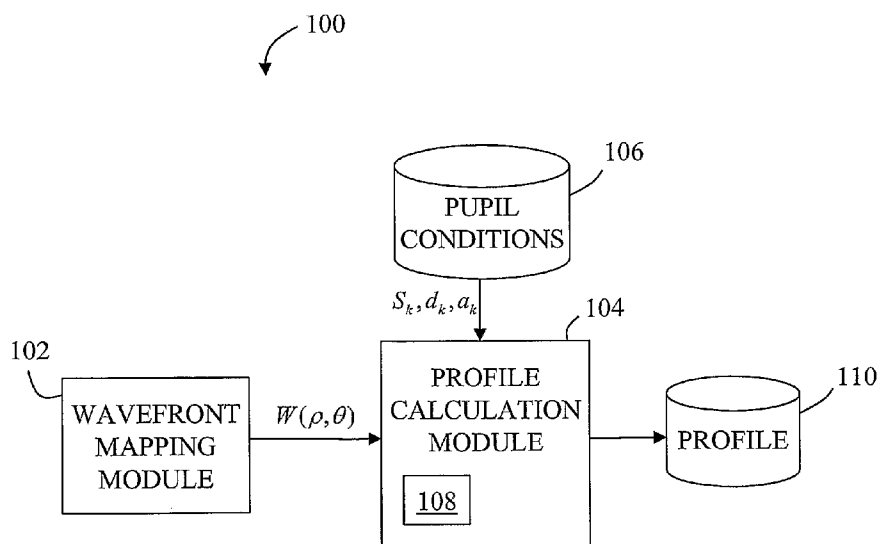
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(54) Title: OCULAR WAVEFRONT-CORRECTION PROFILING



(57) Abstract: Providing multi-focal visual correction includes determining a plurality of pupil conditions for an eye and determining a target wavefront profile on the basis of the plurality of pupil conditions.

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— *with amended claims*

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AMENDED CLAIMS

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1. A method for providing multi-focal visual correction, the method comprising:

5 determining a plurality of pupil conditions for an eye, wherein a pupil position corresponding to a first pupil condition is non-concentric with a pupil position corresponding to a second pupil condition and determining a target wavefront profile on the basis of the plurality of pupil conditions.

2. The method of claim 1, further comprising:
10 determining a wavefront aberration map for the eye; and determining a wavefront-correction profile on the basis of the target wavefront profile and the wavefront aberration map.

3 The method of claim 2, wherein the wavefront-correction profile is based on a difference between the target wavefront profile and a reference wavefront
15 profile related to the wavefront aberration map.

4. The method of claim 1, wherein determining a plurality of pupil conditions for an eye comprises determining a change in a size of a pupil of the eye, and a change in a position of the pupil.

5. The method of claim 1, wherein determining a plurality of pupil
20 conditions for an eye comprises determining a plurality of desired visual conditions; and estimating pupil conditions corresponding to each of the plurality of desired visual conditions.

6. The method of claim 1, wherein determining a plurality of pupil conditions for an eye comprises simulating a plurality of desired visual conditions; and
25 measuring pupil conditions resulting from each of the desired visual conditions.

7 The method of claim 1, wherein determining a plurality of pupil
conditions for an eye comprises determining a pupil condition corresponding to a
lighting condition.

8 The method of claim 7, wherein determining the pupil condition further
5 comprises determining the pupil condition corresponding to a distance of regard.

9 The method of claim 1, wherein determining a plurality of pupil
conditions for an eye comprises determining a pupil condition corresponding to a
wavelength of light.

10 The method of claim 9, wherein determining the pupil condition further
comprises determining the pupil condition corresponding to a distance of regard.

11 The method of claim 1, wherein determining a plurality of pupil
conditions for an eye comprises recording a pupil condition in an image.

12 The method of claim 11, wherein recording the pupil condition in an
image comprises recording the pupil condition in a video frame.

15 13. The method of claim 11, wherein recording the pupil condition in an
image comprises recording the pupil condition with an infrared camera.

14 The method of claim 1, wherein determining a target wavefront profile
comprises selecting a plurality of distances to objects of regard and determining the
target wavefront profile at least in part on the basis of the plurality of distances.

20 15. The method of claim 1, wherein determining a target wavefront profile
comprises inferring desired visual conditions on the basis of measurements indicative
of a subject's intent to accommodate for the desired visual conditions.

16. The method of claim 1, wherein determining a plurality of pupil conditions for an eye comprises determining a pupil condition relative to an anatomical reference of the eye.

17. The method of claim 16, wherein determining the pupil condition
5 relative to the anatomical reference of the eye comprises determining a pupil size and a pupil position relative to the anatomical reference of the eye.

18. The method of claim 16, wherein the anatomical reference is selected from the group consisting of the limbus, the iris, the dilated pupil, the constricted pupil, the pharmacologically dilated pupil, the conjunctiva, and the cornea.

10 19. The method of claim 1, wherein the plurality of pupil conditions comprises at least three pupil conditions.

20. The method of claim 1, wherein a first pupil condition is determined relative to a second pupil condition

21. The method of claim 2, further comprising:
15 determining the wavefront-correction profile at least in part on the basis of a metric selected from the group consisting of a point spread function, an optical transfer function, a modular transfer function, and a phase transfer function.

22. The method of claim 1, wherein a pupil position corresponding to a first
20 pupil condition is non-concentric with a pupil position corresponding to a second pupil condition.

23. The method of claim 1, wherein determining the target wavefront profile comprises:

- providing a first set of modified coefficients as a function of a set of target coefficients and a first pupil condition;
- providing a second set of modified coefficients as a function of the set of target coefficients and a second pupil condition;
- 5 selecting the set of target coefficients according to constraints for at least one of the first set of modified coefficients and at least one of the second set of modified coefficients; and
- determining the target wavefront profile based on the target coefficients.

24. The method of claim 23, further comprising:
- 10 determining a wavefront aberration map for the eye;
- providing a set of reference coefficients of spatial modes corresponding to the wavefront aberration map, and
- determining a wavefront-correction profile based on the target coefficients and the reference coefficients.

- 15 25. The method of claim 23, wherein selecting the target coefficients comprises selecting the target coefficients based on a metric corresponding to the first and second set of modified coefficients, respectively.

26. The method of claim 25, wherein the metric is selected from the group consisting of a point spread function, an optical transfer function, a modular transfer
- 20 function, and a phase transfer function.

27. The method of claim 25, wherein the metric is based on the volume under a three-dimensional plot of a transfer function.

28. The method of claim 25, wherein selecting the target coefficients includes comparing a value of the metric to a threshold.

29. The method of claim 2, further comprising:

performing laser ablation on the cornea of the eye according to the wavefront-correction profile.

30. The method of claim 29, wherein performing laser ablation comprises
5 performing the laser ablation in a single surgical procedure.

31. The method of claim 2, further comprising:

shaping an optical element according to the wavefront-correction profile.

32. The method of claim 31, wherein shaping comprises
performing laser ablation on the optical element according to the wavefront-
10 correction profile.

33. The method of claim 31, wherein the optical element comprises a lens.

34. The method of claim 33, wherein the lens comprises a contact lens.

35. The method of claim 31, wherein the optical element comprises
spectacles.

36. The method of claim 31, wherein the optical element comprises an
15 intraocular implant.

37. The method of claim 31, wherein the optical element comprises
deformable mirror

38. The method of claim 2, further comprising:
20 irradiating a light-adjustable lens according to the wavefront-correction profile.

39 The method of claim 2, wherein determining the wavefront-correction profile comprises:

simulating an image based on a plurality of candidate wavefront-correction profiles for a subject; and

5 selecting the wavefront-correction profile based on the feedback from the subject.

40. An optical element for placement in an eye comprising:

a surface that is shaped according to a wavefront-correction profile that includes features based on a target wavefront profile;

10 wherein the target wavefront profile includes features based on a plurality of pupil conditions for the eye, wherein a pupil position corresponding to a first pupil condition is non-concentric with a pupil position corresponding to a second pupil condition.

41. The optical element of claim 40, wherein the wavefront-correction
15 profile includes features based on the target wavefront profile and a wavefront aberration map for the eye.

42. The optical element of claim 41, wherein the wavefront-correction profile includes features based on a difference between the target wavefront profile and a reference wavefront profile related to the wavefront aberration map.

20 43. The optical element of claim 40, wherein the plurality of pupil conditions for the eye comprise a change in a size of a pupil of the eye, and a change in a position of the pupil.

44. The optical element of claim 40, wherein the optical element comprises a contact lens.

45. The optical element of claim 40, wherein the optical element comprises an intraocular implant.

46. A system for providing multi-focal visual correction, the system comprising.

5 a profile calculation module configured to

determine a plurality of pupil conditions for an eye, wherein a pupil position corresponding to a first pupil condition is non-concentric with a pupil position corresponding to a second pupil condition;

10 determine a target wavefront profile on the basis of the plurality of pupil conditions; and

determine a wavefront-correction profile on the basis of the target wavefront profile.

47. The system of claim 46, further comprising:

15 a wavefront mapping module configured to determine a wavefront aberration map for the eye;

wherein the profile calculation module is configured to determine the wavefront-correction profile on the basis of the target wavefront profile and the wavefront aberration map.

20 48. The system of claim 47, wherein the profile calculation module is configured to determine the wavefront-correction profile based on a difference between the target wavefront profile and a reference wavefront profile related to the wavefront aberration map.

49. The system of claim 46, wherein the plurality of pupil conditions for the
25 eye comprise a change in a size of a pupil of the eye, and a change in a position of the pupil.