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Datasheet for the decision of 10 December 2014

Case Number: T 1422/11 - 3.2.02

Application Number: 01925086.9

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Language of the proceedings: EN

Title of invention:
DYNAMIC RANGE EXTENSION TECHNIQUES FOR A WAVE-FRONT SENSOR

Applicant:
AMO WaveFront Sciences, LLC

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step (yes)

Decisions cited:

Catchword:

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Case Number: T 1422/11 - 3.2.02

D E C I S I O N
of Technical Board of Appeal 3.2.02
of 10 December 2014

Appellant: (Applicant)	AMO WaveFront Sciences, LLC 14810 Central Avenue, SE Albuquerque, NM 87123 (US)
Representative:	Jones, Ithel Rhys Wynne-Jones, Lainé & James LLP Essex Place 22, Rodney Road Cheltenham GL50 1JJ (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 24 February 2011 refusing European patent application No. 01925086.9 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	E. Dufrasne
Members:	M. Stern
	C. Körber

Summary of Facts and Submissions

I. The applicant lodged an appeal against the decision of the Examining Division refusing European application No. 01 925 086.9. The Examining Division found that the various requests then on file did not fulfil the requirements of Article 123(2) EPC and those of novelty and inventive step in view of the following documents:

D2: DE-A-42 22 395

D10: Liang J. et al.: "Objective measurement of wave aberrations of the human eye with the use of a Hartmann-Shack wave-front sensor", Journal of the Optical Society of America A, Vol. 11, No. 7, July 1994, pages 1949-1957.

II. The Board presented its provisional opinion in a communication dated 26 August 2014.

III. With its letters dated 24 October 2014, 10 and 13 November 2014, the appellant filed amended application documents. The current application documents on which the appellant implicitly requested the grant of a patent are the following: claims 1 to 11 filed on 10 November 2014; description pages 1, 1a, 2 to 5, 5a and 6 to 15 (clean copy) filed on 13 November 2014; figure sheet 1/6 filed on 24 October 2014; figure sheets 2/6 to 6/6 as originally filed.

IV. Claim 1 reads as follows:

"A wavefront analysis system for measuring aberrations in an eye, comprising:

a projecting optical system (12,14,16,18) producing light to be delivered onto a retina of an eye (40);

an adjustable telescope (30) which compensates the light to be delivered onto the retina of the eye (40) for refractive errors in the eye (40), the adjustable telescope (30) being positioned in an optical path between the projecting optical system and the eye (40) and having lenses (32, 34) that are moveable relative to one another to correct for defocus aberrations of the eye (40);

an imaging system which collects light scattered by the retina; and

a wavefront sensor (50) receiving light returned by the retina from the imaging system and detecting an amplitude and phase of a wavefront of the received light,

the telescope further comprising a dynamic range limiting aperture (36) that blocks any rays of the light returned by the retina outside an angular dynamic range of the wavefront sensor (50), the aperture being positioned in between the lenses (32, 34), and wherein the adjustable telescope (30) is located in an optical path from the eye (40) to the wavefront sensor (50)."

Claims 2 to 11 are dependent claims.

V. The arguments by the appellant relevant for the present decision can be summarised as follows.

Claim 1 was novel over D10 since it did not disclose the features of a pre-correction system including a telescope having lenses that were moveable relative to one another being located in an optical path from the eye to the wavefront sensor. In particular, the moveable lens L1 in D10 was not in the optical path from the eye to the wavefront sensor. Moreover, claim 1 was also novel because D10 did not disclose a dynamic range limiting aperture that blocked any rays of the

light returned by the retina outside angular dynamic range of the wavefront analysis sensor. Further, the stop of D10 was not in the optical path from the projecting optical system to the eye.

The objective technical problem to be solved by the skilled person reading D10 was therefore how to prevent mixing or measurement confusion in a wavefront sensor of a wavefront analysis system. No indication of such a problem was contemplated by the authors of D10. The claimed solution to this problem was to use a dynamic range limiting aperture in an adjustable telescope located in both the optical paths from the projecting optical system to the eye and from the eye to the wavefront sensor. The stop in D10 had the purpose of blocking out most of the reflection by lens L2, but not of blocking rays of the light returned by the retina outside an angular dynamic range of the wavefront analysis sensor.

D2 did not contemplate the technical problem of how to prevent mixing or measurement confusion in a wavefront sensor, let alone suggest use of a dynamic range limiting aperture as in claim 1. Therefore, claim 1 was inventive over D2 and D10, either alone or in combination.

Reasons for the Decision

1. The appeal is admissible.

2. The invention relates to a wavefront analysis system for measuring aberrations in the eye using a wavefront sensor (for example, a Hartmann-Shack sensor, as schematically shown in Figure 2; page 10, lines 17 to 19). Wavefront aberrometry measures the full, end-to-

end aberrations through the entire optics of the eye. In these measurements, a spot is projected onto the retina, and the resulting returned light is measured with an optical system, thus obtaining a full, integrated, line-of-sight measurement of the eye's aberrations (paragraph between pages 2 and 3).

3. The wavefront analysis system as defined in claim 1 finds its basis in claim 1; page 9, lines 24 to 27; and page 10, lines 8 to 12 of the application as originally filed. In particular, these passages of the original description provide a basis for defining that the wavefront analysis system comprises an adjustable telescope having lenses that are moveable relative to one another and a dynamic range limiting aperture positioned between the lenses, the telescope being located in an optical path from the projecting optical system to the eye and in an optical path from the eye to the sensor.

Hence, the requirements of Article 123(2) EPC are fulfilled.

4. Novelty

4.1 Document D10 discloses a wavefront analysis system for measuring aberrations in an eye (abstract, Figure 5) comprising, in essence, a light projecting system (laser), an adjustable telescope which compensates the light delivered onto the retina for refractive errors of the eye, the telescope having lenses (L1 and L2) which are moveable with respect to one another (page 1951, lines 4 to 6), and a wavefront sensor (Hartmann-Shack sensor HSS) receiving light returned by the retina.

As can be seen from Figure 5, the adjustable telescope comprising lenses L1 and L2 is positioned in the optical path between the laser and the eye. Only one of its lenses, lens L2, is also positioned in the return path between the eye and the sensor (HSS); not so lens L1. Therefore, the adjustable telescope cannot fairly be said to be also "*located in an optical path between the eye to the wavefront sensor*", as defined in claim 1. Moreover, the adjustable telescope does not comprise any aperture between the lenses, let alone *"a dynamic range limiting aperture that blocks any rays of the light returned by the retina outside an angular dynamic range of the wavefront sensor*", as also defined in claim 1.

Consequently, the subject-matter of claim 1 is novel with respect to D10.

4.2 Document D2 discloses a wavefront analysis system for measuring refraction of an eye comprising, in essence, a light projecting system (28; column 4, lines 32 to 36), a correction system ("Abbildungsoptik" 16) which compensates the light delivered onto the retina for refractive errors of the eye and comprises a moveable lens (column 4, lines 56 to 62), and a wavefront sensor (Hartmann-Shack sensor 34) receiving the light returned by the retina (column 5, lines 18 to 27). Figure 1 shows that the correction system (16) is in both the optical path between the light projecting system (28) and the eye and the optical path between the eye to the wavefront sensor (34). The correction system (16) may comprise, for example, a moveable lens for changing its refractive power (column 4, lines 59 to 62).

D2 does not disclose, however, that the correction system (16) is *"a telescope [...] having lenses that*

are moveable relative to one another to correct for defocus aberrations of the eye [... and] a dynamic range limiting aperture that blocks any rays of the light returned by the retina outside an angular dynamic range of the wavefront sensor, the aperture being positioned in between the lenses", as defined in claim 1.

Consequently, the subject-matter of claim 1 is also novel with respect to D2.

5. Inventive step

5.1 Document D10 may be seen to constitute the closest prior art. As indicated under point 4.1 above, the claimed system differs from that of D10 in that the adjustable telescope is not only located in the optical path between the laser and the eye, but also *"in an optical path between the eye to the wavefront sensor"* and in that it comprises *"a dynamic range limiting aperture that blocks any rays of the light returned by the retina outside an angular dynamic range of the wavefront sensor, the aperture being positioned in between the lenses* (of the adjustable telescope)".

5.2 As indicated on page 10, lines 10 to 13 of the original application, the claimed dynamic range limiting aperture solves the problem of preventing mixing or measurement confusion in a wavefront sensor. In particular, when the wavefront sensor is a Hartmann-Shack sensor, the focal spots cannot collide, interfere or cause confusion with adjacent focal spots.

5.3 No indication of this problem is given in D10, nor is any such solution disclosed. In particular, the stop shown in Figure 5 of D10 is of a different nature. It

is not placed between the lenses of the adjustable telescope (L1, L2), but in the focal point of the fixed telescope lenses L5 and L6 in front of the detector, and it has, moreover, the purpose of blocking out most of the reflections on lens L2 of the light going into the eye (page 1952, left column, lines 2 to 5). The stop is not devised to take into account the specific angular dynamic range of the wavefront sensor, as in the claimed invention. As explained on page 10, lines 8 to 13, this feature of the claimed invention allows the light reflected from the eye to arrive at the sensor collimated to within the dynamic range of the sensor so that no mixing or overlap of the focal spots of the lenslets (of, for example, a Hartmann-Shack sensor) occurs. This effect becomes particularly important when the density of lenslets is increased in order to obtain a larger sampling density and, consequently, smaller wavefront aberrations across the aperture of each lenslet (page 8, lines 12 to 24).

5.4 Moreover, as indicated under point 4.2 above, also D2 does not provide any disclosure or suggestion towards the provision of a dynamic range limiting aperture between lenses of an adjustable telescope as claimed. Thus, also if D2 were to be taken as a starting point, as in the impugned decision, no different conclusion regarding inventive step is to be drawn. The remaining documents on file are even less relevant.

5.5 It follows that the claimed subject-matter is not rendered obvious by the available prior art.

6. As a consequence, the Board concludes that the system defined in claim 1 satisfies the requirements of novelty and inventive step within the meaning of Articles 54 and 56 EPC. This conclusion applies a

fortiori to the preferred embodiments defined in dependent claims 2 to 11.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of:

   - claims 1 to 11 filed on 10 November 2014;

   - description pages 1, 1a, 2 to 5, 5a and 6 to 15 (clean version) filed on 13 November 2014;

   - figure sheet 1/6 filed on 24 October 2014;

   - figure sheets 2/6 to 6/6 as originally filed.

The Registrar: The Chairman:

D. Hampe E. Dufrasne

Decision electronically authenticated