PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

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PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)* 25 FEB 2020

Applicant's or agent's file reference	FOR FURTHER ACTION
037097-00010	See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 19/64911	06 December 2019 (06.12.2019)	06 December 2018 (06.12.2018)

International Patent Classification (IPC) or both national classification and IPC

IPC - A61B 3/11 (2020.01)

CPC - A61B 3/102; A61B 3/11; A61B 3/13; A61B 3/132; A61F 2/1662; A61F 2002/16902; A61F 9/08

Applicant
ADVANCED EUCLIDEAN SOLUTIONS, LLC

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	05 February 2020	Lee Young PCT Help Desk Telephone No. 571-272-4300

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Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into ________________ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(b)).

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

a. ☐ forming part of the international application as filed:

☐ in the form of an Annex C/ST.25 text file.

☐ on paper or in the form of an image file.

b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

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Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	2-3, 9, 11-12, 19-20	YES
	Claims	1, 4-8, 10, 13-18	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	NONE	NO

2. Citations and explanations:

Clams 1, 4-6, 10, 13-15, and 18 lack an inventive step under PCT Article 33(3) as being obvious over US 2011/0270596 A1 (Weeber) in view of US 2015/0103313 A1 to WaveTec Vision Systems, Inc. (herein after "WaveTec").

Regarding claim 1, Weeber discloses an apparatus for intraocular lens selection (para [0012]: The present invention is and includes an apparatus, system and method for predictive modeling to design, evaluate and optimize ophthalmic lenses. Ophthalmic lenses may include, for example, contacts, glasses or intraocular lenses (IOLs)), comprising: obtain at least two ocular measurement parameters for an eye (para [0046]: which patient group clinical testing may be applied at step 322. The clinical testing provides clinical outcomes at step 324. para [0043]: Characteristics of interest may include any one or more of a plurality of patient parameter inputs, such as pupil sizes, off-axis vision, and object distance vision, corneal optical power); a user interface configured to obtain a lens selection parameter for the eye (para [0065]:such as via a graphical user interface (GUI) provided in a clinical setting. The GUI may provide any number of graphical panels for convenient use by a clinician, such as three primary panels. The primary panels may include, for example, an optical parameter panel, a clinical outcome input 412 panel, and a recommended action panel that may be based on simulation 410; para [0064]: the optimizer 420 may optimize the parameters of lenses designed at simulator 406, wherein the simulator initially designed the lens based on patients of a particular pupil diameter and/or having a desired optical power, and wherein optimizer 420 determines variations to the simulation 410 at simulator 406); a memory (para [0037]: associated with one or more computing memories); and a processor communicatively coupled to the biometer, the user interface, and the memory (para [0037]: the apparatus, system and method of the present invention may be embodied in one or more computing processors, associated with one or more computing memories; para [0061]: The at least one processor 402 applies simulator 406 to at least one eye model 404 to output a simulation 410 of eye characteristics, such as VA and/or contrast sensitivity; para [0062]: clinical input 412. Clinical input 412 may be provided over at least one network 414, and is input to at least one processor 402 for comparison to the characteristics of simulation output 410; para [0065]:such as via a graphical user interface (GUI) provided in a clinical setting. The GUI may provide any number of graphical panels for convenient use by a clinician, such as three primary panels. The primary panels may include, for example, an optical parameter panel, a clinical outcome input 412 panel, and a recommended action panel that may be based on simulation 410), and configured to: determine an intraocular lens power based on a formula using the at least two ocular measurement parameters (para [0042]:an ophthalmic lens may be designed and/or provided at step 304 for modeling and for clinical application. Such a lens may, for example, have associated therewith a particular design parameter or parameters...The design parameter or parameters may be derived by the optimizer by determining at least one coefficient of a set of Zernike polynomials. For example, calculating the design parameter or parameters often includes determining a plurality of selected Zernike coefficients, such as for power, astigmatism, or chromatic or spherical aberration, for example, at various orders; para [0043]: model eyes similar in characteristics to the eye for which the design parameter or parameters are to be obtained may be subjected to step 308. Characteristics of interest may include any one or more of a plurality of patient parameter inputs, such as pupil sizes, off-axis vision, and object distance vision, corneal optical power). Weeber fails to disclose a biometer configured to obtain measurement parameters for an eye, an autorefractor configured to obtain a post-operative refraction of the eye; a processor communicatively coupled to autorefractor; correlate the at least two ocular measurement parameters, the intraocular lens power, and the post-operative refraction as a training set. WaveTec discloses a biometer configured to obtain measurement parameters for an eye (para [0016]: Preoperative biometry measurements can be used to measure the axial length of the eye, the curvature of the anterior surface of the cornea, and the white-to-white distance. The axial length of the eye can be measured, for example, by an ultrasound device or by Optical Coherence Tomography (OCT), while the curvature of the anterior surface of the cornea can be measured by, for example, a keratometer (e.g., Kvalues measured in orthogonal meridians that pass through the corneal apex, or anatomical center, of the cornea and are expressed in terms of the radii of curvature or as the dioptric power of the cornea along these orthogonal meridians) or corneal topographer); an autorefractor configured to obtain a post-operative refraction of the eye (para [0033]: At block 220, actual measurements of the postoperative optical power of the eyes can be obtained. These measurements can be performed using, for example, an autorefractor, phoropter, or other suitable instrument); a processor communicatively coupled to autorefractor (para [0008]: and a processor for performing a method comprising, receiving an indication of the aphakic optical power of the patient's eye from the measurement device; para [0033]: These measurements can be performed using, for example, an autorefractor, phoropter, or other suitable instrument); correlate the at least two ocular measurement parameters, the intraocular lens power, and the post-operative refraction as a training set (para [0033]: These postoperative optical power measurements can be used to determine the error that was present in the estimates of the postoperative optical power. In some embodiments, an error value is determined for each eye in the data set; para [0034]: measurements of various characteristics of the eyes in the data set can be obtained; para [0035]: the eyes in the data set can be separated into groups based on their axial length values; para [0027]: FIG. 1, which is a graph 100 that plots prediction error in intraocular lens (IOL) power estimates for a set of eyes as a function of the axial length of those eyes para [0042]:The algorithm is designed to tolerate a relatively large fraction of outlier data that should be ignored while it fits the remainder of good data in a training set). (claim 1 continued)

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(claim 1 continued) It would have been obvious to one of ordinary skill in the art to utilize the biometer, the autorefractor and the processor disclosed by WaveTec to the apparatus disclosed by Weeber to place the eye in as close to an emmetropic state as possible when combined with the refractive power of the cornea of the eye (See WaveTec, para [0006]).

Regarding claim 4, Weeber in view of WaveTec disclose the apparatus of claim 1. WaveTec further discloses wherein the processor is configured to include the final intraocular lens power in the training set (para [0009]: determining, with a processor, an IOL power correction value, the IOL power correction value being determined from the selected relationship and from one or more characteristics of the patient' s eye; applying the IOL power correction value.para [0027]: FIG. 1, which is a graph 100 that plots prediction error in intraocular lens (IOL) power estimates for a set of eyes as a function of the axial length of those eyes para [0042]:The algorithm is designed to tolerate a relatively large fraction of outlier data that should be ignored while it fits the remainder of good data in a training set.).

Regarding claim 5, Weeber in view of WaveTec disclose the apparatus of claim 1, Weeber further discloses wherein the lens selection parameter is one of a target refraction or A-constant (para [0042]: calculating the design parameter or parameters often includes determining a plurality of selected Zernike coefficients, such as for power, astigmatism, or chromatic or spherical aberration, where the coefficients is a constant).

Regarding claim 6, Weeber in view of WaveTec disclose the apparatus of claim 1. Weeber further discloses wherein the at least two ocular measurement parameters are selected from the group consisting of: axial length, corneal power, corneal power index, and anterior chamber depth (para [0043]: such as pupil sizes, off-axis vision, and object distance vision, corneal optical power; para [0067]: The histogram of FIG. 5 c illustrates the axial length of the eye across a population of model eyes).

Regarding claim 10, Weeber discloses a method of intraocular lens selection (para [0012]: The present invention is and includes an apparatus, system and method for predictive modeling to design, evaluate and optimize ophthalmic lenses. Ophthalmic lenses may include, for example, contacts, glasses or intraocular lenses (IOLs)), comprising: obtaining at least two ocular measurement parameters for an eye (para [0046]: which patient group clinical testing may be applied at step 322. The clinical testing provides clinical outcomes at step 324; para [0043]: Characteristics of interest may include any one or more of a plurality of patient parameter inputs, such as pupil sizes, off-axis vision, and object distance vision, corneal optical power); obtaining a lens selection parameter for the eye (para [0064]: the optimizer 420 may optimize the parameters of lenses designed at simulator 406, wherein the simulator initially designed the lens based on patients of a particular pupil diameter and/or having a desired optical power, and wherein optimizer 420 determines variations to the simulation 410 at simulator 406); determining an intraocular lens power based on a formula using the at least two ocular measurement parameters (para [0042]:an ophthalmic lens may be designed and/or provided at step 304 for modeling and for clinical application. Such a lens may, for example, have associated therewith a particular design parameter or parameters...The design parameter or parameters may be derived by the optimizer by determining at least one coefficient of a set of Zernike polynomials. For example, calculating the design parameter or parameters often includes determining a plurality of selected Zernike coefficients, such as for power, astigmatism, or chromatic or spherical aberration, for example, at various orders; para [0043]: model eyes similar in characteristics to the eye for which the design parameter or parameters are to be obtained may be subjected to step 308. Characteristics of interest may include any one or more of a plurality of patient parameter inputs, such as pupil sizes, off-axis vision, and object distance vision, corneal optical power). Weeber fails to disclose measurement parameters for an eye by a biometer; obtaining a post-operative refraction of the eye from an autorefractor communicatively coupled with the biometer; and correlating the at least two ocular measurement parameters, the intraocular lens power, and the post-operative refraction as a training set. WaveTec discloses measurement parameters for an eye by a biometer (para [0016]: Preoperative biometry measurements can be used to measure the axial length of the eye, the curvature of the anterior surface of the cornea, and the white-to-white distance. The axial length of the eye can be measured, for example, by an ultrasound device or by Optical Coherence Tomography (OCT), while the curvature of the anterior surface of the cornea can be measured by, for example, a keratometer (e.g., Kvalues measured in orthogonal meridians that pass through the corneal apex, or anatomical center, of the cornea and are expressed in terms of the radii of curvature or as the dioptric power of the cornea along these orthogonal meridians) or corneal topographer); obtaining a post-operative refraction of the eye from an autorefractor communicatively coupled with the biometer (para [0033]: At block 220, actual measurements of the postoperative optical power of the eyes can be obtained. These measurements can be performed using, for example, an autorefractor, phoropter, or other suitable instrument); a processor communicatively coupled to autorefractor (para [0008]: and a processor for performing a method comprising, receiving an indication of the aphakic optical power of the patient's eye from the measurement device; para [0033]: These measurements can be performed using, for example, an autorefractor, phoropter, or other suitable instrument); and correlating the at least two ocular measurement parameters, the intraocular lens power, and the post-operative refraction as a training set (para [0033]: These postoperative optical power measurements can be used to determine the error that was present in the estimates of the postoperative optical power. In some embodiments, an error value is determined for each eye in the data set; para [0034]: measurements of various characteristics of the eyes in the data set can be obtained; para [0035]: the eyes in the data set can be separated into groups based on their axial length values; para [0027]: FIG. 1, which is a graph 100 that plots prediction error in intraocular lens (IOL) power estimates for a set of eyes as a function of the axial length of those eyes para [0042]:The algorithm is designed to tolerate a relatively large fraction of outlier data that should be ignored while it fits the remainder of good data in a training set.). It would have been obvious to one of ordinary skill in the art to utilize the biometer, the autorefractor and the processor disclosed by WaveTec to the method disclosed by Weeber to place the eye in as close to an emmetropic state as possible when combined with the refractive power of the cornea of the eye (See WaveTec, para [0006]).

Regarding claim 13, Weeber in view of WaveTec disclose the method of claim 12. WaveTec further discloses wherein correlating the at least two ocular measurement parameters, the intraocular lens power, and the post-operative refraction as a training set comprises including the final intraocular lens power in the training set (para [0009]: determining, with a processor, an IOL power correction value, the IOL power correction value being determined from the selected relationship and from one or more characteristics of the patient' s eye; applying the IOL power correction value.para [0027]: FIG. 1, which is a graph 100 that plots prediction error in intraocular lens (IOL) power estimates for a set of eyes as a function of the axial length of those eyes para [0042]:The algorithm is designed to tolerate a relatively large fraction of outlier data that should be ignored while it fits the remainder of good data in a training set). --see next page

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Regarding claim 14, Weeber in view of WaveTec disclose the method of claim 10. Weeber further discloses wherein the lens selection parameter is one of a target refraction or A-constant (para [0042]: calculating the design parameter or parameters often includes determining a plurality of selected Zernike coefficients, such as for power, astigmatism, or chromatic or spherical aberration, where the coefficients is a constant).

Regarding claim 15, Weeber in view of WaveTec disclose the method of claim 10. Weeber further discloses wherein the at least two ocular measurement parameters are selected from the group consisting of: axial length, corneal power, corneal power index, and anterior chamber depth (para [0043]: such as pupil sizes, off-axis vision, and object distance vision, corneal optical power; para [0067]: The histogram of FIG. 5 c illustrates the axial length of the eye across a population of model eyes).

Regarding claim 18, Weeber discloses a non-transitory computer-readable medium storing computer executable instructions (para [0037]: the apparatus, system and method of the present invention may be embodied in one or more computing processors, associated with one or more computing memories; para [0061]: The at least one processor 402 applies simulator 406 to at least one eye model 404 to output a simulation 410 of eye characteristics, such as VA and/or contrast sensitivity), comprising instructions to cause a computer to:
obtain at least two ocular measurement parameters for an eye (para [0046]: which patient group clinical testing may be applied at step 322. The clinical testing provides clinical outcomes at step 324. It is noted the clinical testing is carried by a biometer; para [0043]: Characteristics of interest may include any one or more of a plurality of patient parameter inputs, such as pupil sizes, off-axis vision, and object distance vision, corneal optical power); obtain a lens selection parameter for the eye (para [0064]: the optimizer 420 may optimize the parameters of lenses designed at simulator 406, wherein the simulator initially designed the lens based on patients of a particular pupil diameter and/or having a desired optical power); determine an intraocular lens power based on a formula using the at least two ocular measurement parameters (para [0042]:an ophthalmic lens may be designed and/or provided at step 304 for modeling and for clinical application. Such a lens may, for example, have associated therewith a particular design parameter or parameters...The design parameter or parameters may be derived by the optimizer by determining at least one coefficient of a set of Zernike polynomials. For example, calculating the design parameter or parameters often includes determining a plurality of selected Zernike coefficients, such as for power, astigmatism, or chromatic or spherical aberration, for example, at various orders; para [0043]: model eyes similar in characteristics to the eye for which the design parameter or parameters are to be obtained may be subjected to step 308. Characteristics of interest may include any one or more of a plurality of patient parameter inputs, such as pupil sizes, off-axis vision, and object distance vision, corneal optical power). Weeber fails to disclose measurement parameters for an eye by a biometer; obtain a post-operative refraction of the eye from an autorefractor communicatively coupled with the biometer; and correlate the at least two ocular measurement parameters, the intraocular lens power, and the post-operative refraction as a training set. WaveTec discloses measurement parameters for an eye by a biometer (para [0016]: Preoperative biometry measurements can be used to measure the axial length of the eye, the curvature of the anterior surface of the cornea, and the white-to-white distance. The axial length of the eye can be measured, for example, by an ultrasound device or by Optical Coherence Tomography (OCT), while the curvature of the anterior surface of the cornea can be measured by, for example, a keratometer (e.g., Kvalues measured in orthogonal meridians that pass through the corneal apex, or anatomical center, of the cornea and are expressed in terms of the radii of curvature or as the dioptric power of the cornea along these orthogonal meridians) or corneal topographer); obtain a post-operative refraction of the eye from an autorefractor communicatively coupled with the biometer (para [0033]: At block 220, actual measurements of the postoperative optical power of the eyes can be obtained. These measurements can be performed using, for example, an autorefractor, phoropter, or other suitable instrument); a processor communicatively coupled to autorefractor (para [0008]: and a processor for performing a method comprising, receiving an indication of the aphakic optical power of the patient's eye from the measurement device; para [0033]: These measurements can be performed using, for example, an autorefractor, phoropter, or other suitable instrument); and correlate the at least two ocular measurement parameters, the intraocular lens power, and the post-operative refraction as a training set (para [0033]: These postoperative optical power measurements can be used to determine the error that was present in the estimates of the postoperative optical power. In some embodiments, an error value is determined for each eye in the data set; para [0034]: measurements of various characteristics of the eyes in the data set can be obtained; para [0035]: the eyes in the data set can be separated into groups based on their axial length values; para [0027]: FIG. 1,'which is a graph 100 that plots prediction error in intraocular lens (IOL) power estimates for a set of eyes as a function of the axial length of those eyes para [0042]:The algorithm is designed to tolerate a relatively large fraction of outlier data that should be ignored while it fits the remainder of good data in a training set.). It would have been obvious to one of ordinary skill in the art to utilize the biometer, the autorefractor and the processor disclosed by WaveTec to the medium disclosed by Weeber to place the eye in as close to an emmetropic state as possible when combined with the refractive power of the cornea of the eye (See WaveTec, para [0006]).

Clams 7 and 16 lack an inventive step under PCT Article 33(3) as being obvious over Weeber in view of WaveTec and further in view of US 2016/0302660 A1 to Carl Zeiss Meditec Ag (hereinafter "Carl").

Regarding claim 7, Weeber in view of WaveTec disclose the apparatus of claim 1, but fail to disclose wherein the lens selection formula includes one or more of: a Hoffer Q formula, a Holladay I formula, a Haigis formula, and a SRK/T formula, a Barrett Universal 11 formula, or adjustments thereto. However, Carl discloses wherein the lens selection formula includes one or more of: a Hoffer Q formula, a Holladay I formula, a Haigis formula, and a SRK/T formula, a Barrett Universal 11 formula, or adjustments thereto (para [0006]: Depending on the IOL formula used, for example according to Holladay, Hoffer, Binkhorst, Colenbrander, Shammas or SRK, the approaches are correspondingly different.). It would have been obvious to one of ordinary skill in the art to utilize the formula disclosed by Carl to the apparatus disclosed by Weeber to optimize the results of refractive procedures on the eye (See Carl, para [0002]).

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Regarding claim 16, Weeber in view of WaveTec disclose the method of claim 10, but fail to disclose wherein the lens selection formula includes one or more of: a Hoffer Q formula, a Holladay I formula, a Haigis formula, and a SRK/T formula, a Barrett Universal 11 formula, or adjustments thereto. However, Carl discloses wherein the lens selection formula includes one or more of: a Hoffer Q formula, a Holladay I formula, a Haigis formula, and a SRK/T formula, a Barrett Universal 11 formula, or adjustments thereto (para [0006]: Depending on the IOL formula used, for example according to Holladay, Hoffer, Binkhorst, Colenbrander, Shammas or SRK, the approaches are correspondingly different). It would have been obvious to one of ordinary skill in the art to utilize the formula disclosed by Carl to the method disclosed by Weeber to optimize the results of refractive procedures on the eye (See Carl, para [0002]).

Clams 8 and 17 lack an inventive step under PCT Article 33(3) as being obvious over Weeber in view of WaveTec and further in view of US 2017/0304045 A1 (Cady).

Regarding claim 8, Weeber in view of WaveTec disclose the apparatus of claim 1, but fail to disclose wherein the ocular measurement parameters include intraoperative aberrometry measurements. However, Cady discloses ocular measurement parameters include intraoperative aberrometry measurements (para [0025]: with techniques such as intraoperative wavefront aberrometry now available, refractive outcome can be measured during the actual procedure in which an intraocular pseudophakic contact lens is being implanted). It would have been obvious to one of ordinary skill in the art to utilize the intraoperative aberrometry measurements disclosed by Cady to the apparatus disclosed by Weeber to identify immediately that a desired refractive target is obtained (See Cady, para [0025]).

Regarding claim 17, Weeber in view of WaveTec disclose the method of claim 10, but fail to disclose wherein the ocular measurement parameters include intraoperative aberrometry measurements. owever, Cady discloses ocular measurement parameters include intraoperative aberrometry measurements (para [0025]: with techniques such as intraoperative wavefront aberrometry now available, refractive outcome can be measured during the actual procedure in which an intraocular pseudophakic contact lens is being implanted). It would have been obvious to one of ordinary skill in the art to utilize the intraoperative aberrometry measurements disclosed by Cady to the method disclosed by Weeber to identify immediately that a desired refractive target is obtained (See Cady, para [0025]).

Claims 2, 3, 9, 11, 12, 19, and 20 meet the criteria set forth under PCT Article 33(2)-(3) because the prior art does not teach or fairly suggest the subject matter claimed.

The prior art for claims 2, 3, 11, 12, 19, and 20 is exemplified by Weeber, WaveTec and US 2018/0089493 A1 to Cornell University (hereinafter "Cornell").

Regarding claim 2, Weeber in view of WaveTec disclose the apparatus of claim 1, but fail to disclose wherein the processor is configured to train a deep learning machine using the post-operative refraction of the eye and the intraocular lens power to determine an estimated error of the formula. Cornell discloses deep learning machine (para [0031]: We used as the environment a virtual reality 3-D environment constructed using an open source Panda 3D graphics package. The learning algorithm used was from a "deep learning" family, specifically, a convolutional neural network (CNN).). However, Cornell fails to remedy the deficiencies of Weeber and WaveTec. Therefore, no prior art, alone or in combination discloses the processor is configured to train a deep learning machine using the post-operative refraction of the eye and the intraocular lens power to determine an estimated error of the formula.

Regarding claim 3, Weeber in view of WaveTec disclose the apparatus of claim 1. WaveTec further discloses adjust the lens selection parameter based on the estimated error (para [0044]: The algorithm then performs a linear regression analysis to identify a set of coefficients that improve or optimize the prediction error for the selected subset of eyes; para [0052]: the processor calculates the IOL power correction value. This can be done by, for example, multiplying each of the respective regression coefficients times the value of a corresponding characteristic of the patient's eye.); and redetermine a final intraocular lens power based on the formula and the adjusted lens selection parameter (para [0053]: the IOL power correction value is applied. For example, in some embodiments, the IOLpower correction value is applied to an estimate of postoperative optical power of the patient's eye for a given IOL power value.). Weeber in view of WaveTec fail to disclose wherein the processor is configured to determine the estimated error of the formula using a deep learning machine trained on verified post-operative results including post-operative refractions corresponding to intraocular lens powers. Cornell discloses deep learning machine (para [0031]: We used as the environment a virtual reality 3-D environment constructed using an open source Panda 3D graphics package. The learning algorithm used was from a "deep learning" family, specifically, a convolutional neural network (CNN).). However, Cornell fails to remedy the deficiencies of Weeber and WaveTec. Therefore, no prior art, alone or in combination discloses the processor is configured to determine the estimated error of the formula using a deep learning machine trained on verified post-operative results including post-operative refractions corresponding to intraocular lens powers.

Regarding claim 11, Weeber in view of WaveTec disclose the method of claim 10, but fail to disclose further comprising training a deep learning machine using the post-operative refraction of the eye and the intraocular lens power to determine an estimated error of the formula. Cornell discloses deep learning machine (para [0031]: We used as the environment a virtual reality 3-D environment constructed using an open source Panda 3D graphics package. The learning algorithm used was from a "deep learning" family, specifically, a convolutional neural network (CNN).). However, Cornell fails to remedy the deficiencies of Weeber and WaveTec. Therefore, no prior art, alone or in combination discloses training a deep learning machine using the post-operative refraction of the eye and the intraocular lens power to determine an estimated error of the formula.

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Box V.2 - Citations and Explanations

Regarding claim 12, Weeber in view of WaveTec disclose the method of claim 10. WaveTec discloses adjusting the lens selection parameter based on the estimated error (para [0044]: The algorithm then performs a linear regression analysis to identify a set of coefficients that improve or optimize the prediction error for the selected subset of eyes; para [0052]: the processor calculates the IOL power correction value. This can be done by, for example, multiplying each of the respective regression coefficients times the value of a corresponding characteristic of the patient's eye.); and redetermining a final intraocular lens power based on the formula and the adjusted lens selection parameter (para [0053]: the IOL power correction value is applied. For example, in some embodiments, the IOLpower correction value is applied to an estimate of postoperative optical power of the patient's eye for a given IOL power value.). Weeber in view of WaveTec fail to disclose determining the estimated error of the formula using a deep learning machine trained on verified post-operative results including post-operative refractions corresponding to intraocular lens powers. Cornell discloses deep learning machine (para [0031]: We used as the environment a virtual reality 3-D environment constructed using an open source Panda 3D graphics package. The learning algorithm used was from a "deep learning" family, specifically, a convolutional neural network (CNN).). However, Cornell fails to remedy the deficiencies of Weeber and WaveTec. Therefore, no prior art, alone or in combination discloses determining the estimated error of the formula using a deep learning machine trained on verified post-operative results including post-operative refractions corresponding to intraocular lens powers.

Regarding claim 19, Weeber in view of WaveTec disclose the non-transitory computer-readable medium of claim 18, but fail to disclose further comprising instructions to cause the computer to train a deep learning machine using the postoperative refraction of the eye and the intraocular lens power to determine an estimated error of the formula. Cornell discloses deep learning machine (para [0031]: We used as the environment a virtual reality 3-D environment constructed using an open source Panda 3D graphics package. The learning algorithm used was from a "deep learning" family, specifically, a convolutional neural network (CNN).). However, Cornell fails to remedy the deficiencies of Weeber and WaveTec. Therefore, no prior art, alone or in combination discloses comprising instructions to cause the computer to train a deep learning machine using the postoperative refraction of the eye and the intraocular lens power to determine an estimated error of the formula.

Regarding claim 20, Weeber in view of WaveTec disclose the non-transitory computer-readable medium of claim 18. WaveTec further discloses further comprising instructions to cause the computer to: adjust the lens selection parameter based on the estimated error (para [0044]: The algorithm then performs a linear regression analysis to identify a set of coefficients that improve or optimize the prediction error for the selected subset of eyes; para [0052]: the processor calculates the IOL power correction value. This can be done by, for example, multiplying each of the respective regression coefficients times the value of a corresponding characteristic of the patient's eye.); and redetermine a final intraocular lens power based on the formula and the adjusted lens selection parameter (para [0053]: the IOL power correction value is applied. For example, in some embodiments, the IOLpower correction value is applied to an estimate of postoperative optical power of the patient's eye for a given IOL power value.). Weeber in view of WaveTec fail to disclose determine the estimated error of the formula using a deep learning machine trained on verified post-operative results including post-operative refractions corresponding to intraocular lens powers. Cornell discloses deep learning machine (para [0031]: We used as the environment a virtual reality 3-D environment constructed using an open source Panda 3D graphics package. The learning algorithm used was from a "deep learning" family, specifically, a convolutional neural network (CNN).). However, Cornell fails to remedy the deficiencies of Weeber and WaveTec. Therefore, no prior art, alone or in combination discloses determine the estimated error of the formula using a deep learning machine trained on verified post-operative results including post-operative refractions corresponding to intraocular lens powers.

The prior art for claim 9 is exemplified by Weeber and WaveTec.

Regarding claim 9, Weeber in view of WaveTec disclose the apparatus of claim 1. Weeber further discloses comprising a display device (para [0015]: Correspondingly, the network aspects of the present invention may allow for provision of a computerized graphical user interface embodying the aspects of the present invention.). Weeber in view of WaveTec fail to disclose wherein the processor is configured to render the intraocular lens power on a relevant portion of a super surface including ideal or near ideal portions of a plurality of intraocular lens selection formulas based on a range of the at least two ocular measurement parameters most suitable to each individual intraocular lens selection formula. Therefore, no prior art, alone or in combination discloses he processor is configured to render the intraocular lens power on a relevant portion of a super surface including ideal or near ideal portions of a plurality of intraocular lens selection formulas based on a range of the at least two ocular measurement parameters most suitable to each individual intraocular lens selection formula.

Claims 1-20 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.