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APPLICATION NUMBER: 62/020,252

FILING DATE: July 02, 2014

RELATED PCT APPLICATION NUMBER: PCT/US15/39105

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SYSTEMS AND METHODS FOR ALIGNMENT OF THE EYE FOR OCULAR IMAGING

CROSS-REFERENCE TO RELATED APPLICATION(S)

[001] None.

FIELD OF THE INVENTION

[002] Disclosed herein are systems and methods form alignment of the eye for ocular imaging.

BACKGROUND OF THE INVENTION

[003] In ocular imaging, proper alignment of the subject's eye is a prerequisite to quality ocular image acquisition. Traditional approaches to achieving alignment rely on a trained operator of the imaging device to adjust system optics until alignment is achieved. Other approaches use automation to adjust optical elements to achieve alignment. Both of these approaches rely on servo motors which add cost and complexity to the system. For example, manual handheld fundus cameras require the user manually positioning a camera, and often require an integrated screen to view the eye. Traditional manual desk-mounted fundus cameras require the user to manually steer the camera with a joytick to the correct alignment. Automated or semi-automated fundus cameras require complex motors, additional cameras and sensors, and built-in image processing to drive the automated alignment, thereby adding significant cost. Accordingly, there is a need in the art for an alignment system with reduced cost, complexity, and ease of operation.

BRIEF SUMMARY OF THE INVENTION

[004] Disclosed herein are is an ocular alignment system for aligning a subject's eye with an optical axes of an ocular imaging device comprising one or more guide light and one or more baffle configured to mask the one or more guide light from view of the subject such that the one or more guide light is only visible to the subject when the eye of the subject is aligned with the optical axis of an ocular imaging system.

[005] While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. As will be realized, the

invention is capable of modifications in various obvious aspects, all without departing from the spirit and scope of the present invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

- [006] FIG. 1 is schematic diagram of the system according to certain embodiments.
- [007] FIG. 2 is a schematic diagram of the system according to certain embodiments.
- [008] FIG. 3 is a schematic diagram of baffles according to certain embodiments.
- [009] FIG. 4 is schematic diagram of indicator signals according to certain embodiments.

DETAILED DESCRIPTION

[010] The present invention relates to an optical imaging system for imaging the eye of a subject which allows a subject to properly position and align its eye with the optical path of an ocular imaging system in response to visual cues from the system. This is in contrast to prior art optical imaging systems where the subject's eye position is assumed constant and alignment is achieved by adjusting the position of camera elements with respect to that eye. Thus, the disclosed system utilizes the precise oculomotor alignment system of the human eye to self align, instead of relying on the trained operators or expensive servo motors to achieve alignment.

[011] According to certain embodiments, the system comprises a camera, for example a fundus camera, having an image sensor, one or more guide lights, positioned laterally between the image sensor and the subject's eye. In certain embodiments, the system further comprises one or more baffles, positioned between the one or more guide light and subject's eye. The one or more baffle is configured to occlude the subject's view of the one or more guide light until the eye of the subject is properly positioned and aligned translationally (along x, y, z axes) and rotationally (along theta, eta, zeta axes) with respect to the optical path of the imaging device so as to provide for optimal image acquisition.

Guide Lights

[012] In certain embodiments, as best seen in Figs 1 and 2, the one or more guide light is a ring light, that is, a light forming a substantially ring-like shape. The guide light is masked by one or more baffle which according to certain embodiments, is of a substantially cone-like

shape with the wide end of the cone at the ring guide light and the narrow end near the eye of the subject. In certain embodiments, as the subject approaches the device, a coaxial light becomes visible to aid in coarse alignment of the subject's eye with the system. As the subject directs its gaze into the device, some section of the one or more guide light ring comes into view. As the subject further adjusts its gaze toward alignment, more and more of the ring becomes visible until entire ring is visible indicating that alignment has been achieved. During this process, the aspect of the ring that is not visible will direct the subject to adjust its eye in the appropriate direction for alignment. For example, if the right side of the ring is fully visible but the left is not, then the subject adjusts its eye to the right until the light becomes visible.

[013] According to certain embodiments, best shown in FIG 1, the system is external to the ocular imaging device. For example in certain embodiments, the guide lights are positioned on a ring between the objective lens of the camera and the subject's eye. According to certain alternative embodiments, best shown in FIG 2a, the system is integrated into the ocular imaging device. In certain embodiments the guide lights are positioned around the objective lens of the camera. In further embodiments, the guide lights are positioned within the optics of a fundus camera, or other optical device, in the illumination pathway.

[014] According to certain embodiments, best shown in FIG 2b, additional direction is provided to the subject by providing a sequence of lights that serve as sequential focal points. As the subject aligns its eye with each of the sequential focal points, the subjects eye is guided along the z-axis until they are looking at the target ring of light.

[015] In certain embodiments, one or more of the guide lights are implemented as collimated light sources such as laser light. In these embodiments, the one or more guide lights can be direct along a specific path configured to be visible only when the eye is properly positioned. Accordingly, baffles are no longer necessarily needed.

[016] FIG 3 shows exemplary baffles according to certain embodiments. As will be appreciated by one skilled in the art, the angle of the baffle constrains the light emission such that only a beam at the desired beam path angle is emitted, allowing for precise control of the position of the eye required for viewing the masked light.

[017] In certain alternative embodiments, the one or more guide lights are further comprised of sets guide lights, wherein each set is configured to achieve alignment with respect to a specific axis. For example, according to certain embodiments, the plurality of guide lights

are further comprised of one or more of z-axis guide lights, configured to be visible when the subject's eye is optimally positioned along the z-axis with respect to the image sensor. The plurality of guide lights are further comprised of one or more x-axis guide lights and one or more y-axis guide lights, configured to be visible to the subject when the subject is optimally positioned and aligned along the x-axis and y-axis, respectively.

Eye of the Subject

[018] In certain embodiments, proper alignment is achieved when the subject's eye is aligned for imaging of the retina. In further embodiments, proper alignment is achieved when the subject's eye is aligned for imaging the cornea. In still further embodiment, proper alignment is achieved when the subject's eye is aligned for imaging the iris. In yet further embodiments, proper alignment is achieved when the subject's eye is aligned for imaging the lens, In further embodiments, proper alignment is achieved when the subject's eye is aligned for imaging the optic nerve head.

Optical Imaging Device

[019] In certain embodiments, the optical imaging device is a fundus camera. In further embodiments, the camera is an optical coherence tomography (OCT) retinal camera. In still further embodiments, the optical imaging device is autorefractor. In yet further embodiments, the optical imaging device is a corneal camera. As will be appreciated by one skilled in the art, other camera types are possible.

Indicator Signals

[020] According to certain embodiments, the system further comprises one or more indicator signals. In these embodiments, the one or more indicator signal serves to provide additional guidance to the subject regarding the required direction of eye movement to achieve alignment. Example indicator signals include but are not limited arrows, colors, or flashing lights. According to certain embodiments, the indicator signals are masked by one or more baffles such that they are only visible when the eye is out of alignment. For example, a rightward pointing arrow indicator signal is a baffled such that it is only visible to the subject when the subject eye is directed to the left of proper alignment.

[021] According to certain embodiments, best shown in FIG 4, indicator signals are comprised of colored ring lights of differing colors. The one or more guide lights is a color different from the colors of the one or more indicator signal. FIG 4a shows an eye out of alignment where the subject is able to view a yellow indicator signal light but unable to see the green guide light. FIG 4b shows an eye of a subject in proper alignment where the subject is able to see the green guide light but unable to see the yellow or red indicator signals.

[022] Although the present invention has been described with reference to preferred embodiments, persons skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

CLAIMS

What is claimed is:

1. An ocular alignment system for aligning a subject's eye with an optical axis of an ocular imaging device comprising:
 - one or more guide light; and
 - one or more baffle configured to mask the one or more guide light from view of the subject such that the one or more guide light is only visible to the subject when the eye of the subject is aligned with the optical axis of an ocular imaging system.
2. The system of claim 1 wherein the one or more guide light is a ring light.
3. The system of claim 1 wherein the one or more guide lights are one or more distinct light sources.
4. The system of claim one wherein the one or more baffle is a cone.
5. The system of claim 1 wherein the one or more guide light is only visible when the eye is aligned along the x, y and z axes with respect to the optical path of the ocular imaging device.
6. The system of claim 1, further comprising one or more indicator signals, wherein the one or more indicator signals indicates to the subject a direction of eye movement to achieve alignment.
7. The system of claim 6 wherein the one or more guide light is only visible when the eye is aligned along the theta, eta, zeta axes with respect to the optical path of the ocular imaging device.
8. The system of claim 5 wherein one or more baffles mask the one or more indicator signal from view of the subject such that the one or more indicator signal is only visible to the subject when the eye of the subject is out of alignment with the optical axis or a target operational distance of the ocular imaging system.
9. The system of claim 6 wherein the one or more indicator signals are arrows.

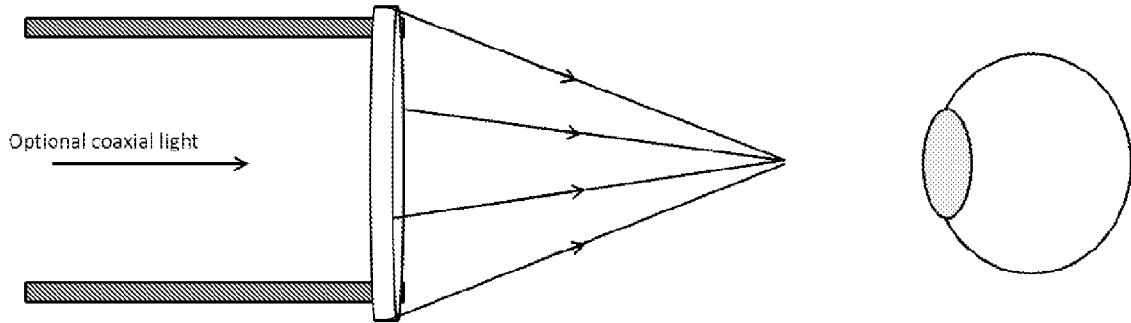
10. The system of claim 6 wherein the one or more indicator signals are colored lights.
11. The system of claim 1 wherein the system is integrated within optical imaging device.
12. The system of claim 1 wherein the system is external to the optical imaging device.
13. The system of claim 1 further comprising a coaxial light visible to the subject when coarse alignment is achieved.

SYSTEMS AND METHODS FOR ALIGNMENT OF THE EYE FOR OCULAR IMAGING

ABSTRACT

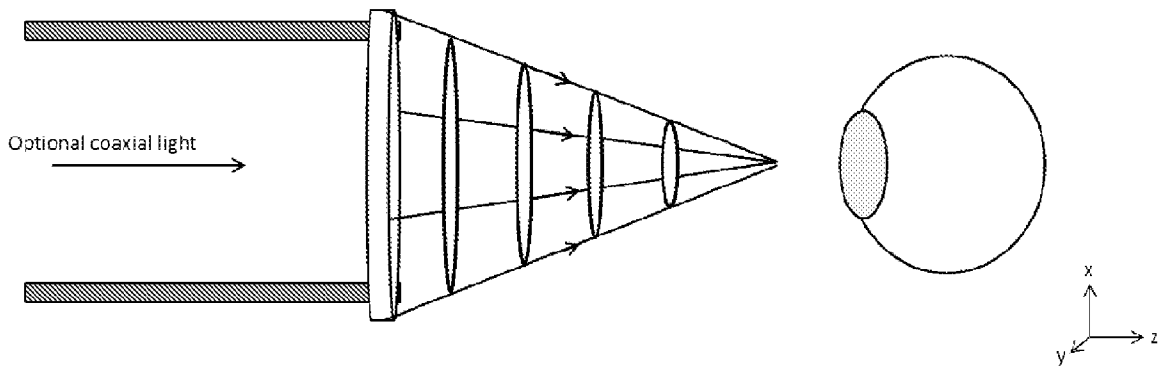
The present invention is an ocular alignment system for aligning a subject's eye with an optical axis of an ocular imaging device comprising one or more guide light and one or more baffle configured to mask the one or more guide light from view of the subject such that the one or more guide light is only visible to the subject when the eye of the subject is aligned with the optical axis of an ocular imaging system.

A.



System external to device

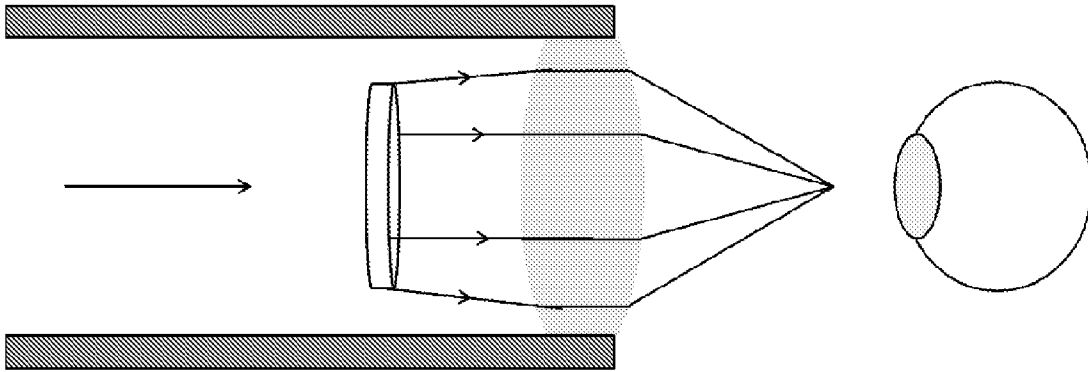
B.



Light paths tracing the surface of a cone

Figure 1

A.



System internal to device

B.

Multiple light sources along the optical path with sequential focal points

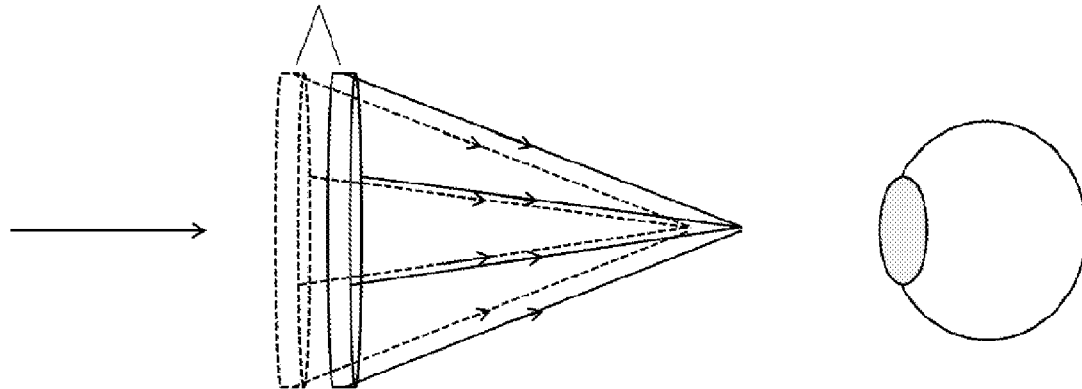
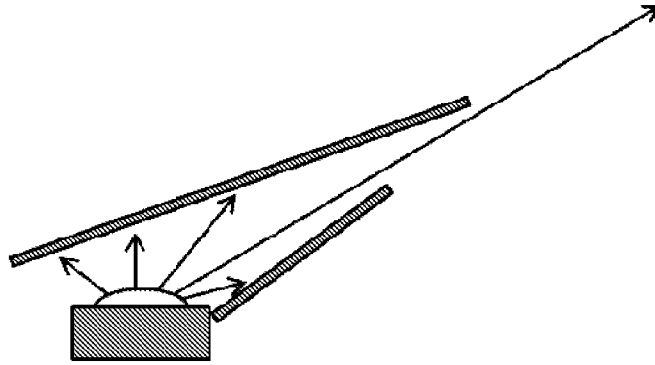


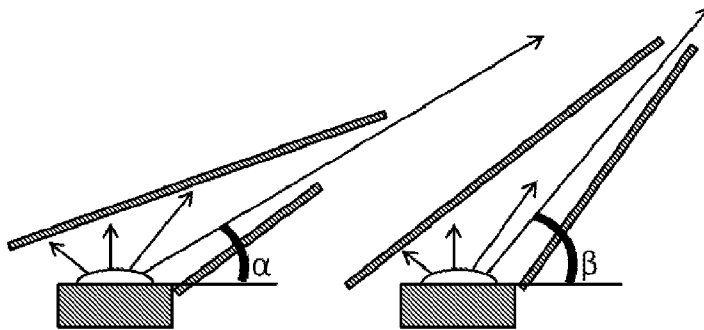
Figure 2

A.



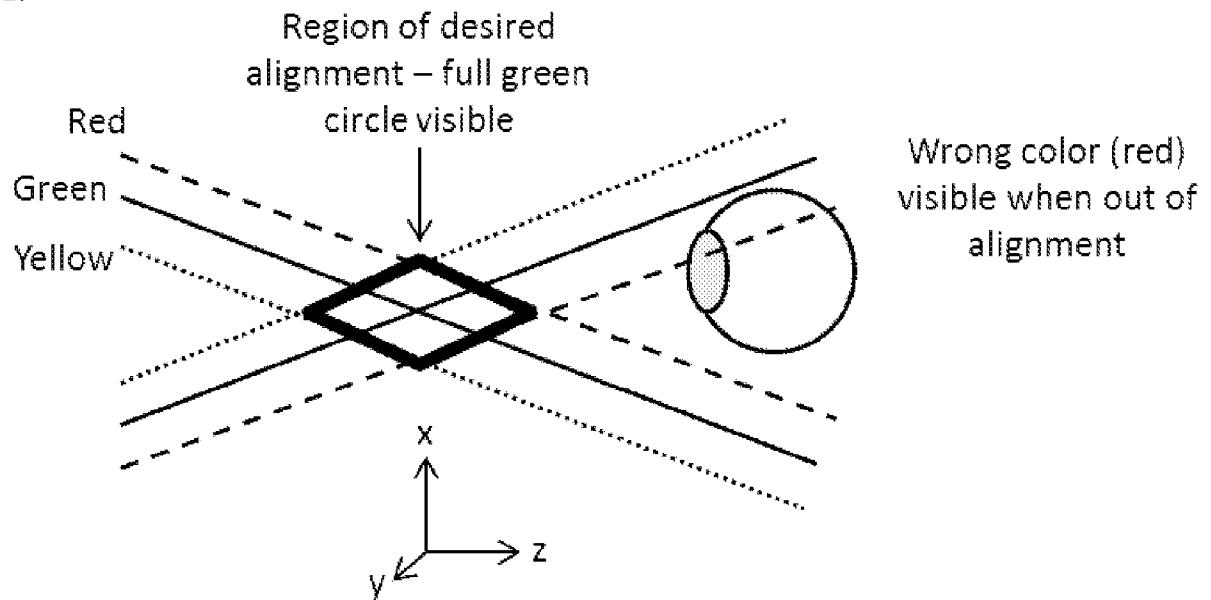
Baffle to constrain beam path

B.



Baffles to constrain beam paths of different light sources at different angles

A.



B.

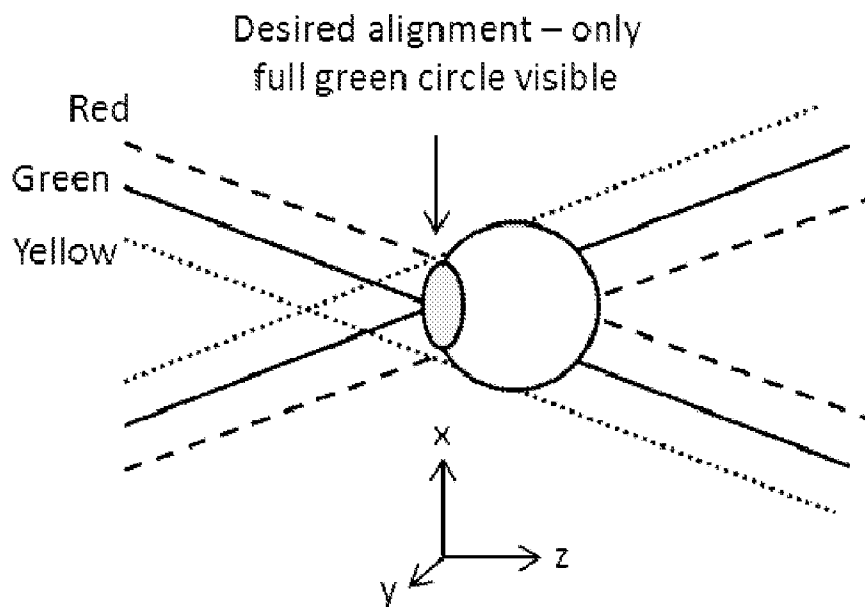


Figure 4

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	8967740/100396
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR ALIGNMENT OF THE EYE FOR OCULAR IMAGING		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2

<input type="checkbox"/>	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
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Inventor 1					<input type="button" value="Remove"/>
Legal Name					
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	Michael	D.	Abramoff		
Residence Information (Select One) <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service					
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City	University Heights	State/Province	IA		
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	Eric		Talmage		
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Postal Code	49315	Country i	US		
Inventor 3					<input type="button" value="Remove"/>
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Ben		Clark		
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Mailing Address of Inventor:

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Postal Code		Country i	US		

Inventor 4

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Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Edward		DeHoog	

Residence Information (Select One) US Residency Non US Residency Active US Military Service

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-------------	------------	-----------------------	----	-------------------------------	----

Mailing Address of Inventor:

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Address 2					
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Customer Number	26386		
Email Address	mattcoryell@davisbrownlaw.com	Add Email	Remove Email

Application Information:

Title of the Invention	SYSTEMS AND METHODS FOR ALIGNMENT OF THE EYE FOR OCULAR IMAGING		
Attorney Docket Number	8967740/100396	Small Entity Status Claimed	<input checked="" type="checkbox"/>
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	

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Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

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Request Early Publication (Fee required at time of Request 37 CFR 1.219)

Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not be** the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	<input checked="" type="radio"/> Customer Number	<input type="radio"/> US Patent Practitioner	<input type="radio"/> Limited Recognition (37 CFR 11.9)
Customer Number	26386		

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This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the application number blank.

Prior Application Status			<input type="button" value="Remove"/>
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
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This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

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Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ^j (if applicable)

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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

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In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

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If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.			
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	8967740/100396
	Application Number	
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	8967740/100396
	Application Number	
Title of Invention	SYSTEMS AND METHODS FOR ALIGNMENT OF THE EYE FOR OCULAR IMAGING	

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EFS ID:	19483885
Application Number:	62020252
International Application Number:	
Confirmation Number:	9712
Title of Invention:	SYSTEMS AND METHODS FOR ALIGNMENT OF THE EYE FOR OCULAR IMAGING
First Named Inventor/Applicant Name:	Michael Abramoff
Customer Number:	26386
Filer:	Kent A. Herink/Patty Law
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		ProvisionalApp_ASFILED_2July 2014.pdf	44649 1d1dc34ad19a1f176a502aea3926a44610 56763	yes	8
Multipart Description/PDF files in .zip description					
	Document Description		Start		End
	Specification		1		5
	Claims		6		7
	Abstract		8		8
Warnings:					
Information:					
2	Drawings-only black and white line drawings	ProvisionalFigs_ASFILED_2July 2014.pdf	325059 20dbb7fa866fb8ec10ccab3e40a51c50db3 576bc	no	4
Warnings:					
Information:					
3	Application Data Sheet	AppDataSheet_2July2014.pdf	1565961 7eac53da6e27a1a21dc69c756cfc4c03115 4b6a	no	8
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30154 b6d60fb43d3af16f20f224438bc514a6fbeb ed4	no	2
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