

(12) **United States Patent**  
**Cleveland**

(10) **Patent No.:** **US 9,510,753 B2**  
(45) **Date of Patent:** **Dec. 6, 2016**

(54) **ASYMMETRIC APERTURE FOR EYETRACKING**  
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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(2013.01); *A61B 3/145* (2013.01); *B81B 7/008* (2013.01); *B81B 7/02* (2013.01); *G02B 27/0093* (2013.01); *G03B 9/02* (2013.01); *G03B 15/03* (2013.01); *G03B 15/05* (2013.01); *G03B 15/06* (2013.01); *G03B 15/16* (2013.01); *G03B 17/561* (2013.01); *G06F 3/013* (2013.01); *G06K 9/00597* (2013.01); *G06K 9/00604* (2013.01); *G06K 9/46* (2013.01); *G06T 7/0042* (2013.01); *H04N 5/23212* (2013.01); *H04N 5/23219* (2013.01); *G03B 17/17* (2013.01); *G06T 2207/30041* (2013.01)

(21) Appl. No.: **14/634,410**  
(22) Filed: **Feb. 27, 2015**

(65) **Prior Publication Data**  
US 2015/0241755 A1 Aug. 27, 2015  
**Related U.S. Application Data**

(58) **Field of Classification Search**  
CPC combination set(s) only.  
See application file for complete search history.

(60) Provisional application No. 61/945,551, filed on Feb. 27, 2014, provisional application No. 61/945,546, filed on Feb. 27, 2014.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,190,393 B2 \* 3/2007 Madsen ..... G02B 7/32 348/131

\* cited by examiner

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(51) **Int. Cl.**  
*G03B 15/14* (2006.01)  
*A61B 3/113* (2006.01)  
*A61B 3/14* (2006.01)  
*A61B 3/00* (2006.01)  
*B81B 7/02* (2006.01)  
*B81B 7/00* (2006.01)  
*H04N 5/232* (2006.01)  
*G03B 9/02* (2006.01)  
*G03B 15/03* (2006.01)  
*G03B 15/06* (2006.01)  
*G03B 15/05* (2006.01)  
*G03B 15/16* (2006.01)  
*G03B 17/56* (2006.01)  
*G06F 3/01* (2006.01)  
*G06K 9/00* (2006.01)  
*G06K 9/46* (2006.01)  
*G06T 7/00* (2006.01)  
*G02B 27/00* (2006.01)  
*G03B 17/17* (2006.01)

(57) **ABSTRACT**

An asymmetric aperture device for a camera is provided that improves light gathering properties by increasing both the light gathering opening of the aperture and the number of light producing light sources placed on the aperture. An asymmetric aperture design is provided that utilizes a significantly larger portion of the camera lens. The tradeoff between the competing objectives of maximizing camera depth of field and maximizing the production of useful focus-condition information within the camera image is optimized. More illumination is provided without significantly increasing the lateral size of the illuminator pattern.

(52) **U.S. Cl.**  
CPC ..... *A61B 3/113* (2013.01); *A61B 3/0025*

**8 Claims, 18 Drawing Sheets**

