



US010656396B1

(12) **United States Patent**  
**Goldenberg et al.**

(10) **Patent No.:** **US 10,656,396 B1**  
(45) **Date of Patent:** **May 19, 2020**

(54) **AUTO FOCUS AND OPTICAL IMAGE STABILIZATION IN A COMPACT FOLDED CAMERA**

USPC ..... 359/554, 557; 250/201.1, 201.2, 201.4; 348/208.99, 208.2, 208.12; 396/52, 55  
See application file for complete search history.

(71) Applicant: **Corephotonics Ltd.**, Tel-Aviv (IL)

(56) **References Cited**

(72) Inventors: **Ephraim Goldenberg**, Ashdod (IL); **Gal Shabtay**, Tel Aviv (IL); **Gal Avivi**, Haifa (IL); **Michael Dror**, Nes Ziona (IL); **Gil Bachar**, Tel-Aviv (IL); **Itay Jerby**, Netanya (IL); **Itay Yedid**, Karne Yosef (IL)

U.S. PATENT DOCUMENTS

4,199,785 A 4/1980 McCullough et al.  
5,005,083 A 4/1991 Grage et al.  
(Continued)

(73) Assignee: **Corephotonics Ltd.**, Tel Aviv (IL)

OTHER PUBLICATIONS

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

Statistical Modeling and Performance Characterization of a Real-Time Dual Camera Surveillance System, Greienhagen et al., Publisher: IEEE, 2000, 8 pages.

(Continued)

(21) Appl. No.: **16/739,131**

(22) Filed: **Jan. 10, 2020**

*Primary Examiner* — Arnel C Lavarias

(74) *Attorney, Agent, or Firm* — Nathan & Associates; Menachem Nathan

**Related U.S. Application Data**

(63) Continuation of application No. 16/289,672, filed on Mar. 1, 2019, now Pat. No. 10,571,666, which is a (Continued)

(57) **ABSTRACT**

(51) **Int. Cl.**  
**G02B 27/64** (2006.01)  
**G02B 13/00** (2006.01)  
(Continued)

Compact folded camera modules having auto-focus (AF) and optical image stabilization (OIS) capabilities and multi-aperture cameras including such modules. In an embodiment, a folded camera module includes an optical path folding element (OPFE) for folding light from a first optical path with a first optical axis to a second optical path with a second optical axis perpendicular to the first optical axis, an image sensor and a lens module carrying a lens with a symmetry axis parallel to the second optical axis. The lens module can be actuated to move in first and second orthogonal directions in a plane perpendicular to the first optical axis, the movement in the first direction being for auto-focus and the movement in the second direction being for OIS. The OPFE can be actuated to tilt for OIS.

(52) **U.S. Cl.**  
CPC ..... **G02B 13/0065** (2013.01); **G02B 7/08** (2013.01); **G02B 7/09** (2013.01); **G02B 13/16** (2013.01); **G02B 27/646** (2013.01); **H04N 5/2257** (2013.01); **H04N 5/2258** (2013.01); **H04N 5/23258** (2013.01); **H04N 5/23287** (2013.01); **G02B 26/0816** (2013.01)

(58) **Field of Classification Search**  
CPC ..... G02B 7/04; G02B 27/64; G02B 27/646; H04N 5/23248; H04N 5/23264; H04N 5/2328; H04N 5/23287

**15 Claims, 14 Drawing Sheets**

300

