



US010498961B2

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

(10) **Patent No.: US 10,498,961 B2**  
(45) **Date of Patent: \*Dec. 3, 2019**

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

(71) Applicant: **Corephotonics Ltd.**, Tel-Aviv (IL)  
(72) Inventors: **Ephraim Goldenberg**, Ashdod (IL); **Gil Bachar**, Tel-Aviv (IL); **Itay Jerby**, Netanya (IL); **Gal Shabtay**, Tel-Aviv (IL)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/360,047**

(22) Filed: **Mar. 21, 2019**

(65) **Prior Publication Data**

US 2019/0222758 A1 Jul. 18, 2019

**Related U.S. Application Data**

(63) Continuation of application No. 16/055,175, filed on Aug. 6, 2018, now Pat. No. 10,284,780, which is a continuation of application No. 15/505,120, filed as application No. PCT/IB2016/055308 on Sep. 5, 2016, now Pat. No. 10,070,060.

(Continued)

(51) **Int. Cl.**  
**H04N 5/232** (2006.01)  
**G02B 27/64** (2006.01)

(Continued)

(52) **U.S. Cl.**  
CPC ..... **H04N 5/23248** (2013.01); **G02B 27/64** (2013.01); **G02B 27/646** (2013.01);  
(Continued)

(58) **Field of Classification Search**  
CPC ..... H04N 5/23248; G03B 3/10; G03B 13/36; G03B 17/17; G03B 27/64;

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

FOREIGN PATENT DOCUMENTS

CN 101276415 A 10/2008  
CN 102739949 A 10/2012  
(Continued)

OTHER PUBLICATIONS

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

(Continued)

*Primary Examiner* — Lin Ye

*Assistant Examiner* — Chriss S Yoder, III

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

(57) **ABSTRACT**

Folded digital camera module comprising 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 camera module is adapted to perform optical image stabilization (OIS) involving at least one tilt motion of the OPFE tilt around an axis such that the OPFE tilt creates an image Roll movement and a shift movement, the OPFE tilt-created image Roll movement compensating for a folded camera module-induced Roll movement and the shift movement cancelable by a movement of the lens module.

**14 Claims, 5 Drawing Sheets**

