



US010678029B1

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

(10) **Patent No.:** **US 10,678,029 B1**
(45) **Date of Patent:** ***Jun. 9, 2020**

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

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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.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/782,707**

(22) Filed: **Feb. 5, 2020**

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 continuation of application No. 15/917,701, filed on Mar. 11, 2018, now Pat. No. 10,613,303, which is a continuation of application No. 15/303,863, filed as (Continued)

(51) **Int. Cl.**
G02B 27/64 (2006.01)
G02B 13/00 (2006.01)
G02B 13/16 (2006.01)
G02B 7/08 (2006.01)
H04N 5/225 (2006.01)
H04N 5/232 (2006.01)

(Continued)

(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**
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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,927,600 B2 * 3/2018 Goldenberg G02B 13/0065
10,571,666 B2 * 2/2020 Goldenberg G02B 27/646
2018/0196238 A1 * 7/2018 Goldenberg G02B 7/09

* cited by examiner

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(57) **ABSTRACT**

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.

18 Claims, 14 Drawing Sheets

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