

(19) **United States**
 (12) **Patent Application Publication** (10) **Pub. No.: US 2023/0232130 A1**
 Geva et al. (43) **Pub. Date: Jul. 20, 2023**

(54) **IMAGE SENSORS AND SENSING METHODS TO OBTAIN TIME-OF-FLIGHT AND PHASE DETECTION INFORMATION**

Publication Classification

(51) **Int. Cl.**
H04N 25/705 (2006.01)
H04N 13/271 (2006.01)
G06T 7/593 (2006.01)
H04N 13/207 (2006.01)
H04N 25/75 (2006.01)
 (52) **U.S. Cl.**
 CPC *H04N 25/705* (2023.01); *G06T 7/593* (2017.01); *H04N 13/207* (2018.05); *H04N 13/271* (2018.05); *H04N 25/75* (2023.01)

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

(72) Inventors: **Nadav Geva, Tel Aviv (IL); Michael Scherer, Tel Aviv (IL); Ephraim Goldenberg, Tel Aviv (IL); Gal Shabtay, Tel Aviv (IL)**

(21) Appl. No.: **18/186,151**

(22) Filed: **Mar. 18, 2023**

Related U.S. Application Data

(63) Continuation of application No. 17/375,299, filed on Jul. 14, 2021, now Pat. No. 11,637,977.
 (60) Provisional application No. 63/055,912, filed on Jul. 24, 2020, provisional application No. 63/052,001, filed on Jul. 15, 2020.

(57) **ABSTRACT**

Indirect time-of-flight (i-ToF) image sensor pixels, i-ToF image sensors including such pixels, stereo cameras including such image sensors, and sensing methods to obtain i-ToF detection and phase detection information using such image sensors and stereo cameras. An i-ToF image sensor pixel may comprise a plurality of sub-pixels, each sub-pixel including a photodiode, a single microlens covering the plurality of sub-pixels and a read-out circuit for extracting i-ToF phase signals of each sub-pixel individually.

440

