

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau

(43) International Publication Date
18 April 2024 (18.04.2024)



(10) International Publication Number
WO 2024/081846 A1

(51) International Patent Classification:

G01B 11/06 (2006.01) G02B 21/36 (2006.01)
G01B 11/24 (2006.01) G02B 26/02 (2006.01)
G02B 21/24 (2006.01)

(21) International Application Number:

PCT/US2023/076784

(22) International Filing Date:

13 October 2023 (13.10.2023)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/416,193 14 October 2022 (14.10.2022) US

(71) Applicant: **CYBEROPTICS CORPORATION**
[US/US]: 5900 Golden Hills Drive, Golden Valley, Min-
nesota 55416 (US).

(72) Inventors: **HAUGAN, Carl E.**; 2031 Goodrich Avenue,
St. Paul, Minnesota 55105 (US). **SKUNES, Timothy A.**;
102 Dylan Court, Mahtomedi, Minnesota 55115 (US).

(74) Agent: **CHRISTENSON, Christopher R.**; 141 West 1st
Street, Suite 100, Waconia, Minnesota 55387 (US).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG,
KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY,
MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA,

(54) Title: SYNCHRONOUS MODULATE, GATE AND INTEGRATE 3D SENSOR

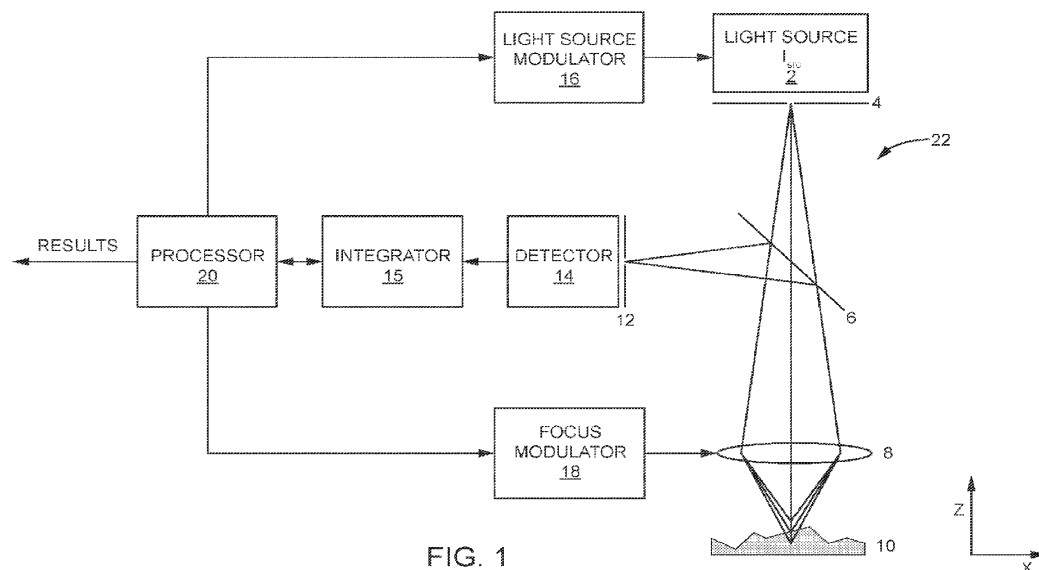


FIG. 1

(57) Abstract: A confocal three-dimensional sensor (22) for measuring height of a point on an object (10) is provided. The sensor (22) includes a light source (2) and a light source modulator (16) configured to temporally modulate the light source intensity. A source pinhole aperture (4) is positioned to be illuminated by the light source (2) and a focus-tunable lens (8) is configured to focus illumination passing through the source pinhole aperture (4) onto the object (10). A detector pinhole aperture (12) is configured to receive reflected light from the object (10), wherein the focus-tunable lens (8) is configured to image the reflected light from the object (10) onto the detector pinhole aperture (12). A detector (14) and integrator (15) are configured to output a measurement indicative of total light transmitted through the detector pinhole aperture (12). A processor (20) is operably coupled to the detector (14), integrator (15), and light source modulator (16). The processor (20) is configured to synchronously cause the light source modulator (16) to modulate light

[Continued on next page]

NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

source intensity while causing the focus tunable lens (8) to sweep axial focal position, the processor (20) being further configured to calculate a height of the point on the object (10) based on the output from the detector (14) and integrator (15).