

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

(19) World Intellectual Property  
Organization  
International Bureau

(43) International Publication Date  
20 October 2022 (20.10.2022)



(10) International Publication Number  
**WO 2022/221471 A1**

(51) International Patent Classification:

G01S 7/00 (2006.01) G06V 20/00 (2022.01)  
G06K 9/00 (2022.01) G01C 15/00 (2006.01)  
G06T 5/00 (2006.01)

(21) International Application Number:

PCT/US2022/024710

(22) International Filing Date:

13 April 2022 (13.04.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

17/230,730 14 April 2021 (14.04.2021) US

(71) Applicant: **LINEAGE LOGISTICS, LLC** [US/US]; 1  
Park Plaza, Suite 550, Irvine, California 92614 (US).

(72) Inventors: **ECKMAN, Christopher Frank**; 1 Park Plaza,  
Suite 550, Irvine, California 92614 (US). **LOWE, Brady  
Michael**; 1 Park Plaza, Suite 550, Irvine, California 92614  
(US). **HALL, Alexander**; 1 Park Plaza, Suite 550, Irvine,  
California 92614 (US).

(74) Agent: **HOFF, Christopher C.** et al.; Fish & Richardson  
P.C., P.O. Box 1022, Minneapolis, Minnesota 55440-1022  
(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, CZ, DE, DJ, DK, DM, DO,  
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,  
HR, HU, ID, IL, IN, IR, IS, IT, JM, JO, JP, KE, KG, KH,  
KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA,  
MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI,  
NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU,

(54) Title: POINT CLOUD FILTERING

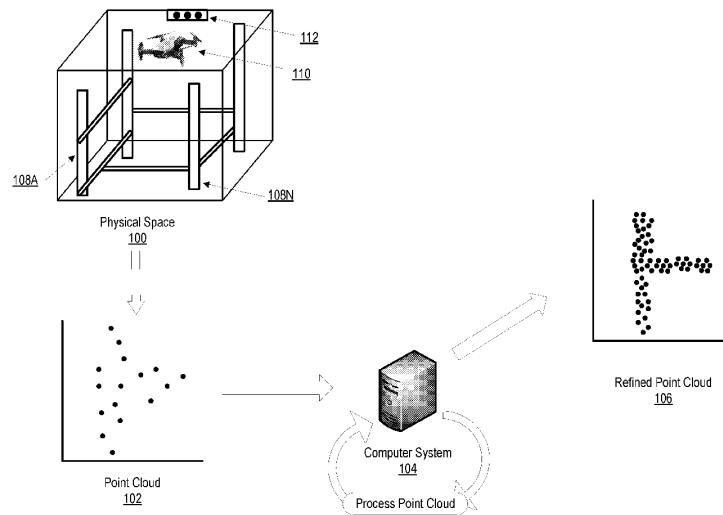


FIG. 1A

(57) **Abstract:** This specification describes systems and methods for refining point cloud data. Methods can include receiving point cloud data for a physical space, iteratively selecting points along an x, y, and z dimension, clustering the selected points into 2D histograms, determining a slope value for each 2D histogram, and removing, based on the slope value exceeding a predetermined value, points from the point cloud data. Methods can also include iteratively voxelizing each 2D histogram into predetermined mesh sizes, summing points in each voxelized 2D histogram, removing, based on determining the summation is below a predetermined sum value, points from the point cloud data, keeping, based on determining that a number of points in each voxelized 2D histogram exceeds a threshold value, a center point, selecting, for each histogram, a point, identifying, nearest neighbors in the point cloud data, removing the identified nearest neighbors from the data, and returning remaining points.

[Continued on next page]

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, GH, GM, KE, LR, LS, MW, MZ, NA, RW, 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, 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).

**Declarations under Rule 4.17:**

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

**Published:**

— *with international search report (Art. 21(3))*