

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

(19) World Intellectual Property
Organization
International Bureau

(43) International Publication Date
18 March 2021 (18.03.2021)



(10) International Publication Number
WO 2021/050177 A1

(51) International Patent Classification:
B64D 45/00 (2006.01) *G06N 20/00* (2019.01)
B64C 39/02 (2006.01)

(21) International Application Number:
PCT/US2020/044974

(22) International Filing Date:
05 August 2020 (05.08.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/900,380 13 September 2019 (13.09.2019) US
16/887,194 29 May 2020 (29.05.2020) US

(71) Applicant: **WING AVIATION LLC** [US/US]; 1600 Amphitheatre Parkway, Mountain View, California 94043 (US).

(72) Inventors: **SINDHWANI, Vikas**; 1600 Amphitheatre Parkway, Mountain View, California 94043 (US). **SIDAHMED, Hakim**; 1600 Amphitheatre Parkway, Mountain View, California 94043 (US). **CHOROMANSKI, Krzysztof**; 1600 Amphitheatre Parkway, Mountain View, California 94043 (US). **JONES, Brandon L.**; 1600 Amphitheatre Parkway, Mountain View, California 94043 (US).

(74) Agent: **CLAASSEN, Cory G.** et al.; Christensen O'Connor Johnson Kindness PLLC, 1201 Third Avenue, Suite 3600, Seattle, Washington 98101 (US).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM,

(54) Title: UNSUPERVISED ANOMALY DETECTION FOR AUTONOMOUS VEHICLES

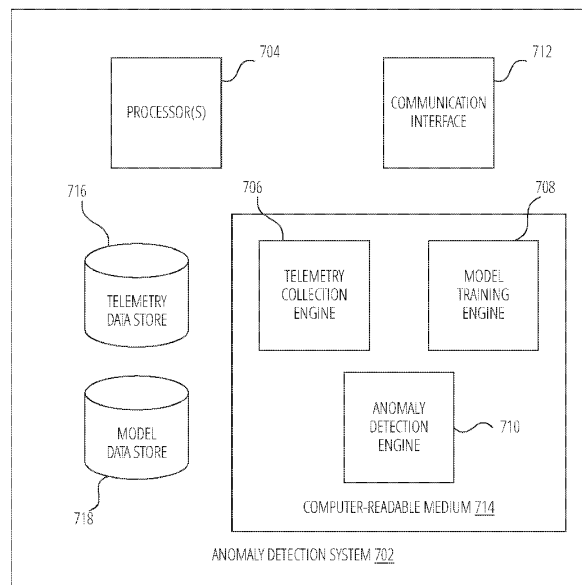


FIG. 7

(57) Abstract: In some embodiments, techniques are provided for analyzing time series data to detect anomalies. In some embodiments, the time series data is processed using a machine learning model. In some embodiments, the machine learning model is trained in an unsupervised manner on large amounts of previous time series data, thus allowing highly accurate models to be created from novel data. In some embodiments, training of the machine learning model alternates between a fitting optimization and a trimming optimization to allow large amounts of training data that includes untagged anomalous records to be processed. Because a machine learning model is used, anomalies can be detected within complex systems, including but not limited to autonomous vehicles such as unmanned aerial vehicles. When anomalies are detected, commands can be transmitted to the monitored system (such as an autonomous vehicle) to respond to the anomaly.

[Continued on next page]

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, 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, 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).

Published:

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