



US011656364B2

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

(10) **Patent No.:** **US 11,656,364 B2**

(45) **Date of Patent:** **May 23, 2023**

(54) **REAL-TIME CORRELATION OF SENSED POSITION DATA WITH TERRESTRIAL FEATURES**

(58) **Field of Classification Search**  
None  
See application file for complete search history.

(71) Applicant: **Freeport-McMoRan Inc.**, Phoenix, AZ (US)

(56) **References Cited**

(72) Inventors: **Mary Amelia Walker**, Phoenix, AZ (US); **Robert Catron**, Phoenix, AZ (US); **Brian Vaughan**, St. Louis, MO (US); **Hung Jung Lu**, St. Louis, MO (US)

U.S. PATENT DOCUMENTS

5,123,087 A 6/1992 Newell et al.  
5,848,374 A 12/1998 Wakabayashi et al.  
8,718,932 B1 5/2014 Pack et al.  
9,183,438 B1 11/2015 Dhein  
(Continued)

(73) Assignee: **Freeport-McMoRan Inc.**, Phoenix, AZ (US)

OTHER PUBLICATIONS

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 419 days.

Supplemental European Search Report, dated Aug. 3, 2022, for European Patent Application No. 18937763, corresponding to International Application No. PCT/US2018/057356, 7 pages.  
(Continued)

(21) Appl. No.: **16/893,615**

*Primary Examiner* — Abdhesh K Jha

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

(74) *Attorney, Agent, or Firm* — Fennemore Craig, P.C.

(65) **Prior Publication Data**  
US 2020/0301022 A1 Sep. 24, 2020

(57) **ABSTRACT**

**Related U.S. Application Data**

(63) Continuation of application No. 16/167,989, filed on Oct. 23, 2018, now Pat. No. 10,712,448.

Methods and systems of correlating sensed position data with terrestrial features receive sensed position data from a position sensing system operatively associated with a moveable object; select a reduced set of snap point candidates from terrestrial data based on a sensed position point; choose a best snap point candidate from among the reduced set of snap point candidates based on a plurality of predictive variables and corresponding weighting factors for each snap point candidate in the reduced set of snap point candidates; and snap the sensed position point to the best snap point candidate to produce a snapped position point. The selecting, choosing, and snapping processes are performed in substantially real time so that the systems and methods correlate the sensed position data from the moveable object with terrestrial features in substantially real time.

(51) **Int. Cl.**  
**G01S 19/27** (2010.01)  
**G01S 19/07** (2010.01)  
**G06N 5/046** (2023.01)  
**G06F 17/15** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **G01S 19/27** (2013.01); **G01S 19/07** (2013.01); **G06F 17/15** (2013.01); **G06N 5/046** (2013.01)

**24 Claims, 12 Drawing Sheets**

