US 20250370477A1

(19) **United States**

(12) **Patent Application Publication**

**Frederick et al.**

(10) **Pub. No.: US 2025/0370477 A1**

(43) **Pub. Date: Dec. 4, 2025**

(54) **AUTONOMOUS DRONE MESH SENSOR DEPLOYMENT SYSTEM**

(71) Applicant: **Uniform Sierra Aerospace, LLC**, West Lafayette, IN (US)

(72) Inventors: **Jeremy Frederick**, West Lafayette, IN (US); **Nick Hansen**, West Lafayette, IN (US); **Duncan Mulgrew**, West Lafayette, IN (US)

(21) Appl. No.: **19/034,874**

(22) Filed: **Jan. 23, 2025**

**Related U.S. Application Data**

(63) Continuation of application No. 18/677,146, filed on May 29, 2024, now Pat. No. 12,242,288.

**Publication Classification**

(51) **Int. Cl.**

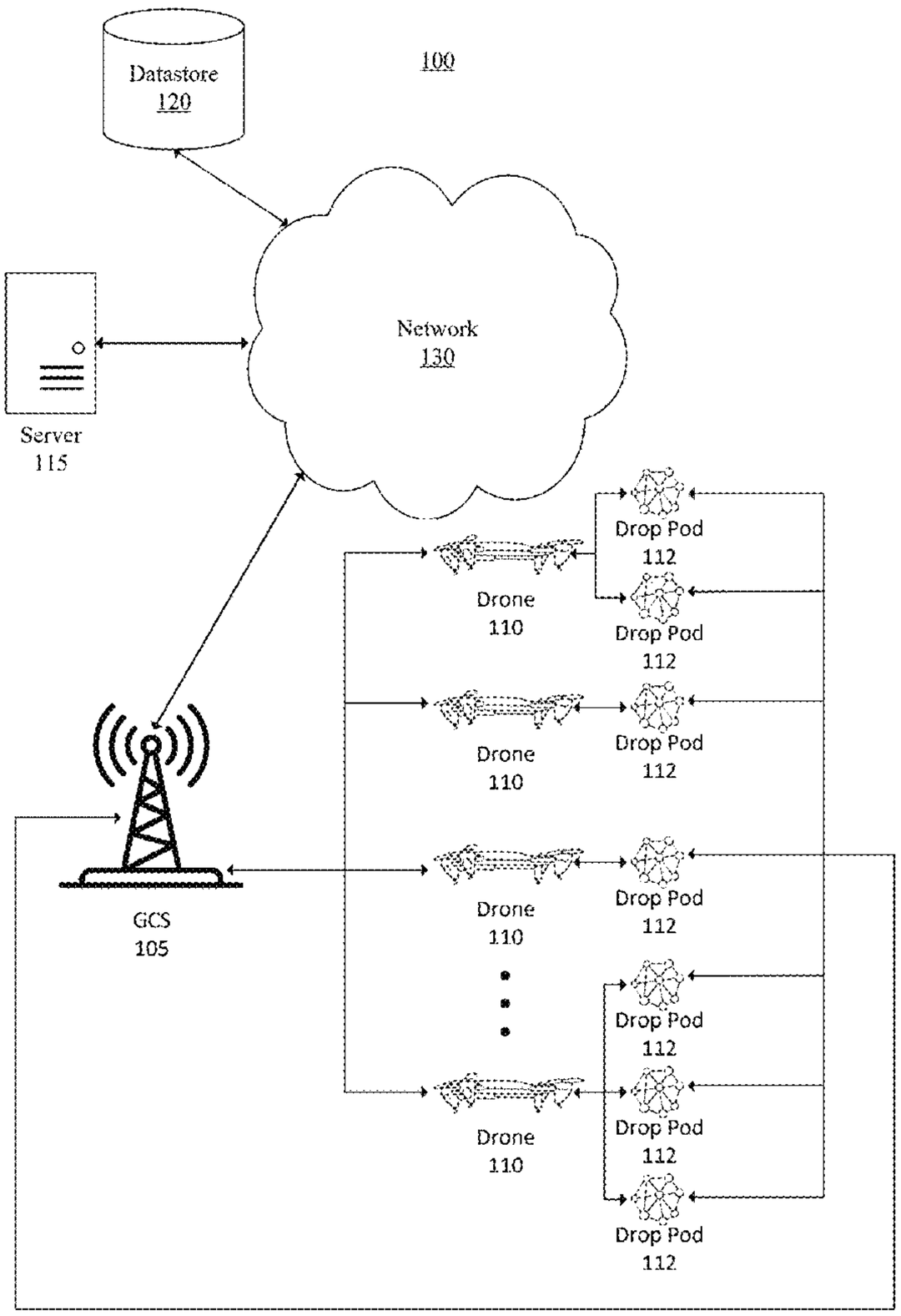
| | |
|---|---|
| ***G05D 1/656*** | (2024.01) |
| ***B64D 1/08*** | (2006.01) |
| ***G05D 1/222*** | (2024.01) |
| ***G05D 1/243*** | (2024.01) |
| ***G05D 1/247*** | (2024.01) |
| ***G05D 105/40*** | (2024.01) |
| ***G05D 109/20*** | (2024.01) |
| ***H04L 67/12*** | (2022.01) |

(52) **U.S. Cl.**

CPC ..... ***G05D 1/665*** (2024.01); ***B64D 1/08*** (2013.01); ***G05D 1/222*** (2024.01); ***G05D 1/243*** (2024.01); ***G05D 1/247*** (2024.01); ***H04L 67/12*** (2013.01); *G05D 2105/40* (2024.01); *G05D 2109/20* (2024.01)

(57) **ABSTRACT**

Systems, tools and methods for deploying a mesh sensor network. The system comprises one or more aircraft configured to carry one or more drop pods into an environment and the deploying of the drop pods at points of interest. The aircraft and drop pods may comprise arrays of sensors for monitoring the areas that they are operating in. The aircraft and drop pods may include mesh radio communication devices and operate as nodes in the mesh network. The location at which each drop pod is to be deployed may be determined based on the type of sensors carried by the drop pod.



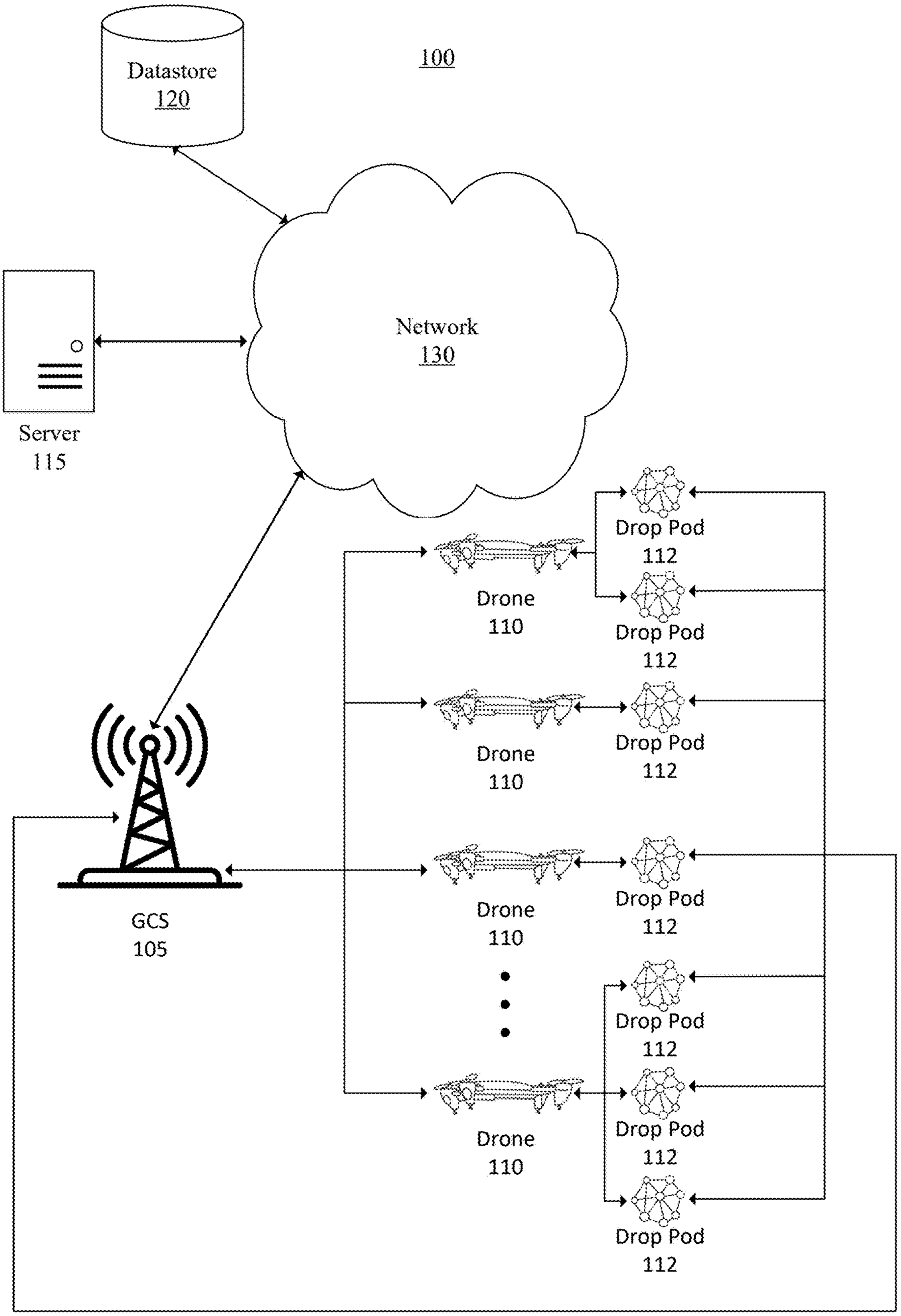

100
Datastore
120
Network
130
Server
115
GCS
105
Drone
110
Drop Pod
112

FIG. 1

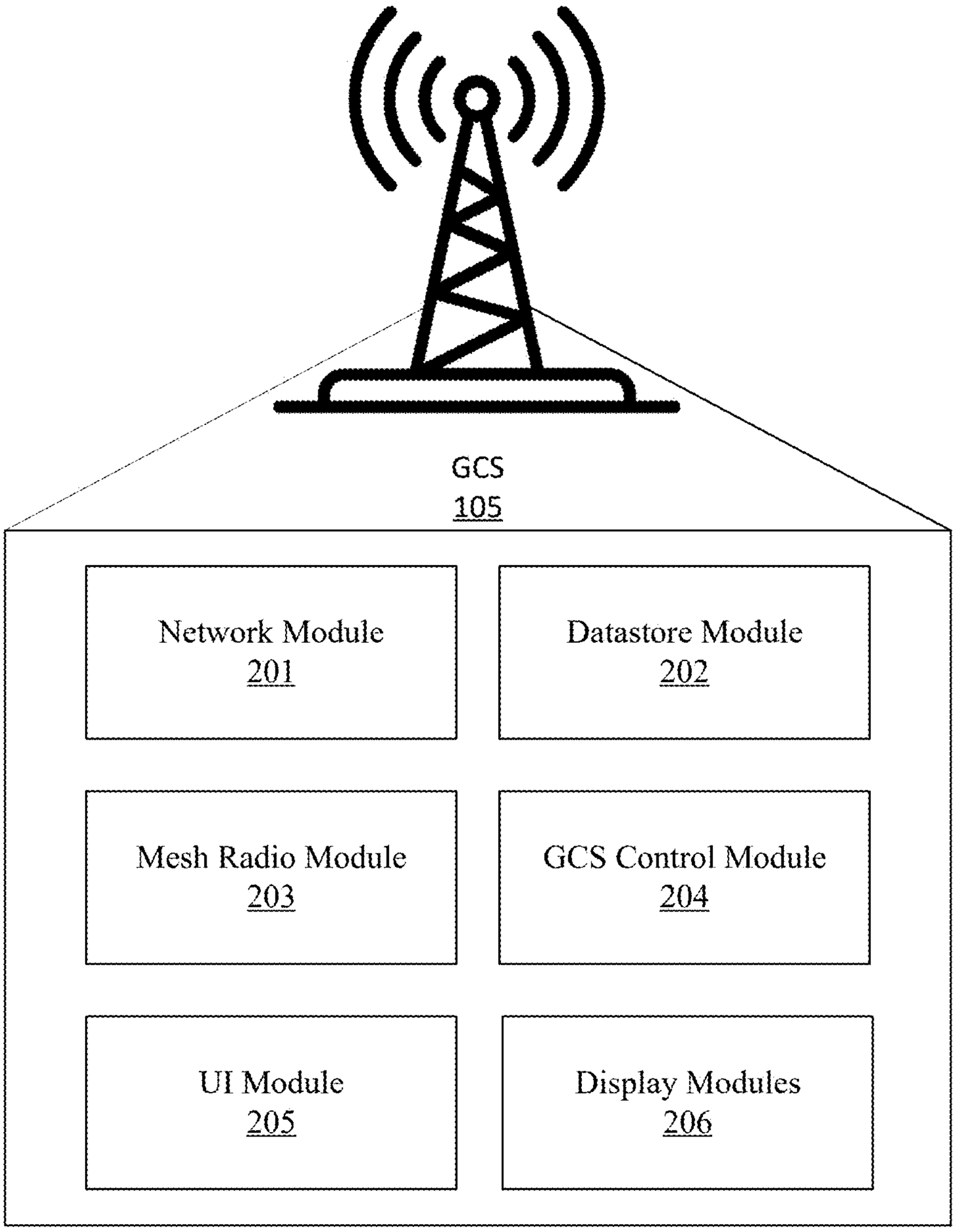

GCS
105
Network Module
201
Datastore Module
202
Mesh Radio Module
203
GCS Control Module
204
UI Module
205
Display Modules
206

FIG. 2A

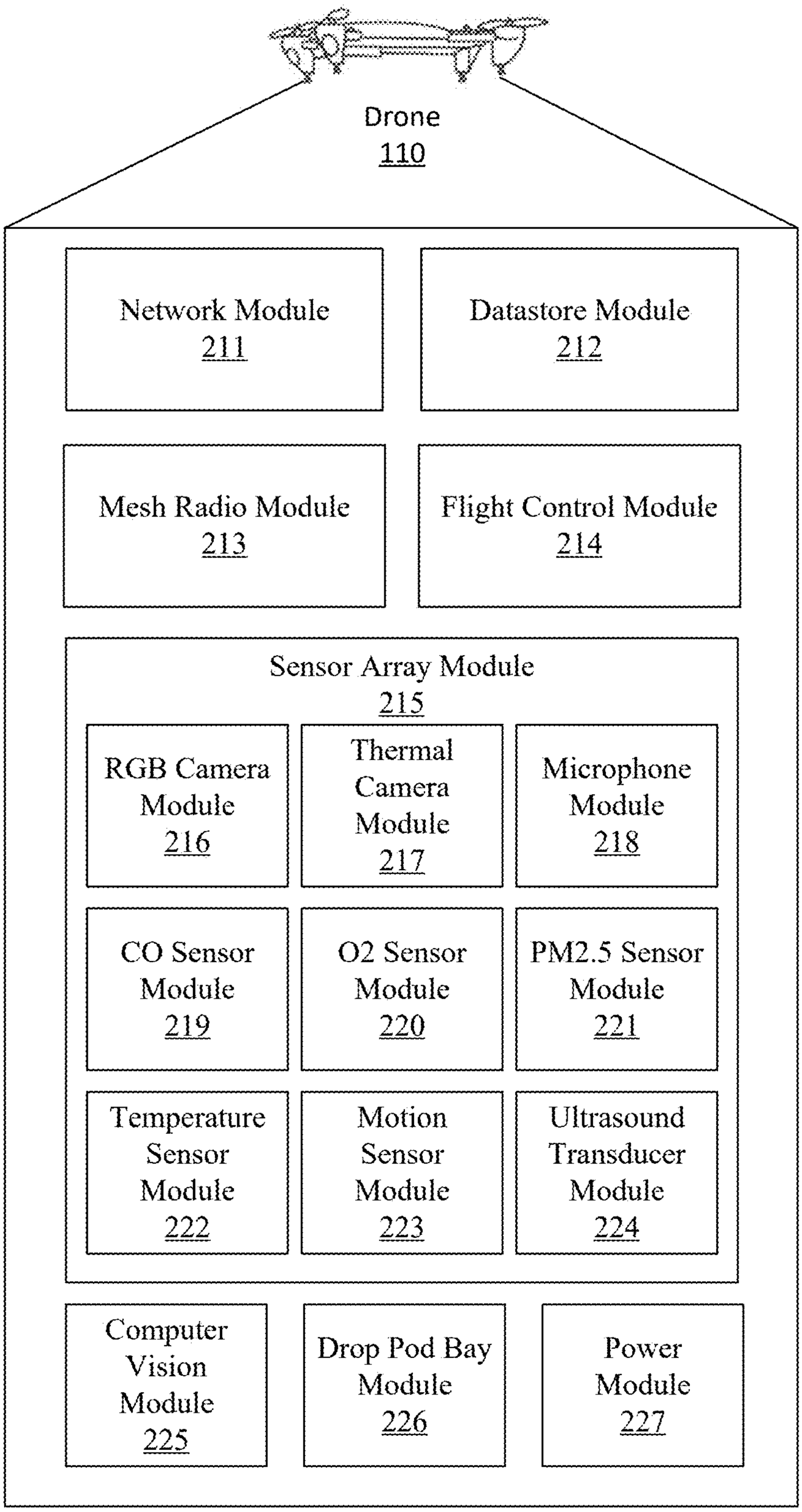

Drone
110
Network Module
211
Datastore Module
212
Mesh Radio Module
213
Flight Control Module
214
Sensor Array Module
215
RGB Camera Module
216
Thermal Camera Module
217
Microphone Module
218
CO Sensor Module
219
O2 Sensor Module
220
PM2.5 Sensor Module
221
Temperature Sensor Module
222
Motion Sensor Module
223
Ultrasound Transducer Module
224
Computer Vision Module
225
Drop Pod Bay Module
226
Power Module
227

FIG. 2B

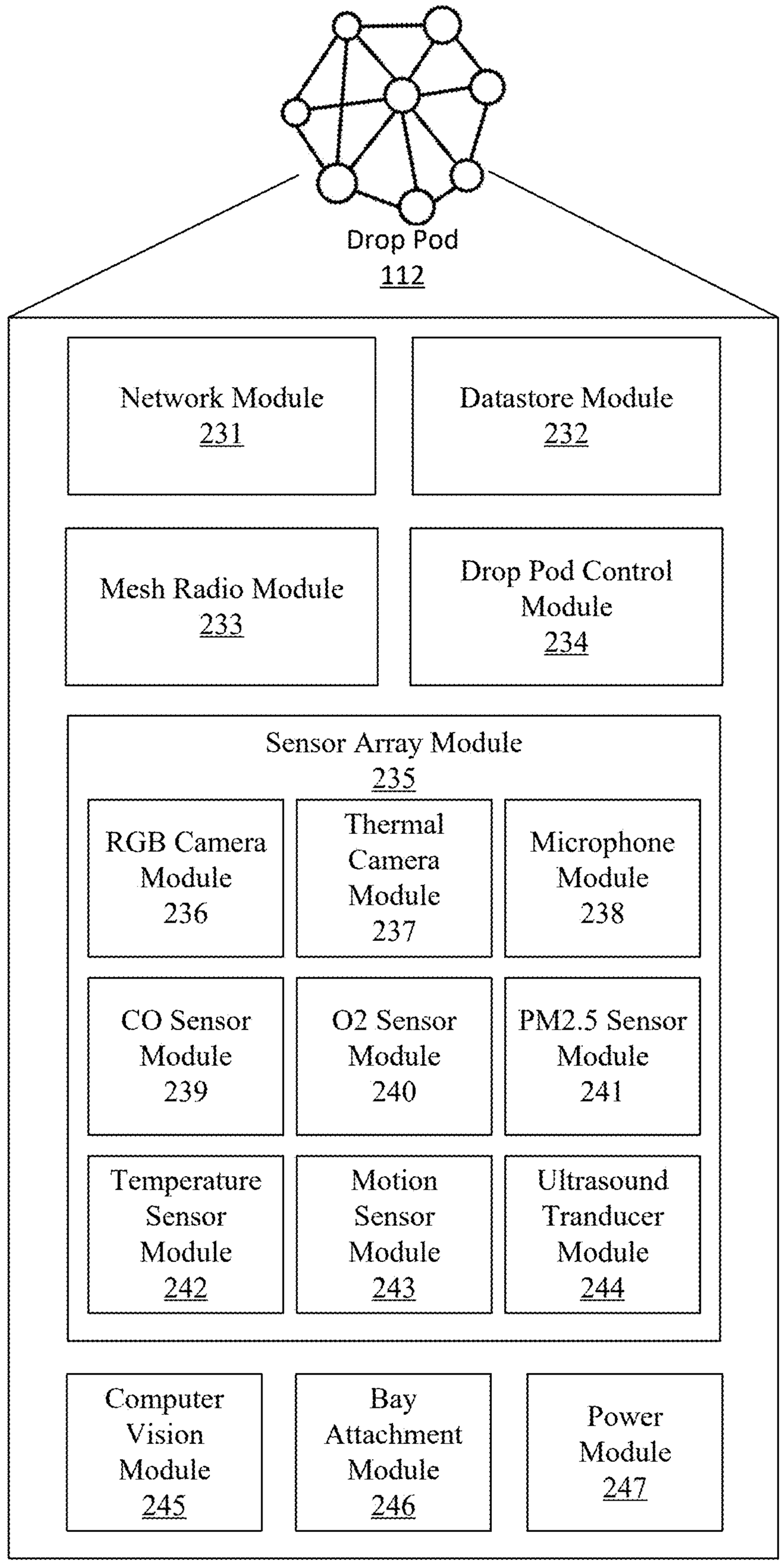

Drop Pod
112
Network Module
231
Datastore Module
232
Mesh Radio Module
233
Drop Pod Control Module
234
Sensor Array Module
235
RGB Camera Module
236
Thermal Camera Module
237
Microphone Module
238
CO Sensor Module
239
O2 Sensor Module
240
PM2.5 Sensor Module
241
Temperature Sensor Module
242
Motion Sensor Module
243
Ultrasound Tranducer Module
244
Computer Vision Module
245
Bay Attachment Module
246
Power Module
247

FIG. 2C

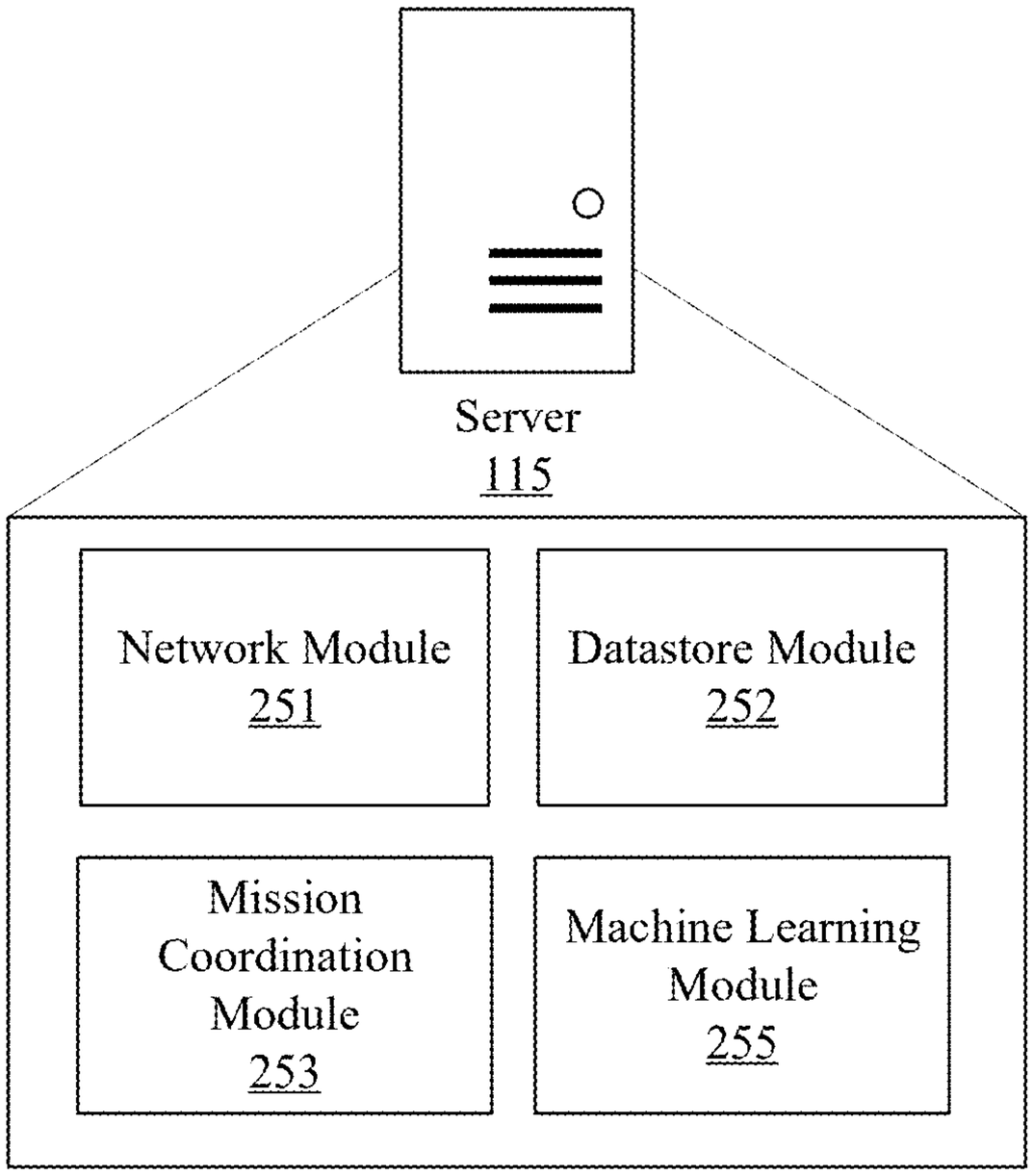

Server
115
Network Module
251
Datastore Module
252
Mission
Coordination
Module
253
Machine Learning
Module
255

FIG. 2D

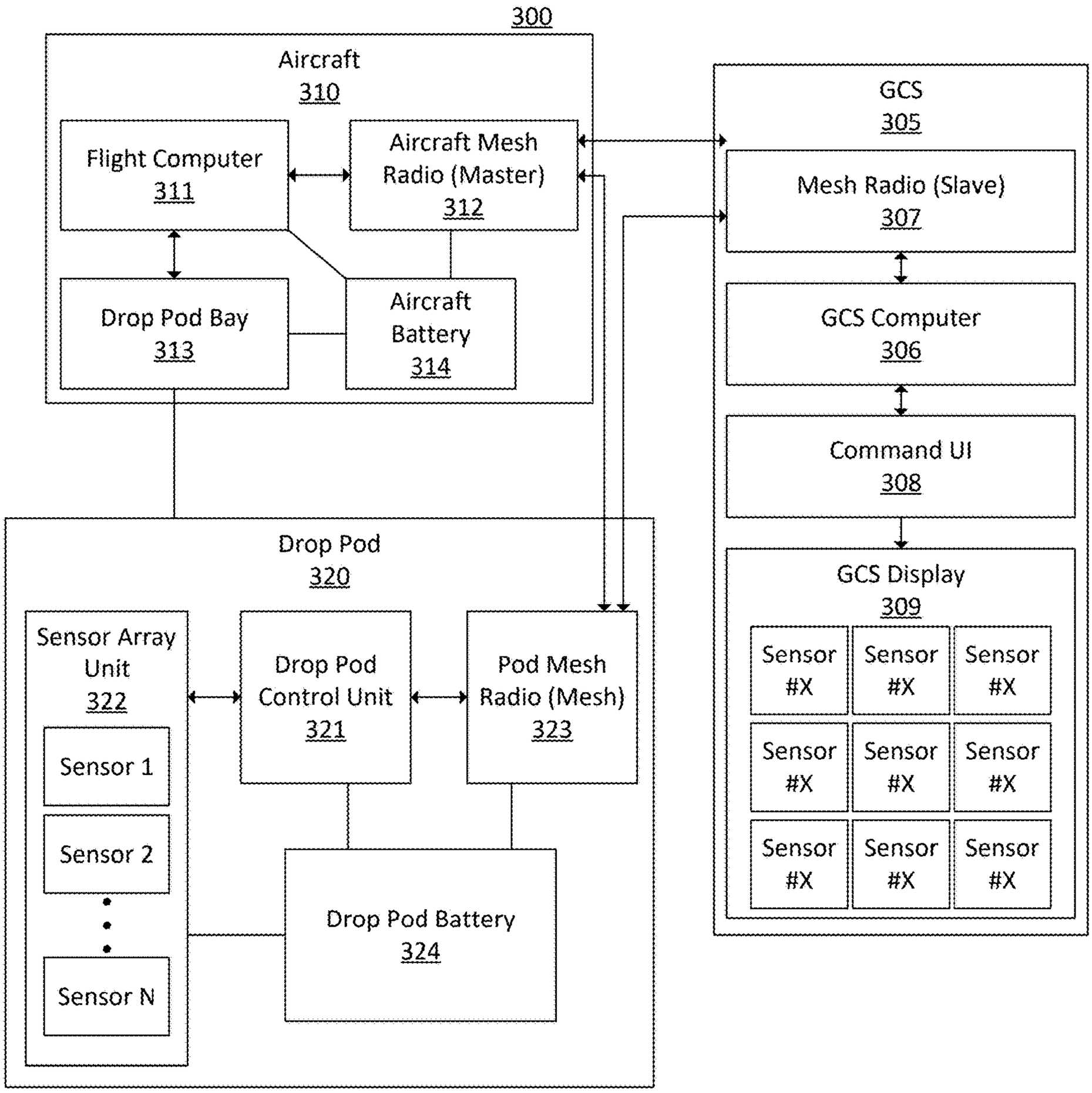

300
Aircraft
310
Flight Computer
311
Aircraft Mesh
Radio (Master)
312
Drop Pod Bay
313
Aircraft
Battery
314
GCS
305
Mesh Radio (Slave)
307
GCS Computer
306
Command UI
308
GCS Display
309
Sensor
#X
Drop Pod
320
Sensor Array
Unit
322
Sensor 1
Sensor 2
Sensor N
Drop Pod
Control Unit
321
Pod Mesh
Radio (Mesh)
323
Drop Pod Battery
324

FIG. 3

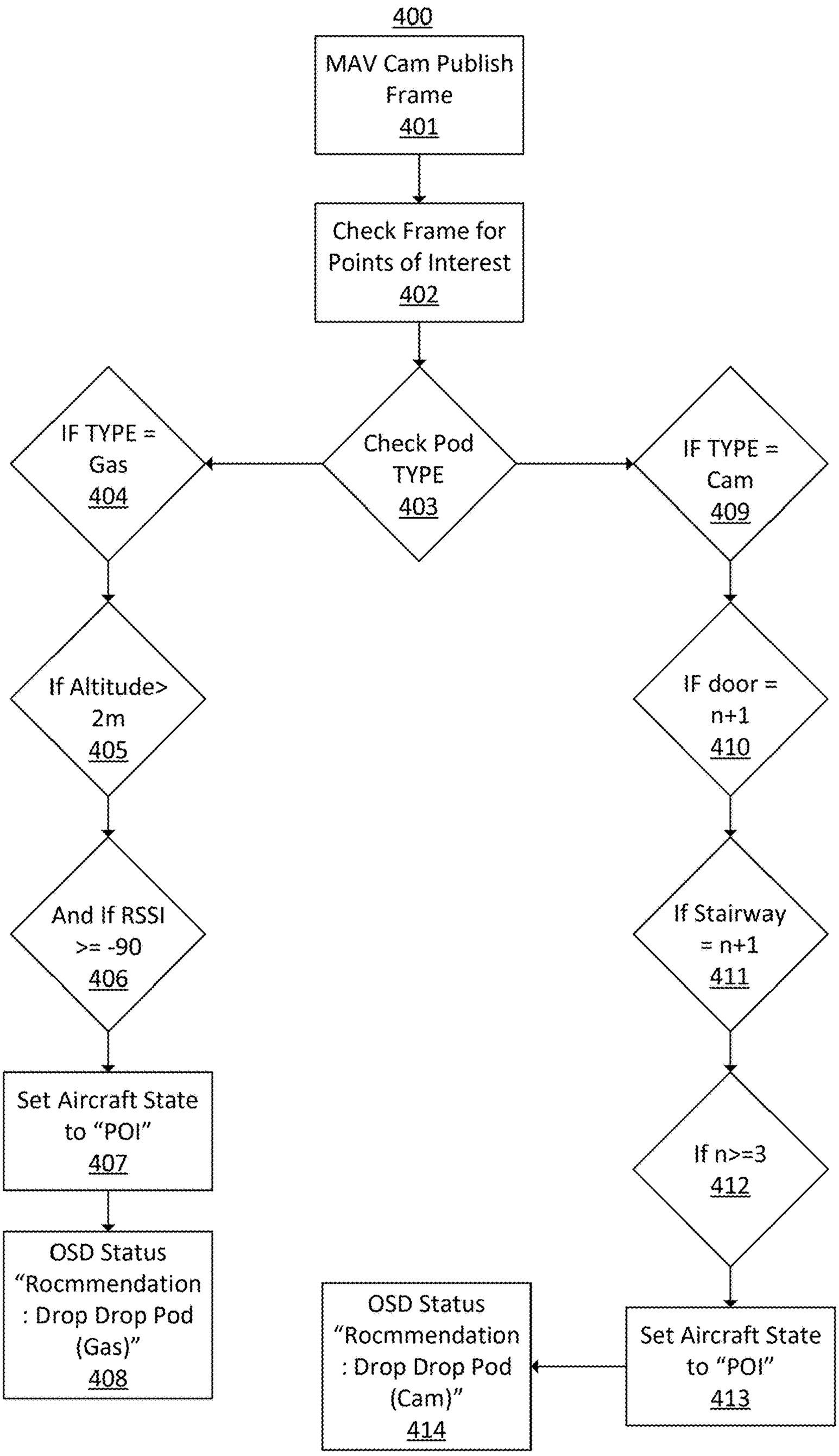

400
MAV Cam Publish Frame 401
Check Frame for Points of Interest 402
Check Pod TYPE 403
IF TYPE = Gas 404
If Altitude> 2m 405
And If RSSI >= -90 406
Set Aircraft State to "POI" 407
OSD Status "Rocmmendation : Drop Drop Pod (Gas)" 408
IF TYPE = Cam 409
IF door = n+1 410
If Stairway = n+1 411
If n>=3 412
Set Aircraft State to "POI" 413
OSD Status "Rocmmendation : Drop Drop Pod (Cam)" 414

FIG. 4A

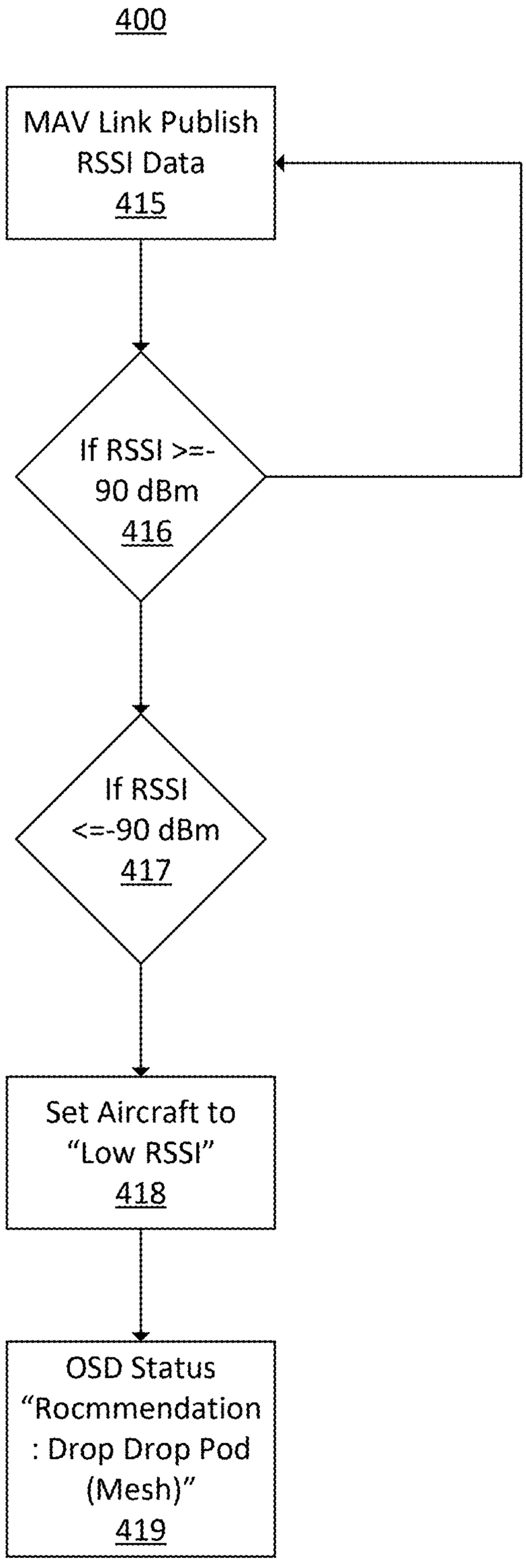

400
MAV Link Publish RSSI Data 415
If RSSI >=-90 dBm 416
If RSSI <=-90 dBm 417
Set Aircraft to "Low RSSI" 418
OSD Status "Rocmmendation : Drop Drop Pod (Mesh)" 419

FIG. 4B

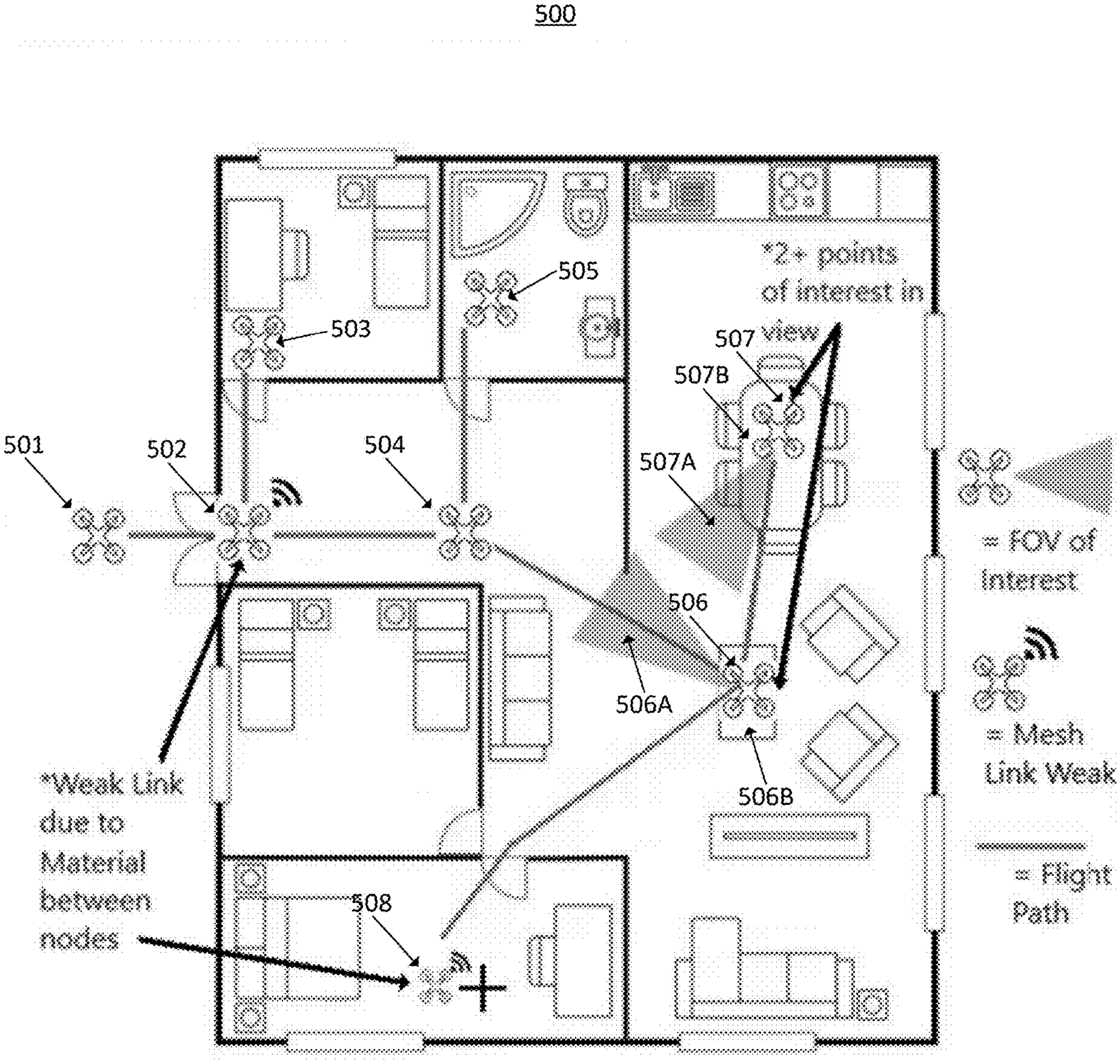

500
505
503
*2+ points of interest in view
507
507B
501
502
504
507A
= FOV of interest
506
506A
506B
= Mesh Link Weak
*Weak Link due to Material between nodes
508
= Flight Path

FIG. 5

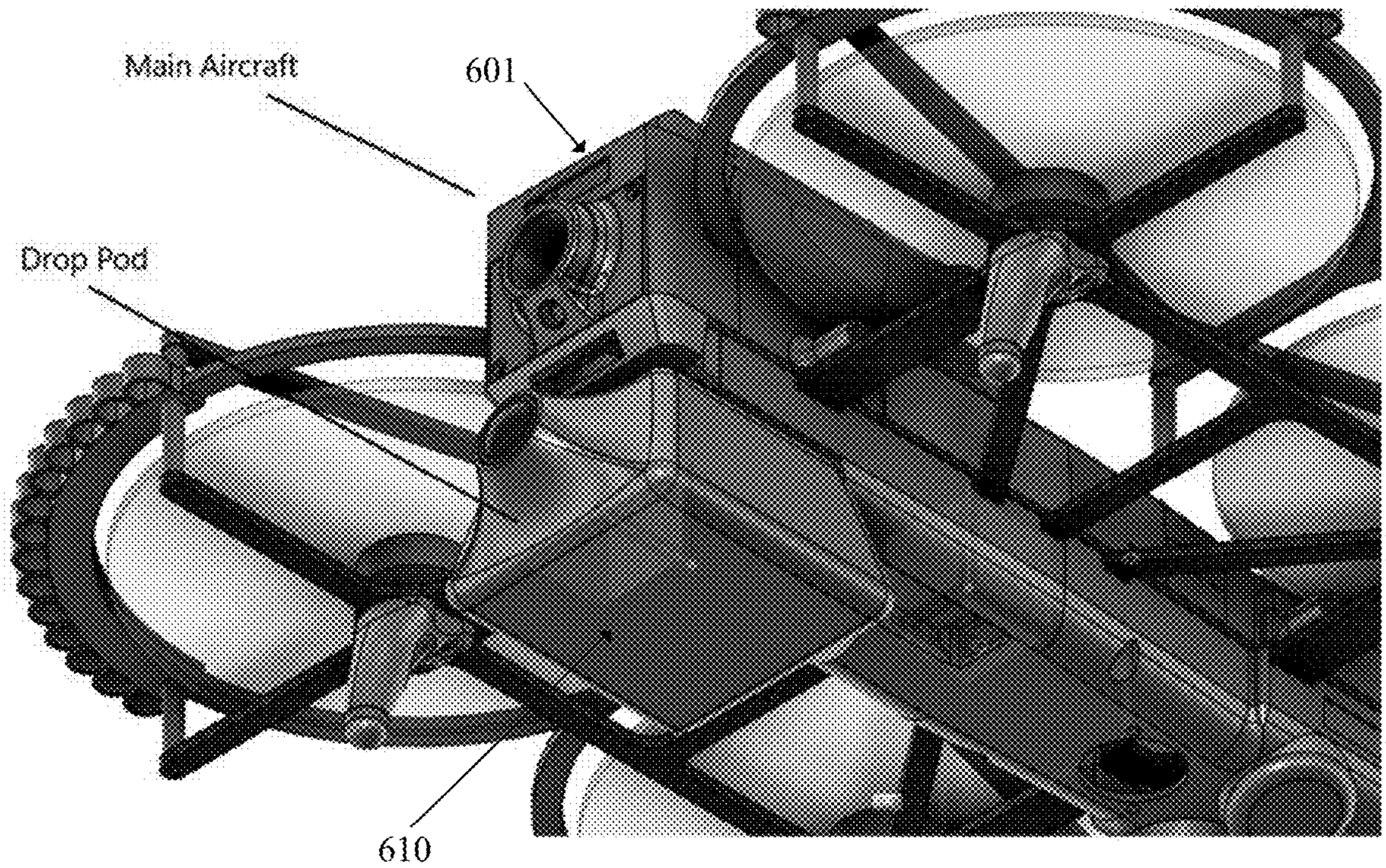

600
Main Aircraft
601
Drop Pod
610

FIG. 6A

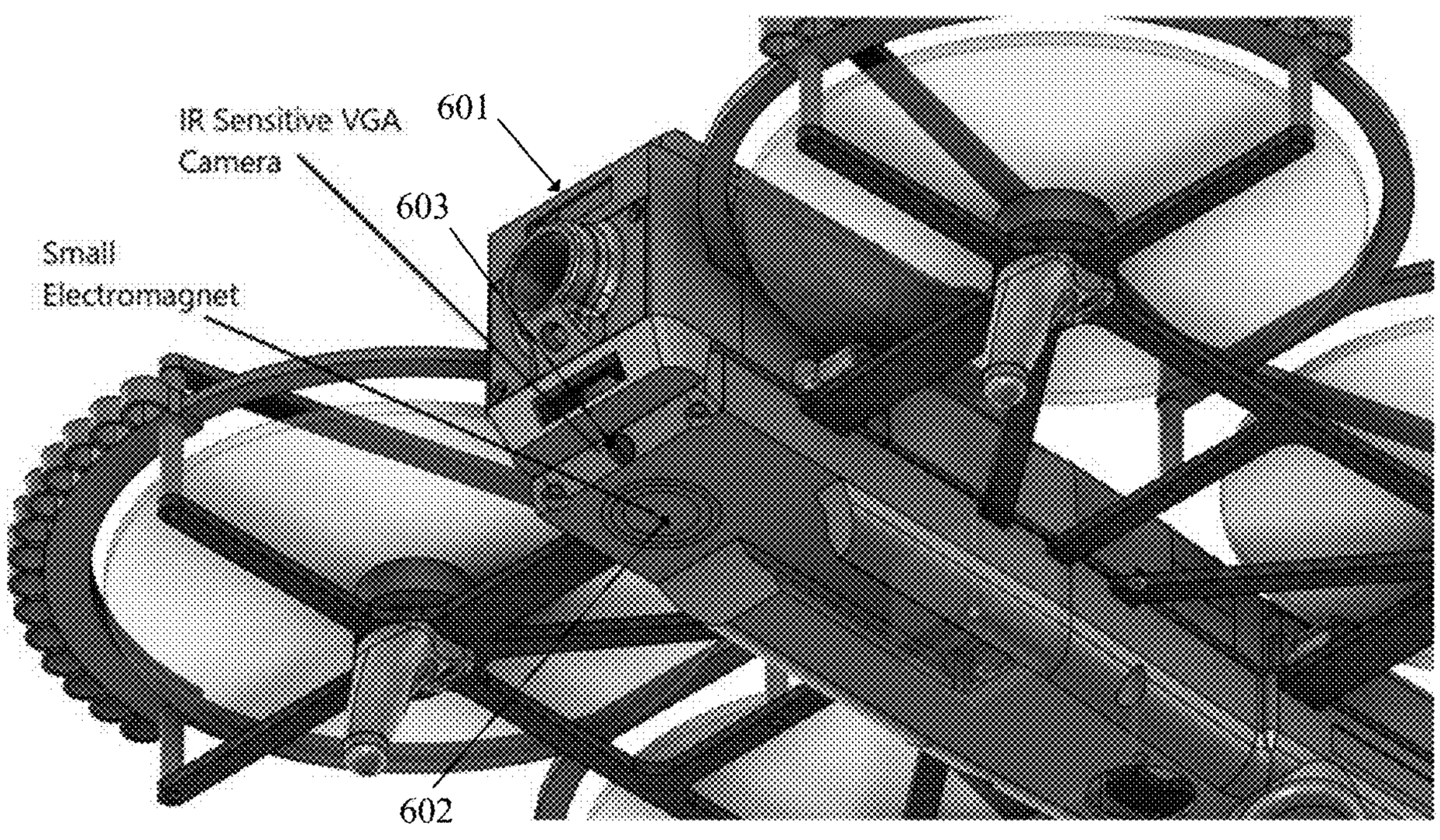

600
IR Sensitive VGA Camera
601
603
Small Electromagnet
602

FIG. 6B

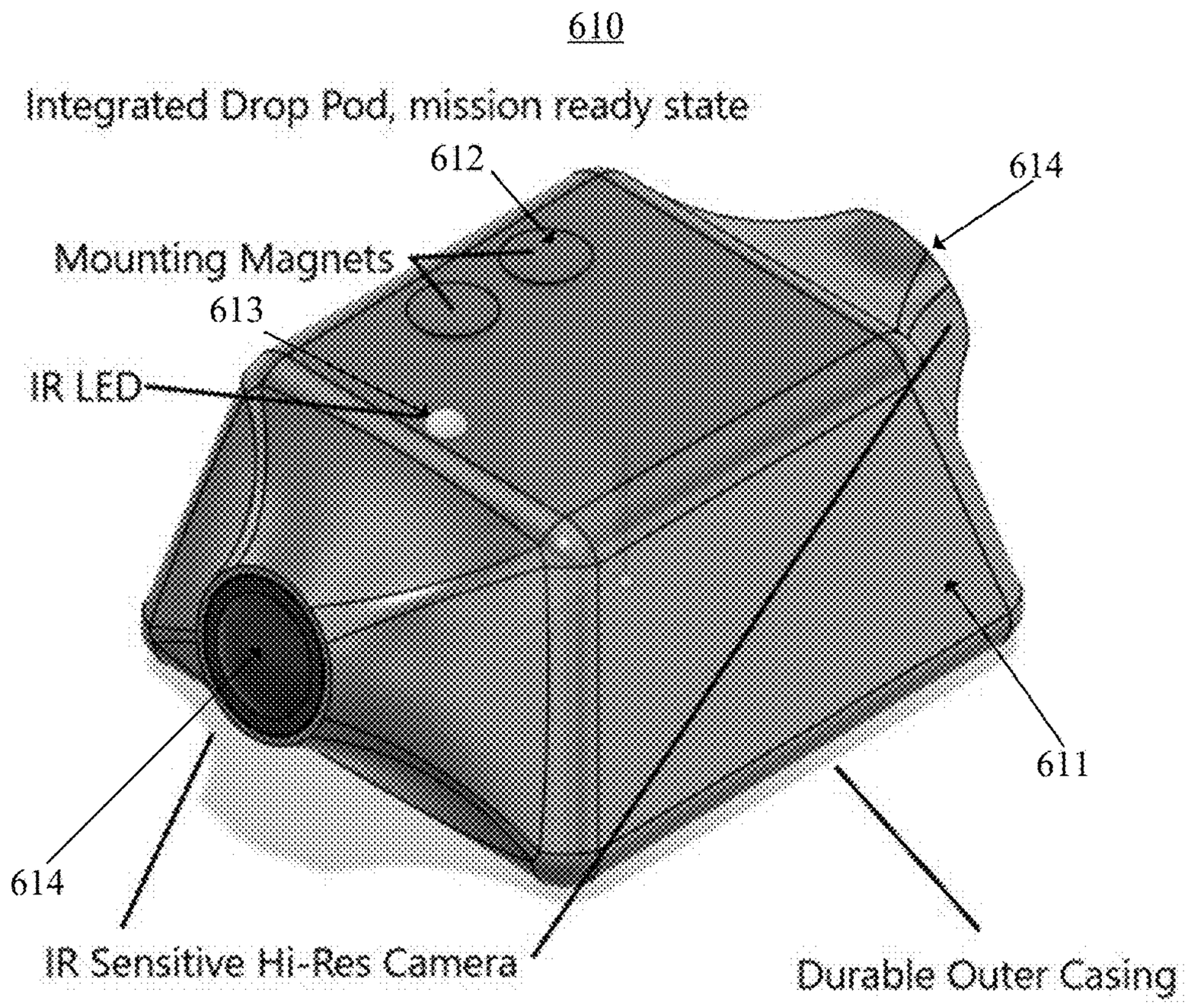



FIG. 6C

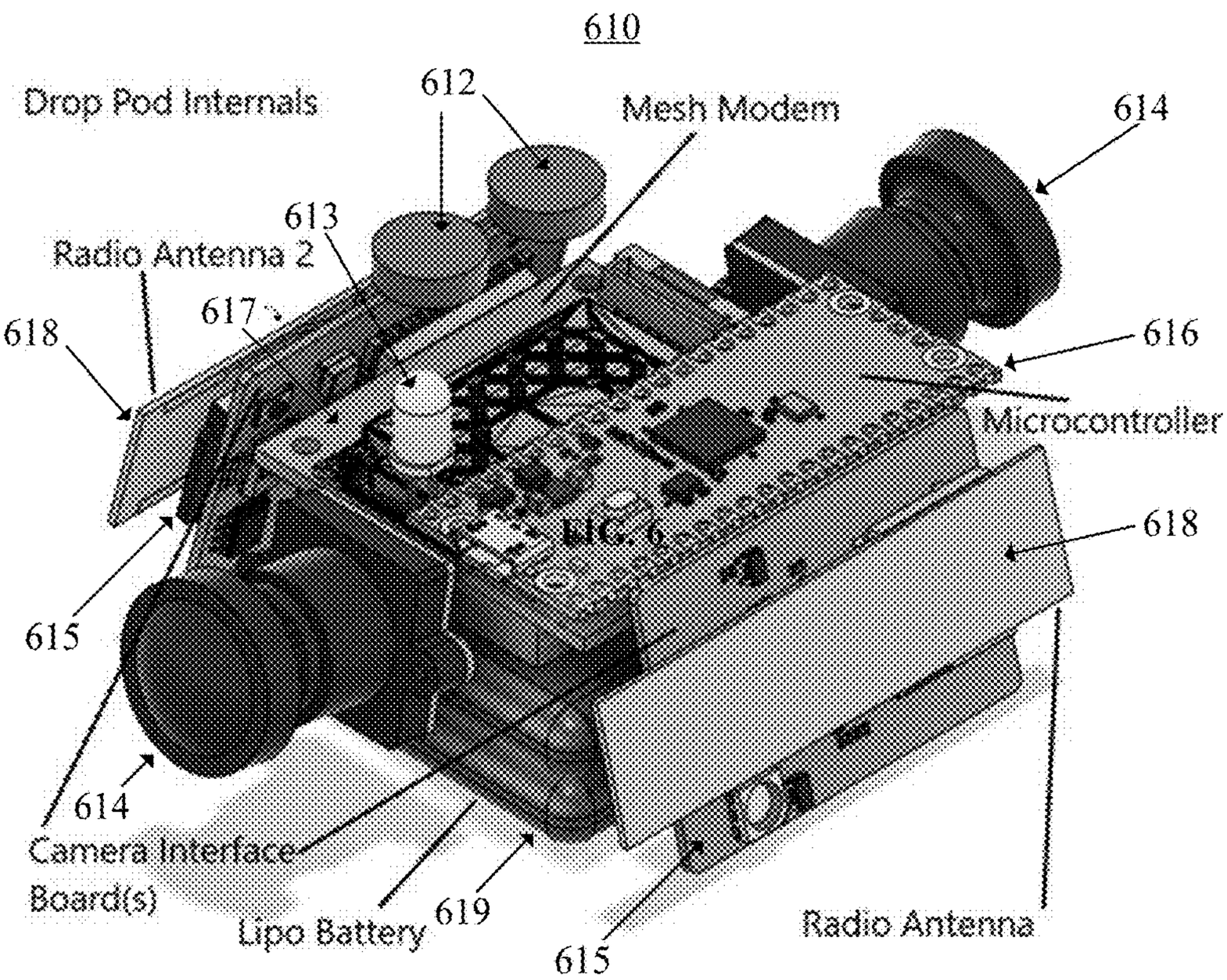



FIG. 6BD

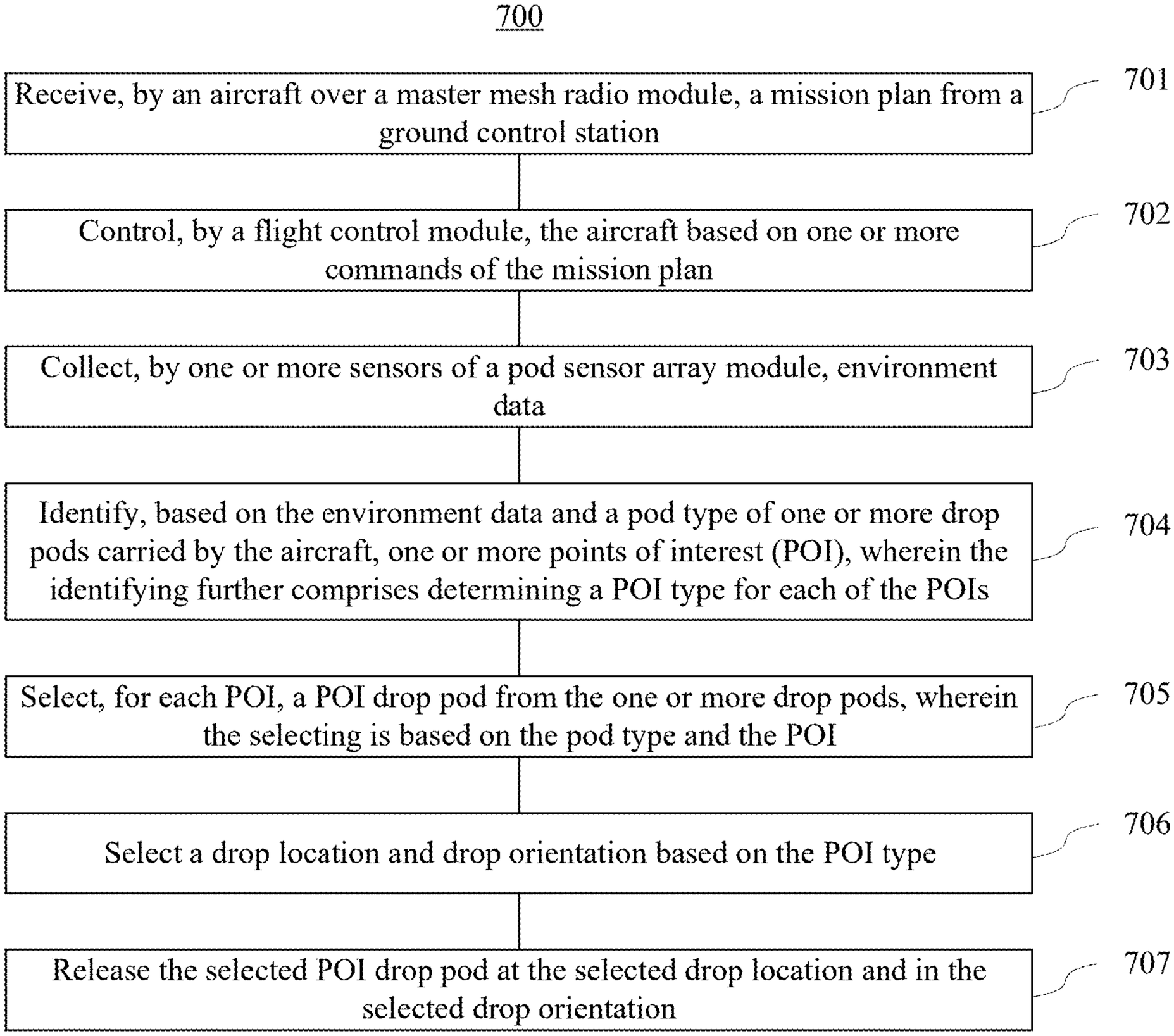

700
Receive, by an aircraft over a master mesh radio module, a mission plan from a ground control station
701
Control, by a flight control module, the aircraft based on one or more commands of the mission plan
702
Collect, by one or more sensors of a pod sensor array module, environment data
703
Identify, based on the environment data and a pod type of one or more drop pods carried by the aircraft, one or more points of interest (POI), wherein the identifying further comprises determining a POI type for each of the POIs
704
Select, for each POI, a POI drop pod from the one or more drop pods, wherein the selecting is based on the pod type and the POI
705
Select a drop location and drop orientation based on the POI type
706
Release the selected POI drop pod at the selected drop location and in the selected drop orientation
707

FIG. 7

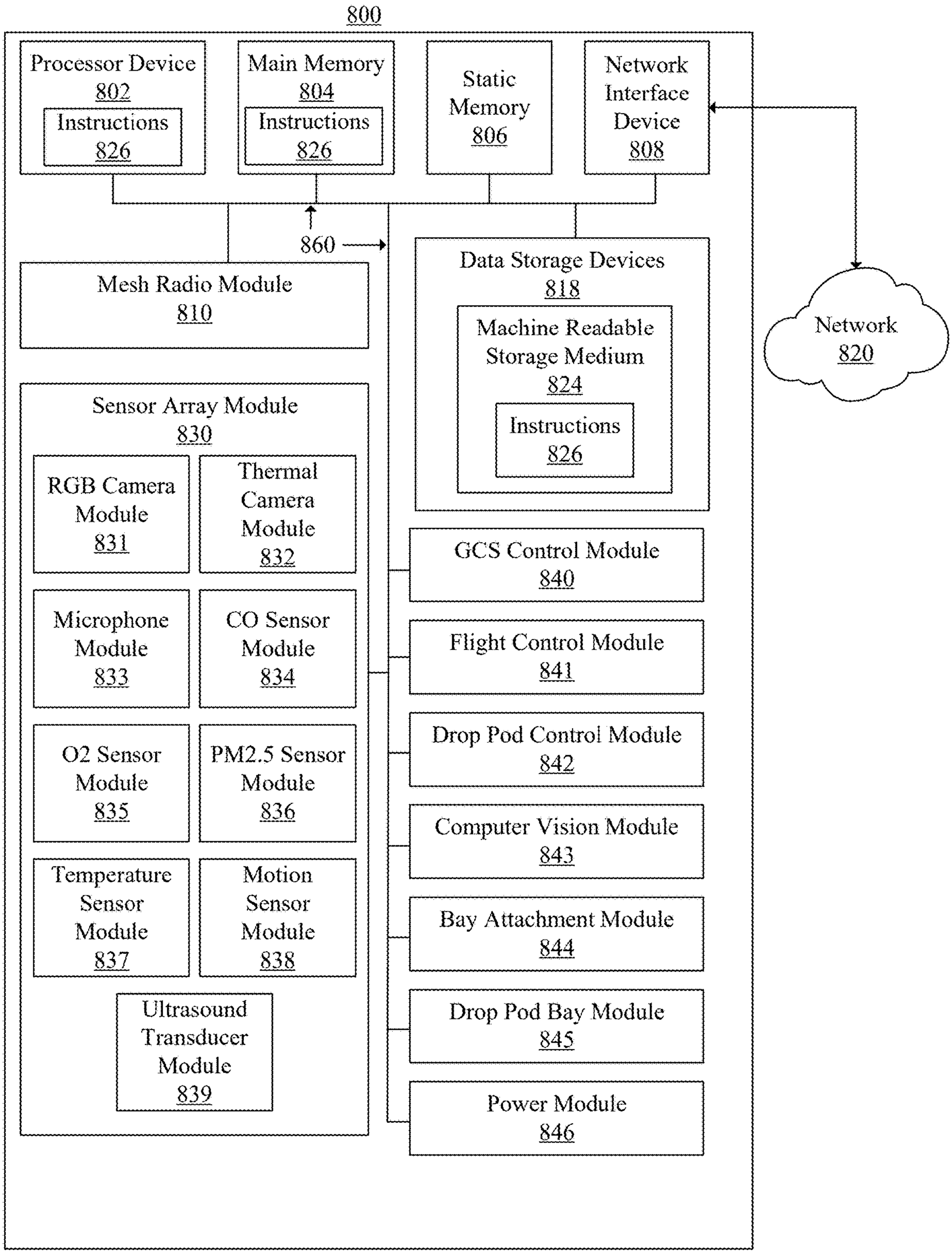

800
Processor Device
802
Instructions
826
Main Memory
804
Instructions
826
Static Memory
806
Network Interface Device
808
860
Mesh Radio Module
810
Data Storage Devices
818
Machine Readable Storage Medium
824
Instructions
826
Network
820
Sensor Array Module
830
RGB Camera Module
831
Thermal Camera Module
832
Microphone Module
833
CO Sensor Module
834
O2 Sensor Module
835
PM2.5 Sensor Module
836
Temperature Sensor Module
837
Motion Sensor Module
838
Ultrasound Transducer Module
839
GCS Control Module
840
Flight Control Module
841
Drop Pod Control Module
842
Computer Vision Module
843
Bay Attachment Module
844
Drop Pod Bay Module
845
Power Module
846

FIG. 8

# AUTONOMOUS DRONE MESH SENSOR DEPLOYMENT SYSTEM

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application is a continuation of U.S. patent application Ser. No. 18/677,146, filed on May 29, 2024, which is hereby incorporated by reference in its entirety.

## FIELD

**[0002]** The present invention relates generally to systems, tools and methods to deploy and wirelessly communicate with sensors within an environment.

## BACKGROUND

**[0003]** Poor communication and coordination of assets in hazardous environments can be costly and dangerous for everyone involved. Fires and natural disasters require responders to risk their lives in the search for survivors. The danger is increased due to the lack of reliable communication and environmental data. The present invention resolves these shortcomings.

## SUMMARY

**[0004]** The system and methods described herein provide for the deployment of a mesh sensor network. The mesh sensor deployment system may comprise a mesh network further comprising a ground control station (GCS), an aircraft and one or more drop pods. The GCS may comprise a GCS control module, a slave mesh radio module, a command UI module, and one or more display units. The drop pods may comprise a drop pod control module, a pod mesh radio module, and a pod sensor array module. The pod sensor array module may comprise one or more sensor types. Each of the drop pods may have a pod type that corresponds to the sensor types. The aircraft may comprise a flight control module, a master mesh radio module, an aircraft sensor array module, and a drop pod bay unit. The one or more drop pods may be attached to the aircraft through the drop pod bay unit.

**[0005]** In some embodiments, the aircraft may be configured to receive, by the master mesh radio module over the mesh network, a mission plan from the GCS. The mission plan may comprise one or more commands. The flight control module may be configured to control the aircraft based on the one or more commands. The aircraft sensor array module may be configured to collect environmental data. Based on the environment data and the pod type of the one or more drop pods, one or more points of interest (POI) may be identified. The identifying may further comprise determining a POI type for each of the POIs. For each POI, a POI drop pod from the one or more drop pods may be selected. The selecting may be based on the pod type and the POI. The drop pod bay unit may deploy each of the selected POI drop pods. The deploying may comprise selecting a drop location and drop orientation based on the POI type and releasing the selected POI drop pod at the selected drop location.

**[0006]** In some embodiments, one or more of the one or more POIs may be a gas type POI, and the identification may be based in part on an altitude of the aircraft and a mesh network signal strength.

**[0007]** In some embodiments, one or more of the one or more POIs may be a camera type POI,

**[0008]** and the identification may be based in part on a count corresponding to a number of doors and stairways encountered by the aircraft.

**[0009]** In some embodiments, one or more of the one or more POIs may be a mesh node type POI, and the identification may be based in part on a mesh network signal strength being below a predetermined threshold value.

**[0010]** In some embodiments, the pod sensor array module may comprise one or more RGB camera modules, one or more thermal camera modules, one or more microphone modules, one or more CO sensor modules, one or more O2 sensor modules, one or more PM2.5 sensor modules, one or more temperature sensor modules, one or more motion sensor modules, or one or more ultrasound transducer modules. In some embodiments, the aircraft sensor array module may comprise one or more RGB camera modules, one or more thermal camera modules, one or more microphone modules, one or more CO sensor modules, one or more O2 sensor modules, one or more PM2.5 sensor modules, one or more temperature sensor modules, one or more motion sensor modules, or one or more ultrasound transducer modules.

**[0011]** In some embodiments, the GCS may be configured to generate, by the GCS control module, a mission plan. The mission plan may comprise one or more flight paths and one or more mission objectives. The one or more flight paths may comprise a plurality of waypoints. The mission plan may be transmitted, over the slave mesh radio module, to the aircraft. The GCS may further be configured to receive, over the slave mesh radio module, aircraft status from the aircraft and pod status from each of the deployed POI drop pods. The GCS may be configured to generate, by the command UI module, a graphical user interface based on the received aircraft status and the received pod status of each of the deployed POI drop pods. The received aircraft status and the received pod status of each of the deployed POI drop pods may comprise one or more sensor readings. The one or more display units may display the graphical user interface.

**[0012]** In some embodiments, the GCS may further be configured to receive, by the command UI module, control input from a user. The control input may correspond to modification to the mission plan. The GCS control module may be configured to generate a modified mission plan based on the received control input. The modified mission plan may then be transmitted, by the slave mesh radio module, to the aircraft.

**[0013]** In some embodiments, the aircraft may further comprise a computer vision module. The aircraft may be further configured to capture, by the aircraft sensor array module, image data of the environment. The captured image data may be analyzed by the computer vision module. The computer vision module may further comprise one or more trained machine learning models. The aircraft may further be configured to autonomously modify the flight plan based on the analysis of the computer vision module. The modification of the flight plan may comprise adding or removing waypoints to the flight path and adding or removing mission objectives. In some embodiments, identifying the one or more POIs may be further based at least in part on the analysis of the computer vision module and the modification of the flight plan.

**[0014]** The appended claims may also serve as a summary of this application.

**[0015]** The features and components of these embodiments will be described in further detail in the description which follows. Additional features and advantages will also be set forth in the description which follows, and in part will be implicit from the description, or may be learned by the practice of the embodiments. The detailed description and specific examples are intended for illustration only and are not intended to limit the scope of the disclosure.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0016]** The present disclosure will become better understood from the detailed description and the drawings, wherein:

**[0017]** FIG. **1** is a diagram illustrating an exemplary autonomous drone mesh sensor deployment system in which some embodiments may operate.

**[0018]** FIG. **2**A is a diagram illustrating a ground control station (GCS) in accordance with aspects of the present disclosure.

**[0019]** FIG. **2**B is a diagram illustrating an exemplary drone in accordance with aspects of the present disclosure.

**[0020]** FIG. **2**C is a diagram illustrating an exemplary drop pod in accordance with aspects of the present disclosure.

**[0021]** FIG. **2**D is a diagram illustrating an exemplary server in accordance with aspects of the present disclosure.

**[0022]** FIG. **3** is a diagram illustrating an exemplary sensor deployment system in accordance with some embodiments.

**[0023]** FIG. **4**A is a flow chart illustrating an exemplary method that may be performed in accordance with some embodiments.

**[0024]** FIG. **4**B is a flow chart illustrating an exemplary method that may be performed in accordance with some embodiments.

**[0025]** FIG. **5** is a diagram illustrating an exemplary mission that may be performed in accordance with some embodiments.

**[0026]** FIG. **6**A is a diagram illustrating an exemplary autonomous drone and drop pod in accordance with some embodiments.

**[0027]** FIG. **6**B is a diagram illustrating an exemplary autonomous drone after deployment of a drop pod in accordance with some embodiments.

**[0028]** FIG. **6**C is a diagram illustrating an exemplary drop pod in accordance with some embodiments.

**[0029]** FIG. **6**D is a diagram illustrating an exemplary drop pod in accordance with some embodiments.

**[0030]** FIG. **7** is a flow chart illustrating an exemplary method that may be performed in accordance with some embodiments.

**[0031]** FIG. **8** is a diagram illustrating an exemplary computer/control system that may perform processing in some embodiments and in accordance with aspects of the present disclosure.

## DETAILED DESCRIPTION

**[0032]** In this specification, reference is made in detail to specific embodiments of the invention. Some of the embodiments or their aspects are illustrated in the drawings.

**[0033]** For clarity in explanation, the invention has been described with reference to specific embodiments, however it should be understood that the invention is not limited to the described embodiments. On the contrary, the invention covers alternatives, modifications, and equivalents as may be included within its scope as defined by any patent claims. The following embodiments of the invention are set forth without any loss of generality to, and without imposing limitations on, the claimed invention. In the following description, specific details are set forth in order to provide a thorough understanding of the present invention. The present invention may be practiced without some or all of these specific details. In addition, well known features may not have been described in detail to avoid unnecessarily obscuring the invention.

**[0034]** In addition, it should be understood that steps of the exemplary methods set forth in this exemplary patent can be performed in different orders than the order presented in this specification. Furthermore, some steps of the exemplary methods may be performed in parallel rather than being performed sequentially. Also, the steps of the exemplary methods may be performed in a network environment in which some steps are performed by different computers in the networked environment.

**[0035]** Some embodiments are implemented by a computer system. A computer system may include a processor, a memory, and a non-transitory computer-readable medium. The memory and non-transitory medium may store instructions for performing methods and steps described herein.

**[0036]** The following generally relates to a system, platform and methods for deploying a wireless mesh sensor array network. In some embodiments, the system may be utilized in dangerous situations such as fires, active shooter scenarios, urban warfare or hostage situations.

**[0037]** FIG. **1** is a diagram illustrating an exemplary autonomous drone mesh sensor deployment system **100** in which some embodiments may operate. The autonomous drone mesh sensor deployment system **100** may comprise one or more ground control stations (GCS) **105**, one or more drones **110**, one or more drop pods **112**, one or more servers **115**, one or more datastores **120** and one or more networks **130**.

**[0038]** The one or more GCSs **105** may be connected to the one or more drones **110** and one or more drop pods **112** over one or more mesh networks. The GCSs may further be connected to the one or more server **115** and datastore **120** over network **130**.

**[0039]** The one or more drones **110** may be configured to carry one or more drop pods **112** in a drop pod bay and deposit the one or more drop pods **112** during execution of a predetermined mission, autonomous navigation, under control of a user at the GCS **105** or combination thereof. The drones **110** may be configured to communicate, over a mesh network, with GCSs **105** and drop pods **112**. The drones **110** may be configured to operate as nodes in the mesh network and relay data from one node to another node. The one or more drones **110** may further comprise one or sensor arrays.

**[0040]** The one or more drop pods **112** may comprise one or more sensor arrays. Data collected by the sensor array may then be transmitted from the drop pods **112** to the one or more drones **110** and/or one or more GCSs **105**.

**[0041]** Server **115** may be one or more physical or virtual machines configured to communicate with the one or more GCSs **105** and the one or more datastores **120**. The one or

more servers **115** may be configured as a distributed computing infrastructure and processing of applications and other software may be carried out on the cloud.

**[0042]** Datastores **120** may communicate with one another over network **130**. Datastores **120** may be any storage device capable of storing data for processing or as a result of processing information at the GCSs **105**, drones **110**, drop pods **112** and/or servers **115**. The datastores **120** may be a separate device or the same device as server **115**. The datastores **120** may be located in the same location as that of server **115**, or at separate locations.

**[0043]** Network **130** may be an intranet, internet, mesh, LTE, GSM, peer-to-peer or other communication network that allows the one or more servers **115** to communicate with the one or more GCSs **105** and datastores **115**.

**[0044]** FIG. **2**A is a diagram illustrating an exemplary ground control station (GCS) **105** in accordance with aspects of the present disclosure. GCS **105** may comprise network module **201**, datastore module **202**, a mesh radio module **203**, a GCS control module **204**, a UI module **205** and one or more display modules **206**.

**[0045]** Network module **201** may transmit and receive data from other computing systems via a network such as network **130** as described above with regard to FIG. **1**. In some embodiments, the network module **201** may enable transmitting and receiving data from the Internet. Data received by the network module **201** may be used by the other modules. The modules may transmit data through the network module **201**.

**[0046]** The datastore module **202** may be configured to store information generated by the one or more modules operating at the GCS **105**. The one or more modules operating at the GCS **105** may also retrieve information from the datastore module **202**. Datastore module **202** may also be configured to receive and store information received over network module **201** or through mesh radio module **203**.

**[0047]** Mesh radio module **203** may be configured to send and receive data over one or more wireless communications protocols. In some embodiments, the mesh radio module **203** may communicate over sub 1 ghz bands, such as LORAWAN or ZIGBEE. In some embodiments, the mesh radio module **203** may communicate over LPWAN, Bluetooth, BLE, WIFI (802.11/802.15/802.16), GSM, LTE, or other cellular protocols. The mesh radio module **203** may further be any wireless communication technology capable of communication between nodes. In some embodiments, the mesh radio module **203** may further comprise one or more radio antennas. The radio antennas may be directional or omnidirectional.

**[0048]** GCS control module **204** may be configured to generate mission plans for one or more aircraft. The mission plans may comprise one or more mission objectives and one or more flight paths. The flight paths may comprise one or more waypoints. In some embodiments the GCS control module **204** may collect data from the one or more aircrafts. The GCS control module **204** may be configured to command the one or more aircraft to deploy one or more drop pods carried by the aircraft. The GCS module may further be configured to collect and analyze data received, through mesh radio module **203**, from the one or more aircraft and the one or more drop pods.

**[0049]** UI module **205** may be configured to generate one or more graphical user interfaces based on the generated mission plans, the received data from the one or more aircraft and one or more drop pods, the analysis performed by the GCS control module **204** and the state/status of the aircrafts and drop pods. The UI module **205** may also be configured to receive commands from one or more users, wherein the one or more received commands are associated with one or more of the aircraft and/or the one or more drop pods. Received commands may be processed by the GCS control module **204** and relayed to the one or more aircraft and/or one or more drop pods. The received commands may be used to generate one or more modifications to the mission plan.

**[0050]** Display modules **206** may be configured to display information related to the state/status of the one or more aircraft and one or more drop pods. Information collected from the one or more aircraft and one or more drop pods may also be displayed.

**[0051]** FIG. **2**B is a diagram illustrating an exemplary drone **110** in accordance with aspects of the present disclosure. Drone **110** may comprise network module **211**, datastore module **212**, mesh radio module **213**, flight control module **214**, sensor array module **215**, computer vision module **225**, drop pod bay module **226** and power module **227**.

**[0052]** Network module **211** and datastore module **212** may be the same or similar to that of network module **201** and datastore module **202** as described above with regard to FIG. **2**A.

**[0053]** Mesh radio module **213** may be the same or similar to that of mesh radio module **203** as described above with regard to FIG. **2**A.

**[0054]** Flight control module **214** may be configured to control flight parameters of the aircraft. Flight control module **214** may be configured to generate control signals for one or more motors, actuators, sensors or other modules of the aircraft based at least in part on a mission plan received over the mesh radio module **213**.

**[0055]** Sensor array module **215** may comprise one or more RGB camera modules **216**, thermal camera modules **217**, microphone modules **218**, CO sensor modules **219**, O2 sensor modules **220**, PM2.5 sensor modules **221**, temperature sensor modules **222**, motion sensor modules **223**, and/or ultrasound transducer modules **224**. The sensors of the sensor array module **215** may be configured to collect, filter and/or process sensor data from the environment around the aircraft. The sensor data may be transmitted to the GCS over mesh radio module **213**. Sensor data may also be analyzed by the flight control module **214**.

**[0056]** Computer vision module **225** may be configured to analyze images collected by one or more of the sensors of the sensor array module **215**. The computer vision module may use one or more trained machine learning models to perform the analysis.

**[0057]** Drop pod bay module **226** may be configured to securely hold and transport one or more drop pods during mission operation. The drop pod bay module **226** may further comprise one or more mechanisms configured to selectively secure and/or release the one or more drop pods. In some embodiments, one or more magnetic grasping units may be used to hold the one or more drop pods in place and/or retrieve previously deployed drop pods. The magnetic grasping units may be electromagnetic devices. Deployment of drop pods may be facilitated by disabling the

electromagnetics. Conversely, retrieval and carrying of the drop pods may be facilitated by energizing the electromagnetic devices.

**[0058]** In some embodiments, the drip pod bay module **226** may employ latch mechanisms and articulated grasping units to retrieve, secure and release the drop pods.

**[0059]** Power module **227** may comprise one or more electrical power storage units and/or one or more electrical power sources, such as battery modules, solar energy/photovoltaic modules, inductive electricity receivers, electric generators or combination thereof.

**[0060]** FIG. **2**C is a diagram illustrating an exemplary drop pod **112** in accordance with aspects of the present disclosure. Drop pod **112** may comprise network module **231**, datastore module **232**, mesh radio module **233**, drop pod control module **234**, sensor array module **235**, computer vision module **245**, bay attachment module **246** and power module **247**.

**[0061]** Network module **231** and datastore module **232** may be the same or similar to that of network module **201** and datastore module **202** as described above with regard to FIG. **2**A.

**[0062]** Mesh radio module **233** may be the same or similar to that of mesh radio module **203** as described above with regard to FIG. **2**A and mesh radio module **213** as described above with regard to FIG. **2**B.

**[0063]** Drop pod control module **234** may be configured to analyze sensor data from the sensor array module **235** and perform operations associated with the mission plan or commands received over the mesh network.

**[0064]** Sensor array module **235** may comprise one or more RGB camera modules **236**, thermal camera modules **237**, microphone modules **238**, CO sensor modules **239**, O2 sensor modules **240**, PM2.5 sensor modules **241**, temperature sensor modules **242**, motion sensor modules **243**, and/or ultrasound transducer modules **244**. Sensor array module **235** may be the same or similar to that of sensor array module **215** as described above with regard to FIG. **2**B.

**[0065]** Computer vision module **245** and power module **247** may be the same or similar to that of computer vision module **225** and power module **227** **215** as described above with regard to FIG. **2**B.

**[0066]** Bay attachment module **246** may be configured to interface with drop pod bay module **226** of the aircraft, facilitating the retrieval, carrying and deployment of the drop pod. The bay attachment module **246** may be electromagnets, permanent magnets, latches or other retaining devices.

**[0067]** FIG. **2**D is a diagram illustrating an exemplary server **115** in accordance with aspects of the present disclosure. Server **115** may comprise network module **251**, datastore module **252**, mission coordination module **253** and machine learning module **255**.

**[0068]** Network module **251**, may be the same or similar to that of network module **201** in FIG. **2**A and will not be described for the sake of brevity.

**[0069]** Datastore module **252** may be the same or similar to that of datastore module **202** in FIG. **2**A and will not be described for the sake of brevity.

**[0070]** Mission coordination module **253** may be configured to coordinate communication and command control of aircraft and drop pods between a plurality of GCSs.

**[0071]** Machine learning module **255** may be configured to train and generate one or more machine learning models used by the computer vision modules **225** and **245**. In some embodiments, the machine learning module may further generate models corresponding to path planning and POI determination.

**[0072]** FIG. **3** is a diagram illustrating an exemplary sensor deployment system **300** in accordance with some embodiments. The sensor deployment system **300** may comprise one or more GCSs, one or more aircrafts **310** and one or more drop pods **320**.

**[0073]** Each of the one or more GCSs **305** may comprise one or more GCS computers **306**, mesh radios (slave) **307**, command UIs **308** and GCS displays **309**.

**[0074]** The GCS computers **306** may be configured to receive, over the mesh radios (slave) **307**, and analyze data received from the one or more aircraft and one or more drop pods. The data received may correspond to status/state data of the aircraft and drop pods and/or collected sensor data from the aircraft and drop pods. The GCS computers may also generate mission plans and control commands for the aircraft and drop pods and transmit said mission plans and control commands over the mesh radios (slave) **307**.

**[0075]** The command UIs **308** may be configured to generate one or more graphical user interfaces and one or more command interfaces corresponding to the aircrafts and drop pods.

**[0076]** The GCS displays **309** may be configured to display the one or more graphical user interfaces generated by the command UIs **308**.

**[0077]** The one or more aircrafts **310** may comprise one or more flight computers **311**, aircraft mesh radios (master) **312**, drop pod bays **313** and aircraft batteries **314**. The structure and operation of aircraft **310** are described above with regard to FIG. **2**B.

**[0078]** The one or more drop pods **320** may comprise one or more drop pod control units **321**, sensor array units **322**, pod mesh radios (mesh) **323** and drop pod batteries **324**. The structure and operation of drop pods **320** are described above with regard to FIG. **2**C.

**[0079]** FIG. **4**A is a flow chart illustrating an exemplary process flow **400** that may be performed in accordance with some embodiments.

**[0080]** At step **401**, an aircraft or drop pod of the system may be configured to publish one or more MAV Cam frames. The MAV Cam frames may be published directly to a GCS, a server, through a cloud service or combination thereof. The publishing may be performed over the mesh radio network and/or other wireless network.

**[0081]** At step **402**, the system may be configured to check the frame for points of interest (POIs). If one or more POIs are identified, the system may then proceed to step **403**.

**[0082]** At step **403**, the system may be configured to check the pod type. If the pod type is "Gas" the system proceeds through step **404** to step **405**. If the pod type is "Cam" the system proceeds through step **409** to step **410**.

**[0083]** At step **405**, the system may be configured to determine an altitude of the aircraft and the attached pod. If the altitude is above 2 meters, the system proceeds to step **406**.

**[0084]** At step **406**, the system may be configured to check a signal strength of the mesh network. If the RSSI of the network is greater than or equal to −90, the system proceeds to step **407**.

**[0085]** At step **407**, the system may be configured to set the aircraft state to "POI".

**[0086]** At step **408**, the system may be configured to set an on screen display (OSD) status to "Recommendation: Drop Drop Pod (Gas)". The OSD status may then be displayed as a prompt or notification to a user/controller through an OSD at a GCS.

**[0087]** At step **410**, when the type has been determined to be "Cam," the system may be configured to keep track of a POI count. The system may also be configured to identify doors within the environment. In some embodiments, the system may be configured to increment the POI count upon the aircraft passing through a door and/or identifying a door.

**[0088]** At step **411**, the system may further be configured to identify stairways within the environment. The system may increment the POI count upon taking a stairway and/or identifying a stairway.

**[0089]** At step **412**, the system may be configured to determine if the POI count has reached or exceeded a predetermined threshold value. For example, the POI count may be set to a value such as "3" as is the case in FIG. **4**A. If the POI count is greater than or equal to the predetermined threshold, the system proceeds to step **413**.

**[0090]** At **413**, the system may be configured to set the aircraft state to "POI" and proceed to step **414**.

**[0091]** At step **414**, the system may be configured to set the OSD status to "Recommendation: Drop Drop Pod (Cam)". The OSD status may then be displayed as a prompt or notification to a user/controller through an OSD at a GCS.

**[0092]** FIG. **4**B is a flow chart illustrating an exemplary process flow **400** that may be performed in accordance with some embodiments.

**[0093]** At step **415**, an aircraft or drop pod of the system may be configured to publish MAV Link RSSI data. The MAV Link RSSI data may be published directly to a GCS, a server, through a cloud service or combination thereof. The publishing may be performed over the mesh radio network and/or other wireless network.

**[0094]** At step **416**, if the published RSSI is greater than or equal to a predetermined threshold value, such as −90 db as shown in FIG. **4**B, the system returns to step **415**. If the RSSI value is less than the predetermined threshold value the system may proceed through step **417** to step **418**.

**[0095]** At step **418**, the system may be configured to set the aircraft state to "Low RSSI" and proceed to step **419**.

**[0096]** At step **419**, the system may be configured to set the OSD status to "Recommendation: Drop Drop Pod (Mesh)". The OSD status may then be displayed as a prompt or notification to a user/controller through an OSD at a GCS.

**[0097]** FIG. **5** is a diagram illustrating an exemplary mission **500** that may be performed in accordance with some embodiments. An aircraft, in accordance with some embodiments, is shown performing a mission within a building. The process flows from FIGS. **4**A and **4**B may be used in the exemplary mission to identify POIs and determine locations to drop one or more drop pods. The aircraft starts at waypoint **501** and proceeds to enter the building/building unit through a doorway at waypoint **502**. In this example, upon reaching waypoint **502**, the aircraft and/or GCS may determine that the mesh radio strength is below a predetermined threshold value. The aircraft may then be instructed to drop a mesh radio drop pod to increase communication coverage within the building. The aircraft may then continue to explore the building/building unit by following a flight path to additional waypoints. The flight path may be generated by a user/controller before the beginning of the mission or in real time during operation of the mission. In some embodiments, a pregenerated flight path may be modified or changed during operation of the mission. The modification/changes to the mission may be initiated by the user/controller based on data received (video frames, sensor readings, signals strength) from the aircraft. In some embodiments, modification/changes to the mission may be initiated by the aircraft itself in an autonomous manner. In some embodiments, the aircraft itself or a GCS system may be configured to generate the flight path of the aircraft in an autonomous manner and in real-time. In some embodiments, computer vision may be used to identify POIs, obstacles, people, animals, furniture and other objects within proximity to the aircraft.

**[0098]** After dropping the mesh radio drop pod at waypoint **502**, the aircraft may be instructed/decide to proceed along a flight path. As shown in the example of FIG. **5**, the aircraft proceeds to waypoint **503**, **504**, **505** and to **506**. At waypoint **506** the aircraft may identify a POI based on one or more sensor readings or identified objects in the room. In the example, at waypoint **506** the aircraft may identify a POI corresponding to the placement of a camera drop pod. The determination may be based on the identification of doors encountered along the flight path. The aircraft may further identify one or more locations at which to place the camera drop pod. For example, the aircraft may identify a table or flat surface upon which to place the camera drop pod and determine a direction in which to orient the camera drop pod. In some embodiments, a field of view (FOV) of interest may be determined, and the placement/orientation of the camera drop pod may be determined based on the FOV of interest. As shown in FIG. **5**, at waypoint **506**, a FOV of interest **506**A is determined and a drop location **506**B is identified for the camera drop pod. The aircraft may then be instructed to place the camera drop pod at drop location **306**B in an orientation corresponding to the FOV of interest **506**A. The aircraft may then proceed along the flight path to waypoint **507**. Similarly, at waypoint **507**, a FOV of interest **507**A may be identified and a drop pod may be placed at drop location **507**B. The determination of the FOV of interest **507**A, drop location **507**B and orientation of the drop pod may be similar to or the same as that described above with regard to waypoint **506**. In some embodiments, the drop pod deployed at waypoint **506** and/or **507** may be a gas drop pod configured to analyze the air within the room. In some embodiments, the drop pod may be a multisensory drop pod, comprising a plurality of sensors. For example, the drop pods dropped at waypoints **506** and **507** may include one or more cameras, microphones, gas sensors, ultrasonic transducers and/or mesh radio transceivers.

**[0099]** In the exemplary mission, the aircraft may then continue on the flight path to waypoint **508**. As shown in the example of FIG. **5**, the mesh radio strength at waypoint **508** may be determined to be below the predetermined threshold value. The aircraft may then be instructed to drop a mesh radio drop pod in a similar manner to that performed at waypoint **502**.

**[0100]** FIGS. **6**A-**6**D are diagrams illustrating the functioning of an exemplary autonomous drone drop pod system **600** in accordance with some embodiments. The autonomous drone drop pod system **600** may comprise a main aircraft **601**, one or more pod attachment mechanisms **602**, one or more aircraft sensors **603** and one or more drop pods **610**. FIG. **6**A shows the main aircraft **601** with an attached

drop pod **610**. In some embodiments, there may be more than one drop pod attached to the main aircraft **601**. FIG. **6**B shows the main aircraft **601** after deployment of the drop pod **610** of FIG. **6**A. As shown in FIG. **6**B, the main aircraft **601** may include an electromagnet as the pod attachment mechanism **602**. In some embodiments, the pod attachment mechanism may be a mechanical and/or magnetic mechanism configured to hold the one or more drop pods **610** securely in place. The main aircraft **601**, as shown in FIG. **6**B also includes an infrared sensitive camera sensor **603**. In some embodiments, the one or more sensors **603** may include sensors for analyzing the environment of the aircraft and/or locating the one or more drop pods **610**. For example, the aircraft may have a plurality of sensors including video cameras, infrared cameras, thermal cameras, ultrasonic transducers, microphones and/or inductive proximity sensors.

**[0101]** With regard to FIG. **6**C, the drop pod **601** is shown comprising an outer casing **611**, mounting magnets **612**, an IR LED light **613** and two IR sensitive cameras **614**. In some embodiments, the mounting magnets **612** may be mounting hardware for the one or more pod attachment mechanisms **602** of the aircraft. In some embodiments, the IR sensitive cameras **614** may be cameras capable of capturing a wide spectrum of light. The type of camera and spectrum of capture of the drop pod cameras **614** may be determined based on the mission and environment in which the drop pod is to be placed. In some embodiments, a single camera may be used. In some embodiments, a plurality of cameras may be used by the drop pod, and the position and orientation of the plurality of cameras may be environment and mission specific.

**[0102]** FIG. **6**D is a diagram illustrating the internal components of the drop pod **610**. The drop pod **610** may further comprise one or more camera interface boards **615**, one or more microcontrollers **616**, one or more mesh modems **617**, one or more radio antennas **618** and one or more batteries **619**. In some embodiments, the one or more microcontrollers may correspond to the drop pod control module **234** as described with regard to FIG. **2**C.

**[0103]** FIG. **7** is a flow chart illustrating an exemplary method **700** that may be performed in accordance with some embodiments.

**[0104]** At step **701**, the system is configured to receive, by an aircraft over a master mesh radio module, a mission plan from a ground control station.

**[0105]** At step **702**, the system is configured to control, by a flight control module, the aircraft based on one or more commands of the mission plan.

**[0106]** At step **703**, the system is configured to collect, by one or more sensors of a pod sensor array module, environment data.

**[0107]** At step **704**, the system is configured to identify, based on the environment data and a pod type of one or more drop pods carried by the aircraft, one or more points of interest (POI), wherein the identifying further comprises determining a POI type for each of the POIs.

**[0108]** At step **705**, the system is configured to select, for each POI, a POI drop pod from the one or more drop pods, wherein the selecting is based on the pod type and the POI.

**[0109]** At step **706**, the system is configured to select a drop location and drop orientation based on the POI type.

**[0110]** At step **707**, the system is configured to release the selected POI drop pod at the selected drop location and in the selected drop orientation.

**[0111]** FIG. **8** illustrates an example machine of a computer system within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed. In alternative implementations, the machine may be connected (e.g., networked) to other machines in a LAN, an intranet, an extranet, an ad-hoc network, a mesh network, and/or the Internet. The machine may operate in the capacity of a server or a client machine in client-server network environment, as a peer machine in a peer-to-peer (or distributed) network environment, or as a server or a client machine in a cloud computing infrastructure or environment.

**[0112]** The machine may be a personal computer (PC), a tablet PC, a set-top box (STB), a Personal Digital Assistant (PDA), a cellular telephone, a web appliance, a server, a network router, a switch or bridge, or any machine capable of executing a set of instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more of the methodologies discussed herein.

**[0113]** The example computer system **800** includes a processing device **802**, a main memory **804** (e.g., read-only memory (ROM), flash memory, dynamic random access memory (DRAM) such as synchronous DRAM (SDRAM) or Rambus DRAM (RDRAM), etc.), a static memory **806** (e.g., flash memory, static random access memory (SRAM), etc.), and a data storage device **818**, which communicate with each other via a bus **860**.

**[0114]** Processing device **802** represents one or more general-purpose processing devices such as a microprocessor, a central processing unit, or the like. More particularly, the processing device may be complex instruction set computing (CISC) microprocessor, reduced instruction set computing (RISC) microprocessor, very long instruction word (VLIW) microprocessor, or processor implementing other instruction sets, or processors implementing a combination of instruction sets. Processing device **802** may also be one or more special-purpose processing devices such as an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a digital signal processor (DSP), network processor, or the like. The processing device **802** is configured to execute instructions **826** for performing the operations and steps discussed herein.

**[0115]** The computer system **800** may further include a network interface device **508** to communicate over the network **820**. The computer system **800** may also include a mesh radio module **810**, sensor array module **830**, GCS control module **840**, flight control module **841**, drop pod control module **842**, computer vision module **843**, bay attachment module **844**, drop pod bay module **845** and power module **846**. The sensor array module may further comprise one or more RGB camera modules **831**, thermal camera modules **832**, microphone modules **833**, CO sensor modules **834**, **02** sensor modules **835**, PM2.5 sensor modules **836**, temperature sensor modules **837**, motion sensor modules **838**, and/or ultrasound transducer modules **839**.

**[0116]** Mesh radio module **810**, sensor array module **830**, RGB camera modules **831**, thermal camera modules **832**,

microphone modules **833**, CO sensor modules **834**, O2 sensor modules **835**, PM2.5 sensor modules **836**, temperature sensor modules **837**, motion sensor modules **838**, ultrasound transducer modules **839**, flight control module **841**, computer vision module **843**, drop pod bay module **845** and power module **846** may be the same or similar to mesh radio module **213**, sensor array module **215**, RGB camera modules **216**, thermal camera modules **217**, microphone modules **218**, CO sensor modules **219**, O2 sensor modules **220**, PM2.5 sensor modules **221**, temperature sensor modules **222**, motion sensor modules **223**, ultrasound transducer modules **224**, flight control module **214**, computer vision module **225**, drop pod bay module **226** and power module as disclosed in FIG. **2**B.

**[0117]** GCS control module **840** may be the same or similar to GCS control module **204** as disclosed in FIG. **2**A.

**[0118]** Drop pod control module **842** and bay attachment module **844** may be the same or similar to drop pod control module **234** and bay attachment module **246** as disclosed in FIG. **2**C.

**[0119]** The data storage device **818** may include a machine-readable storage medium **824** (also known as a computer-readable medium) on which is stored one or more sets of instructions or software **826** embodying any one or more of the methodologies or functions described herein. The instructions **826** may also reside, completely or at least partially, within the main memory **804** and/or within the processing device **802** during execution thereof by the computer system **800**, the main memory **804** and the processing device **802** also constituting machine-readable storage media. Information, including data used in the processes and methods of the system and the one or more sets of instructions or software, may also be stored in blockchain, as NFTs or other decentralized technologies.

**[0120]** In one implementation, the instructions **826** include instructions to implement functionality corresponding to the components of a device to perform the disclosure herein. While the machine-readable storage medium **824** is shown in an example implementation to be a single medium, the term "machine-readable storage medium" should be taken to include a single medium or multiple media (e.g., a centralized or distributed database, and/or associated caches and servers) that store the one or more sets of instructions. The term "machine-readable storage medium" shall also be taken to include any medium that is capable of storing or encoding a set of instructions for execution by the machine and that cause the machine to perform any one or more of the methodologies of the present disclosure. The term "machine-readable storage medium" shall accordingly be taken to include, but not be limited to, solid-state memories, optical media and magnetic media.

**[0121]** It will be appreciated that the present disclosure may include any one and up to all of the following examples.

**[0122]** Example 1. A mesh sensor deployment system, the mesh sensor deployment system comprising: a mesh network comprising a ground control station (GCS), an aircraft and one or more drop pods, and wherein the GCS comprises: GCS control module; a slave mesh radio module; a command UI module; and one or more display units; the drop pods comprise: a drop pod control module; a pod mesh radio module; and a pod sensor array module, wherein the pod sensor array module comprises one or more sensor types and wherein a pod type of the drop pod corresponds to the sensor types; and the aircraft comprises: flight control module; a master mesh radio module; an aircraft sensor array module; and a drop pod bay unit, wherein the one or more drop pods are attached to the aircraft through the drop pod bay unit; and wherein the aircraft is configured to: receive, by the master mesh radio module over the mesh network, mission plan from the GCS, wherein the mission plan comprises one or more commands; control, by the flight control module, the aircraft based on the one or more commands; collect, by the aircraft sensor array module, environment data; identify, based on the environment data and the pod type of the one or more drop pods, one or more points of interest (POI), wherein the identifying further comprises determining a POI type for each of the POIs; select, for each POI, a POI drop pod from the one or more drop pods, wherein the selecting is based on the pod type and the POI; deploy, by the drop pod bay unit, each of the selected POI drop pods, wherein the deploying comprises: selecting a drop location and drop orientation based on the POI type; and releasing the selected POI drop pod at the selected drop location. The system of claim **1**, wherein one or more of the one or more POIs is a gas type POI, and the identification is based in part on an altitude of the aircraft and a mesh network signal strength.

**[0123]** Example 2. The system of Example 1, wherein one or more of the one or more POIs is a gas type POI, and the identification is based in part on an altitude of the aircraft and a mesh network signal strength.

**[0124]** Example 3. The system of any one of Examples 1-2, wherein one or more of the one or more POIs is a camera type POI, and the identification is based in part on a count corresponding to a number of doors and stairways encountered by the aircraft.

**[0125]** Example 4. The system of any one of Examples 1-3, wherein one or more of the one or more POIs is a mesh node type POI, and the identification is based in part on a mesh network signal strength being below a predetermined threshold value.

**[0126]** Example 5. The system of any one of Examples 1-4, wherein the pod sensor array module comprises: one or more RGB camera modules; one or more thermal camera modules; one or more microphone modules; one or more CO sensor modules; one or more O2 sensor modules; one or more PM2.5 sensor modules; one or more temperature sensor modules; one or more motion sensor modules; or one or more ultrasound transducer modules; and wherein the aircraft sensor array module comprises: one or more RGB camera modules; one or more thermal camera modules; one or more microphone modules; one or more CO sensor modules; one or more O2 sensor modules; one or more PM2.5 sensor modules; one or more temperature sensor modules; one or more motion sensor modules; or one or more ultrasound transducer modules.

**[0127]** Example 6. The system of any one of Examples 1-5, wherein the GCS is configured to: generate, by the GCS control module, a mission plan, wherein the mission plan comprises one or more flight paths and one or more mission objectives, and wherein the one or more flight paths comprise a plurality of waypoints; transmit, over the slave mesh radio module, the mission plan to the aircraft; receive, over the slave mesh radio module, aircraft status from the aircraft and pod status from each of the deployed POI drop pods; generate, by the command UI module, a graphical user interface based on the received aircraft status and the received pod status of each of the deployed POI drop pods, wherein the received aircraft status and the received pod

status of each of the deployed POI drop pods comprise one or more sensor readings; and display, by the one or more display units, the graphical user interface.

**[0128]** Example 7. The system of any one of Examples 1-6, wherein the GCS is further configured to: receive, by the command UI module, control input from a user, wherein the control input corresponds to modification to the mission plan; generate, by the GCS control module, a modified mission plan based on the received control input; and transmit, by the slave mesh radio module, the modified mission plan to the aircraft.

**[0129]** Example 8. The system of any one of Examples 1-7, wherein the aircraft further comprises a computer vision module and wherein the aircraft is further configured to: capture, by the aircraft sensor array module, image data of the environment; analyze, by the computer vision module, the captured image data, wherein the computer vision module comprises one or more trained machine learning models; autonomously modify the flight plan based on the analysis of the computer vision module, wherein the modification of the flight plan comprises: adding or removing waypoints to the flight path; and adding or removing mission objectives; and wherein identifying the one or more POIs is further based at least in part on the analysis of the computer vision module and the modification of the flight plan.

**[0130]** Example 9. A mesh sensor deployment method, the mesh sensor deployment method comprising: generating a mesh network comprising a ground control station (GCS), an aircraft and one or more drop pods, wherein the GCS comprises; a GCS control module; a slave mesh radio module; a command UI module; and one or more display units; wherein the drop pods comprise: a drop pod control module; a pod mesh radio module; and a pod sensor array module, wherein the pod sensor array module comprises one or more sensor types and wherein a pod type of the drop pod corresponds to the sensor types; and wherein the aircraft comprises: a flight control module; a master mesh radio module; an aircraft sensor array module; and a drop pod bay unit, wherein the one or more drop pods are attached to the aircraft through the drop pod bay unit; and wherein the aircraft is configured to: receive, by the master mesh radio module over the mesh network, mission plan from the GCS, wherein the mission plan comprises one or more commands; control, by the flight control module, the aircraft based on the one or more commands; collect, by the aircraft sensor array module, environment data; identify, based on the environment data and the pod type of the one or more drop pods, one or more points of interest (POI), wherein the identifying further comprises determining a POI type for each of the POIs; select, for each POI, a POI drop pod from the one or more drop pods, wherein the selecting is based on the pod type and the POI; deploy, by the drop pod bay unit, each of the selected POI drop pods, wherein the deploying comprises: selecting a drop location and drop orientation based on the POI type; and releasing the selected POI drop pod at the selected drop location.

**[0131]** Example 10. The method of Example 9, wherein one or more of the one or more POIs is a gas type POI, and the identification is based in part on an altitude of the aircraft and a mesh network signal strength.

**[0132]** Example 11. The method of any one of Examples 9-10, wherein one or more of the one or more POIs is a camera type POI, and the identification is based in part on a count corresponding to a number of doors and stairways encountered by the aircraft.

**[0133]** Example 12. The method of any one of Examples 9-11, wherein one or more of the one or more POIs is a mesh node type POI, and the identification is based in part on a mesh network signal strength being below a predetermined threshold value.

**[0134]** Example 13. The method of any one of Examples 9-12, wherein the pod sensor array module comprises: one or more RGB camera modules; one or more thermal camera modules; one or more microphone modules; one or more CO sensor modules; one or more O2 sensor modules; one or more PM2.5 sensor modules; one or more temperature sensor modules; one or more motion sensor modules; or one or more ultrasound transducer modules; and wherein the aircraft sensor array module comprises: one or more RGB camera modules; one or more thermal camera modules; one or more microphone modules; one or more CO sensor modules; one or more O2 sensor modules; one or more PM2.5 sensor modules; one or more temperature sensor modules; one or more motion sensor modules; or one or more ultrasound transducer modules.

**[0135]** Example 14. The method of any one of Examples 9-13, wherein the GCS is configured to: generate, by the GCS control module, a mission plan, wherein the mission plan comprises one or more flight paths and one or more mission objectives, and wherein the one or more flight paths comprise a plurality of waypoints; transmit, over the slave mesh radio module, the mission plan to the aircraft; receive, over the slave mesh radio module, aircraft status from the aircraft and pod status from each of the deployed POI drop pods; generate, by the command UI module, a graphical user interface based on the received aircraft status and the received pod status of each of the deployed POI drop pods, wherein the received aircraft status and the received pod status of each of the deployed POI drop pods comprise one or more sensor readings; and display, by the one or more display units, the graphical user interface.

**[0136]** Example 15. The method of any one of Examples 9-14, wherein the GCS is further configured to: receive, by the command UI module, control input from a user, wherein the control input corresponds to modification to the mission plan; generate, by the GCS control module, a modified mission plan based on the received control input; and transmit, by the slave mesh radio module, the modified mission plan to the aircraft.

**[0137]** Example 16. The method of any one of Examples 9-15, wherein the aircraft further comprises a computer vision module and wherein the aircraft is further configured to: capture, by the aircraft sensor array module, image data of the environment; analyze, by the computer vision module, the captured image data, wherein the computer vision module comprises one or more trained machine learning models; autonomously modify the flight plan based on the analysis of the computer vision module, wherein the modification of the flight plan comprises: adding or removing waypoints to the flight path; and adding or removing mission objectives; and wherein identifying the one or more POIs is further based at least in part on the analysis of the computer vision module and the modification of the flight plan.

**[0138]** Some portions of the preceding detailed descriptions have been presented in terms of algorithms and symbolic representations of operations on data bits within a

computer memory. These algorithmic descriptions and representations are the ways used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of operations leading to a desired result. The operations are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

**[0140]** It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the above discussion, it is appreciated that throughout the description, discussions utilizing terms such as "identifying" or "determining" or "executing" or "performing" or "collecting" or "creating" or "sending" or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage devices.

**[0141]** The present disclosure also relates to an apparatus for performing the operations herein. This apparatus may be specially constructed for the intended purposes, or it may comprise a general purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium, such as, but not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMS, EEPROMs, magnetic or optical cards, or any type of media suitable for storing electronic instructions, each coupled to a computer system bus.

**[0142]** Various general purpose systems may be used with programs in accordance with the teachings herein, or it may prove convenient to construct a more specialized apparatus to perform the method. The structure for a variety of these systems will appear as set forth in the description above. In addition, the present disclosure is not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the disclosure as described herein.

**[0143]** The present disclosure may be provided as a computer program product, or software, that may include a machine-readable medium having stored thereon instructions, which may be used to program a computer system (or other electronic devices) to perform a process according to the present disclosure. A machine-readable medium includes any mechanism for storing information in a form readable by a machine (e.g., a computer). For example, a machine-readable (e.g., computer-readable) medium includes a machine (e.g., a computer) readable storage medium such as a read only memory ("ROM"), random access memory ("RAM"), magnetic disk storage media, optical storage media, flash memory devices, etc.

**[0144]** In the foregoing disclosure, implementations of the disclosure have been described with reference to specific example implementations thereof. It will be evident that various modifications may be made thereto without departing from the broader spirit and scope of implementations of the disclosure as set forth in the following claims. The disclosure and drawings are, accordingly, to be regarded in an illustrative sense rather than a restrictive sense.

What is claimed is:

**1**. A mesh sensor deployment system for real-time environmental data gathering, the system comprising:

one or more drop pods, wherein each of the one or more drop pods comprise:

a connection interface for an aircraft;

a pod mesh radio module;

a pod battery module; and

one or more pod sensor modules, wherein the one or more pod sensor modules comprise one or more sensors consisting of cameras, microphones, gas sensors and temperature sensors;

wherein the one or more deployed drop pods are configured to be retrieved or repositioned by the aircraft.

**2**. The system of claim **1**, wherein the aircraft connection interface comprises an electromagnet.

**3**. The system of claim **1**, wherein each of the one or more drop pods comprise:

a first camera disposed on a first side of the drop pod; and

a second camera disposed on a second opposite side of the drop pod.

**4**. The system of claim **1**, wherein each of the one or more drop pods comprise:

a mesh radio module configured to create a mesh wireless network with other drop pods and/or to create a mesh wireless network with the aircraft.

**5**. The system of claim **1**, further comprising:

one or more aircrafts, wherein each of the one or more aircrafts carries a payload of one or more of the one or more drop pods, and wherein each of the one or more aircrafts further comprises:

one or more aircraft sensor modules;

a drop pod connection interface; and

an aircraft battery module.

**6**. The system of claim **5**, further comprising:

an aircraft mesh radio module in communication with a Ground Control Station (GCS) and the one or more drop pods, and wherein the aircraft mesh radio module is configured to:

receive data and instructions from the GCS;

transmit instructions to the one or more drop pods;

receive sensor data from the one or more drop pods;

send, to the GCS, aircraft sensor module data; and

relay the received sensor data to the GCS.

**7**. The system of claim **6**, further comprising wherein the ground control station comprises:

a GCS mesh radio module;

a GCS controller module; and

a user interface module;

wherein, for each aircraft, the GCS is configured to:

determine a drop location to drop each of the one or more drop pods carried by the aircraft, wherein the determining comprises:

receiving, over the GCS mesh radio module, data feeds from the aircraft, wherein the data feeds comprise captured image frames and a radio signal strength indicator (RSSI);

identifying, based on analysis of the captured image frames and a type associated with the one or more drop pods carried by the aircraft, one or more points of interest (POIs) for each of the one or more drop pods; and

determining, based on a selection of a deploying drop pod, a drop point from the one or more POIs associated with the deploying drop pod when the RSSI drops below a predetermined threshold; and

instruct the aircraft to drop the deploying drop pod at the determined drop point; and

wherein the GCS is further configured to:

generate, by the user interface module, a graphical representation of the received data feeds from each aircraft and each drop pod; and

display, to an operator, the generated graphical representation.

**8**. The system of claim **7**, wherein the user interface module is further configured to generate an on screen display recommendation to the operator when the RSSI of one of the one or more aircrafts drops below the predetermined threshold, and wherein the recommendation comprises a list of drop pods carried by the aircraft and a list of POIs associated with each of the drop pods.

**9**. The system of claim **8**, wherein the GCS is configured to generate and maintain a mission map of an environment being explored, wherein the generation of the mission map comprises performing a simultaneous location and mapping based on the data feeds received from the one or more aircrafts and the one or more drop pods.

**10**. The system of claim **6**, wherein the GCS is further configured to generate a mission plan for each of the one or more aircrafts based on the generated mission map.

**11**. The system of claim **6**, wherein a mesh network is maintained between each of the deployed drop pods and the GCS.

**12**. The system of claim **10**, wherein the mission plan further comprises one or more projected drop locations, wherein the projected drop locations are based on a current state of the mission map, wherein the state of the mission map includes sensor data, the RSSI and locations of each of the deployed drop pods, and wherein the one or more projected drop locations are determined based on a distribution of the deployed drop pods and an estimated signal strength map of the mesh network.

**13**. The system of claim **12**, wherein the GCS is further configured to:

identify weak regions of the mesh network;

simulate changes to the mesh network coverage based on redeployment of one or more of the deployed drop pods to a redeployed location;

select one or more of the deployed drop pods based on the simulation;

send instructions to one or more of the one or more aircrafts to retrieve the selected one or more deployed drop pods from their current location and to transport and redeploy the retrieved drop pods to their associated redeployed location.

**14**. A method of deploying a system for real-time environmental data gathering, the system comprising:

deploying, via an aircraft, one or more drop pods, wherein each of the one or more drop pods comprise:

a connection interface for the aircraft, wherein the one or more deployed drop pods are configured to be retrieved or repositioned by the aircraft;

a pod mesh radio module; and

a pod battery module;

one or more pod sensor modules, wherein the one or more pod sensor modules comprise one or more sensors consisting of cameras, microphones, gas sensors and temperature sensors; and

receiving sensor data from the one or more sensors, the deployed one or more drop pods.

**15**. The method of claim **14**, further comprising:

relocating, via the aircraft, the deployed one or more drop pods from a first location to a second location.

**16**. The method of claim **14**, further comprising:

receiving, data feeds from the aircraft, wherein the data feeds comprise captured image frames received by the aircraft from the one or more drop pods.

**17**. The method of claim **14**, wherein each of the one or more drop pods comprise:

a first camera disposed on a first side of the drop pod; and

a second camera disposed on a second opposite side of the drop pod.

**18**. The method of claim **14**, wherein each of the one or more drop pods comprise:

a mesh radio module configured to create a mesh wireless network with other drop pods and/or to create a mesh wireless network with the aircraft.

**19**. The method of claim **14**, further comprising:

automatically determining a location to release a carried drop pod from the aircraft; and

automatically releasing the carried drop pod from the aircraft.

**20**. The method of claim **14**, further comprising:

establishing a mesh network between the aircraft and the one or more drop pods;

determining a drop point for the one or more drop pods; and

instructing the aircraft to drop the one or more drop pods at the drop point.

* * * * *