

UNMANNED AERIAL VEHICLE DELIVERY SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application is a continuation of U.S. Application No. 15/963,610, filed on April 26, 2018, entitled UNMANNED AERIAL VEHICLE DELIVERY SYSTEM, the disclosure of which is hereby incorporated herein by reference.

BACKGROUND

[0002] Delivery services, also known as courier services, mail services, and shipping services, such as those offered by the U.S. Postal Service and commercial carriers, provide delivery of letters, packages, and parcels to and from residences and businesses across the country. As the number of deliveries increases, alternative methods of such delivery services are becoming more and more popular. For instance, unmanned aerial vehicle (UAV) may be used to perform various tasks relating to delivery services, including, for instance, picking up and dropping off packages for “last mile” deliveries. These UAVs can be controlled by a remote operator and/or operate autonomously to complete such tasks. UAVs can therefore be efficient tools for providing such services. However, as UAV deliveries becomes a reality, ensuring safe, secure and user-friendly delivery will be a significant challenge.

BRIEF SUMMARY

[0003] ~~Aspects of the present disclosure provide a delivery system. The delivery system includes a UAV having one or more computing devices configured to receive sensor data for a predetermined delivery area; use the sensor data to identify one or more grid cells of a grid corresponding to a map of the predetermined delivery area, the identified one or more grid cells corresponding to locations acceptable for delivery by the UAV; receive, from a mobile receptacle unit (MRU), information identifying a set of grid cells of the grid identified by the MRU as being acceptable for delivery; determine a delivery location by identifying a common grid cell between the identified one or more grid cells and the set of grid cells received from the MRU; and send the common grid cell to the MRU in order to attempt a delivery of a package at the delivery location.~~ According to an aspect of the present invention, there is provided a delivery system comprising: an unmanned aerial vehicle (UAV) having one or more UAV computing devices configured to: receive sensor data for a predetermined delivery area; use the sensor data to identify one or more grid cells of a grid corresponding to a map of the predetermined delivery area, the identified one or more grid cells corresponding to locations acceptable for delivery by the UAV; receive, from a mobile receptacle unit (MRU), information identifying a set of grid cells of the grid identified by the MRU as being acceptable for delivery; determine a delivery location by identifying a common grid cell between the identified one or more grid cells and the set of grid cells received from the MRU; send the common grid cell to the MRU to instruct the MRU to navigate to the common grid cell in order to attempt a delivery of a package at the delivery location; and attempt the delivery of the package to the MRU while the MRU is present at the delivery location; and a

sensor configured to identify when the MRU is located in a storage area for storing the MRU after the package is delivered to the MRU, wherein the MRU is configured to maneuver to the storage area after a completed delivery.

[0004] In one example, the one or more computing devices are further configured to rank the identified one or more grid cells, and wherein the ranking is also used to identify the common grid cell where there is more than one common grid cell. In another example, the one or more computing devices are further configured to receive, from the MRU, a ranking for the set of grid cells, and wherein the ranking is also used to identify the common grid cell where there is more than one common grid cell. In this example, the one or more computing devices are also configured to rank the identified one or more grid cells, and wherein the ranking of the identified one or more grid cells is also used to identify the common grid cell where there is more than one common grid cell. In another example, the one or more computing devices are further configured to: maneuver the UAV to a delivery position with respect to the delivery location; receive confirmation that the MRU is located at the delivery location; and attempt to deliver the package to the MRU from the delivery position. In this example, the one or more computing devices are also configured to receive sensor information identifying wind conditions at the predetermined delivery area

CLAIMS

1. A delivery system comprising:

~~an unmanned aerial vehicle (UAV) having one or more computing devices configured to:~~
~~receive sensor data for a predetermined delivery area;~~
~~use the sensor data to identify one or more grid cells of a grid corresponding to a map of the predetermined delivery area, the identified one or more grid cells corresponding to locations acceptable for delivery by the UAV;~~
~~receive, from a mobile receptacle unit (MRU), information identifying a set of grid cells of the grid identified by the MRU as being acceptable for delivery;~~
~~determine a delivery location by identifying a common grid cell between the identified one or more grid cells and the set of grid cells received from the MRU; and~~
~~send the common grid cell to the MRU in order to attempt a delivery of a package at the delivery location.~~

2. The system of claim 1, wherein the one or more computing devices are further configured to rank the identified one or more grid cells, and wherein the ranking is also used to identify the common grid cell where there is more than one common grid cell.

3. The system of claim 1, wherein the one or more computing devices are further configured to receive, from the MRU, a ranking for the set of grid cells, and wherein the ranking is also used to identify the common grid cell where there is more than one common grid cell.

4. The system of claim 3, wherein the one or more computing devices are further configured to rank the identified one or more grid cells, and wherein the ranking of the identified one or more grid cells is also used to identify the common grid cell where there is more than one common grid cell.

5. The system of claim 1, wherein the one or more computing devices are further configured to:
—— maneuver the UAV to a delivery position with respect to the delivery location;
receive confirmation that the MRU is located at the delivery location; and
attempt to deliver the package to the MRU from the delivery position.

6. The system of claim 5, wherein the one or more computing devices are further configured to:
—— receive sensor information identifying wind conditions at the predetermined delivery area; and
—— use the sensor information to maneuver the UAV to the delivery position with respect to the delivery position.

7. The system of claim 6, wherein the sensor information is received from an anemometer of the UAV.

~~8. The system of claim 6, wherein the sensor information is received from an anemometer of the MRU.~~

~~9. The system of claim 1, further comprising the MRU.~~

~~10. The system of claim 9, wherein the MRU includes one or more panels configured to open in order to reveal a receptacle area of the MRU, and wherein the receptacle area is configured to accept delivery of the package from the UAV.~~

~~11. The system of claim 10, wherein the one or more panels include at least two panels, and wherein the MRU further includes mesh material arranged between the at least two panels in order to increase a likelihood of the package reaching the receptacle area.~~

~~12. The system of claim 10, wherein the one or more panels are configured to close in order to enclose the package within the receptacle area.~~

~~13. The system of claim 10, wherein the receptacle area includes a sensor configured to confirm delivery of the package.~~

~~14. The system of claim 9, wherein the MRU further includes one or more computing devices configured to:~~

~~—— maneuver the MRU through the predetermined delivery area and collect sensor data for the predetermined delivery area while maneuvering the MRU;~~

~~—— identify obstacles in the predetermined delivery area that would prevent the MRU from accepting a delivery at the area of the identified obstacles; and~~

~~—— use the identified obstacles to identify the set of grid cells.~~

~~15. The system of claim 14, wherein the one or more computing devices of the MRU are further configured to:~~

~~—— receive recipient preferences for the predetermined delivery area; and~~

~~—— use the recipient preferences in order to identify the set of grid cells.~~

~~16. The system of claim 15, wherein the one or more computing devices of the MRU are configured to identify the set of grid cells by:~~

~~—— identifying a first set of grid cells using the identified obstacles; and~~

~~—— filtering the first set of grid cells to identify the set of grid cells.~~

~~17. The system of claim 1, wherein the one or more computing devices are further configured to:~~

~~receive one or more recipient preferences for the predetermined delivery area; and~~

~~use the one or more recipient preferences to identify the common grid cell.~~

~~18. The system of claim 1, further comprising a storage area for storing the MRU after a package is delivered to the MRU.~~

~~19. The system of claim 18, wherein the one or more computing devices of the MRU are further configured to maneuver the MRU to the storage area after a completed delivery; and wherein the storage area includes a sensor configured to identify when the MRU is located in the storage area.~~

~~20. The system of claim 19, further comprising a notification device configured to provide a notification when the MRU is located in the storage area.~~

1. A delivery system comprising:

an unmanned aerial vehicle (UAV) having one or more UAV computing devices configured to:

receive sensor data for a predetermined delivery area;

use the sensor data to identify one or more grid cells of a grid corresponding to a map of the predetermined delivery area, the identified one or more grid cells corresponding to locations acceptable for delivery by the UAV;

receive, from a mobile receptacle unit (MRU), information identifying a set of grid cells of the grid identified by the MRU as being acceptable for delivery;

determine a delivery location by identifying a common grid cell between the identified one or more grid cells and the set of grid cells received from the MRU;

send the common grid cell to the MRU to instruct the MRU to navigate to the common grid cell in order to attempt a delivery of a package at the delivery location; and

attempt the delivery of the package to the MRU while the MRU is present at the delivery location; and

a sensor configured to identify when the MRU is located in a storage area for storing the MRU after the package is delivered to the MRU, wherein the MRU is configured to maneuver to the storage area after a completed delivery.

2. The system of claim 1, wherein the one or more UAV computing devices are further configured to rank the identified one or more grid cells, and wherein the ranking is also used to identify the common grid cell where there is initially more than one common grid cell.

3. The system of claim 1, wherein the one or more UAV computing devices are further configured to receive, from the MRU, a ranking for the set of grid cells, and wherein the ranking is also used to identify the common grid cell where there is initially more than one common grid cell.

4. The system of claim 3, wherein the one or more UAV computing devices are further configured to rank the identified one or more grid cells, and wherein the ranking of the identified one or more grid cells is also used to identify the common grid cell where there is initially more than one common grid cell.

5. The system of claim 1, wherein the one or more UAV computing devices are further configured to:
maneuver the UAV to a delivery position with respect to the delivery location;
receive confirmation that the MRU is located at the delivery location; and
attempt to deliver the package to the MRU from the delivery position.

6. The system of claim 5, wherein the one or more UAV computing devices are further configured to:
receive sensor information identifying wind conditions at the predetermined delivery area; and
use the sensor information to maneuver the UAV to the delivery position.

7. The system of claim 6, wherein the sensor information is received from an anemometer of the UAV.

8. The system of claim 6, wherein the sensor information is received from an anemometer of the MRU.

9. The system of claim 1, further comprising the MRU.

10. The system of claim 9, wherein the MRU includes one or more panels configured to open in order to reveal a receptacle area of the MRU, and wherein the receptacle area is configured to accept delivery of the package from the UAV.

11. The system of claim 10, wherein the one or more panels include at least two panels, and wherein the MRU further includes mesh material arranged between the at least two panels in order to increase a likelihood of the package reaching the receptacle area.

12. The system of claim 10, wherein the one or more panels are configured to close in order to enclose the package within the receptacle area.

13. The system of claim 10, wherein the receptacle area includes a sensor configured to confirm delivery of the package.

14. The system of claim 9, wherein the MRU further includes one or more MRU computing devices configured to:

maneuver the MRU through the predetermined delivery area and collect sensor data for the predetermined delivery area while maneuvering the MRU;

identify obstacles in the predetermined delivery area that would prevent the MRU from accepting a delivery at the area of the identified obstacles; and
use the identified obstacles to identify the set of grid cells.

15. The system of claim 14, wherein the one or more MRU computing devices are further configured to:
receive recipient preferences indicating one or more preferred or nonpreferred locations within the predetermined delivery area for delivery of the package to the MRU, wherein the predetermined delivery area comprises an area of land; and
use the recipient preferences in order to identify the set of grid cells.

16. The system of claim 15, wherein the one or more MRU computing devices are configured to identify the set of grid cells by:
identifying a first set of grid cells using the identified obstacles; and
filtering the first set of grid cells to identify the set of grid cells.

17. The system of claim 1, wherein the one or more UAV computing devices are further configured to:
receive one or more recipient preferences indicating one or more preferred or nonpreferred locations within the predetermined delivery area for delivery of the package to the MRU, wherein the predetermined delivery area comprises an area of land; and
use the one or more recipient preferences to identify the common grid cell.

18. The system of claim 17, wherein the one or more recipient preferences include conditional rules for identifying the common grid cell.

19. The system of claim 1, further comprising a notification device configured to provide a notification when the MRU is located in the storage area.