Delivery-Location Recharging During Aerial Transport Tasks

[0001] This application claims priority to U.S. Patent Application No. 15/852,804, filed on December 22, 2017, which is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] An unmanned system, which may also be referred to as an autonomous vehicle, is a vehicle capable of travel without a physically-present human operator. An unmanned system may operate in a remote-control mode, in an autonomous mode, or in a partially autonomous mode.

[0003] When an unmanned system operates in a remote-control mode, a pilot or driver that is at a remote location can control the unmanned vehicle via commands that are sent to the unmanned vehicle via a wireless link. When the unmanned system operates in autonomous mode, the unmanned system typically moves based on pre-programmed navigation waypoints, dynamic automation systems, or a combination of these. Further, some unmanned systems can operate in both a remote-control mode and an autonomous mode, and in some instances may do so simultaneously. For instance, a remote pilot or driver may wish to leave navigation to an autonomous system while manually performing another task, such as operating a mechanical system for picking up objects, as an example.

[0004] Various types of unmanned systems exist for various different environments. For instance, unmanned aerial vehicles (UAVs) are configured for operation in the air (e.g., flight). Examples include quad-copters and tail-sitter UAVs, among others. Unmanned systems also exist for hybrid operations in which multi-environment operation is possible. Examples of hybrid unmanned vehicles include an amphibious craft that is capable of operation on land as well as on water or a floatplane that is capable of landing on water as well as on land. Other examples are also possible.

SUMMARY

[0005] An unmanned aerial vehicle (UAV) can be used to deliver items to one or more recipients, such as various goods or food items. In certain cases, a UAV delivery task could involve both transporting an item or items to a recipient at a designated delivery location, and also transporting an item or items back from the delivery location. In this scenario, there is often

down-time, where a UAV waits on the recipient to provide an item or items for return (waiting for return of re-usable utensils used to consume delivered food items, or waiting for a recipient to try on delivered clothing items). Such downtime may reduce the efficiency of a UAV in providing delivery services, since it reduces the number of deliveries a UAV is capable of completing in a given amount of time. Accordingly, example embodiments may help to more efficiently utilize UAV downtime in item return scenarios by initiating or requesting initiation of a recipient-assisted recharging process at the delivery location, such that the UAV can recharge its battery or batteries during such downtime.

[0006] In one aspect, an example method involves: (a) during a transport task being carried out by a UAV, determining that the UAV has arrived at a delivery location, wherein the transport task comprises at least a first flight segment to transport a payload from a loading location to a delivery location, delivery of the payload at the delivery location, and a second flight segment from the delivery location to a next location; (b) in response to determining that the UAV has arrived at the delivery location, initiating a notification process requesting a recipient-assisted recharging process comprising a manually-assisted coupling of the UAV to a power source at or near the delivery location, wherein the notification process comprises transmitting, to a computing device associated with a recipient of the payload, a request for the recipient to take action to couple the UAV to the power source after delivery of the payload to the recipient; (d) determining that the recipient-assisted recharging process has recharged a battery of the UAV to a target level, and responsively: (i) determining when a non-returnable portion of the payload has been removed from, and a returnable portion of the payload is coupled to or held by, the UAV; and (ii) when the non-returnable portion is removed and the returnable portion is secured, initiating the second flight segment for the transport task.

[0007] In another aspect, an example method involves: (a) during a transport task being carried out by a UAV, determining that the UAV has arrived at a delivery location, wherein the transport task comprises at least a first flight segment from a source location to a delivery location for delivery of a payload, and a second flight segment from the delivery location to a next location; (b) in response to determining that the UAV has landed at the delivery location: (i) providing an interface for receiving an indication as to whether or not a return payload will be loaded at the delivery location; and (ii) initiating a notification process requesting a recipient-assisted recharging process comprising a manually-assisted coupling of the UAV to a power

source at or near the delivery location, wherein the notification process comprises transmitting, to a computing device associated with a recipient of the payload, a request for the recipient to take action to couple the UAV to the power source after delivery of the payload to the recipient; (c) determining that the recipient-assisted recharging process has recharged a battery of the UAV to a target level; (d) when an indication is received that no return payload will be loaded at the delivery location and the recipient-assisted recharging process has recharged the battery to the target level, initiating the second flight segment; and (d) when an indication is received that a return payload will be loaded at the delivery location and the recipient-assisted recharging process has recharged the battery to the target level, determining when the returned portion of the payload is loaded on or in the UAV and responsively initiating the second flight segment.

[0008] In a further aspect, an unmanned aerial vehicle (UAV) comprises: a rechargeable battery, a power interface for electronically coupling to an external AC power source, an AC/DC converter coupled to the power interface and operable to convert alternating current to direct current, a charging circuit operable to use direct current from the AC/DC converter to charge the rechargeable battery, and one or more control systems. The one or more control systems are operable to: (i) cause the UAV to carry out a first flight segment from a loading location to a delivery location, wherein the first flight segment is part of a transport task being carried out by the UAV; (ii) determine that the UAV has arrived at the delivery location; (iii) in response to determining that the UAV has arrived at the delivery location: (a) determine when a non-returnable portion of the payload is removed from, and a returnable portion of the payload is secured to or within, a payload bay of the UAV; and (b) initiate a notification process to indicate that a recipient-assisted recharging process should be initiated, wherein the recipient-assisted recharging process involves connection of the power interface to an external AC power source at the delivery location, wherein the notification process comprises transmitting, to a computing device associated with a recipient of the payload, a request for the recipient to take action to connect the power interface to the external AC power source after delivery of the payload to the recipient; and (iv) in response to (a) a determination that the recipient-assisted recharging process has recharged the rechargeable battery of the UAV to a target level, and (b) a determination that the non-returnable portion is removed and the returnable portion is secured,

initiate a second flight segment of the transport task.

[0009] These as well as other aspects, advantages, and alternatives, will become apparent to those of ordinary skill in the art by reading the following detailed description, with reference where appropriate to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figure 1A is a simplified illustration of an unmanned aerial vehicle, according to example embodiments.

[0011] Figure 1B is a simplified illustration of an unmanned aerial vehicle, according to example embodiments.

[0012] Figure 1C is a simplified illustration of an unmanned aerial vehicle, according to example embodiments.

CLAIMS

What is claimed is:

1. A method comprising:

determining that an unmanned aerial vehicle (UAV) has arrived at a delivery location while carrying out a transport task, wherein the transport task comprises at least a first flight segment to transport a payload from a loading location to a delivery location, delivery of the payload at the delivery location, and a second flight segment from the delivery location to a next location;

in response to determining that the UAV has arrived at the delivery location, initiating a notification process requesting a recipient-assisted recharging process comprising a manually-assisted coupling of the UAV to a power source at or near the delivery location, wherein the notification process comprises transmitting, to a computing device associated with a recipient of the payload, a request for the recipient to take action to couple the UAV to the power source after delivery of the payload to the recipient; and

determining that the recipient-assisted recharging process has recharged a battery of the UAV to a target level;

determining when a non-returnable portion of the payload has been removed from, and a returnable portion of the payload is coupled to or held by, the UAV; and

after the non-returnable portion is removed and the returnable portion is secured, initiating the second flight segment for the transport task.

2. The method of claim 1, wherein the non-returnable portion of the payload comprises an item, and wherein returnable portion of the payload comprises packaging or a container for the item.

3. The method of claim 2, wherein the item comprises a food item.

4. The method of claim 2, wherein the packaging or container is formed from one or more recyclable materials.

5. The method of claim 4, wherein the transport task further comprises one or more flight segments to transport the packaging or container to a recycling location.

6. The method of claim 1, wherein the next location comprises a carrier-operated location.

7. The method of claim 1, wherein the next location comprises a source location for

item transport.

8. The method of claim 1, wherein the transport task is a multi-delivery task, wherein the payload comprises a first payload and a second payload, wherein the first payload comprises the returnable and non-returnable portions, and wherein the second payload comprises a second returnable portion and a second non-returnable portion, and wherein the next location is a second delivery location corresponding to the second payload.

9. The method of claim 8, further comprising, after delivering the non-returnable portion of the second payload at the second delivery location, initiating a third flight segment from the second delivery location to a third location.

10. The method of claim 1, wherein the non-returnable portion of the payload comprises at least one food item, and wherein returnable portion of the payload comprises at least one re-usable utensil, dishware, or tableware item.

11. A method comprising:

determining that an unmanned aerial vehicle (UAV) has arrived at a delivery location while carrying out a transport task, wherein the transport task comprises at least a first flight segment from a loading location to a delivery location for delivery of a payload, and a second flight segment from the delivery location to a next location;

in response to determining that the UAV has landed at the delivery location:

providing an interface for receiving an indication as to whether or not a return payload will be loaded at the delivery location;

initiating a notification process requesting a recipient-assisted recharging process comprising a manually-assisted coupling of the UAV to a power source at or near the delivery location, wherein the notification process comprises transmitting, to a computing device associated with a recipient of the payload, a request for the recipient to take action to couple the UAV to the power source after delivery of the payload to the recipient;

determining that the recipient-assisted recharging process has recharged a battery of the UAV to a target level;

when an indication is received that no return payload will be loaded at the delivery location and the recipient-assisted recharging process has recharged the battery to the target level, initiating the second flight segment; and

when an indication is received that a return payload will be loaded at the delivery

location and the recipient-assisted recharging process has recharged the battery to the target level:

determining when the returned portion of the payload is loaded on or in the UAV, and responsively initiating the second flight segment.

12. The method of claim 11, wherein the payload comprises one or more items of clothing.

13. The method of claim 12, wherein the notification process indicates that the recipient-assisted recharging process should be initiated so the UAV can charge while the recipient tried on the one or more items of clothing.

14. The method of claim 13, wherein the one or more items comprise a plurality of items, the method further comprising:

receiving an indication that a first of the plurality of items will be returned, but no indication that a second of the plurality of items will be returned.

15. The method of claim 11, further comprising:

when the indication is received that a return payload will be loaded at the delivery location and the recipient-assisted recharging process has recharged the battery to the target level:

determining that (a) a predetermined period of time has elapsed since arriving at the delivery location or since the indication that the return payload will be loaded, and (b) the return payload has not been loaded, and responsively initiating the second flight segment without the return payload.

16. The method of claim 11, wherein the return payload comprises one or more items from the delivered payload.

17. The method of claim 11, wherein the return payload comprises one or more items that were not part of the delivered payload.

18. The method of claim 17, wherein the return payload comprises one or more items that were delivered during a previous transport task.

19. An unmanned aerial vehicle (UAV) comprising:

a rechargeable battery;

a power interface for electronically coupling to an external AC power source;

an AC/DC converter coupled to the power interface and operable to convert alternating

current to direct current;

a charging circuit operable to use direct current from the AC/DC converter to charge the rechargeable battery; and

one or more control systems operable to:

cause the UAV to carry out a first flight segment from a loading location to a delivery location, wherein the first flight segment is part of a transport task being carried out by the UAV;

determine that the UAV has arrived at the delivery location;

in response to determining that the UAV has arrived at the delivery location: (a) determine when a non-returnable portion of the payload is removed from, and a returnable portion of the payload is secured to or within, a payload bay of the UAV; and (b) initiate a notification process to indicate that a recipient-assisted recharging process should be initiated, wherein the recipient-assisted recharging process involves connection of the power interface to an external AC power source at the delivery location, wherein the notification process comprises transmitting, to a computing device associated with a recipient of the payload, a request for the recipient to take action to connect the power interface to the external AC power source after delivery of the payload to the recipient; and

in response to (a) a determination that the recipient-assisted recharging process has recharged the rechargeable battery of the UAV to a target level, and (b) a determination that the non-returnable portion is removed and the returnable portion is secured, initiate a second flight segment of the transport task.

20. The aerial vehicle of claim 19, the payload bay being arranged to secure a payload during flight.