unit. The temperature control unit can include a temperature controlled compartment in which temperature-sensitive items could be transported. For example, the temperature control unit can take the form of a temperature-controlled packaging that can be coupled to the UAV and in which items could be transported.

[0006] However, operation of a temperature control unit can consume significant UAV battery resources. In order to avoid any mishaps (e.g., the UAV battery depleting before the item is delivered), it is desirable for the ATSP to assign the task of delivering a temperature-sensitive item to a UAV that is capable of delivering the item without encountering mishaps. Accordingly, disclosed herein is a method of selecting, from a fleet of UAVs, a UAV that can successfully deliver a specific temperature-sensitive item to a specified delivery location. Within examples, selecting the UAV can be based on a preferred temperature range at which the item can be maintained, an estimated travel distance that available UAVs would travel to perform the task, a total weight of the available UAVs, among other factors.

[006a] According to a first aspect of the present invention, there is provided a computer-implemented method comprising:

generating a transport task to fulfill a request for delivery of a temperature-sensitive item, wherein the transport task includes maintaining a temperature of the temperature-sensitive item within a preferred temperature range during a delivery of the temperature-sensitive item;

based on the transport task, selecting an available unmanned vehicle (UV) from a fleet of UVs to travel a total travel distance to complete the transport task;

determining, based on a battery energy level of the selected available UV, an energy deficit in the battery energy level of the selected available UV needed to account for an estimated sum of energy to be consumed during the transport task, wherein the estimated sum of energy to be consumed includes an amount of energy expected to be consumed in maintaining the preferred temperature range during the delivery and an amount of energy estimated to be consumed in traveling the total travel distance of the transport task;

selecting a self-powered packaging unit from a plurality of self-powered packaging units to hold the temperature-sensitive item and to electrically couple to the UV based on the selected self-powered packaging unit having an energy capacity greater than the energy deficit in the battery energy level of the selected available UV;

and

controlling the selected available UV to use the selected self-powered packaging unit to perform the transport task.

[0006b] According to a second aspect of the present invention, there is provided a system comprising:

a fleet of unmanned vehicles (UVs) that are configured to transport temperature-sensitive items;

at least one communication interface operable to communicate with item-provider computing devices;

at least one processor; and

program instructions stored on a non-transitory computer readable medium and executable by the at least one processor to perform functions including:

generating a transport task in response to receiving from an item-provider computing device a request for delivery of a temperature-sensitive item, wherein the transport task involves delivering the temperature-sensitive item while maintaining a temperature of the temperature-sensitive item within a preferred temperature range;

based on the transport task, selecting an available unmanned vehicle (UV) from ea fleet of UVs to travel a total travel distance to complete the transport task;

determining, based on a battery energy level of the selected available UV, an energy deficit in the battery energy level of the selected available UV needed to account for an estimated sum of energy to be consumed during the transport task, wherein the estimated sum of energy to be consumed includes an amount of energy expected to be consumed in maintaining the preferred temperature range during the delivery and an amount of energy estimated to be consumed in traveling the total travel distance of the transport task;

selecting a self-powered packaging unit from a plurality of self-powered packaging units to hold the temperature-sensitive item and to electrically couple to the UV based on the selected self-powered packaging unit having an energy capacity greater than the energy deficit in the battery energy level of the selected available UV;

and

controlling the selected available UV to use the selected self-powered packaging unit to perform the transport task.

[006c] According to a third aspect of the present invention, there is provided a computer-implemented method comprising:

generating a transport task to fulfill a request for delivery of a temperature-sensitive

item, wherein the transport task involves delivering the temperature-sensitive item while maintaining a temperature of the temperature-sensitive item within a preferred temperature range;

based on the transport task, selecting an available unmanned vehicle (UV) from a fleet of UVs to travel a total travel distance to complete the transport task;

determining, based on a battery energy level of the selected available UV, an energy deficit in the battery energy level of the selected available UV needed to account for an estimated sum of energy to be consumed during the transport task, wherein the estimated sum of energy to be consumed includes an amount of energy expected to be consumed in maintaining the preferred temperature range during the delivery and an amount of energy estimated to be consumed in traveling the total travel distance of the transport task;

selecting a self-powered packaging unit from a plurality of self-powered packaging units to hold the temperature-sensitive item and to electrically couple to the UV based on the selected self-powered packaging unit having an energy capacity greater than the energy deficit in the battery energy level of the selected available UV;

and

controlling the selected available UV to use the selected self-powered packaging unit to perform the transport task.

[0007] ~~In one aspect a~~A method is also disclosed. The method includes generating a transport task to fulfill a request for delivery of a temperature-sensitive item, where the transport task involves delivering the temperature-sensitive item while maintaining a temperature of the temperature-sensitive item within a preferred temperature range. The method also includes calculating an amount of required energy to perform the transport task for each available unmanned vehicle (UV) of a fleet of UVs. Further, the method includes, based on (i) the amount of required electrical energy for each available UV, and (ii) a respective remaining battery energy level for each available UV, selecting a first UV to perform the transport task. Yet further, the method includes assigning the transport task to the first UV.

[0008] ~~In another aspect, a~~A system is also disclosed. The system includes a fleet of unmanned vehicles (UVs) that are configured to transport temperature-sensitive items. The system also includes at least one communication interface operable to communicate with item-provider computing devices, and at least one processor. Further, the system includes program instructions stored on a non-transitory computer readable medium and executable by the at least one processor to perform functions including: generating a transport task in response to

receiving from an item-provider computing device a request for delivery of a temperature-sensitive item, where the transport task involves delivering the temperature-sensitive item while maintaining a temperature of the temperature-sensitive item within a preferred temperature range. The functions also include calculating an amount of required

energy to perform the transport task for each available unmanned vehicle (UV) of a fleet of UVs. Further, the functions include based on (i) the amount of required electrical energy for each available UV, and (ii) a respective remaining battery energy level for each available UV, selecting a first UV to perform the task. Yet further, the functions include assigning the transport task to the first UV.

[0009] ~~In another aspect, a~~A method is also disclosed. The method includes generating a transport task to fulfill a request for delivery of a temperature-sensitive item, where the transport task involves delivering the temperature-sensitive item while maintaining a temperature of the temperature-sensitive item within a preferred temperature range. The method also includes based on the transport task, selecting an unmanned vehicle (UV) tier from which to select a UV to perform the transport task. Furthermore, the method includes calculating an amount of required energy to perform the transport task for each available UV of the selected UV tier. Further, the method includes based on (i) the amount of required electrical energy for each available UV, and (ii) a respective remaining battery energy level for each available UV, selecting a first UV to perform the task. Yet further, the method includes assigning the transport task to the first UV.

[0010] 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 FIGURES

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

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

[0013] Figure 1C is a simplified illustration of an unmanned aerial vehicle, according to example embodiments.

[0014] Figure 1D is a simplified illustration of an unmanned aerial vehicle, according to example embodiments.

[0015] Figure 1E is a simplified illustration of an unmanned aerial vehicle, according to example embodiments.

[0016] Figure 2A is a simplified block diagram illustrating components of an unmanned aerial system, according to example embodiments.

[0017] Figure 2B is a simplified block diagram illustrating components of a temperature control unit, according to example embodiments.

CLAIMS

What is claimed is:

1. A computer-implemented method comprising:

generating a transport task to fulfill a request for delivery of a temperature sensitive item, wherein the transport task includes maintaining a temperature of the temperature-sensitive item within a preferred temperature range during delivery;

calculating an amount of required energy to perform the transport task for each available unmanned vehicle (UV) of a fleet of UVs;

based on (i) the amount of required energy for each available UV, and (ii) a respective remaining battery energy level for each available UV, selecting a first UV to perform the transport task; and

assigning the transport task to the first UV.

2. The method of claim 1, wherein generating a transport task to fulfill a request for delivery of a temperature-sensitive item comprises:

determining the preferred temperature range for the temperature-sensitive item.

3. The method of claim 2, wherein the preferred temperature range is based on a type of the temperature-sensitive item.

4. The method of claim 1, wherein the respective remaining battery energy level for each UV is indicative of a respective remaining amount of battery energy, and wherein selecting the first UV to perform the transport task comprises:

for each available UV, comparing the amount of required energy to the respective remaining amount of battery energy for the UV;

based on the comparing, determining, from the available UVs, a subset of UVs that are capable of performing the transport task; and

selecting the first UV from the subset of UVs.

5. The method of claim 4, wherein determining a subset of UVs that are capable of performing the transport task comprises:

based on the comparing, including in the subset of UVs one or more UVs for which the respective remaining amount of battery energy exceeds the amount of required energy.

6. The method of claim 4, wherein selecting the first UV from the subset of UVs comprises:

calculating a respective delivery efficiency for each UV in the subset; and

based on the respective delivery efficiencies of the UVs in the subset, selecting the first UV, wherein the first UV has a greatest respective delivery efficiency amongst the respective delivery efficiencies of the UVs in the subset.

7. The method of claim 4, wherein selecting the first UV from the subset of UVs comprises:

calculating a respective delivery time for each UV in the subset; and

based on the respective delivery times of the UVs in the subset, selecting the first UV, wherein the first UV has a fastest respective delivery time amongst the respective delivery times of the UVs in the subset.

8. The method of claim 1, wherein the amount of required energy to perform the transport task for each available UV is calculated based on at least one of: (i) a respective estimated travel distance for the UV to perform the transport task, (ii) a respective weight of the UV, and (iii) the preferred temperature range for the temperature-sensitive item.

9. The method of claim 8, wherein the respective estimated travel distance comprises: (i) a first distance from a respective current location of the UV to a pick-up location of the temperature-sensitive item, (ii) a second distance from the pick-up location to a delivery location of the temperature-sensitive item, and (iii) a third distance from the delivery location to a UV charging station near to the delivery location.

10. A system comprising:

a fleet of unmanned vehicles (UVs) that are configured to transport temperature-sensitive items;

at least one communication interface operable to communicate with item provider computing devices;

at least one processor; and

program instructions stored on a non-transitory computer readable medium and executable by the at least one processor to perform functions including:

generating a transport task in response to receiving from an item provider computing device a request for delivery of a temperature-sensitive item, wherein the transport task involves delivering the temperature-sensitive item while maintaining a temperature of the temperature-sensitive item within a preferred temperature range;

calculating an amount of required energy to perform the transport task for each available unmanned vehicle;

based on (i) the amount of required energy for each available UV, and (ii) a respective remaining battery energy level for each available UV, select a first UV to perform the transport task; and

assigning the transport task to the first UV.

11. The system of claim 10, wherein each respective UV comprises a respective temperature control unit.

12. The system of claim 11, wherein the respective temperature control unit comprises one of: a heating element or a cooling element.

13. The system of claim 11, wherein the respective temperature control unit comprises one or more temperature sensors that are configured to monitor at least a temperature of a compartment of the respective temperature control unit.

14. The system of claim 11, wherein the respective temperature control unit comprises a rechargeable energy storage device, wherein the rechargeable energy storage device is configured to provide power to at least one of: the respective temperature control unit or the respective UV.

15. The system of claim 11, wherein the respective temperature control unit is electrically coupled to the respective UV via an electrical coupling element.

16. The system of claim 11, wherein the respective temperature control unit comprises a communication module configured to establish a communication link between the respective temperature control unit and the respective UV.

17. The system of claim 10, wherein generating a transport task to fulfill a request for delivery of a temperature-sensitive item comprises:

determining a preferred temperature range for the temperature-sensitive item.

18. The system of claim 10, wherein the respective remaining battery energy level for each UV is indicative of a respective remaining amount of battery energy, and wherein selecting the first UV to perform the transport task comprises:

for each available UV, comparing the amount of required energy to the respective remaining amount of battery energy for the UV;

based on the comparing, determining a subset of UVs that are capable of performing the transport task; and

selecting the first UV from the subset of UVs.

19. The system of claim 18, wherein determining a subset of UVs that are capable of performing the transport task comprises:

based on the comparing, including in the subset of UVs one or more UVs for which the respective remaining amount of battery energy exceeds the amount of required energy.

20. The system of claim 18, wherein selecting the first UV from the subset of UVs comprises:

calculating a respective delivery efficiency for each UV in the subset; and

based on the respective delivery efficiencies of the UVs in the subset, selecting the first UV, wherein the first UV has a greatest respective delivery efficiency amongst the respective delivery efficiencies of the UVs in the subset.

21. The system of claim 18, wherein selecting the first UV from the subset of UVs comprises:

calculating a respective delivery time for each UV in the subset; and

based on the respective delivery times of the UVs in the subset, selecting the first UV, wherein the first UV has a fastest respective delivery time amongst the respective delivery times of the UVs in the subset.

22. A computer-implemented method comprising:

generating a transport task to fulfill a request for delivery of a temperature sensitive item, wherein the transport task involves delivering the temperature sensitive item while maintaining a temperature of the temperature sensitive item within a preferred temperature range;

based on the transport task, selecting an manned vehicle (UV) tier from which to select a UV to perform the transport task;

calculating an amount of required energy to perform the transport task for each available UV of the selected UV tier;

based on (i) the amount of required energy for each available UV, and (ii) a respective remaining battery energy level for each available UV, select a first UV to perform the transport task; and

assigning the transport task to the first UV.

23. The computer-implemented method of claim 22, wherein the respective remaining battery energy level for each unmanned vehicle (UV) is indicative of a respective remaining amount of battery energy, and wherein selecting the first UV to perform the transport task comprises:

for each available UV, comparing the amount of required energy to the respective remaining amount of battery energy for the UV;

~~based on the comparing, determining a subset of UVs that are capable of performing the transport task; and~~

~~selecting the first UV from the subset of UVs.~~

1. A computer-implemented method comprising:

generating a transport task to fulfill a request for delivery of a temperature-sensitive item, wherein the transport task includes maintaining a temperature of the temperature-sensitive item within a preferred temperature range during a delivery of the temperature-sensitive item;

based on the transport task, selecting an available unmanned vehicle (UV) from a fleet of UVs to travel a total travel distance to complete the transport task; determining, based on a battery energy level of the selected available UV, an energy deficit in the battery energy level of the selected available UV needed to account for an estimated sum of energy to be consumed during the transport task, wherein the estimated sum of energy to be consumed includes an amount of energy expected to be consumed in maintaining the preferred temperature range during the delivery and an amount of energy estimated to be consumed in traveling the total travel distance of the transport task;

selecting a self-powered packaging unit from a plurality of self-powered packaging units to hold the temperature-sensitive item and to electrically couple to the UV based on the selected self-powered packaging unit having an energy capacity greater than the energy deficit in the battery energy level of the selected available UV;

and

controlling the selected available UV to use the selected self-powered packaging unit to perform the transport task.

2. The computer-implemented method of claim 1, wherein generating a transport task to fulfill a request for delivery of a temperature-sensitive item comprises:

determining the preferred temperature range for the temperature-sensitive item.

3. The computer-implemented method of claim 2, wherein the preferred temperature range is based on a type of the temperature-sensitive item.

4. The computer-implemented method of claim 1, wherein selecting the available UV from the fleet of UVs to travel the total travel distance to complete the transport task comprises:

calculating a respective delivery efficiency for each UV; and

based on the respective delivery efficiencies of the UVs, selecting the available UV, wherein the available UV has a greatest respective delivery efficiency amongst the respective delivery efficiencies of the UVs.

5. The computer-implemented method of claim 1, wherein selecting the available UV from the fleet of UVs to travel the total travel distance to complete the transport task comprises:

calculating a respective delivery time for each UV; and

based on the respective delivery times of the UVs, selecting the available UV, wherein the available UV has a fastest respective delivery time amongst the respective delivery times of the UVs.

6. The computer-implemented method of claim 1, wherein calculating the estimated sum of energy to be consumed during the transport task is further based on at least one of: (i) a respective estimated travel distance for the UV to perform the transport task, or (ii) a respective weight of the UV.

7. The computer-implemented method of claim 6, wherein the respective estimated travel distance comprises: (i) a first distance from a respective current location of the UV to a pick-up location of the temperature-sensitive item, (ii) a second distance from the pick-up location to a delivery location of the temperature-sensitive item, and (iii) a third distance from the delivery location to a UV charging station near to the delivery location.

8. The computer implemented method of claim 1 wherein the self-powered packaging unit includes a power system comprising at least one power source configured to power the self-powered packaging unit.

9. A system comprising:

a fleet of unmanned vehicles (UVs) that are configured to transport temperature-sensitive items;

at least one communication interface operable to communicate with item-provider computing devices;

at least one processor; and

program instructions stored on a non-transitory computer readable medium and executable by the at least one processor to perform functions including:

generating a transport task in response to receiving from an item-provider computing device a request for delivery of a temperature-sensitive item, wherein the transport task involves delivering the temperature-sensitive item while maintaining a temperature of the temperature-sensitive item within a preferred temperature range;

based on the transport task, selecting an available unmanned vehicle (UV) from ea fleet of UVs to travel a total travel distance to complete the transport task;

determining, based on a battery energy level of the selected available UV, an energy deficit in the battery energy level of the selected available UV needed to account for an estimated sum of energy to be consumed during the transport task, wherein the estimated sum of energy to be consumed includes an amount of energy expected to be consumed in maintaining the preferred temperature range during the delivery and an amount of energy estimated to be consumed in traveling the total travel distance of the transport task;

selecting a self-powered packaging unit from a plurality of self-powered packaging units to hold the temperature-sensitive item and to electrically couple to the UV based on the selected self-powered packaging unit having an energy capacity greater than the energy deficit in the battery energy level of the selected available UV;

and

controlling the selected available UV to use the selected self-powered packaging unit to perform the transport task.

10. The system of claim 9, wherein the self-powered packaging unit comprises one of: a heating element or a cooling element.

11. The system of claim 9, wherein the self-powered packaging unit comprises one or more temperature sensors that are configured to monitor at least a temperature of a compartment of the self-powered packaging unit.

12. The system of claim 9, wherein the self-powered packaging unit includes a rechargeable energy storage device, wherein the rechargeable energy storage device is configured to provide power to the self-powered packaging unit and the UV, wherein power is provided to the UV by at least one of: (i) directly providing power to the UV, or (ii) recharging at least one battery of the UV.

13. The system of claim 9, wherein the self-powered packaging unit comprises a communication system configured to establish a communication link between the self-powered packaging unit and the available UV.

14. The system of claim 9, wherein generating a transport task to fulfill a request for delivery of a temperature-sensitive item comprises:

determining a preferred temperature range for the temperature-sensitive item.

15. The system of claim 9, wherein selecting the available UV from the fleet of UVs to travel the total travel distance to complete the transport task comprises:

calculating a respective delivery efficiency for each UV; and

based on the respective delivery efficiencies of the UVs, selecting the available UV, wherein the available UV has a greatest respective delivery efficiency amongst the respective delivery efficiencies of the UVs.

16. The system of claim 9, wherein selecting the available UV from the fleet of UVs to travel the total travel distance to complete the transport task comprises:

calculating a respective delivery time for each UV; and

based on the respective delivery times of the UVs, selecting the available UV, wherein the available UV has a fastest respective delivery time amongst the respective delivery times of the UVs.

17. A computer-implemented method comprising:

generating a transport task to fulfill a request for delivery of a temperature-sensitive item, wherein the transport task involves delivering the temperature-sensitive item while maintaining a temperature of the temperature-sensitive item within a preferred temperature range;

based on the transport task, selecting an available unmanned vehicle (UV) from a fleet of UVs to travel a total travel distance to complete the transport task;

determining, based on a battery energy level of the selected available UV, an energy deficit in the battery energy level of the selected available UV needed to account for an estimated sum of energy to be consumed during the transport task, wherein the estimated sum of energy to be consumed includes an amount of energy expected to be consumed in

maintaining the preferred temperature range during the delivery and an amount of energy estimated to be consumed in traveling the total travel distance of the transport task;

selecting a self-powered packaging unit from a plurality of self-powered packaging units to hold the temperature-sensitive item and to electrically couple to the UV based on the selected self-powered packaging unit having an energy capacity greater than the energy deficit in the battery energy level of the selected available UV;

and

controlling the selected available UV to use the selected self-powered packaging unit to perform the transport task.