viable technology for many delivery services and companies. However, despite its many advantages, one of the potential problems of using drones to deliver packages is its failure to deliver at a customer controlled address. In a typical urban residential/commercial area, any two customers can have desired delivery locations very close to each other. In certain situations, a specific desired receiving area maybe adjacent to other potential receiving areas, perhaps separated by less than a meter, and drones or other autonomous vehicles may fail to deliver packages accurately at such delivery addresses. The problem with the present day Global Positioning System (GPS) based drone delivery system is that commercially used GPS systems can neither offer the high degree of accuracy that would be required for precise landing of a drone at a delivery address, nor does it provide differentiation between parties at the same address, nor does it provide feedback to the deliverer. Likewise the current coordinate-based delivery systems cannot account for safety and obstruction issues. Even in an area that is easily located via GPS there may be preferred areas within that address that should be avoided for safety or obstacle reasons, such as a children's play area or telephone wires.

[0007] On the other hand, the high accuracy navigation systems are very expensive, consume a lot of power and size and, thus, are a hurdle in implementing those systems in commercial utilization of autonomous package delivery system. There are available some other systems and methods for autonomous delivery vehicle navigation which do not require very high initial investment. But such systems need electric power and proper maintenance. For example, some landing zone indicators use electric lights to indicate their location. These indicators consume high amount of electricity and are often accompanied by dedicated generators. Hence, this won't be appropriate for a consumer who does not want to actively maintain his landing zone, or supply it with power. Some landing zone indicators use lasers which also consume much power. This also won't be appropriate for consumers who do not want to actively maintain their landing zone, or supply it with power.

[0008] Many delivery services will soon begin adopting the new form of delivery; that is, delivery through autonomous vehicles. But, to revolutionize the autonomous delivery service, it is imperative that the proper infrastructure is developed which enables successful implementation of drone delivery or delivery by other autonomous vehicles. What is needed is a system and method for delivering payloads to a specific location with high accuracy through an inexpensive and easy to use navigation system.

FEATURES OF THE INVENTION

[0009] Embodiments of the present invention provide a system and method for high accuracy delivery of payloads at desired locations by autonomous delivery vehicles through inexpensive and easy to implement navigation system.

[0010] Embodiments of the present invention provide a system and method for delivering payloads to a specific location with high accuracy by cooperation between the payload delivery system and the delivery location.

[0011] Embodiments of the present invention provide a system and method for delivering payloads at a landing zone wherein the landing zone require no power to announce its position.

[0012] Embodiments of the present invention provide a system and method for precise delivery of payloads at a target landing zone wherein the target landing zone requires no maintenance.

[0013] Embodiments of the present invention provide a central database to store GPS location, unique identity of landing zone and unique user code for facilitating fast and easy communication of information for precise delivery of payloads to a specific location.

[0014] Embodiments of the present invention provide a system and method for delivering payloads to a specific location which works for several types of delivery vehicles like drones and other autonomous vehicles.

[0015] Embodiments of the present invention provide a system and method for precise delivery of payloads at a target landing zone as desired by a customer among a plurality of landing zones associated with other customers and located in close proximity to the target landing zone.

[0016] Embodiments of the present invention provide a feedback system and method for confirming delivery of a payload at a desired location by an autonomous delivery vehicle.

[0017] Details of the foregoing aspects of the invention, as well as additional aspects, features and advantages of the invention will become apparent to those skilled in the art upon consideration of the following detailed description of the preferred embodiments exemplifying the best mode of carrying out the invention as presently perceived.

BRIEF SUMMARY OF THE INVENTION

[0018] The following presents a simplified summary in order to provide a basic understanding of some aspects of the disclosed invention. This summary is not an extensive overview, and it is not intended to identify key/critical elements or to delineate the scope thereof. Its sole purpose is to present some concepts in a simplified form as a prelude to the more detailed description that is presented later.

[0018a] Disclosed herein is an autonomous delivery vehicle for delivery of a payload, the autonomous delivery vehicle including: a navigator configured to: receive, from a remote system, unique identifier information that includes a unique identity of a unique identifier and geophysical location information of a delivery location for delivery of the payload, wherein the unique identifier is located at the delivery location, and wherein the unique identifier is a machine readable code recognizable in any frequency that lies within a visible frequency range, an infrared frequency range, or an ultra violet frequency range of an electromagnetic spectrum, wherein the unique identity of the unique identifier has been captured via a camera of a mobile device; and navigate, based on the geophysical location information of the delivery location, the autonomous delivery vehicle to the delivery location; and a scanner configured to: scan the delivery location to locate the unique identifier based on the unique identity of the unique identifier; and in response to locating the unique identifier, provide one or more signals to cause the autonomous delivery vehicle to navigate to the unique identifier for delivery of the payload.

[0018b] According to a first aspect of the present invention, there is provided a method for delivery of a payload by an autonomous delivery vehicle, the method including: receiving, by the autonomous delivery vehicle, unique identifier information that includes a unique identity of a unique identifier and geophysical location information of a delivery location for delivery of the payload, wherein the payload comprises an article, wherein the unique identifier is located at the delivery location, ~~and~~ wherein the unique identifier is a machine readable code recognizable in any frequency that lies within a visible frequency range, an infrared frequency range, or an ultra violet frequency range of an electromagnetic spectrum, ~~and~~ wherein a mobile computing device associated with a user captures the unique identity of the unique identifier ~~is captured~~ via a camera of ~~a~~ the mobile computing device ~~associated with a user, the identity of the unique identifier~~ and generates the geophysical location information ~~being captured by the mobile computing device while the mobile computing device and~~ of the unique identifier, wherein the geophysical location information of the unique identifier ~~are located at~~ identifies a landing zone for the autonomous delivery vehicle, and wherein the unique identity and geophysical location information of the unique identifier is sent, by the mobile computing device, to one or more systems remote from the mobile computing device; navigating, by the autonomous delivery vehicle and based on the geophysical location information, the autonomous delivery vehicle to the delivery location of the unique identifier; scanning, by the autonomous delivery vehicle, the delivery location to locate the unique identifier based on the unique identity of the unique identifier; and in response to locating the unique identifier, causing, by the autonomous delivery vehicle, the autonomous delivery vehicle to navigate to the unique identifier for delivery of the payload.

[0018c] According to a second aspect of the present invention, there is provided a system for delivery of a payload by an autonomous delivery vehicle, the system configured to: obtain unique identifier information that includes a unique identity of a unique identifier and geophysical location information of a delivery location for delivery of the payload, wherein the unique identifier is located at the delivery location, and wherein the unique identifier is a machine readable code recognizable in any frequency that lies within a visible frequency range, an infrared frequency range or an ultra violet frequency range of an electromagnetic spectrum wherein a mobile computing device associated with a user captures said unique identity of the unique identifier ~~is captured~~ via a camera of ~~a~~ the mobile computing device ~~associated with said user, the identity of the unique identifier~~ and generates the geophysical location information ~~being captured by the mobile computing device while the mobile computing device and~~ of the unique identifier, wherein the geophysical location information of the unique identifier ~~are located at~~ identifies a landing zone for the

autonomous delivery vehicle, and wherein the unique identity and geophysical location information of the unique identifier was sent, via the mobile computing device, to the system; and provide, to the autonomous delivery vehicle, the unique identifier information, wherein the autonomous delivery vehicle is configured to: navigate to the delivery location based on the geophysical location information of the delivery location, scan the delivery location to locate the unique identifier based on the unique identity of the unique identifier, and in response to locating the unique identifier, cause the autonomous delivery vehicle to navigate to the unique identifier for delivery of the payload.

[0018d] According to a third aspect of the present invention, there is provided a system for delivery of a payload by an autonomous delivery vehicle, the system comprising at least one processor configured to: obtain unique identifier information that includes a unique identity of a unique identifier and geophysical location information of a delivery location for delivery of the payload, wherein the unique identifier is located at the delivery location, wherein the unique identifier is a machine readable code recognizable in any frequency that lies within a visible frequency range, an infrared frequency range or an ultra violet frequency range of an electromagnetic spectrum, wherein a mobile computing device associated with a user captures the unique identifier ~~is captured by a user~~ via a camera of the mobile computing device ~~of a user~~ and generates the geophysical location information of the unique identifier via a geospatial location sensor of the mobile computing device, wherein the geophysical location information of the unique identifier identify a landing zone for the autonomous delivery vehicle, and wherein the unique identity and geophysical location information of the unique identifier is sent, by the mobile computing device, to a precise delivery system server remote from the mobile computing device, and wherein the unique identifier information is associated with a user code and the unique identifier information is stored associated with the user code in ~~a~~ the precise delivery system server and wherein the unique identifier information is retrieved by the system from the precise delivery system server by using the user code; and provide, to the autonomous delivery vehicle, the unique identifier information, wherein the autonomous delivery vehicle is configured to: navigate to the delivery location based on the geophysical location information of the delivery location, scan the delivery location to locate the unique identifier based on the unique identity of the unique identifier, and in response to locating the unique identifier, cause the autonomous delivery vehicle to navigate to the unique identifier for delivery of the payload.

[0019] Embodiments of the present invention are directed to a system and method for safe and effective delivery of a payload at a precise location by autonomous delivery vehicles. A machine-readable unique identifier, such as a barcode, optionally affixed to a substrate is laid at a place (e.g., top of a building or backyard, driveway or any other place where an autonomous vehicle can deliver) where a user wants delivery of a consignment. In the most basic embodiment the recipient prints out a unique barcode for display at the landing zone. In another embodiment, the user (recipient) can print out a unique identifier on a common home computer printer and then download and install a mobile app, hereinafter referred to as precise delivery app, on a mobile computing device such as a smartphone from a precise delivery system server through a network. Once the unique identifier is placed, the user can open the precise delivery app, activate the smartphone camera or scanner and, standing near the unique identifier, scan the unique identifier. The precise delivery app reads the unique identity of the unique identifier and also collects the GPS location or geophysical location of the smartphone or the location where the unique identifier is placed. The GPS location of the smartphone or the geophysical location of the user determined delivery address can be considered as the approximate location of the unique identifier. The unique identifier information, which includes the unique identity of the unique identifier and the geophysical location of the unique identifier, can be sent to the precise delivery system server where this information gets stored. In some embodiments, for each user registered with the precise delivery system server, the precise delivery system server generates a user code and the unique identifier information is stored associated with this user code corresponding to each user ID or user code. In another embodiment the unique identifier is pre-associated with data referring to the contents of the delivery which the drone or drone controller checks for accuracy prior to final release of the payload.

[0020] If the user needs delivery of an item from a third party at the place where he/she has positioned the unique identifier, he/she can send the unique identifier information to the third party system directly or the user can send only his/her user code to the third party system and the third party system will be able to retrieve the unique identifier information from the precise delivery system server based on the user code. The third party system can feed the unique identifier information of the target unique identifier; that is, the unique identifier where the user is requesting delivery of a payload by an autonomous delivery vehicle. In accordance with an embodiment of the present invention the autonomous delivery vehicle

includes a navigation system comprising a first prior art navigator and a second scanner navigator. The autonomous vehicle, carrying a payload, determines its route to the approximate location of the target unique identifier with the help of the first prior art navigator. Once the autonomous delivery vehicle reaches the approximate geophysical location of the target unique identifier, the second scanner navigator scans each and every unique identifier that may be present around that location to locate the unique identifier that matches the unique identifier of the target unique identifier as fed by the third party to the autonomous delivery vehicle. If the autonomous delivery vehicle succeeds in locating the target unique identifier the second scanner navigator system, optionally in coordination with the first prior art system, guides the autonomous delivery vehicle to the target unique identifier where the delivery of the payload can be made.

[0021] The system and method as per embodiments of the present invention offers an inexpensive solution for a highly accurate autonomous delivery of a payload at locations desired by a user and the system and method can be adopted for implementation at a large scale commercial use.

[0022] To the accomplishment of the foregoing and related ends, certain illustrative aspects of the disclosed invention are described herein in connection with the following description and the annexed drawings. These aspects are indicative, however, of but a few of the various ways in which the principles disclosed herein can be employed and is intended to include all such aspects and their equivalents. Other advantages and novel features will become apparent from the following detailed description when considered in conjunction with the drawings.

Brief Description of Drawings

[0023] In order to describe the manner in which features and other aspects of the present disclosure can be obtained, a more particular description of certain subject matter will be rendered by reference to specific embodiments that are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments and are not therefore to be considered to be limiting in scope, nor drawn to scale for all embodiments, various embodiments will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

FIG.1

[0024] FIG.1 illustrates a unique identifier in accordance with an embodiment of the present invention;

FIG.2

[0025] FIG.2 illustrates a unique identifier placed on the roof of an apartment building in accordance with an embodiment of the present invention;

FIG.3

[0026] FIG. 3 illustrates a general architecture of a cooperative system for precise autonomous delivery that operates in accordance with an embodiment of the present invention;

FIG.4

[0027] FIG. 4 illustrates an autonomous delivery vehicle approaching a cluster of residential buildings carrying a payload based on prior art navigation methods;

FIG.5

[0028] FIG. 5 illustrates an autonomous delivery vehicle electronically scanning and searching for the unique identifier for precise landing in accordance with an em-

CLAIMS

1. A method for delivery of a payload by an autonomous delivery vehicle, the method comprising:

receiving, by the autonomous delivery vehicle, unique identifier information that includes a unique identity of a unique identifier and geophysical location information of a delivery location for delivery of the payload, wherein the payload comprises an article bought by a user,

wherein the unique identifier is located at the delivery location, ~~and~~

~~———~~wherein the unique identifier is a machine readable code recognizable in any frequency that lies within a visible frequency range, an infrared frequency range, or an ultra violet frequency range of an electromagnetic spectrum, ~~and~~ wherein a mobile computing device associated with a user captures the unique identity of the unique identifier ~~is captured~~ via a camera of ~~a~~ the mobile computing device ~~associated with a user, the identity of the unique identifier~~ and generates the geophysical location information ~~being captured by~~ of the unique identifier ~~the mobile computing device while the mobile computing device and~~ , wherein the geophysical location information of the unique identifier ~~are located at~~ identifies a landing zone for the autonomous delivery vehicle, and wherein the unique identity and geophysical location information of the unique identifier is sent, by the mobile computing device, to one or more systems remote from the mobile computing device;

navigating, by the autonomous delivery vehicle and based on the geophysical location information, the autonomous delivery vehicle to the delivery location of the unique identifier;

scanning, by the autonomous delivery vehicle, the delivery location to locate the unique identifier based on the unique identity of the unique identifier; and

in response to locating the unique identifier, causing, by the autonomous delivery vehicle, the autonomous delivery vehicle to navigate to the unique identifier for delivery of the payload.

2. The method as in claim 1, wherein the scanning is performed via a scanner that includes an optical scanner, an ultra violet scanner, a vibration scanner, a radio frequency scanner, and/or an infrared scanner.

3. The method as in claim 1, wherein the unique identifier information is provided to the autonomous delivery vehicle by the one or more ~~of the~~ systems remote from the mobile computing device.

4. The method as in claim 1, wherein the geophysical location information has been obtained via a geospatial location sensor of the mobile computing device.

5. The method as in claim 1, wherein the unique identifier information further comprises data related to contents of the payload.

6. The method as in claim 1, wherein the unique identifier is generated in electronic form by the one or more systems remote from the mobile computing device, ~~system~~ and the unique identifier is sent in electronic form to a computing device associated with the user.

7. The method as in claim 1, further comprising:

obtaining, by the autonomous delivery vehicle, an acknowledgement of a successful delivery of the payload.

8. The method as in claim 7, wherein the acknowledgement is an electronic code.

9. The method as in claim 7, wherein the acknowledgement is a physical receipt provided at the delivery location.

10. A system for delivery of a payload by an autonomous delivery vehicle, the system configured to:

obtain, based at least in part on a user code for a user associated with the payload, unique identifier information that includes a unique identity of a unique identifier and geophysical location information of a delivery location for delivery of the payload,

wherein the unique identifier is located at the delivery location, and

wherein the unique identifier is a machine readable code recognizable in any frequency that lies within a visible frequency range, an infrared frequency range or an ultra violet frequency range of an electromagnetic spectrum,

wherein a mobile computing device associated with a user captures said unique identity of the unique identifier ~~is captured~~ via a camera of ~~a~~ the mobile computing device ~~associated with said user, the identity of the unique identifier~~ and generates the geophysical location information ~~being captured by~~ of the unique identifier ~~the mobile computing device while the mobile computing device and~~, wherein the geophysical location information of the unique identifier ~~are located at~~ identifies a landing zone for the autonomous delivery vehicle, and wherein the unique identity and geophysical location information of the unique identifier is sent, via the mobile computing device, to the system; and

provide, to the autonomous delivery vehicle, the unique identifier information,

wherein the autonomous delivery vehicle is configured to:

navigate to the delivery location based on the geophysical location information of the delivery location,

scan the delivery location to locate the unique identifier based on the unique identity of the unique identifier, and

in response to locating the unique identifier, cause the autonomous delivery vehicle to navigate to the unique identifier for delivery of the payload.

11. The system as in claim 10, wherein the mobile computing device is connected with a detachable electronic device configured to add additional capability of scanning and transmission to the mobile computing device.

12. The system of claim 10, wherein an article in the payload is bought by the user via a user interface displayed via a display device of a computing device.

13. The system of claim 12, wherein the computing device is the mobile computing device and the user interface is associated with a mobile application running on the mobile computing device.

14. The system of claim 13, wherein the geophysical location information is ~~obtained~~ generated via a geospatial location sensor of the mobile computing device accessed by the mobile application.

15. The system of claim 10, wherein the geophysical location information is associated with an address of the user.

16. The system of claim 10, wherein the unique identifier information is stored associated with the user code in a server.

17. The system of claim ~~10~~ 16, wherein the system is configured to obtain the unique identifier information from the server based on the user code.

18. The system of claim 10, wherein the unique identifier is attached to a substrate.

19. A system for delivery of a payload by an autonomous delivery vehicle, the system comprising at least one processor configured to:

obtain unique identifier information that includes a unique identity of a unique identifier and geophysical location information of a delivery location for delivery of the payload,

wherein the unique identifier is located at the delivery location,

wherein the unique identifier is a machine readable code recognizable in any frequency that lies within a visible frequency range, an infrared frequency range or an ultra violet frequency range of an electromagnetic spectrum, wherein a mobile computing device associated with a user captures the unique identifier ~~is captured by a user~~ via a camera of the mobile computing device ~~of a user~~ and generates the geophysical location information of the unique identifier via a geospatial location sensor of the mobile computing device, wherein the geophysical location information of the unique identifier identify a landing zone for the autonomous delivery vehicle, and wherein the unique identity and geophysical location information of the unique identifier is sent, by the mobile computing device, to a precise delivery system server remote from the mobile computing device, and

wherein the unique identifier information is associated with a user code and the unique identifier information is stored associated with the user code in ~~a~~ the precise delivery system server and wherein the unique identifier information is retrieved by the system from the precise delivery system server by using the user code; and

provide, to the autonomous delivery vehicle, the unique identifier information, wherein the autonomous delivery vehicle is configured to:

navigate to the delivery location based on the geophysical location information of the delivery location,

scan the delivery location to locate the unique identifier based on the unique identity of the unique identifier, and

in response to locating the unique identifier, cause the autonomous delivery vehicle to navigate to the unique identifier for delivery of the payload.