Title: AUTONOMOUS GROUND STATION INTERFACING AERIAL DELIVERY

Abstract: To provide an autonomous ground station (20) for interfacing aerial delivery, which handles autonomously the reception of a smart parcel box (21) from a drone (22), then delivering each content in each sub-parcel to a specific person, and returning back the empty smart parcels to the drone (22). The station (20) is made of many empty coupled in-out columns (30) opened to receive boxes (21) from drones to move inside the machine (20), wherein each box (21) is made of cells (24), containing sub-parcels, to be delivered via a mini-gate (25), that is actuated after entering the sub-parcel code to the machine (20) via a data entry system (38). The boxes are moved through the station (20) from the inlet downward under gravity, and then depending on hydraulically piston supported plates (40), (41) it is pushed to the exit column (32), and then out to be collected via the drone (22).
AUTONOMOUS GROUND STATION INTERFACING AERIAL DELIVERY

Description of the Invention

Technical Field of Invention

This invention relates to a postal station, delivering parcels received from unmanned aerial vehicles (drones).

Background Art

Unmanned aerial vehicles, which are also called pilotless aircraft or remote piloted vehicles, are finding their way to markets recently, and in the near future, in numerous commercial and civil uses.

One of the recent required demands from drones to do, is the parcels delivery: gifts, books, governmental documents, and this may be expanded to personal or other commercial types of parcels delivery, linked to shipment express services, provided by DHL, ARAMEX, TNT...etc.

Even to make a drone carry a suitable size parcel is very obvious for a low skills person, and even to create a compartment in a drone for a document, to be carried and delivered to another reception destination, according to a pre-programmed rout (path) is also obvious for a person skilled or non skilled in the art, but the way how to deliver the parcel is the issue.

Up to date, all the delivery and handling proposed procedures are simple and manual, and actually unpractical, the followings are part of the unlimited reasons:

1- The person to whom the parcel should be delivered, should be a vailable at the delivery location on time.

2- No indoor delivery, so the person should wait out under any .whether conditions.

3- Each drone should be provided with a special code recognition device, and a mechanism to unlock the parcel from the drone.

4- The drone should land on the ground, normally inside a yard front of a villa, or house, but not inside an office, or a flat in a tower where most people live, or over any delivery station, because personal delivery by hand limit the delivery to be only at the ground.
5- The programmed route of the drone can not guess if the landing location is safe, e.g: already occupied by a vehicle, or a vehicle reversing toward it, or a fountain spraying water on it, or a child, boy, dog, or a nosy person intends to interfere.

6- As the drone has a limited waiting time for delivery, then any delay from a person who should receive the shipment for any normal reason, means the shipment is not delivered, and penalties should be paid by him, instead of getting a cutting-edge service.

So, the only solution is to deliver these parcels to a delivery station, where a drone can carry and handle a set of parcels, in one box, and deliver it to that secure, and safe station, which has a known location, and a known landing area away from the ground, while the station offers a waiting time for delivery, which can reach 7-10 days. Such a station can be established inside a compound, complex, mall, governmental body, or any public nearby place.. etc.

The prior art is not showing any postal station handling parcels delivered to it through a drone, but it is showing that Packstations are well-known to be used in Germany, more than any other country.

These stations are providing automated booths for self-service collection of parcels and oversize letters as well as dispatch of parcels 24 hours a day, seven says a week. A person, not a drone, opens the gates of the boxes, and keep the parcel inside, the receiver is notified via email or SMS, then the receiver Via a magnetic stripe card and PIN to be entered to the machine, to specify and unlock the gate, he can get to his parcel.

In the prior art, general relevance patents can be found, such as: a Separate Packstation disclosed under German Patent No.: DE102006025617A1. Storage, in particular picking storage and storage management system, and method for operating the same, disclosed under Patent No.: EP2639186A2.

Patent No.: US 20140032034 A1, disclosed under the title: Transportation using network of unmanned aerial vehicles, is disclosing the use of a ground station to provide navigational aids that help the delivery vehicles locate the position of the ground station with increased accuracy, but still it is not disclosing at all how a ground station can receive, deliver, or return the shipment.
Disclosure of Invention

Brief Description

To provide an autonomous ground station for interfacing aerial delivery, which handles autonomously the reception of the smart boxes inclosing the parcels from a drone, delivery of each content in each sub-parcel to a specific person, and returning back the empty smart parcels to the drone.

Smart parcel box reception: The station is made of many empty columns opened from the top, facing a ceiling, for each agency, two columns are specified, a drone deliver the box to inside the first column, which has an opening fitting the size of the box with a clearance, and inner side walls having four rails (grooved tracks) so that the box is guided down through them, but with a slow speed, due to the half-braked side wheels installed on the box sides.

Sub-parcel delivery: as each box is made of sub-cells, wherein inside each sub-cell a sub-parcel for a specific person is located, then while the box is moving down, the autonomous station can scan a fluorescent code printed on the side of each smart box, such that when a person comes for picking up his sub-parcel, then after entering its code, the machine can locate the location of the box, the sub-parcel, and the mini-gate (sub-gate) facing it, then it unlock that mini-gate, and indicate conventionally where to collect the sub-parcel.

Box return: beside each box inlet (reception) column, there is a return (outlet) column, wherein the inlet column is open from down side to the outlet column. Once a box is sensed to reach the bottom of the inlet column, a hydraulically piston supported side-plate pushes the box toward the outlet column, then once the box is sensed there, another hydraulically piston supported bottom-plate pushes the box up, such that each time a box gets to there, it is pushed up, with the boxes over it, until the top box reaches the top opening of the outlet column, where it is picked up and returned by the drone.

Note that while looping inside both columns, the station keeps tracking the box through variable compartments, such that where ever it is, it can indicate for the receiver the location of his sub-parcel.
Brief Description of the Drawings:

- FIG. 1: Illustrates a 3-D view for the box of parcels.
- FIG. 2: Illustrates a 3-D view for the carrier-casing enclosing the box of parcels in steps.
- FIG. 3: Illustrates a 3-D view for the parcels box wheels engagement with the guide rail of the carrier casing.
- FIG. 4: Illustrates a 3-D view for the parcels box fully enclosed in the carrier-casing.
- FIG. 5: Illustrates a 3-D lower side view for the parcels box, while carried by the drone, and enclosed by the carrier casing.
- FIG. 6: Illustrates a 3-D view for the autonomous station.
- FIG. 7: Illustrates a closer 3-D view for the autonomous station with the PIN code data entry screen.
- FIG. 8: Illustrates a 3-D view for the parcel box inside a column of the autonomous station, with the one way locks illustrated.
- FIG. 9 (A- I): Illustrates a 3-D view for the parcel box movement in-between being handled to the inlet opening, crossing the delivery gates down, then up to the outlet opening, to be picked up (returned).
- FIG. 10: Illustrates a 3-D view for another embodiment for the same autonomous station, but depending on horizontal motorized belts for moving the parcel box instead of gravity and hydraulic force.

Detailed description for carrying out the Invention:

Best Mode for Carrying out the Invention:

In order to make it easy to carry out the invention, a detailed description of the parts of the invention, supported with figures, is provided here, wherein the main parts are arranged sequentially, according to the importance of the part, it is made easy to read, by referring to each feature, with a number included in the
parts description text, and in the parts numbering list, the numbering of parts features is indicated here, by starting it sequentially from number 20, whenever a part feature appears in a text, it will be directly assigned its required serial number.

As the autonomous ground station 20 is interfacing aerial delivery, the areal delivery operation should be described here first in brief, before describing in detail how to carry out the invention of the autonomous station 20.

1- The parcel box (FIG.s 1-5): For a parcel box 21 to be carried by a drone 22, and then handled to an autonomous station 20, it should be modified such that it adapts to the autonomous station 20 as well as to the drone 22, which means if the parcel box 21 is to be entered from the top of the autonomous station 20 to glide down, in one embodiment it should have a semi-braked wheels 23, to make it move down slowly.

From another side, for the parcel box 21, to carry many different e.g envelopes for different persons, it means it should be divided into cells 24, and as each cell 24 in this box 21 is containing a sub-parcel that should face a mini-gate 25 in the autonomous station 20, it means this parcel box 21, should have the side of its cells 24 that is facing the mini-gates 25 kept permanently open.

In total, a parcel box 21 which requires four side wheels 23, and an open side, to be carried by a drone 22, it should be enclosed in another carrier-casing 26 fixed to the bottom of the drone 22, such that this carrier-casing 26 is having its bottom side permanently open to pick or get the parcel box 21 inside it, from over a belt or a table, also this carrier casing 26 should have four vertical side grooves 27 with rails 28 facing the wheels 23, to let these wheels 23 of the parcel box 21 move on them, guiding the box 21 inside the carrier-casing 26, which locks via its arms 29 on the parcel box 21 depending on any conventional locking mechanism.

2- Autonomous ground station 20 (FIG.s 6, 7): The autonomous station 20 can be located indoor or outdoor, but with a protection for its top side from (rain, dust) depending permanently on a ceiling over it, and
conventionally automatic gates (not shown), opening only when a parcel box 21 is handled, or picked up.

The station is divided into many coupled columns 30, inlet column 31, outlet column 32, each column is opened from its top side for handling the parcel box 21 in for collection, or returning it out for pick up to be reused for new parcels shipment, so there is inlet (handling) opening 33, and outlet return opening 34.

The columns 30, 31 are hollow to let the parcel box 21 moves through it, the columns 30, 31 can be filled with parcel boxes 21. Each column 30, 31 has from the top to the bottom, is divided into many empty compartments 35, with no upper or lower barriers except at the bottom of the columns. Each column is also having a long its side vertically four grooves 36, inside which the four wheels 23 of the parcel box 21 moves (FIG. 8). Each compartment 35 is taking at least the size of the parcel box 21, and each compartment 35 is having a number of mini-gates 25 facing the user from outside, and from inside facing the cells 24 of the sub-parcels inside the parcel box 21, as the parcel box 21 is permanently open from the its side that is facing these mini-gates 25, it means each mini-gate 25 is facing always a cell 24 of a sub-parcel.

The autonomous machine 20 is having at each point in each compartment 35 a scanner 37 (not shown), that scanner 37 is scanning a fluorescent code printed and sticked on the correct location on the box 21, such that this code sticker is facing a scanner 37 in each specific compartment 35, through this code, the scanner 37 can know to which address a sub-parcel inside a cell 24 inside a specific box 21, is referring.

When a person comes to collect his sub-parcel, he enters through the key board 38 the data of the code messaged or emailed to him, then the processors communicate with the memory of the machine 20, which allocates which compartment 35 is having the box 21 inside it, and which cell 24 is having the sub-parcel, and which mini-gate 25 should be unlocked to get the sub-parcel.
Note 1: a plate can be located in the far end inside each cell 24, such that this plate is moved forward by any electromagnetic force via a conventional mechanism, so that this plate pushes the sub-parcel a little out when the mini-gate is opened, to ease the collection of the sub-parcel.

Note 2: while entering documents to the parcel-box at the sender location (government, or courier hub..) a scanning system can be used just at the inlet of the parcel box 21, to come back for its data, if receivers complained from missing documents in a sub-parcel.

Note 3: Always while the parcel box 21 is moving from a compartment 35 to another, the new compartment 35 rescan the new box sticker code data, and updates instantly the memory of the machine 20 about the change in the location of the box.

3- Parcel box 21 delivery: a drone 22 following a programmed GPS route can get to a specific autonomous station 20, wherein as disclosed in the prior art, the station assists the drone 22 to approach over a specific opening via different laser beams from laser beams emitters 39 FIG. 9. A, then the following steps are followed to handle the parcel box 21:

a- As any inaccurate drop of the parcel box 21 over the opening, will not guarantee it will enter the column 31, then to be sure 100% the box 21 is dropped through the inlet opening 33 of the column 31, another set of four laser beams 39 are received at each corner of the drone 22 to adjust itself to the opening 33, depending on feed back data from distance sensors, tilt angle sensor, and inclination angle sensor.

Note: the laser beams 39 can be tactically of a larger cross sectional area when the drone 22 is many decimeters away from the opening, then as the drone 22 approaches the opening 33, the cross sectional area of the laser beams 39 decreases, such that the drone 22 gradually keep adjusting itself relative to the narrow beams 39, which finally set it correctly over the opening FIG. 9- B- C.

b- Parcel box 21 gliding down slowly toward the bottom of the inlet column 31 FIG. 9- D.
c- Parcel box 21 located at the bottom of the inlet column 31, there, a conventional load sensor, or infrared sensor can sense the availability of the box 21, wherein a hydraulically piston supported side-plate (HPS Side-plate) is activated to push the box 21 toward the bottom of the outlet column 32 FIG. 9- E, F.

d- Once the box 21 is sensed at the bottom of outlet column 32, using the same sensors, then another a hydraulically piston supported bottom-plate (HPS Bottom-plate) 41 pushes the box 21 up to the next upper compartment 35, where a conventional one way mechanical lock 42 (FIG. 9), prevents it from falling down after the HPS bottom-plate 41 is returned down FIG. 9- F, G. (Note: one hydraulic circuit 43, is controlled to operate each one of the HPS plates 40, 41).

e- each time a new box 21 gets down to the bottom of the inlet column 31, it is pushed to the bottom of the outlet column 32, then up, during this process, both columns 31, 32 will be filled with boxes 21, meanwhile the delivery of sub-parcels is taking place, even the boxes 21 are moving. Noting that always one of the bottom compartments 35 is empty, so that the box 21 can be moved in-between them. Once a box 21 is expelled out of the outlet opening 34, the drone 22 picks it up (supposed to be empty) and returns it back to the original source hub, to be filled again, and the cycle continues repeatedly FIG. 10- H- i.

4- It need to be assured here, that this disclosed autonomous ground station 20 which is depending on moving the box by gravity and hydraulic force, is one of the best embodiments of many simple obvious embodiment for the inventors of this invention. These embodiments can be designed based on this invention, wherein a drone 22 is delivering parcels from behind the autonomous station to a belt, that is distributing the parcels to boxes or to compartments which permanently opened from the belt side, wherein the distribution to inside the boxes or compartments can be via any conventional mechanism pushing or moving the parcels into the empty boxes or compartments, and may be retrieving them when empty.
It is also clear and obvious for the inventors that another embodiment for this invention illustrated in FIG. 10 for the same autonomous station 20, but depending on horizontally motorized belts 44 for moving the parcel box 21, instead of depending on gravity and hydraulic force, wherein built-in rows of belts 44, chains, or any conveyor receiving horizontally, vertically... drones 22 and parcels box 21 from e.g right inlet side 45 in the station 20, and moving the parcels box 21 to face delivery mini-gates 25, but while moving forward to the outlet or exit side (left) 46 of the station 20, within a week or ten days... time, where the drone 22 once again receive the empty boxes 21, noting that the machine (station) 20 through this period is having the capability to locate the sub-parcels, and main parcel facing a specific delivery mini-gates 25, in the same way mentioned before.

Note 1: the drones 22 themselves or the belt 44 can return to the machine 20, the boxes 21 that still have many parcels not picked up, but with paying extra charges for the delay.

Note 2: The mini-gates 25 can be replaced in other autonomous ground stations 20 by bigger ones, depending on the sizes of parcels, and type of station, so maybe there are small, medium, large size gates for each size of parcel.

Note 3: The inlet 45 and exit side 46 of the station 20 that is illustrated in FIG 11 cannot be accessed by individuals; it is normally either blocked from view.
Industrial applicability:

1- Autonomous ground station interfacing aerial delivery having its tools, and mechanisms, made from available tools, parts, mechanisms, with applicable modifications.

2- Multiple uses for multiple bodies: courier service, governmental departments... etc.

3- The fastest ever service of delivery by drones can be interfaced to make the delivery from the drones to the receivers practical, safe, secure, and time saving.

4- A compact station that can be located in many locations, providing easy to reach service.

5- A revolutionary development in postal service, taking the whole industry many steps forward.

6- Based on such a machine, many aspects and types of commercial handling, delivery, and return back can be carried out for different types and sizes of materials, parcels, documents, food...
Parts Drawing Index:

20  Autonomous ground station.
21  Parcels box.
22  Drone.
23  Half-braked wheels.
24  Cells.
25  Mini-gate.
26  Carrier-casing.
27  Side grooves.
28  Casing rails.
29  Locking arms.
30  Coupled columns.
31  inlet column.
32  Outlet column.
33  Inlet opening.
34  Outlet opening.
35  Compartment.
36  Vertical grooves.
37  Scanner.
38  Key board (Data entry system).
39  Laser beams emitters.
40  HPS Side-plate.
41  HPS Bottom plate.
42  One-way lock.
43  Hydraulic circuit.
44  Motorized belt.
45  Station inlet side.
46  Station outlet (exit) side.
Claims

1- An autonomous ground station interfacing aerial delivery (20), comprising:
   an autonomous ground station machine (20);
   a parcel box (21);
   a sets of coupled columns (30);
   an inlet column (31);
   an outlet column (32);
   an inlet opening (33);
   an outlet opening (34);
   a compartments (35);
   a motorized mini-gates (25);
   a scanners (37)
   a keyboard (38);
   a laser beams emitters (39);
   a HPS side-plate (40);
   a HPS bottom-plate (41);
   a one way locks (42);
   a hydraulic circuit (43);
   a motorized belt (44);
   a right side Inlet (45);
   a left side exit (46).

2- The autonomous ground station (20) according to claim 1, wherein the parcel box (21) is to be carried by a drone (22), and then handled to an autonomous station (20), such that it is modified to adapt and move slowly inside the station (20) depending on its half-braked wheels (23), and to adapt to the carrier-casing (26) of the drone (22).

3- The autonomous ground station (20) according to claim 1, wherein the parcel box (21) is divided into cells (24), such that each cell (24) in this box (21) is containing a sub-parcel that should face a mini-gate (25) in the autonomous station (20).

5- The autonomous ground station (20) according to claim 1, wherein the station (20) is divided into many coupled columns (30), each consisting of
inlet column (31), and outlet column (32), each column is opened from its top side for handling in the parcel box (21) for collection, or returning it out for pick up to be reused for new parcels shipment, so there is inlet (handling) opening (33), and outlet return opening (34).

6- The autonomous ground station (20) according to claim 1, wherein the columns (30), (31) are hollow to let the parcel box (21) moves through it, such that the columns (30), (31) can be filled with parcel boxes (21).

7- The autonomous ground station (20) according to claim 1, wherein each column (30), (31) is divided into many empty compartments (35), with no upper or lower barriers except at the bottom of the columns.

8- The autonomous ground station (20) according to claim 1, wherein each column (30), (31) is having a long its side a four vertical grooves (36), inside which the four wheels (23) of the parcel box (21) moves.

9- The autonomous ground station (20) according to claim 1, wherein each compartment (35) is taking at least the shape and size of the parcel box (21), and each compartment (35) is having a number of mini-gates (25) facing the user from outside, and from inside facing the cells (24) of the sub-parcels inside the parcel box (21), as the parcel box (21) is permanently open from the its side that is facing these mini-gates (25), it means each mini-gate (25) is facing always a cell (24) of a sub-parcel.

10- The autonomous ground station (20) according to claim 1, wherein each compartment (35) is having a scanner (37), to scan a fluorescent code printed and sticked on the correct location on the box (21), such that this code sticker is facing a scanner (37) in each specific compartment (35), by this code, the scanner (37) can know to which address a sub-parcel inside a cell (24) inside a specific box (21), is referring.

11- The autonomous ground station (20) according to claim 1, wherein the data entry key board (38) is transferring the data of the code entered, to the memory of the machine (20), which allocates which compartment (35) is having the box (21) inside it, and which cell (24) is having the sub-parcel, and which mini-gate (25) should be unlocked to get the sub-parcel.
12-The autonomous ground station (20) according to claim 1, wherein the laser beam emitters (39) emit beams to be received at each corner of the drone (22), such that it adjusts itself to the opening (33), (34), depending on feed back data from distance sensors, tilt angle sensor, and inclination angle sensor.

13-The autonomous ground station (20) according to claim 1, wherein the HPS side-plate (40) is activated by the hydraulic circuit (43) to push the parcel box (21) sideways toward the bottom of the outlet column (32), if it is sensed to be located in the lower compartment (35) of the inlet column (31), or that of the outlet column (32).

14-The autonomous ground station (20) according to claim 1, wherein the HPS bottom-plate (41) is activated by the hydraulic circuit (43) to push the parcel box (21) from the bottom compartment (35) at the bottom of column outlet (31) up to the next upper compartment (35), where a conventional one way mechanical lock (42) prevents it from falling down after the HPS bottom-plate (41) is returned down.

15-The autonomous ground station (20) according to claim 1, wherein the HPS plates (40), (41) keeps pushing parcel boxes (21) from inlet column (31) to outlet column (32) and then up, until a box (21) is expelled out of the outlet opening (34), the drone (22) picks it up (supposed to be empty) and returns it back to the original source hub, to be filled again, and the cycle continues repeatedly.

16- The autonomous ground station (20) according to claim 1, wherein the autonomous station (20) in another embodiment is depending on a horizontally motorized belts (44) for moving the parcel box (21), instead of depending on gravity and hydraulic force, wherein built-in rows of belts (44), chains, or any conveyor receiving horizontally, vertically... drones (22) and parcels box (21) from e.g right inlet side (45) of the station (20), and moving the parcels box (21) to face delivery mini-gates (25), but while moving forward to the outlet or exit side (left) (46) of the station 20, within a week or ten days... time.