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(54) UAV SYSTEM AND METHOD

UAV-SYSTEM UND VERFAHREN

SYSTÈME DE VÉHICULE AÉRIEN SANS PILOTE (UAV) ET PROCÉDÉ

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Description

FIELD OF THE INVENTION

[0001] This invention relates to systems employing UAV's and corresponding methods of operating UAV's, in particular relating to deployment of UAV's.

BACKGROUND OF THE INVENTION

[0002] Unmanned Air Vehicles (UAV) are well known and have many uses, which may include active surveillance or over-the-hill data gathering.

[0003] For example, by way of general background interest, the following publications disclose various UAV configurations:

EP 1884463 discloses a Micro Air-Vehicle (MAV) starting system that provides the combined functions of: packing protection of sensitive vehicle components, a mechanical starting assembly, and a launch pad. The disclosed preferred embodiment comprises a container and a container lid with the MAV clamped to the lid. Also disposed on the container lid is a starting assembly. The lid which doubles as a launching pad with the attached MAV is removed from the container, placed on the ground, the MAV is started with the starling mechanism and launched.

US 7,089,843 discloses a launcher including a plurality of launch tubes for stowing and launching a plurality of air vehicles. A central air manifold is operatively connected to an air storage tank; a first launch tube air manifold is operatively connected to a first group of the launch tubes and operatively connected to the central air manifold. The first launch tube air manifold has a separate port corresponding to each launch tube of the first group of launch tubes. A release valve mechanism is removably mounted in one of the ports of the first launch tube air manifold, the release valve mechanism controlling the passage of launch air between the first launch tube air manifold and the launch tube corresponding to the port in which the release valve mechanism is mounted. A plug is removably mounted in each of the ports not occupied by the release valve mechanism.

US 6,119,976 discloses a shoulder launched unmanned reconnaissance system for providing overhead visual surveillance of remote targets is disclosed. The system includes a reconnaissance air vehicle which may be fired from a portable launcher, accelerated to flight speed, and remotely controlled using a ground control system. The vehicle is flown to the target area to enable an onboard wide angle video system to transmit video images of the target to the ground control system for processing and display. The ground control system enables the reconnaissance vehicle to be flown to a recovery area and to descend in a stall mode after the flight is completed for maintenance prior to reuse. The air vehicle includes collapsible wings which are deployable after launch by a spring actuated mechanism.

US 2009/015460 A1 discloses a method for determining whether a target is of interest, wherein a radar system is used for developing a topographic map of the target area. The radar is then used for detecting and tracking targets which move through the target area.

WO 2008/085536 A2 discloses a system for reconnaissance comprising an unmanned airborne vehicle which is composed of a fixed wing airplane which is propelled by individual UAVs that are attached to the fixed wing. The fixed wing airplane serves as fuel tank for the individual UAVs.

[0004] Other known UAV systems include, for example, the "MAV" system by Aerovironment, and the "Train Cable UAV" by Planum Vision.

SUMMARY OF THE INVENTION

[0005] The invention is defined in the appended claims. According to the invention there is provided a method for guarding a perimeter, comprising:

(a) providing infiltration information of an actual or suspected infiltration at a location target zone associated with said perimeter by at least one infiltration agent;

(b) deploying at least one ready-to-launch UAV to said target zone responsive to receiving said infiltration information;

(c) operating said at least one UAV to search a target area around said target zone to thereby locate and home onto at least one said infiltration agent; and

(d) at least one of:

identifying nature of at least one said homed-onto infiltration agent or nature of said infiltration via said at least one UAV and providing data corresponding to said nature; and

tracking at least one said homed-onto infiltration agent via said at least one UAV and providing data corresponding to a location of said homed-onto infiltration agent to enable neutralization thereof.

[0006] Herein, "guarding" includes, *inter alia,* one or more of watching, sensing, detecting, data gathering, and so on relating to unwanted and/or unexpected and/or unauthorized and/or hostile and/or dangerous infiltration agents (human and/or non-human), as well as relating to such agents and/or one or more of defending, protecting against, preventing intrusion by, controlling a location with respect to, securing against, providing safety from, such agents.

[0007] For example, step (b) may comprise speed-

launching at least one ready-to-launch UAV in a trajectory or along any suitable flight path to said target zone responsive to receiving said infiltration information

[0008] The method according to invention includes the following features.

[0009] Wherein said at least one supplemental UAV may be speed launched in step (d) for supplementing said identification in step (I), and/or said tracking in step (II), or taking over said identification and/or said tracking, respectively, from said UAV previously launched in step (b).

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 schematically illustrates a system according to an embodiment of the invention.

Fig. 2 illustrates an embodiment of a UAV launcher.

Fig. 3 illustrates an embodiment of a UAV.

Fig. 4 illustrates another embodiment of a UAV launcher.

Fig. 5 schematically illustrates an application of the embodiment of Fig. 1.

Fig. 6 schematically illustrates another application of the embodiment of Fig. 1.

Fig. 7 schematically illustrates another application of the embodiment of Fig. 1.

Fig. 8 schematically illustrates a method according to an embodiment of the invention; **Fig. 8(a)** schematically illustrates a variation of the embodiment of Fig. 8.

DETAILED DESCRIPTION OF EMBODIMENTS

[0011] Referring to Figs. **1** to **3,** a multi-purpose UAV deployment system according to a first embodiment of the invention, generally designated **100,** comprises a control center **200** and a plurality of UAV launchers **300.**

[0012] Referring to Fig. **2,** each launcher **300** is configured for speed-launching at least one UAV **400** in an automated manner in response to receiving a control command signal to do so, and thus each launcher **300** is configured for operating unattended. In the embodiment illustrated in Fig. **2,** the launcher **300** is configured for speed-launching one or a plurality of UAV's and comprises a plurality of launch housings **310,** each launch housing **310** housing a UAV **400,** which in operation of the respective launch housing **400** is in a ready for launch mode (RFL mode). In alternative variations of this embodiment, at least one launcher is configured for speed-launching one UAV and comprises a respective launch housing. The launch housing **310** further comprises a suitable launching system (not shown) configured for imparting a forward momentum to the respective UAV **400** sufficient to enable the UAV to become airborne and subsequently be capable of maintaining flight under its own power after exiting the respective launch housing **310.** For example, the launching system may be configured for launching the respective UAV via any suitable pneumatic, hydraulic, pyrotechnic, elastic, mechanical or other arrangement.

[0013] In alternative variations of this embodiment, the launch housing **310** does not comprise any specific mechanism or arrangement to eject and push out the respective UAV **400** therefrom for launching the same. Rather, the UAV **400** is itself configured for exiting the launch housing **310** under its own power - for example the UAV may have VTOL, STOL or V/STOL capabilities, and/or may comprise auxiliary power packs (e.g. rocket assisted take-off systems).

[0014] The launcher **300** further comprises a suitable communication system **350,** comprising at least a receiver for receiving command signals transmitted by the control center **200.** In this embodiment, the communication system **350** also comprises a transmitter for transmitting signals at least to the control center **200.** Furthermore, the launcher **300** may comprise a control unit **390,** such as for example a microprocessor, for controlling operation thereof.

[0015] In this embodiment, the communication system **350** is wireless, for example operatively connected to the control center **200** wirelessly via a radio transmitter using any suitable radio band, either directly, or via a system of relay stations and/or via satellite connection. In alternative variations of this embodiment, communication system **350** may be cable-based, and is operatively connected to the control center **200** via a cable network, or is based on laser communication or fiber optics, or comprises a combination of different communications media, for example.

[0016] The launcher **300** in this embodiment comprises a pointing mechanism **360,** which is configured for enabling the azimuth and/or elevation of the respective launch housings **310** to be selectively controlled, thereby providing any desired or optimal launch direction **LD** for the launch housings **310.** Further, the launcher **300,** while in use is typically statically deployed at a fixed geographical location in this embodiment, is readily transportable to a different geographical location when desired, by means of trailer 370, which can be pulled by any suitable vehicle, for example. In alternative variations of this embodiment, at least one launcher **300** is permanently deployed at one geographical location in a fixed permanent installation, while in these or other alternative variations of this embodiment, at least one launcher **300** may be self-propelled, for example affixed on a carrier vehicle, which may be, for example, a land vehicle, a sea-faring vehicle, an amphibious vehicle, a hovercraft, etc. In alternative variations of this embodiment, at least one launcher **300** does not comprise a pointing mechanism, and is permanently pointing in one direction, at least relative to the launcher base.

[0017] The launcher **300** further comprises a GPS or any other suitable global positioning system, and furthermore the control unit **390** is configured for operating the communication system **350** to send a signal to the control center **200** advising the same of the geographical position of the respective launcher **300** according to its GPS location. Alternatively, the position of the respective launcher **300** may be determined manually, and relayed to the control center **200** by personnel such as for example the ground crew responsible for deploying the launcher **300.**

[0018] After deployment, the launcher **300** is configured for operating in an automated manner, without the need for any ground crew. A ground crew may be provided from time to time for repair, maintenance and refurbishment, but operation of the launcher **300** for launching the respective UAV's is generally automated and responsive to receiving suitable control signals to this effect from the control center **200.**

[0019] In these or other alternative variations of this embodiment, one launch housing may be used to launch multiple UAV's, which may be stored one behind another serially in the launch housing, or may be stored one above another in the launch housing, or may be loaded one at a time to the launch housing using a suitable loading mechanism. For example, referring to Fig. 4, at least one launcher according to a different embodiment, and designated with the reference numeral **300',** comprises one or more multiple launch housings **310'** mounted onto a pointing mechanism **360',** and also comprises control unit **390'** configured for operating the communication system **350'.** Each such multiple launch housing **310'** comprises a launch tube **320'** configured for speed launching a UAV, and a UAV magazine **370'** comprising a plurality of UAV's **400** in stacked arrangement, and configured for loading each UAV from the magazine **350'** in turn to the launch tube **320'** after the previous UAV has been launched.

[0020] Referring again to Fig. **1,** the control center **200** comprises a suitable command and control module **210** (CC Module), which in operation may be configured for processing intelligence data ID and deciding whether or not to launch one or more UAV's **400,** from one or more launchers **300,** and in which direction and towards which particular target zone. The CC Module **210** in operation is further configured for processing surveillance and other data provided by the launched one or more UAV's **400,** and for passing on such surveillance and other data and/or analysis thereof to another party. The control center **200** further comprises a suitable communication system **250,** comprising at least a transmitter for transmitting command signals to the launchers **300.** In this embodiment, the communication system **250** also comprises a receiver for receiving signals from at least the launchers **300.** Furthermore, the control center **200** comprises a controller **290,** such as for example a microprocessor, for controlling operation thereof.

[0021] In this embodiment, the communication system **250** is wireless, for example operatively connected to the launchers **300** wirelessly via a radio transmitter using any suitable radio band, either directly, or via a system of relay stations and/or via satellite connection. In alternative variations of this embodiment, communication system **250** may be cable-based, and is operatively connected to the launchers **300** via a cable network, or is based on laser communication, fiber optics or any other suitable means of communication, or comprises a combination of different communications media, for example.

[0022] The control center **200** is in operation further configured for receiving intelligence data **ID,** and may do so in one or more forms. In particular, such data **ID** may include a suspected location of a target that it is desired to identify and/or track. Such data may include human intelligence, for example observers **490** in the field may spot a suspected target **T** and radio or otherwise advise the control center **200** of the fact and location of the suspected target **T.**

[0023] Where the system **100** is used for guarding a perimeter against infiltration, wherein the target is an infiltrator, additionally or alternatively, breaches in the perimeter (e.g., a fence, wall, etc.) may be sensed optically and/or thermally and/or by sound and/or by touch/movement and/or electronically, and data indicative of the breach is suitably transmitted to the control center **200.** Additionally or alternatively, human intelligence data may include data of a possible infiltration at a particular time and/or place, and this data is suitably transmitted to the control center **200.**

[0024] Additionally or alternatively, the control center **200** may comprise a receiver for receiving satellite intelligence data from a satellite network **492,** for example satellite image data (visible spectrum, infra red, etc) of a particular target zone at a particular reference time, and this image data may be analyzed to provide such intelligence data to the control center **200.** Additionally or alternatively, the control center **200** comprises or is operatively connected to a suitable sensing module, for example any suitable SIGINT module for intercepting signals, optionally including at least one of an ELINT module and a COMINT module.

[0025] Additionally or alternatively, the control center **200** comprises a suitable detection system **270** (which may comprise, for example, a suitable radar system and/or a suitable ground based electro optic system) operatively connected thereto for detecting a target T within a particular radius of operation, around the control center **200** and/or around one or more additional zones, wherein a number of linked radar systems and/or ground based electro-optic systems may be provided for radar coverage thereof.

[0026] In this embodiment, the CC Module **210** is in the form of one or more human operators, skilled at receiving and analyzing the aforesaid intelligence data, and at deciding whether to launch one or more said UAV from one or more launchers. The controller **250** may assist the human controller by highlighting the closest launcher

available and ready for launch with respect to a particular target.

[0027] In alternative variations of this embodiment, the CC Module **210** may be fully automated and thus comprises a suitable computer system that is configured for initiating a launch of a UAV based on predetermined parameters.

[0028] In this embodiment, the control center **200** is at a geographically fixed, static location, at least during operation thereof. In alternative variations of this embodiment, the control center **200** may be comprised in a mobile platform - for example transported by means of a vehicle (e.g., carried by the vehicle or towed as a trailer by the vehicle), and the vehicle may be, for example, a land vehicle, a sea-faring vehicle, an amphibious vehicle, a hovercraft, etc, or for example carried by personnel - and the center **200** may be operated also when mobile.

[0029] Referring to Fig. **3,** each said UAV **400** is configured as a non-tethered vehicle in the form of a steerable airborne platform comprising at least one sensor system configured at least for enabling a target within the sensor's field of view FOV to be identified. In this embodiment, the sensor system comprises a suitable imaging system **410** configured for providing in real time a video stream in the visible spectrum, and may be further configured for providing corresponding infrared images and/or comprises enhanced night vision features. In alternative variations of this embodiment, the imaging system may additionally or alternatively comprise a Synthetic Aperture Radar (SAR) and/or any other suitable sensor system.

[0030] The imaging system **410** may comprise a suitable camera, preferably an electronic camera, preferably mounted to the UAV **400** via a stabilizing platform such as to compensate for vibration etc, and thus provide stable images to the control center **200** via communications module **420.** The UAV **400** comprises a suitable propulsion unit **430,** which may be electrically powered, or fuel powered, or a hybrid, for example, for providing powered flight and/or VTOL capability to the UAV. Preferably, the imaging system **410** comprises a pointing mechanism **412** which is configured for enabling the azimuth and elevation of the imaging system **410** to be selectively controlled, thereby providing any desired line of sight (LOS) for the imaging system within a defined field of regard FOR. Further, the imaging system may be configured for providing a variety of magnifications, and/or fields of view (FOV). Such imaging systems are well known in the art.

[0031] According to one aspect of the invention, the UAV **400** may be based on any suitable micro-UAV's, for example the "Mosquito" UAV, produced by Israel Aerospace Industries Ltd, Israel. According to another aspect of the invention, the UAV **400** may be based on any suitable mini-UAV's, for example the Birdeye family of UAV's, produced by Israel Aerospace Industries Ltd, Israel. According to another aspect of the invention, the UAV **400** may be based on any suitable larger UAV's, for example the I-View UAV's, produced by Israel Aerospace Industries Ltd, Israel.

[0032] The UAV **400** is configured for being automatically launched from its respective housing **310** when in the aforesaid RFL mode, in which the respective UAV **400** is fuelled and/or has sufficient electrical power to enable operation of the propulsion system and for powering the additional on-board systems, for example the imaging system **410** and communications module **420.** At least in this embodiment, each operative said launcher comprises at least one said UAV in RFL mode, and may have additional said UAV's in RFL mode, and/or is configured for placing more said UAV's in RFL mode in an automated manner.

[0033] Once launched, the UAV may be steered to the desired location in any number of ways. For example, the UAV may receive a particular flight plan to the target zone while still in the launcher housing prior to launch via a suitable communication, or may up-load the flight plan after launch via suitable data-link. Additionally or alternatively, the UAV may be pre-programmed with a plurality of flight plans, for example one each to particular predetermined target zones, and the desired flight plan is brought on-line in the UAV. Alternatively, the UAV is steered manually to the target zone via a UAV operator **205.**

[0034] In variations of this embodiment where the launched UAV **400** comprised a payload, for example the imaging system or other payload, the payload may be operated by means of a payload operator **206,** who optionally may also be the UAV operator **205.**

[0035] In this embodiment, the payload operator **206** and the UAV operator **205** are comprised in the control center **200,** and are located in the same location. In alternative variations of the embodiment, the payload operator **206,** and/or the UAV operator **205,** may be independent of the control center **200** and may be located at different geographical locations.

[0036] In this embodiment, the UAV **400** further comprises a suitable GPS or the like, and the communication module **420** is configured for transmitting the geographical location of the UAV **400** to the control center **200.** Furthermore, the communication module **420** may further transmit the direction of the LOS of imaging system **410** with respect to datum coordinate system UCS of the UAV, the UAV's direction and altitude, and the attitude of coordinate system UCS with respect to an Earth-based coordinate system ECS such as used by the GPS system, and may also further transmit data regarding the magnification of image and other optical parameters. With this data it is possible to then calculate the position and thus the geographical location (with respect to the aforesaid Earth-based coordinate system) of whatever object is in the field of view FOV of the imaging system **410.**

[0037] Furthermore, the communication module **420** is also configured for providing identification data for the respective UAV **400,** for example an IFF or IP code, so

that data received from each UAV by the control center **200** can be associated with its respective UAV **400.**

[0038] In one application of the first embodiment, and referring to Fig. **1,** the system **100** is configured for facilitating guarding of a particular perimeter, for example defending the perimeter against infiltration, and the plurality of launchers **300** (individually designated as **300a, 300b, 300c,** etc.) are deployed along the perimeter. For example such a perimeter may be a political border **900** between the host nation **910** on which the launchers are deployed and a neighboring nation or other geographical/geopolitical entity **930** which may be hostile or harbor hostile or undesirable elements with respect to the host nation **910.** Each launcher **300** has an associated radius of operation R, which can be understood to refer to a characteristic range of the respective UAV **400,** attained after a predetermined elapsed time t from launch from the respective launcher **300.** The elapsed time t may thus be regarded as a desired response time for the UAV to reach a particular location. In this embodiment, the various launchers **300** are spaced from one another and from the border such that each radius of operation R (individually designated as Ra, Rb, Rc, etc. respectively corresponding to the respective launchers **300a, 300b, 300c,** etc.) overlap with the border **900,** and also with respect to one another at least close to the border **900,** as illustrated in Fig. 5.

[0039] The control center **200** is also located in the host nation **910** (although in variations of this embodiment it may be elsewhere, for example airborne or at sea in neutral or international areas), but may be further distanced from the border **900,** for example for site security considerations, particularly if the border zone in the vicinity of the border **900** is hostile.

[0040] The border **900** may comprise a fence or wall **920,** comprising sensors **925** including proximity sensors and/or breaching sensors, respectively configured for sensing proximity of a foreign object (for example a body or vehicle) to the wall and for sensing breaches in the wall, and a communication module **930** for transmitting to the control center **200** sensor data indicative of such proximity or breach when such an event happens.

[0041] In this embodiment, all the launchers **300** are substantially similar to one another, at least in terms of the type of launching systems provided, and the type of UAV launched by each housing **310,** and may also be similar to one another in having the same number of launch housings **310** per launcher, though in alternative variations of this embodiment, each launcher may have a number of launch housings that may the same or different with respect to the other launchers **300.** In yet other variations of this embodiment, each launcher may be different from the other launchers, in terms of type of launching systems provided, and/or in terms of the type of UAV launched by each housing **310** of the launcher, and/or in terms of the number of launch housings **310** per launcher **300,** and so on. Accordingly, the radius of operation R associated with each launcher **300** may be different from one another between the different launchers **300.**

[0042] In this application of the first embodiment, a number of launchers **300** are in communication with the control center **200** via wireless transmitters 292, while other launchers **300** are in communication with the control center **200** via cables **295.**

[0043] In one method of operation of the system **100,** designated with reference numeral **800** and referring also to Fig. 8, in step **810** the control center **200** receives intelligence data of a possible incursion or infiltration of the border **900** at a particular target zone at location A, for example via sensors **925.** Alternatively, such data may originate from one or a combination of the following sources: human intelligence, electronic intelligence, satellite surveillance, etc. The CC Module **210** makes a command decision at **805** whether or not to investigate further, and in the affirmative, a command signal CS is sent out in step **820** to one or more launchers **300** for one or more UAV's to be launched. In the simplest implementation of step **820,** the command signal CS is for launching a single UAV from the launcher closest to the location A, or if the launchers **300** have different UAV capabilities to one another, the launcher having the shortest response time **T** to the location **A.** The particular UAV **400** is automatically launched by the respective launcher **300** responsive to receiving the command signal CS and the UAV is automatically flown (by computer control) or manually flown (by UAV operator **205)** to location A, with the respective imaging system **410** aboard the UAV **400** scanning the target area around the location **A** for signs of a candidate target such as an intruder.

[0044] When a candidate target has been acquired, e.g. detected digitally or in any other suitable manner and homed onto, the next step **830** is to identify the target, and this is followed by decision node **840** - whether this identified target warrants further tracking or not. For example if the target is a human infiltration agent, for example an intruder such as a potential terrorist, illegal alien, smuggler, thief, foreign troops, etc., for example, tracking of the target is continued, while if it turns out that the target is a border guard, a tourist, an animal etc., for example, or it may be decided that the target does not warrant further tracking. On the other hand, the target may be a non-human infiltration target, for example a dangerous animal (e.g., an animal suspected of carrying rabies or an infectious disease), or the target may be a non-human agent such as for example a non-authorized UAV or unmanned land or sea vehicle. In any case, if further tracking is required, then in step **850** the UAV maintains aerial surveillance of the target, in general by maintaining the target within the field of view FOV of the imaging system **410.**

[0045] Further tracking can be manually performed, for example by the UAV operator **205** controlling the UAV in cooperation with the payload (imaging system) operator **206** (which in at least some embodiment may be the same operator), typically at the control center **200** though the operator **206** may be stationed at a different location

and communicates with the UAV to control operation thereof via suitable communication means.

[0046] Alternatively, the tracking may be automated, for example by means of a suitable computerized system and/or an electro-optical auto tracking system.

[0047] The fact, details and other data of the target, including its location in real time, may be relayed by the control center to any desired party, for example ground forces such as border patrol, police etc. that are responsible for confronting and dealing with the target.

[0048] In step **860,** tracking may be terminated, for example when suitable ground forces such as border patrol, police etc. arrive at the location of the target, which has been continuously tracked and relayed to the ground forces via control center 200 by the UAV, and the ground forces may then deal with the target, for example by neutralizing or apprehending any potential threat. The ground forces may include one or more of personnel and vehicles (manned or unmanned), and/or air vehicles and/or sea vehicles as appropriate.

[0049] In step **870** the UAV is recovered. For example the UAV may be flown to a recovery site, where it is landed and refurbished, to be subsequently re-used in the original or a different launcher **300** when needed.

[0050] In a further optional step **855** prior to step **860,** another UAV **400** may be automatically launched from the same or a different launcher **300** in response to receiving a suitable command signal to take over or to assist tracking of the target. This may occur, for example, when the original UAV is damaged, or when the original UAV lacks sufficient fuel or electrical power to maintain tracking operation. In such cases, the operational status of the original UAV is monitored, and the next UAV is launched such that its response time T is less than the estimated time to failure of the original UAV. Thus, location data of the original UAV is used to guide the second UAV to the target and take over tracking, such that tracking and surveillance of the target is effectively continuous and uninterrupted.

[0051] In a variation of this method of operation, a number of UAV's may be launched sequentially or substantially concurrently in step **820.** This may provide multiple redundancy in tracking - for example if one UAV suddenly fails the other UAV's can still provide tracking data. Alternatively, it may turn out that what was initially considered to be a single target is in fact a group of targets that may potentially scatter in different directions, and thus the multiple UAV's may provide tracking of each separate target if there are sufficient targets launched (of course, once the target is identified in step **830** as comprising multiple targets, additional UAV's may be automatically launched and homed in to their location via the data provided by the first UAV. Alternatively, and depending on the terrain on which the target is located, it may be possible for the target to enter a structure having multiple exits, and the strategic solution for ensuring continuation of surveillance is to cover all the exits by providing a UAV to survey each such exit.

[0052] In another variation of step **820,** designated as step **820'** in Fig. 8(a), three UAV's (designated with reference numerals **400a, 400b, 400c)** are launched in response to the command signal **CS,** and is particularly useful where the exact location of the suspected target **T** is not known with certainty and/or where it is suspected or known that the suspected target **T** may move quickly from the last known location within the time taken for the nearest UAV to arrive at this location. In alternative variations of this embodiment, two UAV's or alternatively more than three UAV's may be launched in step **420'** instead of three. In such cases, a probability zone **PZ** may be defined around the last known location of the suspected target **T,** or centered around the area where the suspected target is general located. Thus, perimeter **P** is displaced by a dimension **S** from the center C of the probability zone **PZ** such that the perimeter **P** defines a threshold beyond which it is considered unlikely (within a predefined probability which may differ from case to case) that the suspected target will have traveled, even if traveling at a known, predicted or estimated maximum speed, irrespective of direction, in the time period between detection of the target and the arrival of at least one of the UAV's. While the shape of the probability zone **PZ** is illustrated as circular, it is not necessarily so, and the probability zone may take on any suitable shape, which may generally depend on the nature of the suspected target, its means of mobility, and the nature of the terrain.

[0053] In step **820'** the three UAV's are launched, each one to a different part of the probability zone **PZ.** For example: UAV **400a** and UAV **400b** are each directed to generally opposed extremities, target points **La** and **Lb** respectively, of the probability zone **PZ** at the perimeter **P,** while the third UAV **400c** is directed to a target point **Lc** at or near the center C of the zone. The three UAV's may be launched from the same launcher **300** or from different launchers **300,** optimally according to availability of UAV's in each launcher and according to satisfying the criteria of minimizing the response time of each UAV to its designated target point.

[0054] For example, **La** and **Lb** may lie along the generally direction that the target was observed to be traveling when detected. Alternatively, **La** and/or **Lb** and/or **Lc** may be locations in the probability zone **PZ** having relative high probability of finding the suspected target there. If the suspected target is located by one of the UAV's, steps **830** to **870** may be implemented with respect to this UAV, and the other two UAV's may be recovered as per step **870,** or at least one of these two UAV's may be used to provide multiple redundancy in tracking, as disclosed above, *mutatis mutandis.*

[0055] On the other hand, if by the time the three UAV's reach their target points **La, Lb, Lc** the suspected target is not located by any of the UAV's, step **825'** is then implemented, in which the probability zone PZ is split into three search zones **Za, Zb, Zc,** one zone for each UAV, and which each UAV **400a, 400b, 400c** implements a

search-and-locate mission **M** in its respective zone **Za, Zb, Zc** (Fig. 7). For example, each mission **M** may follow a zigzag path that eventually covers the full respective zone such that the zone comes under observation by the respective imaging system 410 of the respective UAV.

[0056] It is to be noted that the probability zone **PZ** is not necessarily of a static and fixed form. For example, if further intelligence data regarding the suspect target is received while the UAV's are on their way to the probability zone **PZ** or while they are carrying out their missions **M,** the shape and extent of each respective zone **Za, Zb, Zc** may be changed, as well as the number of zones searched and/or the form of the mission **M** changed. Additionally or alternatively, if the suspected target is not detected within a particular time, it may be necessary to expand and/or displace the probability zone **PZ** to account for the possibility that the suspected target may have traveled further and out of the probability zone **PZ.** One possible way to address the expanded probability zone **PZ** is by extending each mission **M** accordingly. Another way is to define a new search zone **Zx** between the original perimeter **P** of the probability zone **PZ** and the expanded perimeter **P'** of the expanded probability zone **PZ,** and to launch one or more additional UAV's to search this zone **Zx.** Of course, this process may be repeated as often as necessary, each time expanding the probability zone **PZ** as required.

[0057] In some cases, it is possible to concurrently have a number of groups of UAV's, each group operating with respect to a respective different probability zone. In such cases, it is also possible to transfer UAV's from one group to another according to specific needs or requirements. For example, it may be that a UAV of one group happens to be closer to a target zone of one particular probability zone than the original UAV that was dispatched to that zone. In another example, rather than launching a new UAV to a particular target zone it may be possible to divert a UAV, that was originally deployed for a different probability zone, to the aforesaid target zone.

[0058] In these or other applications of the system **100,** the respective UAV's **400** may at least in some cases be tactical, mini- or micro- UAV's and/or operated from high altitudes such as to minimize the probability of being detected in flight by the suspected target, and thus reduces the probability of the suspected target from taking evasive action to avoid detection or being tracked. Furthermore, such small-sized UAV's may be maneuvered through confined spaces, for example wooded areas and urban areas in a fast, slow or hovering flight, and in a controllable manner, at least in some cases with greater effectiveness, more safety and lower probability of detection than would be the case with manned air vehicles.

[0059] Additionally or alternatively, at least in some cases larger UAV's may be used where endurance may be required - for example where it is expected that the ground forces cannot arrive and take over for long periods.

[0060] In another application of the system **100,** one or a plurality of launchers **300** may be provided atop masts or rooftops in an urban zone. For example, a launcher **300** may be installed on a rooftop of a building housing a bank and/or of a nearby building or at any other strategic locations. In case of a robbery or attempted robbery, the launcher **300** automatically launches one or more UAV's which can then follow the getaway vehicle used by the criminals until a helicopter can take over surveillance and/or until the vehicle is apprehended. The command signal for activating the system **100** and launching the UAVs may be generated and transmitted, for example automatically on activation of the bank alarm system, or via a coded signal sent directly by lawenforcement agents in the area.

[0061] In another application of the system **100,** one or a plurality of launchers **300** may be additionally or alternatively provided atop vehicles, for example law enforcement vehicles or military vehicles, which may be moving such as on patrol. When required, a UAV from such a vehicle is launched responsive to receiving the command signal **CS** from the control center **200.**

[0062] In another application of the system **100,** one or a plurality of launchers **300** may optionally be provided atop vehicles, for example emergency and rescue forces vehicles (e.g., fire fighters, environmental agencies etc), which may be deployed to answer an emergency situation. When required, a UAV **400** from such a vehicle (and/or from static locations such as illustrated in Fig. 1, for example) may be launched responsive to receiving the command signal CS from the control center **200.** The launcher **300** may stay on the vehicle or may be removed and re-positioned for later usage. The UAV may include as payload, in addition to or instead of the image sensor, a contamination sensor configured for detecting and/or identifying toxic or otherwise dangerous chemical, biological, radiological or nuclear agents, and the UAV is operated to fly into a target zone that is suspected to include such agents. Such a target zone may be associated with a perimeter defining the site of an attack, or may be a building or complex that stores or processes such agents, and the target zone may include a body of such agents, for example smoke or a cloud of particulate matter, or precipitation or a mist, for example. The UAV then uses the contamination sensor to collect and identify any possible contaminants at the target zone, and to enable associated risks to be evaluated. Furthermore, the UAV may stay airborne and track the movement of the body of agents, until they are sufficiently dispersed as to be rendered harmless, or until other resources may be brought into play to deal with the contamination. Optionally, a plurality of UAV's may be launched to monitor and track the body of agents if this expands or moves in multiple directions at the same time.

[0063] Thus, in this application of system **100,** the suspected contamination agents operate as infiltration agents at the target zone.

[0064] In the method claims that follow, alphanumeric

characters and Roman numerals used to designate claim steps are provided for convenience only and do not imply any particular order of performing the steps.

[0065] Finally, it should be noted that the word "comprising" as used throughout the appended claims is to be interpreted to mean "including but not limited to".

[0066] The scope of protection of the present invention is defined **in** the appended claims.

Claims

1. A method for guarding a perimeter, comprising:

(a) providing infiltration information of an actual or suspected infiltration by at least one infiltration agent at a location of a target zone associated with said perimeter;
(b) deploying at least one ready-to-launch UAV (unmanned air vehicle) (400) to said target zone responsive to receiving said infiltration information;
(c) operating said at least one UAV (400) to search a target area around said target zone to thereby locate and home onto at least one said infiltration agent; and
(d) at least one of:

(I) identifying nature of at least one said homed-onto infiltration agent or nature of said infiltration via said at least one UAV (400) and providing data corresponding to said nature; and
(II) tracking at least one said homed-onto infiltration agent via said at least one UAV (400) and providing data corresponding to a location of said homed-onto infiltration agent to enable neutralization thereof,

wherein at least one supplemental said UAV (400) is speed launched in step (d) for supplementing said identification in step (I), and/or said tracking in step (II), or taking over said identification and/or said tracking, respectively, from said UAV (400) previously launched in step (b).

2. Method according to claim 1, wherein step (b) comprises one of:

(b1) providing at least one UAV launcher (300), the or each said UAV launcher (300) comprising at least one UAV (400) in ready-to-launch mode, the or each said UAV launcher (300) configured for enabling each respective UAV (400) to be speed launched responsive to receiving said infiltration information; or
(b2) providing a plurality of said UAV launchers (300), and, strategically deploying said UAV launchers (300) with respect to said perimeter in a manner allowing each said UAV (400) to reach a predetermined point on said perimeter within a predetermined time after launch.

3. Method according to any one of claims 1 to 2, wherein step (a) comprises obtaining infiltration information from at least one of the following sources: human intelligence; human surveillance of said perimeter; electronic intelligence; electronic surveillance of said perimeter; overhead imagery of said perimeter; perimeter breach sensors; radar data; electro-optical and/or infrared surveillance of said perimeter.

4. Method according to any one of claims 1 to 3, wherein in step (b) suitable command signals are generated corresponding to said infiltration information and transmitted to at least one said UAV launcher (300) whereby to activate thereby speed-launching of said at least one ready-to-launch UAV (400).

5. Method according to any one of claims 1 to 4, wherein said UAV (400) comprises a suitable sensor configured for providing image data or other sensor data within a field of view, and step (c) comprises remotely flying said UAV (400) to said target zone, receiving said image data or said other sensor data generated by said UAV (400) of the target zone, and identifying nature of said infiltration agent in step (I) from said image data or said other sensor data, and wherein optionally step (d) comprises maintaining said infiltration agent within said field of view of said sensor.

6. Method according to any one of claims 1 to 5, further comprising step (e), wherein step (e) comprises any one of:

- neutralization of said infiltration agent;
- neutralization of said infiltration agent comprising intercepting, apprehending or immobilizing said at least one infiltration agent by direct human intervention;
- neutralization of said infiltration agent comprising intercepting, apprehending or immobilizing said at least one infiltration agent by direct human intervention, wherein said direct human intervention comprises dispatching to said location one or more of: manned or unmanned ground forces, manned or unmanned airborne forces, and manned or unmanned seaborne forces.

7. Method according to any one of claims 1 to 6, wherein step (b) comprises speed-launching a plurality of said ready-to-launch UAV (400), each to a different respective start location in said target zone, responsive to receiving said infiltration information, and searching a respective portion of said target zone

for said infiltration agent, and wherein optionally including at least one of the following steps:

- wherein at least one of said plurality of said launched UAV's (400) is homed on said infiltration agent in step (c), and at least a first portion of a remainder of said launched UAV's (400) are recovered;
- wherein at least one of said plurality of said launched UAV's (400) is homed on said infiltration agent in step (c), and at least a second portion of a remainder of said launched UAV's (400) are maintained airborne for providing supplemental tracking.

8. Method according to any one of claims 1 to 7, wherein there are a plurality of infiltration agents, wherein step (b) comprises speed-launching a plurality of said ready-to-launch UAV (400), and in step (c) operating each said UAV (400) to home onto a different said infiltration agent.

9. Method according to any one of claims 1 to 8, wherein said data corresponding to said nature in step (d)(I) includes incriminating evidence relating to said nature of said infiltration agent or of said infiltration thereby, and wherein optionally said perimeter constitutes any one of a border between a host country being guarded and a geopolitical entity comprising said infiltration agents prior to said infiltration, or a building or structure; or comprises any one of a fence, wall or line circumscribing an installation; a group of buildings; a complex; a geographical zone.

10. Method according to any one of claims 1 to 9, wherein at least one said ready-to-launch UAV's (400) is configured structurally and/or operatively to minimize detection thereof by said infiltration agents.

11. Method according to any one of claims 1 to 10, wherein said infiltration agent is one of:

- a human agent, wherein said human agent is optionally taken from the group including: terrorist, illegal alien, smuggler, thief, foreign troops.
- a non-human agent, wherein said non-human agent is optionally taken from the group of: non-authorized UAV (400), unmanned land vehicle, unmanned sea vehicle, and a contamination agent, optionally taken from the group including: toxic, chemical, biological, radiological or nuclear agents.

12. Method according to any one of claims 1 to 11, wherein said infiltration information is indicative of a breach of said perimeter.

13. System for guarding a perimeter, comprising:

(a) control center (200) configured for generating a control signal responsive to receiving infiltration information of an actual or suspected infiltration at a location of a target zone associated with said perimeter by at least one infiltration agent;
(b) launch system configured for deploying at least one ready-to-launch UAV (400) to said target zone responsive to receiving said control signal;
(c) at least one controller configured for operating said at least one UAV (400) to search an area around said target zone to thereby locate and home onto at least one said infiltration agent and for at least one of:

(i) identifying nature of said infiltration agent or nature of infiltration; and
(ii) tracking said infiltration agent via said at least one UAV (400); and

(d) communication system (350), configured for providing at least one of:

- data corresponding to said nature in (i); and
- location data corresponding to a location of said infiltration agent in (ii) to enable neutralization thereof,

wherein the system is further configured for speed launching at least one supplemental said UAV (400) for supplementing said identification in step (I), and/or said tracking in step (II), or taking over said identification and/or said tracking, respectively, from said UAV (400) previously launched.

14. System according to claim 13, wherein said launch system comprises at least one a UAV launcher (300) remote from said control center (200) and comprising at least one said UAV (400), the or each said UAV launcher (300) being in operation configured for automatically speed-launching at least one said UAV (400) responsive to receiving said launch command signal from said control center (200).

15. System according to any one of claims 13 to 14, wherein the or each said UAV (400) comprises at least one of:

- a sensor system having a field of view, in operation said UAV (400) being configured for providing sensor data associated with said infiltration agent responsive to said infiltration agent being in said field of view, and wherein optionally said sensor system comprises an image acquisition system for providing images corresponding to said field of view, and wherein optionally

said image acquisition system comprises a pointing mechanism for controllably changing a line of sight of said image acquisition system in at least one or azimuth and elevation; and
- a GPS or other positioning system configured for providing geographical location data of the respective UAV (400) according to a pre-known coordinate system, and wherein optionally said location data is derived from said geographical location data and from knowledge of the line of sight of the image acquisition system and from knowledge of an altitude of the respective said UAV; and wherein optionally said communication system comprises a communication module (420) comprised in the or each said UAV (400) each said communication module (420) being configured, in operation, for receiving said command signal, for enabling operation of the respective UAV (400) by said controller, and for transmitting sensor data provided by said sensor system; and
- a contamination sensor configured for detecting said infiltration agent when in the form of a contaminating agent, and wherein optionally said control center (200) is remote from said launch system; and wherein optionally at least one said UAV launcher (300) is mobile configured for controllably changing its geographical position with respect to at least one of said control center (200) and said perimeter; and wherein optionally said system comprises a plurality of said UAV launchers (300), spaced from one another and at different locations with respect to said perimeter, wherein said control center (200) is configured for providing said launch command signal to a said launcher (300) capable of launching a respective said at least one UAV (400) to minimize said response time.

16. System according to any one of claims 14 to 15, wherein said sensor data is transmitted to at least one of said control center (200) and said controller.

Patentansprüche

1. Verfahren zum Schutz eines Umkreises, umfassend:

(a) Bereitstellen von Infiltrationsinformationen einer tatsächlichen oder vermuteten Infiltration durch wenigstens ein Infiltrationsmittel an einem Ort einer Zielzone, die dem Umkreis zugeordnet ist;
(b) Einsetzen von wenigstens einem startbereiten UAV (unbemanntem Luftfahrzeug) (400) in der Zielzone als Reaktion auf den Empfang der Infiltrationsinformationen;
(c) Betreiben des wenigstens einen UAV (400), um einen Zielbereich um die Zielzone herum zu durchsuchen, um dadurch das wenigstens eine Infiltrationsmittel zu lokalisieren und dieses anzupeilen; und
(d):

(I) Identifizieren der Art des wenigstens einen angepeilten Infiltrationsmittels oder der Art der Infiltration über das wenigstens eine UAV (400) und Bereitstellen von Daten, die dieser Art entsprechen; und/oder
(II) Verfolgen des wenigstens einen angepeilten Infiltrationsmittels über das wenigstens eine UAV (400) und Bereitstellen von Daten, die einem Ort des angepeilten Infiltrationsmittels entsprechen, um dessen Neutralisation zu ermöglichen,

wobei wenigstens eine Ergänzung des UAV (400) in Schritt (d) schnell gestartet wird, um die Identifizierung in Schritt (I) und/oder die Verfolgung in Schritt (II) zu ergänzen oder die Identifizierung und/oder die Verfolgung von dem UAV (400) zu übernehmen, das zuvor in Schritt (b) gestartet wurde.

2. Verfahren nach Anspruch 1, bei dem Schritt (b) umfasst:

(b1) Bereitstellen von wenigstens einer UAV-Starteinrichtung (300), wobei die oder jede UAV-Starteinrichtung (300) wenigstens ein UAV (400) im startbereiten Modus umfasst, wobei die oder jede UAV-Starteinrichtung (300) dazu eingerichtet ist, jedes jeweilige UAV (400) zu aktivieren, um als Reaktion auf den Empfang der Infiltrationsinformationen schnell gestartet zu werden; oder
(b2) Bereitstellen mehrerer der UAV-Starteinrichtungen (300) und strategisches Einsetzen der UAV-Starteinrichtungen (300) in Bezug auf den Umkreis in einer Weise, die es jedem UAV (400) gestattet, einen vorbestimmten Punkt auf dem Umkreis innerhalb einer vorbestimmten Zeit nach dem Start zu erreichen.

3. Verfahren nach einem der Ansprüche 1 bis 2, bei dem Schritt (a) das Beziehen von Infiltrationsinformationen aus wenigstens einer der folgenden Quellen umfasst: menschliche Intelligenz, menschliche Überwachung dieses Umkreises, elektronische Intelligenz, elektronische Überwachung des Umkreises; Überkopfbilder des Umkreises, Umkreiseindringsensoren; Radardaten; elektrooptische und/oder infrarote Überwachung des Umkreises.

4. Verfahren nach einem der Ansprüche 1 bis 3, bei dem in Schritt (b) geeignete Befehlssignale entspre-

chend den Infiltrationsinformationen erzeugt und an die wenigstens einen der UAV-Starteinrichtung (300) gesendet werden, um dadurch einen schnellen Start des wenigstens einen startbereiten UAVs (400) zu aktivieren.

5. Verfahren nach einem der Ansprüche 1 bis 4, bei dem das UAV (400) einen geeigneten Sensor umfasst, der zum Bereitstellen von Bilddaten oder anderen Sensordaten innerhalb eines Sichtfelds eingerichtet ist, und Schritt (c) das Fernfliegen des UAV (400) zu der Zielzone, das Empfangen der Bilddaten oder der anderen Sensordaten, die von dem UAV (400) der Zielzone erzeugt werden, und das Identifizieren der Art des Infiltrationsmittels in Schritt (I) aus den Bilddaten oder den anderen Sensordaten umfasst, und Schritt (d) gegebenenfalls das Halten des Infiltrationsagenten innerhalb des Sichtfelds des Sensors umfasst.

6. Verfahren nach einem der Ansprüche 1 bis 5, weiterhin umfassend Schritt (e), wobei Schritt (e) einen der folgenden Vorgänge umfasst:

- Neutralisation des Infiltrationsmittels;
- Neutralisation des Infiltrationsmittels, umfassend das Abfangen, Erfassen oder Immobilisieren des wenigstens einen Infiltrationsmittels durch direkte menschliche Intervention;
- Neutralisation des Infiltrationsmittels, umfassend das Abfangen, Erfassen oder Immobilisieren des wenigstens einen Infiltrationsmittels durch direkte menschliche Intervention, wobei die direkte menschliche Intervention das Entsenden einer oder mehrerer von bemannten oder unbemannten Bodenstreitkräften, bemannten oder unbemannten Luftstreitkräften und bemannten oder unbemannten Seestreitkräften an diesen Ort umfasst.

7. Verfahren nach einem der Ansprüche 1 bis 6, bei dem Schritt (b) das Schnellstarten einer Vielzahl startbereiter UAV (400) jeweils zu einem anderen jeweiligen Startort in der Zielzone in Reaktion auf das Empfangen der Infiltrationsinformationen und das Durchsuchen eines jeweiligen Abschnitts der Zielzone nach dem Infiltrationsmittel umfasst, wobei gegebenenfalls wenigstens einer der folgenden Schritte enthalten ist:

- wobei wenigstens eines der zahlreichen der gestarteten UAV (400) in Schritt (c) das Infiltrationsmittel anpeilt und wenigstens ein erster Abschnitt eines Restes der gestarteten UAV (400) wiederhergestellt wird;
- wobei wenigstens eines der zahlreichen der gestarteten UAV (400) in Schritt (c) das Infiltrationsmittel anpeilt und wenigstens ein zweiter Abschnitt eines Restes der gestarteten UAV (400) in der Luft gehalten wird, um eine zusätzliche Verfolgung zu ermöglichen.

8. Verfahren nach einem der Ansprüche 1 bis 7, bei dem es zahlreiche Infiltrationsmittel gibt, wobei Schritt (b) das schnelle Starten zahlreicher der startbereiten UAV (400) und in Schritt (c) das Betreiben jedes UAV (400) umfasst, um ein anderes Infiltrationsmittel zu verfolgen.

9. Verfahren nach einem der Ansprüche 1 bis 8, bei dem die Daten, die der Art in Schritt (d) (I) entsprechen, belastende Beweise bezüglich der Art des Infiltrationsmittels oder der Infiltration durch dasselbe umfassen und gegebenenfalls der Umkreis eine Grenze zwischen einem überwachten Gastland und einer geopolitischen Einheit, die die Infiltrationsmittel vor der Infiltration umfasst, oder einem Gebäude oder einer Struktur darstellt, oder einen Zaun, eine Wand oder eine Linie, die eine Einrichtung umschreibt, eine Gruppe von Gebäuden, einen Komplex oder eine geografische Zone umfasst.

10. Verfahren nach einem der Ansprüche 1 bis 9, bei dem wenigstens eines der startbereiten UAV (400) strukturell und/oder operativ dazu eingerichtet ist, die Erfassung desselben durch die Infiltrationsmittel zu minimieren.

11. Verfahren nach einem der Ansprüche 1 bis 10, bei dem das Infiltrationsmittel:

- ein menschliches Mittel ist, wobei das menschliche Mittel wahlweise aus der Gruppe entnommen ist, die besteht aus: Terrorist, illegalem Ausländer, Schmuggler, Dieb, ausländische Truppen, oder
- ein nicht menschliches Mittel ist, wobei das nicht menschliche Mittel optional aus der Gruppe: eines nicht zugelassenen UAVs (400), eines unbemannten Landfahrzeugs, eines unbemannten Seefahrzeugs und eines Kontaminationsmittels entnommen ist, dass wahlweise aus der Gruppe entnommen ist, die umfasst: toxische chemische, biologische, radiologische oder nukleare Mittel.

12. Verfahren nach einem der Ansprüche 1 bis 11, bei dem die Infiltrationsinformationen ein Eindringen in den Umkreis anzeigen.

13. System zum Schutz eines Umkreises, umfassend:

(a) eine Steuerzentrale (200), die dazu eingerichtet ist, ein Steuersignal zu erzeugen, das auf das Empfangen von Infiltrationsinformationen einer tatsächlichen oder vermuteten Infiltration

an einem Ort einer Zielzone reagiert, die dem Umkreis durch wenigstens ein Infiltrationsmittel zugeordnet ist;
(b) ein Startsystem, das dazu eingerichtet ist, wenigstens ein startbereites UAV (400) in der Zielzone bereitzustellen, das auf den Empfang des Steuersignals reagiert;
(c) wenigstens eine Steuereinheit, die zum Betreiben des wenigstens einen UAVs (400) eingerichtet ist, um einen Bereich um die Zielzone zu durchsuchen, um dadurch wenigstens ein Infiltrationsmittel zu lokalisieren und dieses anzupeilen, und zum:

(i) Identifizieren der Art des Infiltrationsmittels oder der Art der Infiltration;
und/oder
(ii) Verfolgen des Infiltrationsmittels über das wenigstens eine UAV (400); und

(d) ein Kommunikationssystem (350), das dazu eingerichtet ist:

- Daten entsprechend der Art bei (i) und/oder
- Standortdaten bereitzustellen, die einem Standort des Infiltrationsmittels bei

(ii) entsprechen, um eine Neutralisierung zu ermöglichen,
wobei das System weiterhin dazu eingerichtet ist, wenigstens ein zusätzliches UAV (400) schnell zu starten, um die Identifikation in Schritt (I) und/oder die Verfolgung in Schritt (II) zu ergänzen oder die Identifikation und/oder die Verfolgung jeweils von dem zuvor gestarteten UAV (400) zu übernehmen.

14. System nach Anspruch 13, bei dem das Startsystem wenigstens eine UAV-Starteinrichtung (300) umfasst, die von der Steuerzentrale (200) entfernt ist und wenigstens ein UAV (400) umfasst, wobei die UAV-Starteinrichtung (300) im Betrieb dazu eingerichtet ist, wenigstens ein UAV (400) schnell zu starten, das auf den Empfang des Startbefehlssignals von der Steuerzentrale (200) reagiert.

15. System nach einem der Ansprüche 13 bis 14, wobei das oder jedes UAV (400) wenigstens eines der folgenden Elemente umfasst:

- ein Sensorsystem mit einem Sichtfeld, wobei im Betrieb das UAV (400) dazu eingerichtet ist, Sensordaten, die dem Infiltrationsmittel zugeordnet sind, in Reaktion darauf bereitzustellen, das sich das Infiltrationsmittel in dem Sichtfeld befindet, und das Sensorsystem wahlweise ein Bilderfassungssystem zum Bereitstellen von Bildern umfasst, die dem Sichtfeld entsprechen, und das Bilderfassungssystem wahlweise einen Zeigemechanismus zum steuerbaren Ändern einer Sichtlinie des Bilderfassungssystems in Azimut und/oder Elevation umfasst; und
- ein GPS oder ein anderes Ortungssystem, das zum Bereitstellen von geografischen Standortdaten des jeweiligen UAV (400) gemäß einem vorbekannten Koordinatensystem eingerichtet ist, wobei die Standortdaten wahlweise aus den geografischen Standortdaten und aus der Kenntnis der Sichtlinie des Bilderfassungssystems und aus Kenntnis einer Höhe des jeweiligen UAV abgeleitet werden und das Kommunikationssystem wahlweise ein Kommunikationsmodul (420) umfasst, das in dem oder jedem UAV (400) enthalten ist, wobei jedes Kommunikationsmodul (420) im Betrieb dazu eingerichtet ist, das Befehlssignal zu empfangen, um den Betrieb des jeweiligen UAV (400) durch die Steuereinrichtung zu ermöglichen, und Sensordaten zu senden, die von dem Sensorsystem bereitgestellt werden; und
- einen Kontaminationssensor, der zum Erfassen des Infiltrationsmittels in Form eines Kontaminationsmittels eingerichtet ist, und die Steuerzentrale (200) wahlweise von dem Startsystem entfernt ist und wahlweise wenigstens eine UAV-Starteinrichtung (300) mobil dazu eingerichtet ist, seine geografische Position in Bezug auf wenigstens eines der Steuerzentralen (200) und des Umkreises steuerbar zu ändern, und das System wahlweise eine Vielzahl von UAV-Starteinrichtungen (300) umfasst, die voneinander beabstandet und an unterschiedlichen Orten in Bezug auf den Umkreis angeordnet sind, wobei die Steuerzentrale (200) dazu eingerichtet ist, das Startbefehlssignal der Starteinrichtung (300) bereitzustellen, die in der Lage ist, das wenigstens eine UAV (400) zu starten, um die Ansprechzeit zu minimieren.

16. System nach einem der Ansprüche 14 bis 15, bei dem die Sensordaten zu dem wenigstens einen Steuerzentrum (200) und der Steuereinheit gesendet werden.

Revendications

1. Procédé de surveillance d'un périmètre, comprenant :

(a) fournir des informations d'infiltration relatives à une infiltration réelle ou suspectée par au moins un agent infiltration au niveau d'une localisation d'une zone cible associée audit périmètre ;

(b) déployer au moins un UAV *(unmanned air vehicle,* véhicule aérien sans humain embarqué) prêt à lancer (400) sur ladite zone cible en réponse à la réception desdites informations d'infiltration ;
(c) faire opérer ledit au moins un UAV (400) pour fouiller une région cible autour de ladite zone cible de manière à localiser l'au moins un dit agent d'infiltration et à se diriger sur celui-ci ; ainsi que
(d) au moins :

(I) identifier la nature de l'au moins un dit agent d'infiltration visé ou la nature de ladite infiltration par le biais dudit au moins un UAV (400) et fournir des données correspondant à ladite nature ; et/ou
(II) suivre l'au moins un dit agent d'infiltration visé par le biais dudit au moins un UAV (4) et fournir des données correspondant à une localisation dudit agent d'infiltration visé pour permettre sa neutralisation,

dans lequel au moins un dit UAV (400) de renfort est lancé rapidement dans l'étape (d) pour renforcer ladite identification dans l'étape (I) et/ou ledit suivi dans l'étape (II), ou prendre le relais de ladite identification et/ou dudit suivi, respectivement, effectué(e) par ledit UAV (400) précédemment lancé dans l'étape (b).

2. Procédé selon la revendication 1, dans lequel l'étape (b) comprend :

(b1) fournir au moins un lanceur d'UAV (300), ledit lanceur d'UAV ou chacun desdits lanceurs d'UAV (300) comprenant au moins un UAV (400) en mode prêt à lancer, ledit lanceur d'UAV ou chacun desdits lanceurs d'UAV (300) étant configuré pour permettre le lancement rapide de chaque UAV (400) respectif en réponse à la réception desdites informations d'infiltration ; ou
(b2) fournir une pluralités desdits lanceurs d'UAV (300) et déployer stratégiquement lesdits lanceurs d'UAV (300) par rapport audit périmètre d'une manière permettant à chacun desdits UAV (400) d'atteindre un point prédéterminé sur ledit périmètre dans un délai prédéterminé après le lancement.

3. Procédé selon l'une quelconque des revendications 1 à 2, dans lequel l'étape (a) comprend l'obtention d'informations d'infiltration de la part d'au moins une des sources suivantes : renseignement humain ; surveillance humaine dudit périmètre ; renseignement électronique ; surveillance électronique dudit périmètre ; imagerie aérienne dudit périmètre ; détecteurs de violation de périmètre ; données radar ; surveillance électro-optique et/ou infrarouge dudit périmètre.

4. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel, dans l'étape (b), des signaux de commande appropriés sont générés en correspondance avec lesdites informations d'infiltration et sont transmis à au moins un desdits lanceurs d'UAV (300), activant ainsi le lancement rapide dudit au moins un UAV prêt à lancer (400).

5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel ledit UAV (400) comprend un détecteur approprié configuré pour fournir des données d'image ou d'autres données de détecteur au sein d'un champ de visée, et l'étape (c) comprend la commande à distance du vol dudit UAV (400) vers ladite zone cible, la réception desdites données d'image ou desdites autres données de détecteur générées par ledit UAV (400) de la zone cible, et l'identification de la nature dudit agent d'infiltration dans l'étape (I) à partir desdites données d'images ou desdites autres données de détecteur, et dans lequel, optionnellement, l'étape (d) comprend le maintien dudit agent d'infiltration au sein dudit champ de visée dudit détecteur.

6. Procédé selon l'une quelconque des revendications 1 à 5, comprenant en outre l'étape (e), dans lequel l'étape (e) comprend l'une quelconque de ces actions :

- neutralisation dudit agent d'infiltration ;
- neutralisation dudit agent d'infiltration, comprenant l'interception, l'interpellation ou l'immobilisation dudit au moins un agent d'infiltration par intervention humaine directe ;
- neutralisation dudit agent d'infiltration, comprenant l'interception, l'interpellation ou l'immobilisation dudit au moins un agent d'infiltration par intervention humaine directe, dans lequel ladite intervention humaine directe comprend l'expédition vers ladite localisation d'une ou de plusieurs : forces terrestres avec ou sans humains embarqués, forces aériennes avec ou sans humains embarqués, forces navales avec ou sans humains embarqués.

7. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel l'étape (b) comprend le lancement rapide d'une pluralité desdits UAV prêts à lancer (400), chacun vers une localisation de départ respective dans ladite zone cible, en réponse à la réception desdites informations d'infiltration, et la fouille d'une partie respective de ladite zone cible à la recherche dudit agent d'infiltration, et incluant, optionnellement, au moins une des étapes suivantes :

- dans lequel au moins un de ladite pluralité desdits UAV (400) lancés est dirigé sur ledit agent d'infiltration dans l'étape (c), et au moins une première partie d'un reste desdits UAV (400) lancés est récupérée ;
- dans lequel au moins un de ladite pluralité desdits UAV (400) lancés est dirigé sur ledit agent d'infiltration dans l'étape (c), et au moins une deuxième partie d'un reste desdits UAV (400) lancés est maintenue en l'air pour fournir un suivi de renfort.

8. Procédé selon l'une quelconque des revendications 1 à 7, dans lequel il existe une pluralité d'agents d'infiltration, dans lequel l'étape (b) comprend le lancement rapide d'une pluralité desdits UAV prêts à lancer (400), et, dans l'étape (c), on fait opérer chacun desdits UAV (400) pour le diriger sur un agent d'infiltration différent desdits agents d'infiltration.

9. Procédé selon l'une quelconque des revendications 1 à 8, dans lequel lesdites données correspondant à ladite nature dans l'étape (d) (I) incluent des preuves incriminantes relatives à ladite nature dudit agent d'infiltration ou de ladite infiltration, et dans lequel, optionnellement, ledit périmètre constitue soit une frontière entre un pays hôte faisant l'objet d'une surveillance et une entité géopolitique comprenant lesdits agents d'infiltration avant ladite infiltration, soit un bâtiment, soit une structure ; ou comprend une clôture ou un mur ou une ligne circonscrivant une installation ; un groupe de bâtiments ; un complexe ; une zone géographique.

10. Procédé selon l'une quelconque des revendications 1 à 9, dans lequel au moins un desdits UAV prêts à lancer (400) est configuré, structurellement et/ou fonctionnellement, pour minimiser sa détection par lesdits agents d'infiltration.

11. Procédé selon l'une quelconque des revendications 1 à 10, dans lequel ledit agent d'infiltration est un des agents suivants :

- un agent humain, dans lequel ledit agent humain est, optionnellement, pris dans le groupe comprenant : un terroriste, un étranger en situation illégale, un contrebandier, un voleur, des troupes étrangères ;
- un agent non humain, dans lequel ledit agent non humain est, optionnellement, pris dans le groupe comprenant : un UAV (400) non autorisé, un véhicule terrestre sans humain embarqué, un véhicule maritime sans humain embarqué, et un agent contaminant, optionnellement pris dans le groupe comprenant : un agent toxique, un agent chimique, un agent biologique, un agent radiologique ou un agent nucléaire.

12. Procédé selon l'une quelconque des revendications 1 à 11, dans lequel lesdites informations d'infiltration indiquent une violation dudit périmètre.

13. Système de surveillance d'un périmètre, comprenant :

(a) un centre de commande (200) configuré pour générer un signal de commande en réponse à la réception d'informations d'infiltration relatives à infiltration réelle ou suspectée au niveau d'une localisation d'une zone cible associée audit périmètre par au moins un agent d'infiltration ;
(b) un système de lancement configuré pour déployer au moins un UAV prêt à lancer (400) sur la zone cible en réponse à la réception dudit signal de commande ;
(c) au moins un dispositif de commande configuré pour faire opérer ledit au moins un UAV (400) pour fouiller une région autour de ladite zone cible de manière à localiser l'au moins un dit agent d'infiltration et à se diriger sur celui-ci, et pour au moins :

(i) identifier la nature dudit agent d'infiltration ou la nature de l'infiltration ; et/ou
(ii) suivre ledit agent d'infiltration par le biais dudit au moins un UAV (400) ; et

(d) un système de communication (350) configuré pour fournir au moins :

- des données correspondant à ladite nature dans (i) ; et/ou
- des données de localisation correspondant à une localisation dudit agent d'infiltration dans (ii) pour permettre sa neutralisation,

dans lequel le système est en outre configuré pour lancer rapidement au moins un desdits UAV (400) de renfort pour renforcer ladite identification dans l'étape (I) et/ou ledit suivi dans l'étape (II), ou prendre le relais de ladite identification et/ou dudit suivi, respectivement, effectué(e) par ledit UAV (400) précédemment lancé.

14. Système selon la revendication 13, dans lequel ledit système de lancement comprend au moins un lanceur d'UAV (300) distant dudit centre de commande (200) et comprenant au moins un desdits UAV (400), ledit lanceur d'UAV ou chacun desdits lanceurs d'UAV (300) étant, en opération, configuré pour le lancement rapide automatique d'au moins un desdits UAV (400) en réponse à la réception dudit signal de commande de lancement depuis ledit centre de commande (200).

15. Système selon l'une quelconque des revendications 13 à 14, dans lequel ledit UAV ou chacun desdits UAV (400) comprend au moins :

- un système détecteur ayant un champ de visée, en opération ledit UAV (400) étant configuré pour fournir des données de détecteur associées audit agent d'infiltration en réponse à la présence dudit agent d'infiltration dans ledit champ de visée, et dans lequel, optionnellement, ledit système détecteur comprend un système d'acquisition d'image destiné à fournir des images correspondant audit champ de visée, et dans lequel, optionnellement, ledit système d'acquisition d'image comprend un mécanisme de pointage permettant de modifier une ligne de visée dudit système d'acquisition d'image par contrôle d'au moins un azimut et/ou une élévation ; et/ou
- un GPS ou autre système de positionnement configuré pour fournir des données de localisation géographique de l'UAV (400) respectif selon un système de coordonnées préalablement connu, et dans lequel, optionnellement, lesdites données de localisation sont déduites desdites données de localisation géographique et de la connaissance de la ligne de visée du système d'acquisition d'image et de la connaissance d'une altitude dudit UAV respectif ; et dans lequel, optionnellement, ledit système de communication comprend un module de communication (420) compris dans ledit UAV ou chacun desdits UAV (400), chaque module de communication (420) étant configuré, en opération, pour recevoir ledit signal de commande, pour permettre l'opération de l'UAV (400) respectif par ledit dispositif de commande, et pour transmettre des données de détecteur fournies par ledit système détecteur ; et/ou
- un détecteur de contamination configuré pour détecter ledit agent d'infiltration lorsqu'il se présente sous la forme d'un agent contaminant, et dans lequel, optionnellement, ledit centre de commande (200) est distant dudit système de lancement ; et dans lequel, optionnellement, au moins un desdits lanceurs d'UAV (300) est mobile et configuré pour modifier sa position géographique de manière contrôlée par rapport à au moins ledit centre de commande (200) et/ou ledit périmètre ; et dans lequel, optionnellement, ledit système comprend une pluralités desdits lanceurs d'UAV (300), situés à distance les uns des autres et à des endroits différents par rapport audit périmètre, dans lequel ledit centre de commande (200) est configuré pour fournir ledit signal de commande de lancement à un desdits lanceurs (300) capable de lancer un desdits au moins un UAV (400) respectifs pour minimiser ledit temps de réponse.

16. Système selon l'une quelconque des revendications 14 à 15, dans lequel lesdites données de détecteur sont transmises à au moins ledit centre de commande (200) et/ou ledit dispositif de commande.

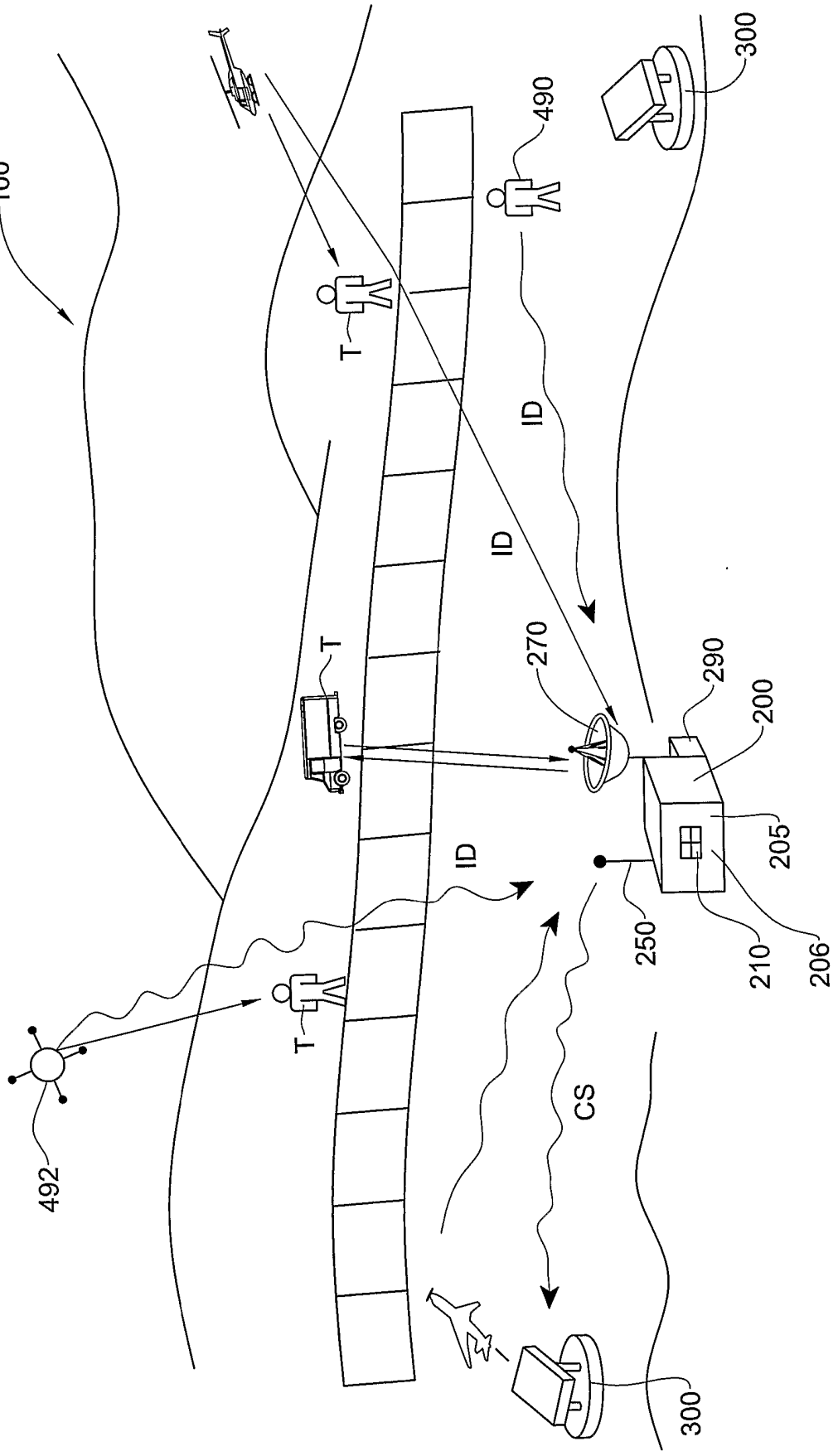

FIG. 1

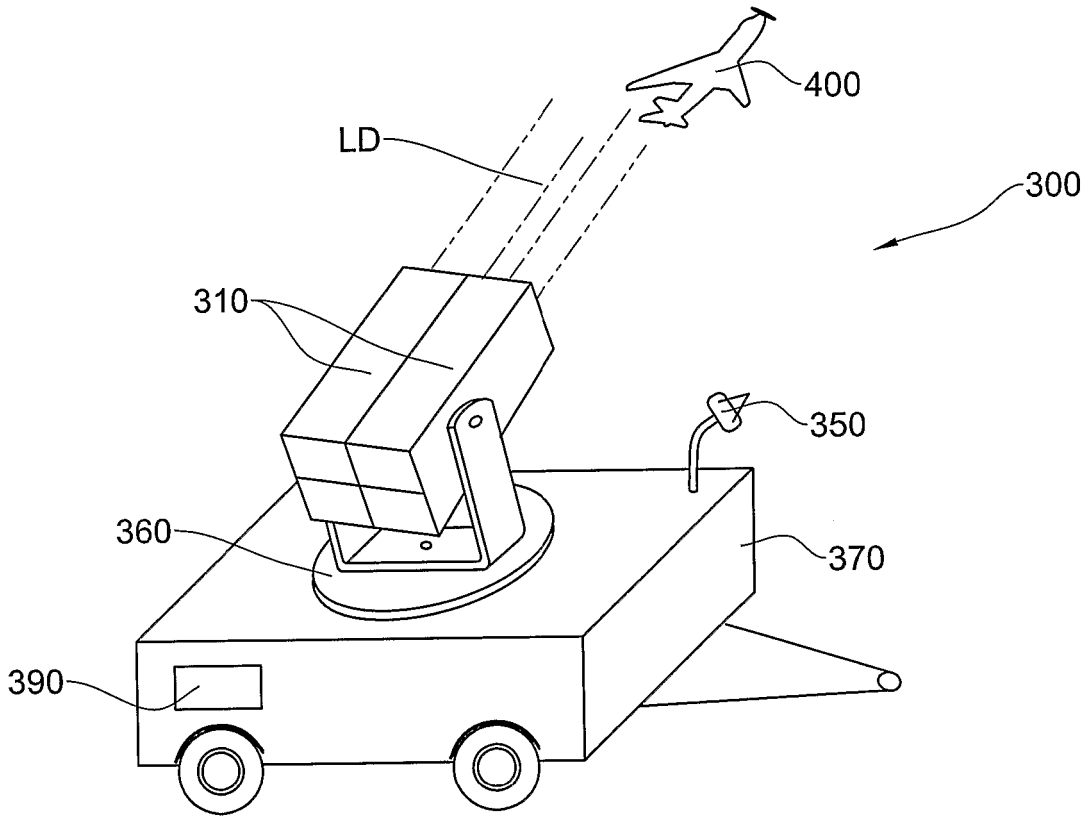

FIG. 2

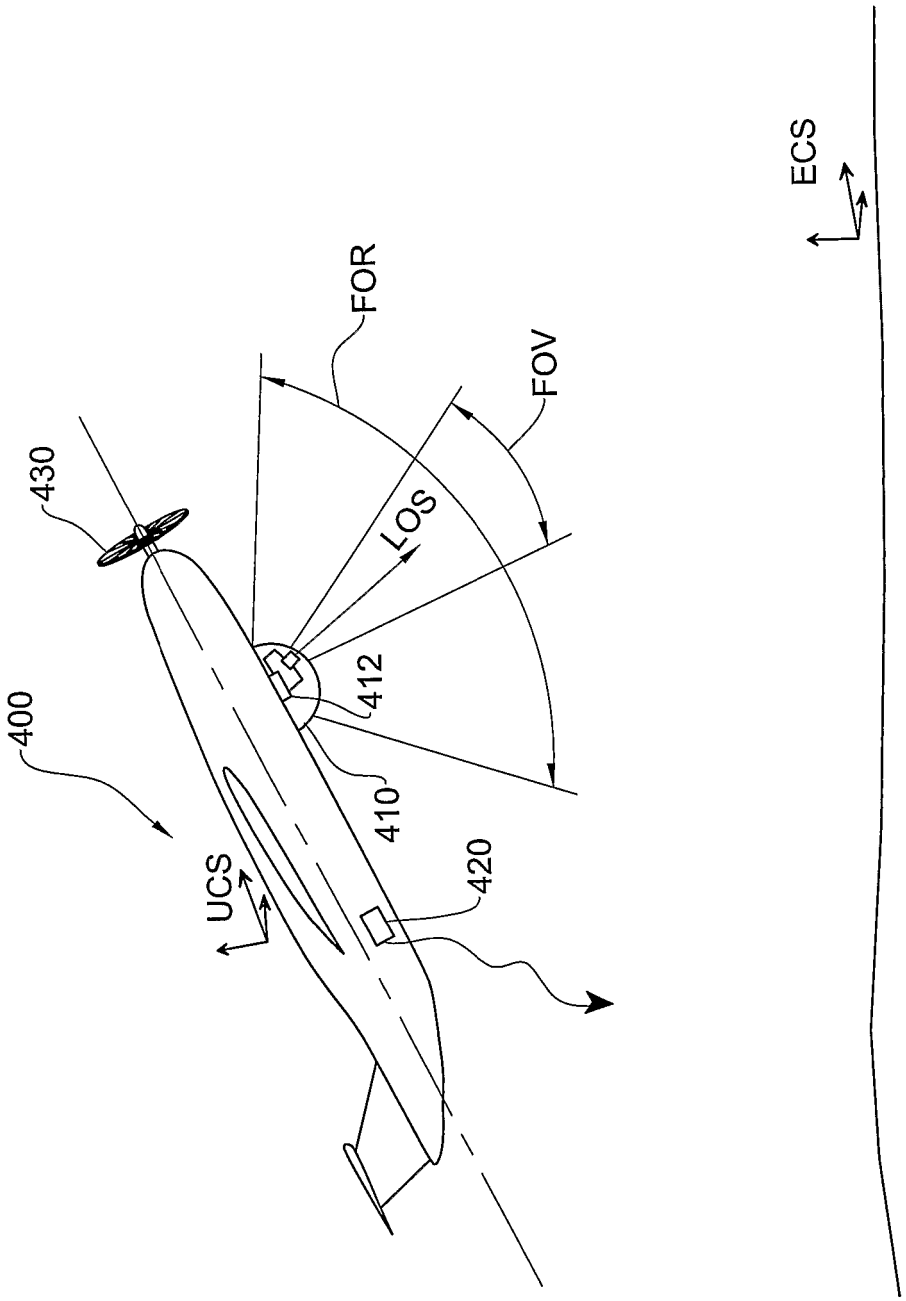

FIG. 3

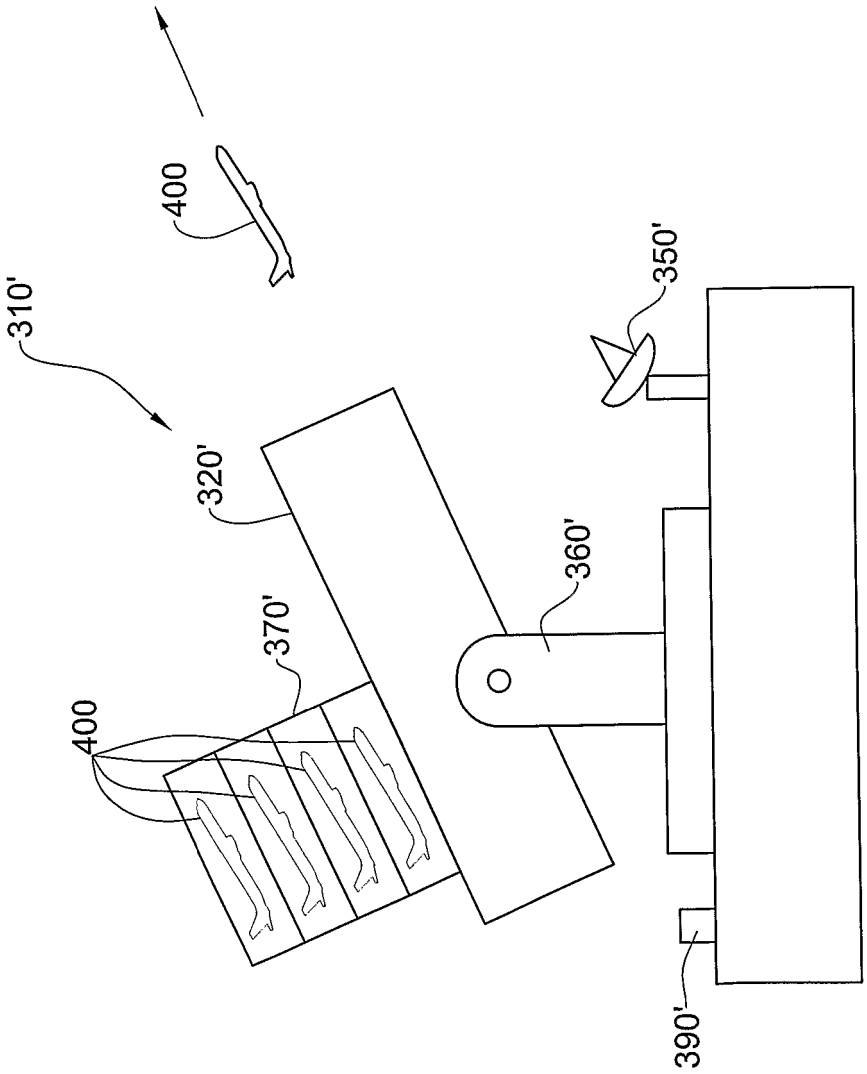

FIG. 4

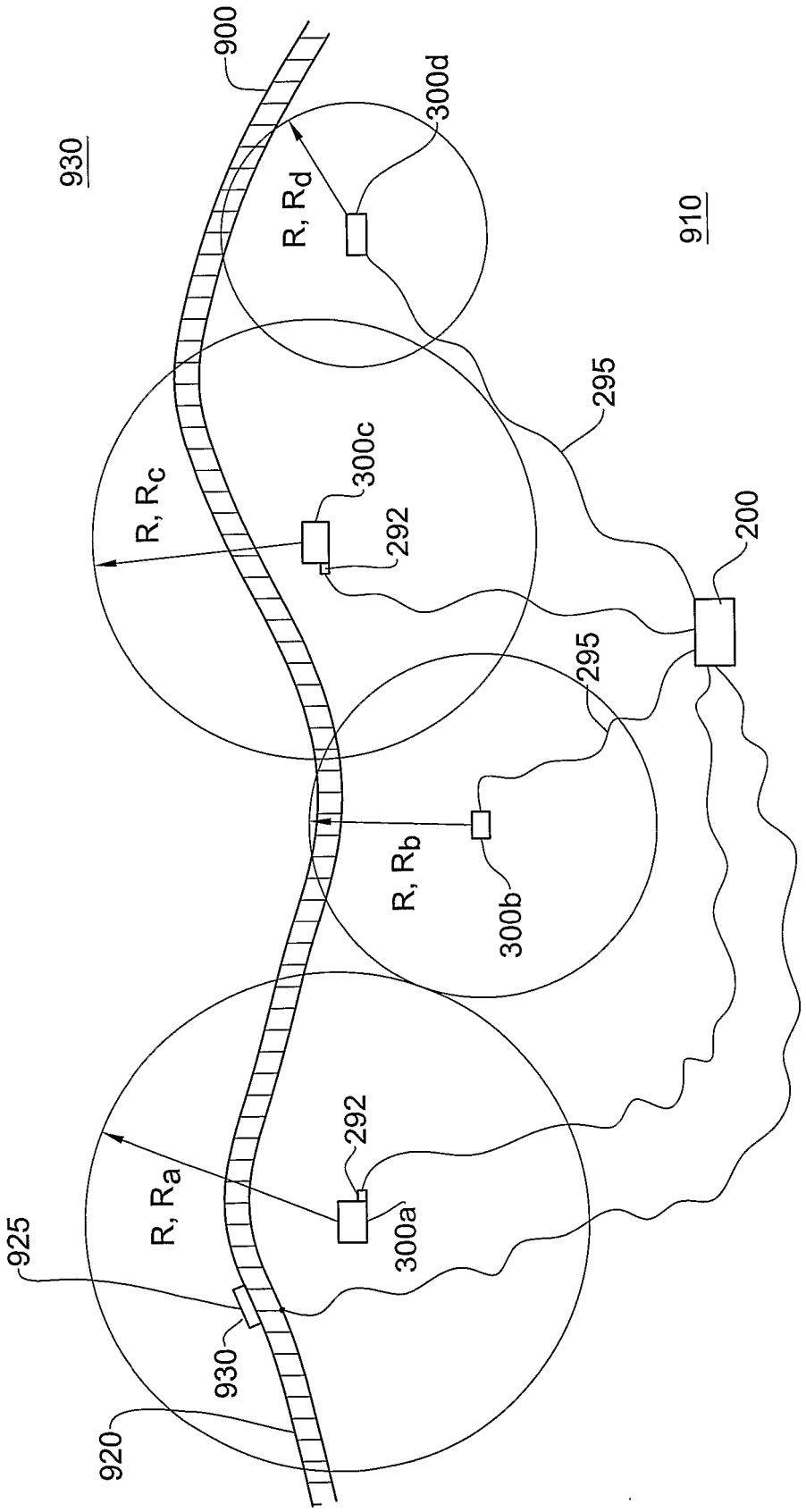
900
930
300d
R, Rd
910
295
300c
R, Rc
292
200
295
R, Rb
300b
292
R, Ra
300a
925
930
920

FIG. 5

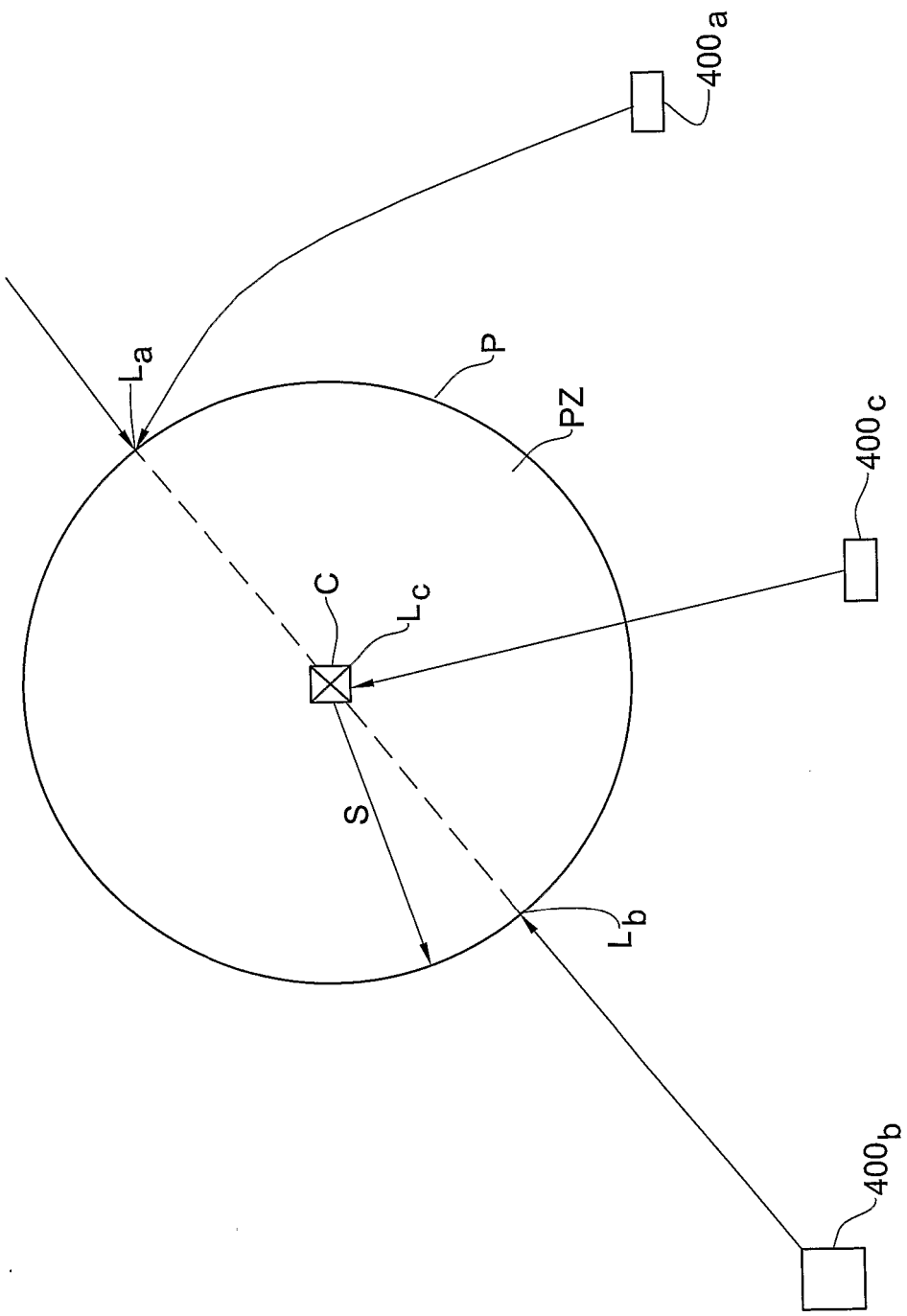

FIG. 6

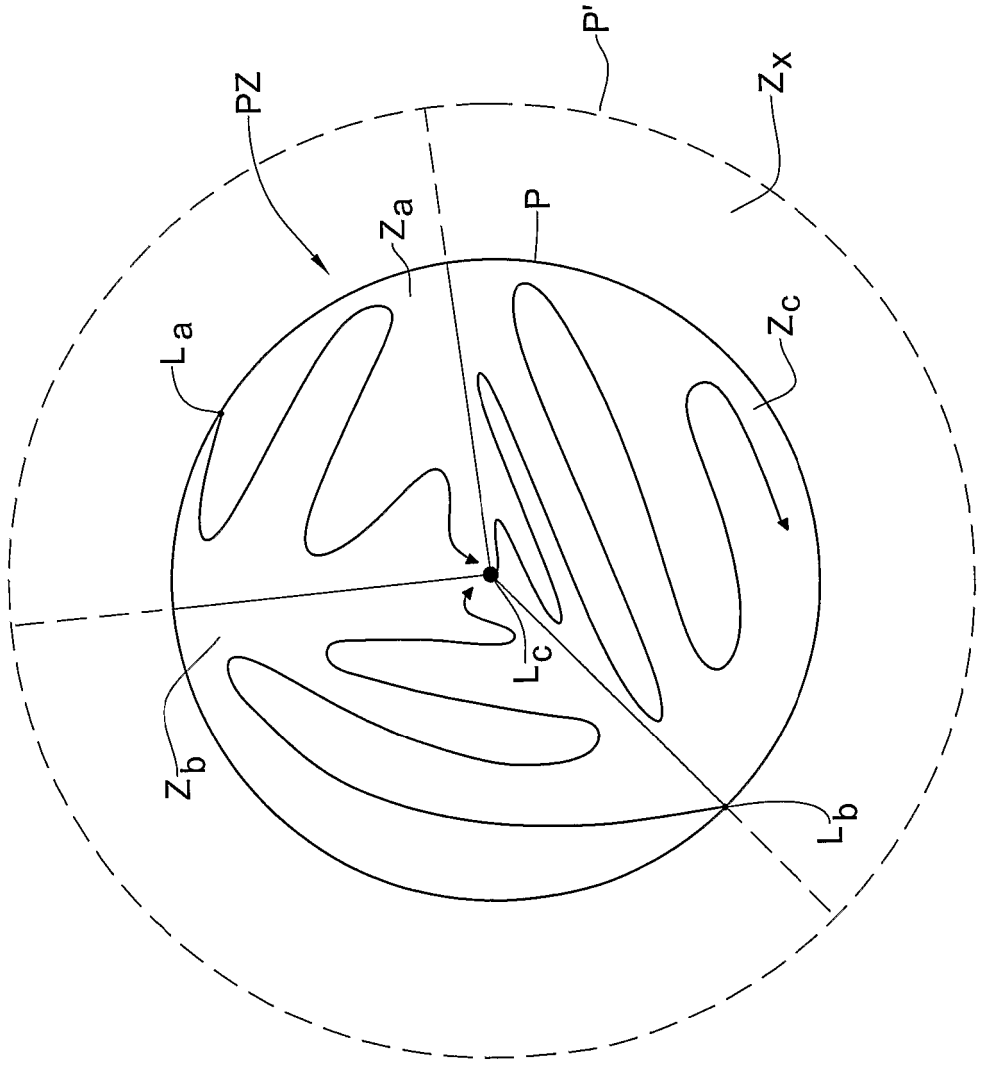

FIG. 7

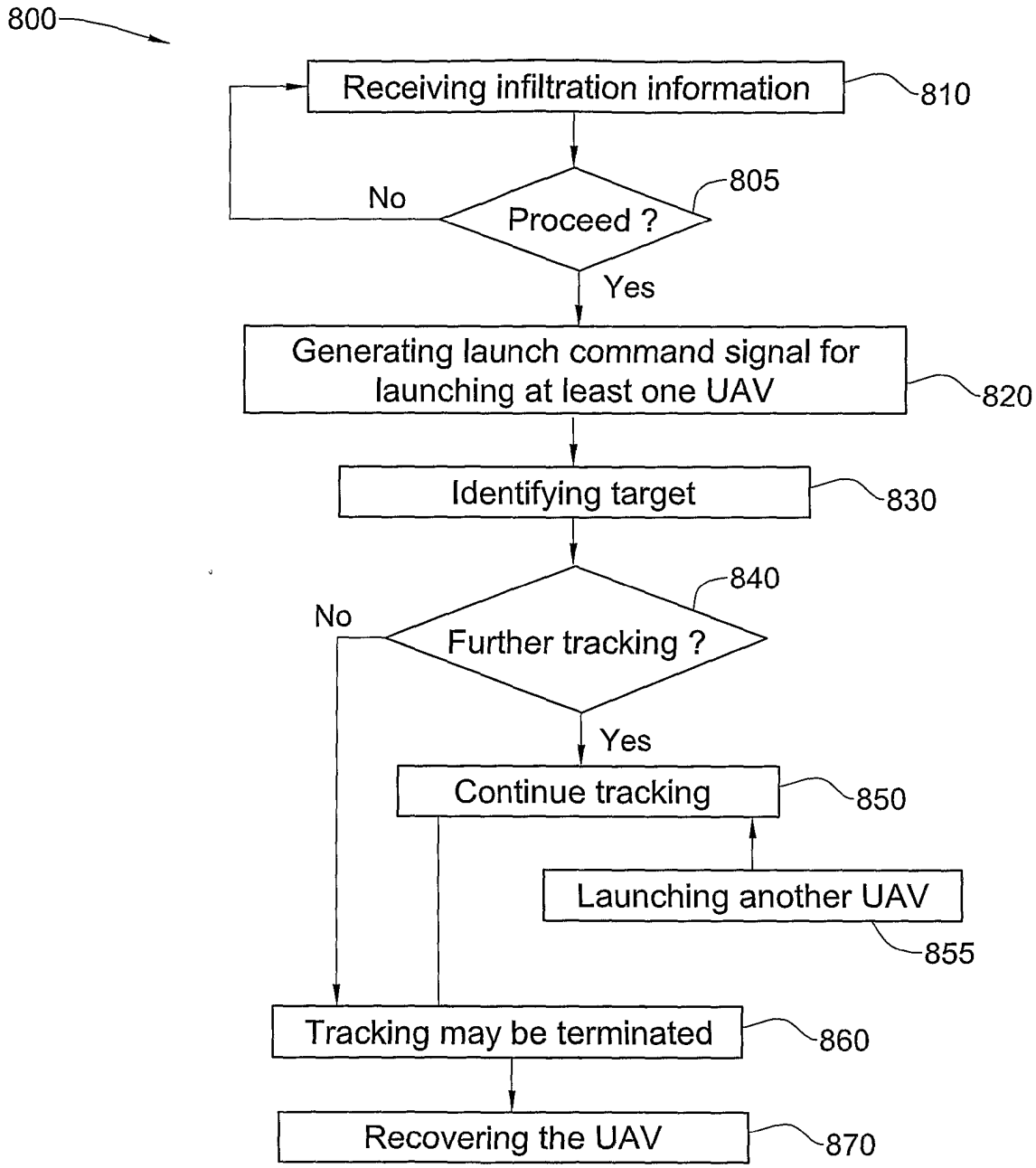
800
Receiving infiltration information
810
No
Proceed ?
805
Yes
Generating launch command signal for launching at least one UAV
820
Identifying target
830
No
Further tracking ?
840
Yes
Continue tracking
850
Launching another UAV
855
Tracking may be terminated
860
Recovering the UAV
870

FIG. 8

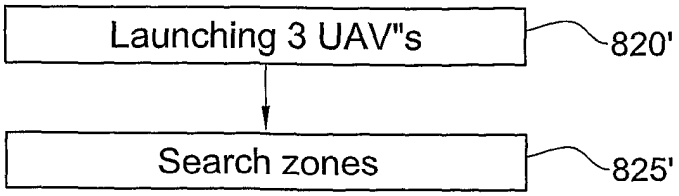
Launching 3 UAV"s
820'
Search zones
825'

FIG. 8(a)

REFERENCES CITED IN THE DESCRIPTION

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- US 2009015460 A1 **[0003]**
- WO 2008085536 A2 **[0003]**