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(54) **BORDERED FLYING TOOL**

EINGESCHRÄNKT FLIEGENDES WERKZEUG

APPAREIL VOLANT DANS DES LIMITES PREDEFINIES

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Description

[0001] The invention relates to a system of automatically controlling the flight of an aircraft to be confined within predetermined boundaries, the system comprising: Global Positioning System registration means for registering reference points located at the boundaries of a predefined zone; an aircraft comprising a body of an aircraft adapted for flying, the body provided with control means for controlling its flight, and a control unit, the control unit being adapted to communicate with the Global Positioning System registration means, to determine the location of the reference points and to determine the aircraft position with respect to the reference points.

[0002] To-date crop dusting is carried out either by a pilot flying a duster plane, and applying the dusting manually on each run. Alternatively, a dusting vehicle, driven on the ground, is used, but this usually proves to be harmful to the crops as the vehicle runs over crops as it advances in the field.

[0003] Unmanned aircraft is also known to have been used for crop dusting, which is remotely controlled from the ground, and depends utterly on very skilled operators to fly it successfully. Night crop-dusting is practically impossible with remote-controlled flown duster, as flying it demands good visability. Furthermore, controlling a remote-controlled unmanned aircraft from the ground is a demanding task taking its toll by increasing the operator's fatigue and therefore is not suited for long operations.

[0004] Unmanned remotely controlled flying machines are known for years. Remote-controlled flying models are used for military tasks, such as reconnaissance missions, as well as civic purposes, such as recreational model flying.

[0005] Unmanned aircrafts usually are controlled with remote control units operated at ground level. Examples of remote control units for unmanned aircraft are described in US-A-5,067,674, US-A-5,608,758, US-A-4,687,975, US-A-4,177,426, and US-A-2.941.753, The latter describing the use of an unmanned aircraft for crop spraying. It is also possible to operate the remote control on board an aircraft.

[0006] However, controlling remotely controlled aircraft requires high skills in operating the remote control unit, as well as utmost attention to the aircraft, its position, heading, pitch, elevation, and speed. Furthermore, flying remotely controlling aircraft is limited to the operator's view range, which may vary depending on the terrain conditions.

[0007] It should be noted that when communication between the aircraft and the remote control unit is broken, the aircraft may still be able to fly, and this can result in the aircraft going astray, flying off beyond the controllers capacity of regaining control on it and repossessing it.

[0008] To the best knowledge of the inventor, there exist unmanned aircraft systems that use computerized maps for navigation. The starting position of the aircraft (i.e. takeoff point or a predetermined position which the aircraft initially reaches) is input to the control unit and the aircraft is made to follow a prescribed route which is calculated by an onboard (or distant) computing unit with reference to the GPS coordinates.

[0009] Satellite tracking systems are also known for some years. The Global Positioning System (GPS), based on high orbiting satellite network, is used in tracking and locating objects on the surface of the Earth. For example, US-A-5,119,102 and US-A-4,359,733 disclosed satellite-based vehicle position determining systems. US-A-5,587,929 and US-A-5,668,739, describe systems and methods for tracking objects using a detection system (GPS).

[0010] US-A-5.334.987 discloses an aircraft control system for applying chemicals to an agricultural field, according to the preamble of claim 1. In this known system use is made of the GPS system to give audible signal, to the pilot of the aircraft indicating to him the position of the aircraft with respect to the field.

[0011] It is suggested that confining the motion of remotely controlled unmanned aircraft within predefined boundaries will allow better control of the aircraft, as well as allow the performance of automated tasks within these boundaries.

[0012] It is an object of the present invention to provide a system and method of an automatically controlled motion of unmanned aircraft confined within predetermined boundaries.

[0013] Another object of the invention is to provide a system and method of an automated unmanned aircraft operating in a confined zone, which can be used for crop dusting or any other routine job within the confined area without or with very little human intervention.

[0014] Yet another object of the present invention is to provide such a system and method that does not require the operator to posses special skills in order to be able to operate it.

[0015] Another object of the present invention is to provide such system and method that uses a location system (such as the GPS) to determine the position of the aircraft.

[0016] Another object of the present invention is to provide such system and method that allows fully automated of the aircraft in the confined zone.

[0017] An aspect of the present invention is the use of a tracking system, such as the Global Positioning System (GPS). Another aspect of the present invention is the confinement of the aircraft to a predetermined confined zone. Another aspect is the provision of fully automated flight of the aircraft within that confined zone.

[0018] There is thus provided, in accordance with a preferred embodiment of the present invention, a system of automatically controlled motion of unmanned aircraft confined within predetermined boundaries, of the above mentioned type.

characterized in that the aircraft is an unmanned aircraft and that said control unit further is adapted to actuate the control means so as to allow the aircraft to fly only within the boundaries of the predetermined zone.

[0019] Furthermore, in accordance with a preferred embodiment of the present invention, said means for registration comprise a plurality of beacons adapted to transmit signals of predetermined frequencies traceable by said control unit, and said control unit is adapted to determine the location of the aircraft relative to said beacons, by comparing the frequencies, by detecting changes in them and by comparing the time that takes each signal to reach the control unit.

[0020] Furthermore, in accordance with a preferred embodiment of the present invention, said aircraft is adapted to fly in a predetermined pattern within the confined zone.

[0021] Furthermore, in accordance with a preferred embodiment of the present invention, said aircraft is a helicopter.

[0022] Furthermore, in accordance with a preferred embodiment of the present invention, said aircraft is adapted to be controlled with a remote control unit operated on the ground, wherein, when the system detects that aircraft approaches the confined zone boundary the control unit overruns the remote control unit and forces the aircraft to remain within the confined zone.

[0023] Furthermore, in accordance with a preferred embodiment of the present invention, the registration means comprise a single portable beacon adapted to be positioned at each reference point and transmit signals traceable by the tracking system, wherein said control unit is adapted to determine the location of the aircraft relative to the reference points.

[0024] Furthermore, in accordance with a preferred embodiment of the present invention, there is provided a method of automatically controlled motion of unmanned aircraft confined within predetermined boundaries, as described in claim 7.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] In order to better understand the present invention, and appreciate its practical applications, the following Figures are provided and referenced hereafter. It should be noted that the Figures are given as examples only and in no way limit the scope of the invention as defined in the appending Claims. Like components are denoted by like reference numerals.

Figure 1	illustrates an outline view of a system of an automatically controlled motion of unmanned aircraft confined within predetermined boundaries, in accordance with a preferred embodiment of the present invention.
Figures 2A and 2B	depict the general features of an aircraft used in the system of the present invention.
Figure 3	illustrates the general features of a beacon used in conjunction with a system in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0026] The present invention aims at providing a system and method of an automatically controlled motion of unmanned aircraft confined within predetermined boundaries. It provides a very good means for restraining the motion of an unmanned aircraft within a known zone of predetermined borders.

[0027] Within these well-defined boundaries the aircraft is set to fly either on a predefined course, such as in circles, or in a combing manner, systematically covering the zone confined by the boundaries, or in any other predetermined course. Alternatively the aircraft may be controlled with a remote control unit, as long as it stays within the confined zone, but upon approaching the boundary, the remotely controlled motion of the aircraft would be overrun by the system of the present invention so as to prevent the aircraft from passing beyond the boundary.

[0028] In view of the nature of the confinement imposed by the system of the present invention, changing the course of the aircraft abruptly upon approaching the boundary, the present invention seems to appeal in particular to aircraft traveling at low speeds (such as helicopters). However it may also be implemented on fast aircraft, for example by introducing transitional measures (such as altering the course of the aircraft enough time before it reaches the boundary in order to allow it to complete a turn).

[0029] An aspect of the present invention is the employment of a tracking system, such as the Global Positioning System (GPS), or any other tracking system. The tracking system is used in determining the boundaries of the confined zone and in determining the aircraft position within these boundaries.

[0030] The present invention is explained hereafter with reference to three embodiments, as shown in the accompanying drawings. These embodiments are given for the purpose of clarity and in no way limit the scope of the present invention, as defined in the appended Claims.

[0031] Reference is made to Figure 1, illustrating an outline view of a system of automatically controlled motion of unmanned aircraft confined within predetermined boundaries, in accordance with a preferred embodiment of the present invention.

[0032] In order to set up the boundaries of the confined zone, a plurality of reference beacons 10 is deployed, positioned at the outer limits 18 of the confined zone. In case of a rectangular zone, as shown in Figure 1, four beacons are deployed. In case of zones of different shapes, such as polygonal zones, the number of beacons deployed will correspond to the number of corners in the particular polygon (3 points for a triangular zone, 4 points for rectangular zone, 5 points for pentagonal zone etc.). The beacons 10 are adapted to transmit simultaneous signal (electromagnetic signal of high frequencies is preferable, as the higher the frequency the higher the accuracy of the system) that can be picked up by a receiver located onboard the aircraft - which, in the case of Figure 1 is an unmanned helicopter 16. Preferably, the beacons are transportable, and may be repositioned on demand. A vehicle 12 with a trailer 14 may be used as means for transporting the aircraft from place to place, as well as be served as landing platform and as fueling station (with fuel a tank provided). The aircraft in Figure 1 is adapted to fly in a predetermined combing pattern 20 so as to cover systematically the entire confined zone area.

[0033] Figures 2A and 2B depict the general features of an aircraft used in the system of the present invention. Helicopter 16 comprises a body 26 of an aircraft suitable for flying, the body provided with control means 24 that control its flight (servos controlling the helicopter's roll, elevation, yaw, rotor pitch, throttle, etc. - hereafter referred to as the controls), a motor 22 connected to a rotor 14, adapted to provide the aircraft lift and thrust needed for its flight, and a control unit 28, which controls the aircraft in flight. The helicopter is also provided with an IMU (Inertial Measurement Unit) 30 that comprises inertial sensors (gyroscopes and accelerometers) for detecting the aircraft position with respect to the perpendicular and the horizontal axis (relating to the Earth). The IMU is employed in order to detect changes in the aircraft's inclination, in order to compensate and stabilize the aircraft. Data from the IMU is processed by the control unit, and after analyzing it the control unit sends the appropriate commands to the servos 24. On the tail an antenna 34 is provided connected to the control unit of the aircraft.

[0034] Control unit 28 (see Figure 2B) comprises a receiver 32 adapted to receive signals transmitted by the beacons 10, via antenna 34. Receiver 32 is electrically connected to a central processing unit (CPU) 38. CPU 38 is adapted to receive the location data picked up by receiver 32 and determine whether the aircraft is within the predetermined boundaries defined by the beacons, and how far it is from the nearest boundary (in a manner explained herein). CPU 38 is also adapted to transmit commands to the aircraft controls 24 so as to divert the aircraft upon approaching the boundary, and alternatively it may also be provided with a programmed set of control commands, so as to command the controls and set the aircraft on a predetermined course within the boundaries (for example in a combing motion, as shown in Figure 1, or in circles or in any other predetermined course).

[0035] The control unit also comprises memory 36 (which may be a volatile memory or ROM) for storing the location data of the beacons that was registered in advance. A power unit 40 powers the control unit.

[0036] The mode of operation of the system of the present invention is hereby explained with reference to the drawings.

[0037] First the boundaries of the confined zone are determined. The operator of the system, who does not need to be a skilled technician or a trained electrician or a flyer, takes the transportable beacons and places each beacon at a corner of the desired confined zone. This can be done by driving a vehicle along the desired zone's boundaries and dropping a beacon at every corner of the zone.

[0038] Then the aircraft is positioned within the confined zone or at a predetermined location outside the zone, and the operator initiates the flight by actuating the aircraft control unit.

[0039] The aircraft position is immediately registered by the control unit with reference to the beacons, as the simultaneous signal, which is transmitted by the beacons is picked up by the receiver, and analyzed by the control unit, to determine the exact location of the aircraft. The location method of an object by a tracking system is known (for example GPS system, ultrasonic systems, laser tracking systems etc.).

[0040] The beacons' location data may be stored in memory 36. The aircraft then takes off in the confined zone (or if in the air enters the confined zone). The CPU is adapted to compare the data of the aircraft's present location with the previously obtained data regarding the beacons location, and is adapted to calculate and determine the distance of the aircraft from the boundaries of the confined zone. When the determined distance of the aircraft from the boundary reaches down to a predetermined value, be it any desired value - positive, zero or negative (if it is desired to allow the aircraft to fly within boundaries larger than the zone physically marked by the beacons, such as in the case of terrain conditions that make it impossible to position the beacons where it is desired to mark the actual boundaries), the CPU commands the controls to alter the aircraft heading, diverting its course.

[0041] The beacons transmit signals that are picked up directly by the control unit, and the control unit is adapted to determine the aircraft's speed and heading. This may be achieved by transmitting signals of predetermined frequencies from each beacon (each beacon's signal having a unique frequency). When the control unit travels away or towards each beacon the time that takes for the signal to reach from the beacon to the aircraft is proportional to the distance

from that beacon, and this feature can be analyzed to determine the aircraft's relative position with respect to the beacon, and hence determine the aircraft's location within the confined zone.

[0042] In the case of the embodiment shown in Figure 1 the CPU is further programmed to fly the aircraft in a sweeping course, where the aircraft flies in straight parallel lines, and upon approaching the boundary of the confined zone the aircraft is diverted to fly back (turning 180 degrees with respect to its previous course), in a path parallel to the path previously defined.

[0043] Figure 3A depicts another preferred embodiment of the present invention. In this embodiment, the tracking system employed is the GPS system. The GPS system is a global tracking system, based on a plurality of satellites deployed orbiting the Earth. At any given moment it is desired that at least five satellites are in view range of a given spot on earth in order to have good accuracy (in Figure 3 only three satellites 62 are depicted for brevity).

[0044] Registration of the confined zone is carried out as follows: a DGPS receiver is carried or driven by the operator of the system and positioned consecutively at each corner 60 of the desired confined zone. When positioned at each comer 60 the operator registers the GPS coordinates. The DGPS (Differential Global Positioning System), which is a commercially available, is an enhanced GPS satellite-based tracking system which has a built-in ability to correct errors caused by interferences of electromagnetic fields, atmospheric changes etc. It comprises a stationary base (which may be positioned onboard trailer 14), and a mobile unit which is mounted onboard the aircraft 16) which intercommunicate. The stationary base is capable of determining its exact location by sampling the GPS signal over time and calculating its average position (determining a correcting factor), whereas the mobile unit is registered both with the GPS and the stationary base and thus its exact location relative to the base is determined (the correcting factor is taken into account).

[0045] The DGPS stationary base is positioned in a predetermined position within the desired confined zone, or in its vicinity, whereas the mobile unit (42 see Figure 3B) is initially transported by the operator to each corner of the confined zone. The operator registers each corner of the confined zone with the DGPS mobile unit. Once the comers have been registered the mobile unit 42 is placed onboard the aircraft, where it is adapted to communicate with the CPU. The aircraft is made to take off and its position coordinates are constantly being monitored by the CPU and compared with the confined zone previously registered coordinates. If the aircraft reaches the boundary the CPU commands the controls to divert the aircraft and keep it within the confined zone.

[0046] The system of the present invention has many uses. The aircraft can be adapted to be used as a lifter, lifting loads (like a crane) in a confined zone (like a construction site, for example). The system may be used to provide boundaries for recreational model flying, so as to prevent the models going astray, or penetrating no-flight zones. The system may be used for routine aereal jobs, such as crop dusting, or banner flying (advertising), with the aircraft flying in a confined zone and sweeping the zone (as shown in Figure 1). These are but some of the tasks and purposes of the present invention, and many more uses are applicable.

[0047] The control unit may optionally be adapted to control the stability of the aircraft, its heading and elevation, using the IMU to provide data to the CPU relating to the aircraft position and orientation, and by adjusting the controls automatically upon detection of unintended diversion or inclination from the desired course.

[0048] It should be clear that the description of the embodiments and attached Figures set forth in this specification serves only for a better understanding of the invention, without limiting its scope as covered by the following Claims.

[0049] It should also be clear that a person skilled in the art, after reading the present specification could make adjustments or amendments to the attached Figures and above described embodiments that would still be covered by the following Claims.

Claims

1. A system of automatically controlling the flight of an aircraft to be confined within predetermined boundaries, the system comprising:

   Global Positioning System registration means for registering reference points located at the boundaries of a predefined zone;
   an aircraft comprising a body of an aircraft adapted for flying, the body provided with control means for controlling its flight, and a control unit, the control unit being adapted to communicate with the Global Positioning System registration means, to determine the location of the reference points and to determine the aircraft position with respect to the reference points,

   characterized in that the aircraft is an unmanned aircraft and that said control unit further is adapted to actuate the control means so as to allow the aircraft to fly only within the boundaries of the predetermined zone.

2. The system according to claim 1, wherein said Global Positioning System registration means comprise a plurality of beacons adapted to transmit signals of predetermined frequencies traceable by said control unit, and wherein said control unit is adapted to determine the location of the aircraft relative to said beacons by comparing the frequencies, by detecting changes in them and by comparing the time that takes each signal to reach the control unit.

3. The system according to claim 1, wherein said aircraft is adapted to fly in a predetermined pattern within the confined zone.

4. The system according to claim 1, wherein said aircraft is a helicopter.

5. The system according to claim 1, wherein said aircraft is adapted to be controlled with a remote control unit operated on the ground, wherein, when the system detects that the aircraft approaches the confined zone boundary, the control unit overruns the remote control unit and forces the aircraft to remain within the confined zone.

6. The system according to claim 1, wherein the registration means comprise a single portable beacon adapted to be positioned at each reference point and transmit signals traceable by the tracking system, and wherein said control unit is adapted to determine the location of the aircraft relative to the reference points.

7. A method of automatically controlling motion of an aircraft confined within predetermined boundaries, the method comprising

providing Global Positioning System registration means for registering reference points located at the boundaries of a predefined zone;
providing an aircraft comprising a body of an aircraft adapted for flying, the body provided with control means for controlling its flight, and a control unit, the control unit being adapted to communicate with the Global Positioning System registration means, to determine the location of the reference points and to determine the aircraft position with respect to the reference points,
registering the location reference points located at corners of the confined zone; and
flying the aircraft within the confined zone,

characterized in that the aircraft is unmanned and that said control unit further is adapted to actuate the control means so as to allow the aircraft to fly only within the boundaries of the predetermined zone, to compare the aircraft's location with respect to the reference points and to divert the aircraft when it approaches the boundary of the confined zone.

Patentansprüche

1. System zum automatischen Steuern des Fluges eines Luftfahrzeugs, das in vorgegebenen Grenzen gehalten werden soll, mit:

Satellitennavigationssystem-Registriermitteln zum Registrieren von Bezugspunkten, die sich an den Grenzen einer vordefinierten Zone befinden;
einem Luftfahrzeug, das einen Körper eines Luftfahrzeugs, der zum Fliegen eingerichtet ist, wobei der Körper mit Steuermitteln zum Steuern seines Fluges versehen ist, und eine Steuereinheit aufweist, wobei die Steuereinheit so eingerichtet ist, dass sie mit den Satellitennavigationssystem-Registriermitteln kommuniziert, die Lage der Bezugspunkte bestimmt und die Position des Luftfahrzeugs zu den Bezugspunkten bestimmt,

dadurch gekennzeichnet, dass das Luftfahrzeug ein unbemanntes Luftfahrzeug ist und dass die Steuereinheit weiterhin so eingerichtet ist, dass sie die Steuermittel so betätigt, dass das Luftfahrzeug nur in den Grenzen der vorgegebenen Zone fliegen kann.

2. System nach Anspruch 1, **dadurch gekennzeichnet, dass** die Satellitennavigationssystem-Registriermittel eine Vialzahl von Funkbaken aufweisen, die so eingerichtet sind, dass sie Signale vorgegebener Frequenzen senden, die von der Steuereinheit verfolgt werden können, und **dadurch gekennzeichnet, dass** die Steuereinheit so eingerichtet ist, dass sie die Lage des Luftfahrzeugs zu den Funkbaken durch Vergleichen der Frequenzen, durch Feststellen von Änderungen der Frequenzen und durch Vergleichen der Zeit, die jedes Signal zum Erreichen der

Steuereinheit braucht, bestimmt.

3. System nach Anspruch 1, **dadurch gekennzeichnet, dass** das Luftfahrzeug so eingerichtet ist, dass es in einem vorgegebenen Muster in der begrenzten Zone fliegt.

4. System nach Anspruch 1, **dadurch gekennzeichnet, dass** das Luftfahrzeug ein Hubschrauber ist.

5. System nach Anspruch 1, **dadurch gekennzeichnet, dass** das Luftfahrzeug so eingerichtet ist, dass es mit einer auf dem Boden betriebenen Fernsteuereinheit gesteuert wird, wobei, wenn das System feststellt, dass das Luftfahrzeug die Grenze der begrenzten Zone anfliegt, die Steuereinheit die Fernsteuereinheit überfährt und das Luftfahrzeug zwingt, in der begrenzten Zone zu bleiben.

6. System nach Anspruch 1, **dadurch gekennzeichnet, dass** die Registriermittel eine einzige transportable Funkbake aufweisen, die so eingerichtet ist, dass sie an jedem Bezugspunkt positioniert wird und Signale sendet, die von dem Nachführsystem verfolgt werden können, und **dadurch gekennzeichnet, dass** die Steuereinheit so eingerichtet ist, dass sie die Lage des Luftfahrzeugs zu den Bezugspunkten bestimmt.

7. Verfahren zum automatischen Steuern der Bewegung eines Luftfahrzeugs, das in vorgegebenen Grenzen gehalten wird, wobei das Verfahren Folgendes aufweist:

Vorsehen von Satellitennavigationssystem-Registriermitteln zum Registrieren von Bezugspunkten, die sich an den Grenzen einer vordefinierten Zone befinden;
Vorsehen eines Luftfahrzeugs, das einen Körper eines Luftfahrzeugs, der zum Fliegen eingerichtet ist, wobei der Körper mit Steuermitteln zum Steuern seines Fluges versehen ist, und eine Steuereinheit aufweist, wobei die Steuereinheit so eingerichtet ist, dass sie mit den Satellitennavigationssystem-Registriermitteln kommuniziert, die Lage der Bezugspunkte bestimmt und die Position des Luftfahrzeugs zu den Bezugspunkten bestimmt;
Registrieren der Lage-Bezugspunkte, die sich an Ecken der begrenzten Zone befinden; und
Fliegen des Luftfahrzeugs in der begrenzten Zone,

dadurch gekennzeichnet, dass das Luftfahrzeug unbemannt ist und dass die Steuereinheit weiterhin so eingerichtet ist, dass sie die Steuermittel so betätigt, dass das Luftfahrzeug nur in den Grenzen der vorgegebenen Zone fliegen kann, dass sie die Lage des Luftfahrzeugs zu den Bezugspunkten vergleicht und dass sie das Luftfahrzeug umleitet, wenn es die Grenze der begrenzten Zone anfliegt.

Revendications

1. Système de commande automatique du vol d'un aéronef devant être limité à l'intérieur de limites prédéterminées, le système comprenant :

un moyen d'enregistrement de système de positionnement global destiné à enregistrer des points de référence situés aux limites d'une zone prédéfinie,
un aéronef comprenant un corps d'aéronef conçu pour voler, le corps étant muni d'un moyen de commande destiné à commander son vol, et une unité de commande, l'unité de commande étant conçue pour communiquer avec le moyen d'enregistrement du système de positionnement global, pour déterminer la localisation des points de référence et pour déterminer la position de l'aéronef par rapport aux points de référence,.

caractérisé en ce que l'aéronef est un drone et que ladite unité de commande est en outre conçue pour actionner le moyen de commande de façon à permettre à l'aéronef de ne voler qu'à l'intérieur des limites de la zone prédéterminée.

2. Système selon la revendication 1, dans lequel ledit moyen d'enregistrement de système de positionnement global comprend une pluralité de balises conçues pour émettre des signaux à des fréquences prédéterminées pouvant être suivies par ladite unité de commande, et dans lequel ladite unité de commande est conçue pour déterminer la localisation de l'aéronef par rapport auxdites balises en comparant les fréquences, en détectant des changements de celles-ci et en comparant le temps qu'il faut à chaque signal pour atteindre l'unité de commande.

3. Système selon la revendication 1, dans lequel ledit aéronef est conçu pour voler suivant une trajectoire prédéterminée à l'intérieur de la zone limitée.

4. Système selon la revendication 1, dans lequel ledit aéronef est un hélicoptère.

5. Système selon la revendication 1, dans lequel ledit aéronef est conçu pour être commandé par une unité de commande à distance actionnée au sol, où, lorsque le système détecte que l'aéronef se rapproche de la limite de la zone limitée, l'unité de commande prend le pas sur l'unité de commande à distance et force l'aéronef à rester à l'intérieur de la zone limitée.

6. Système selon la revendication 1, dans lequel le moyen d'enregistrement comprend une seule balise portative conçue pour être positionnée à chaque point de référence et émettre des signaux pouvant être suivis par le système de suivi, et dans lequel ladite unité de commande est conçue pour déterminer la localisation de l'aéronef par rapport aux points de référence.

7. Procédé de commande automatique du mouvement d'un aéronef limité à l'intérieur de limites prédéterminées, le procédé comprenant les étapes suivantes

fournir un moyen d'enregistrement du système de positionnement global destiné à enregistrer des points de référence localisés aux limites d'une zone prédéfinie,
fournir un aéronef comprenant un corps d'aéronef conçu pour voler, le corps étant muni d'un moyen de commande destiné à commander son vol, et d'une unité de commande, l'unité de commande étant conçue pour communiquer avec le moyen d'enregistrement du système de positionnement global, pour déterminer l'emplacement des points de référence et pour déterminer la position de l'aéronef par rapport aux points de référence,
enregistrer les points de référence de localisation localisés aux coins de la zone limitée, et
faire voler l'aéronef à l'intérieur de la zone limitée,

caractérisé en ce que l'aéronef est un drone et **en ce que** ladite unité de commande est en outre conçue pour actionner le moyen de commande de façon à permettre à l'aéronef de voler uniquement à l'intérieur des limites de la zone prédéfinie, comparer la localisation de l'aéronef par rapport aux points de référence et faire dévier l'aéronef lorsqu'il se rapproche de la limite de la zone limitée.

Fig. 1

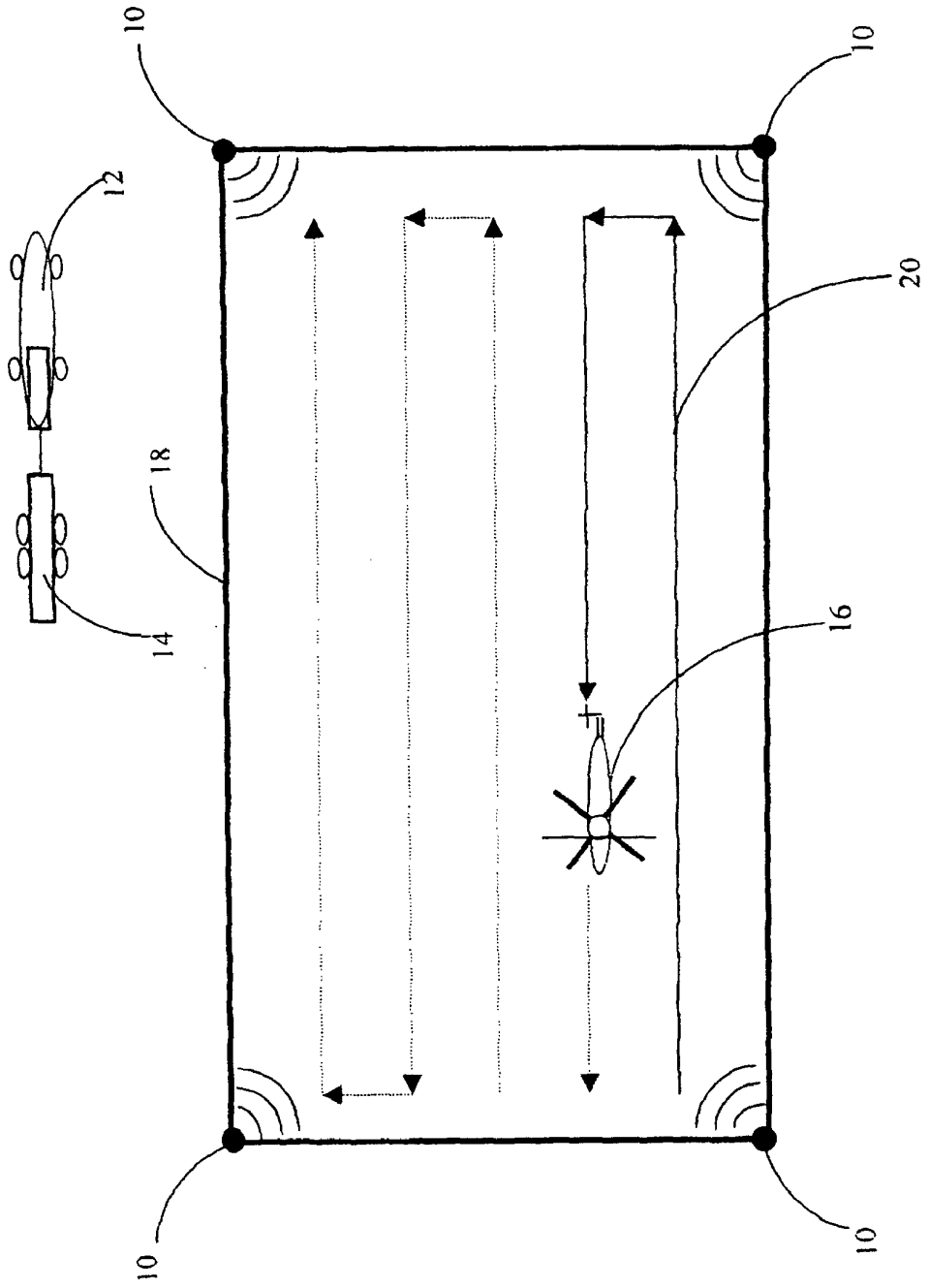


Fig 2A

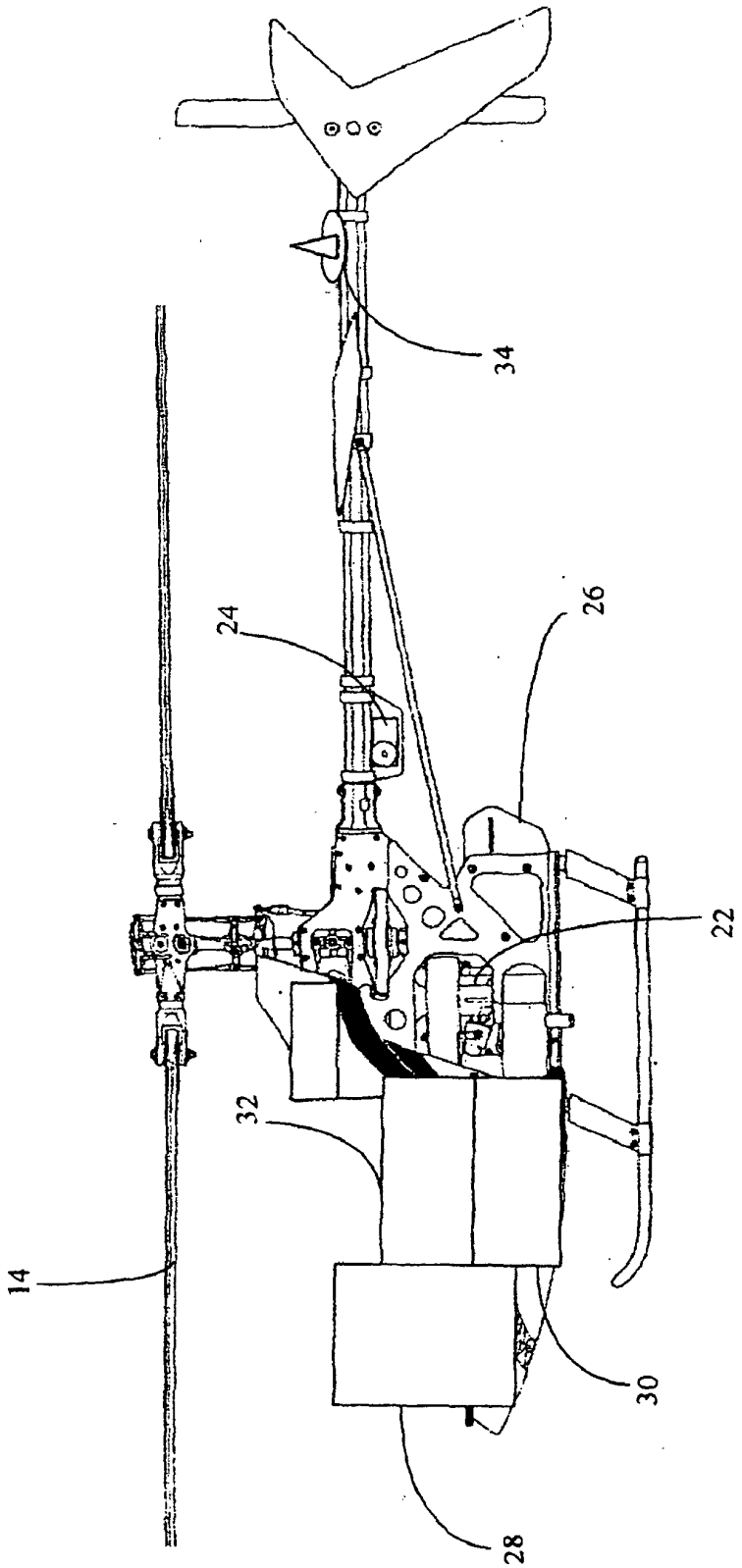
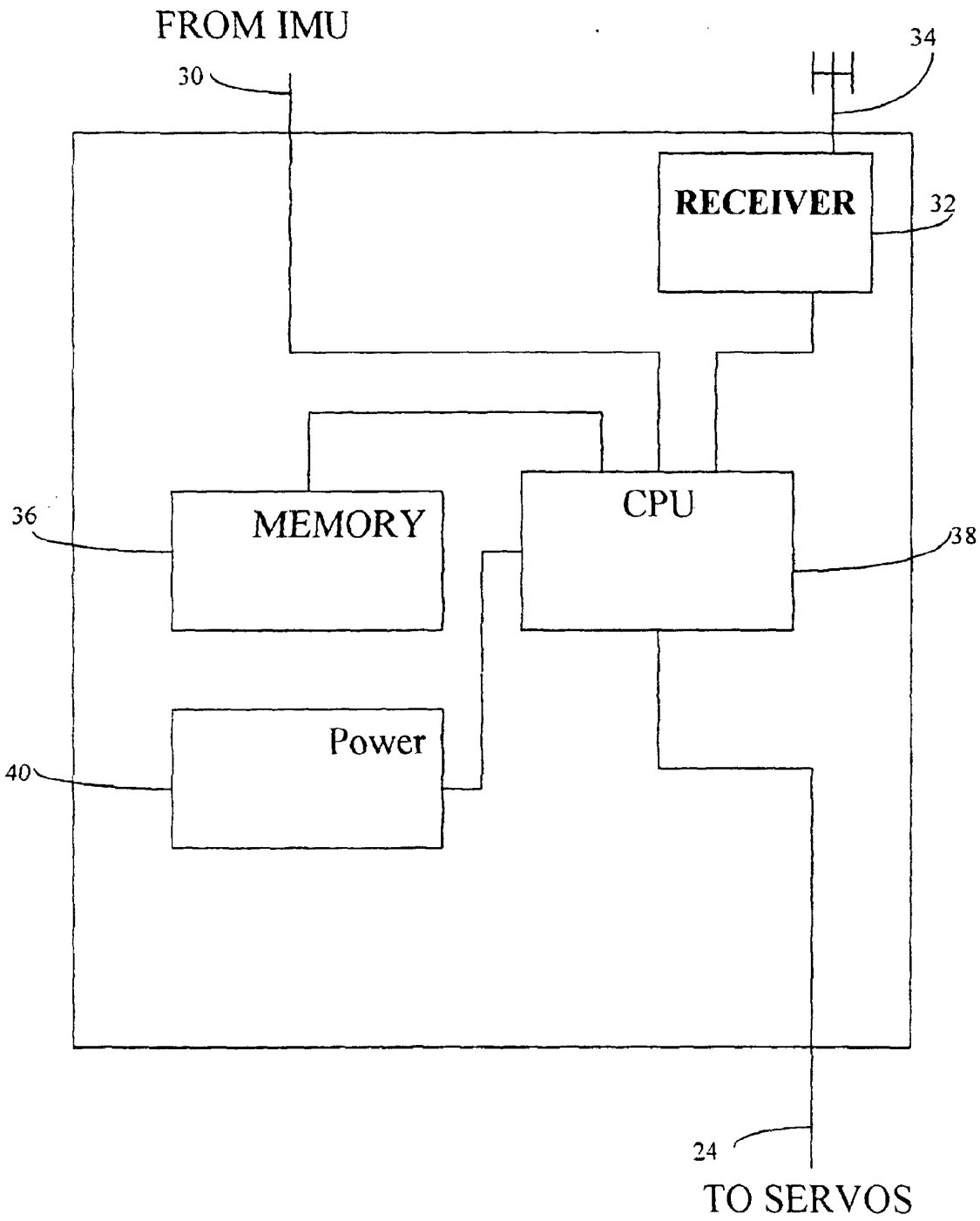


Fig 2B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CPU
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TO SERVOS

Fig. 3A

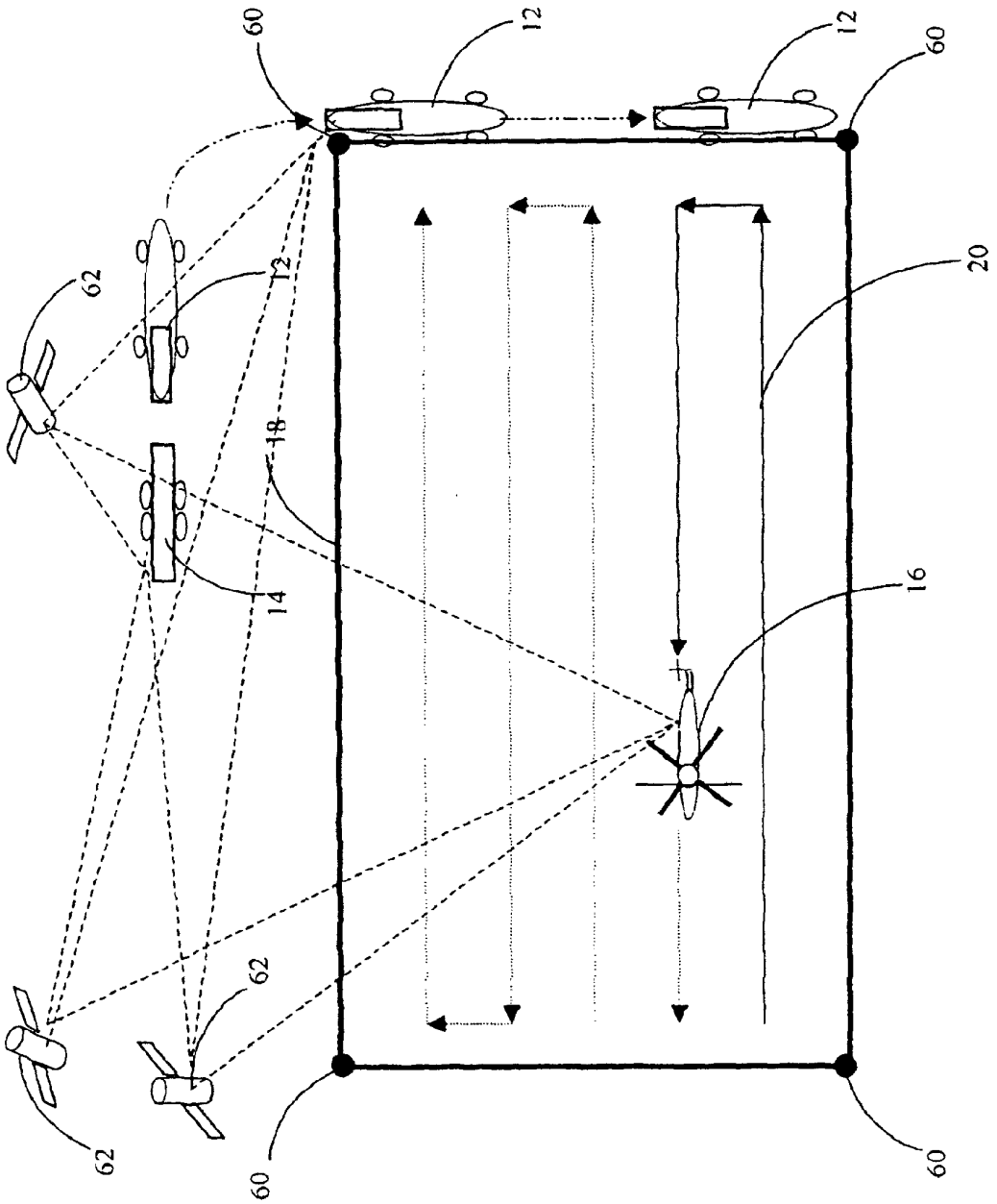
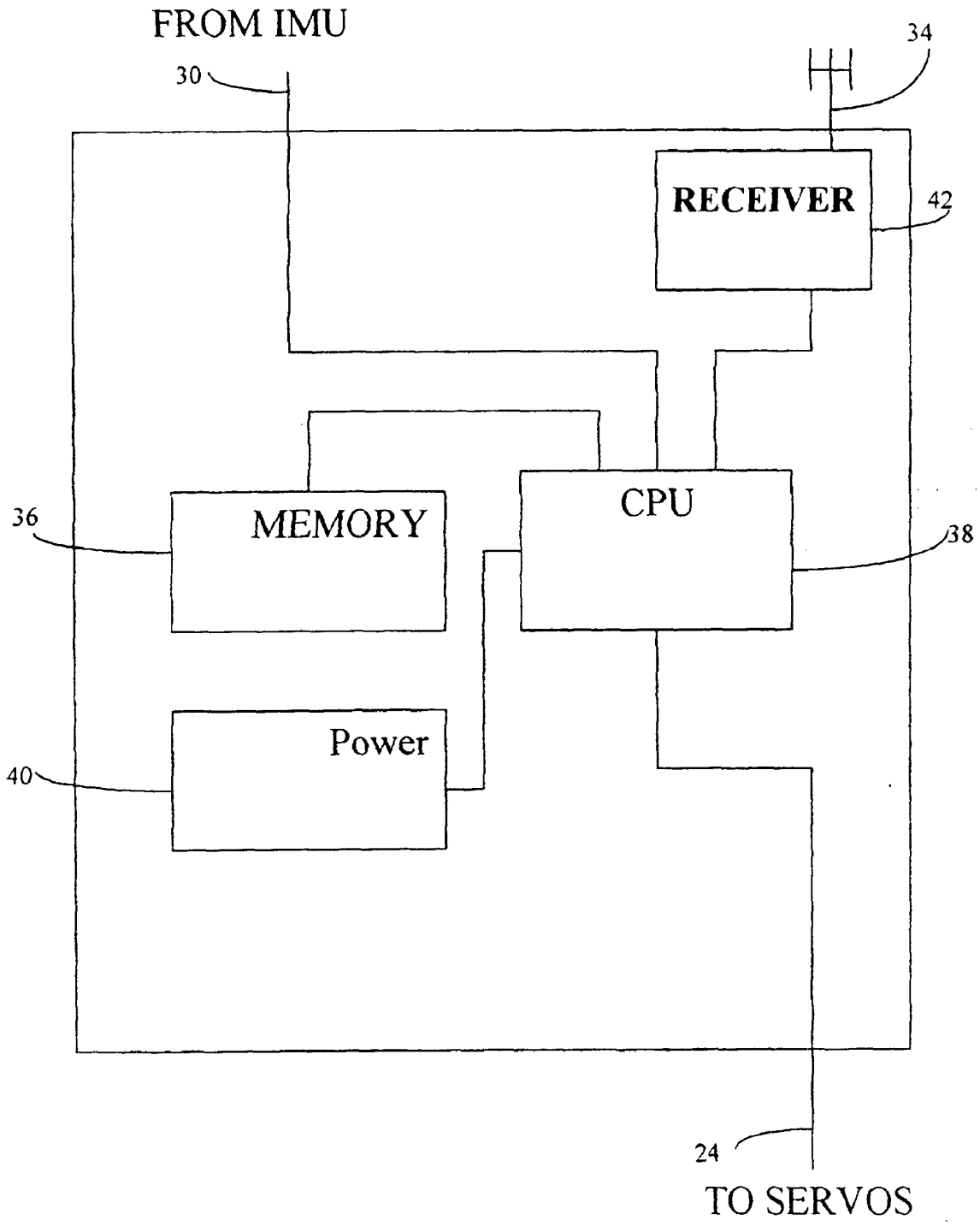


Fig 3B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