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Automatic stabilization system of the UAV at gas-dynamic method takeoff and landing

Automatic stabilization system is based on special construction of gas-dynamic device, namely, each of the gas-dynamic plants: the main and auxiliary, has a matrix structure, with each element of the matrix independent of other, i.e. each element of the matrix creates own air jet.

Construction and peculiarities of the automatic stabilization system

The systems, which realizes the gas-dynamic method, are characterized a mobility and compactness among other systems and methods of UAV takeoff and landing without airfield [1-3]. From other wise, this method allows increase of payload for the flying vehicles with design of airplane on weight of chassis and devices, which provide its working.

However, there is one technical problem on a way of realization this method on the practice. Namely, it is the UAV stabilization on stages of takeoff and landing at small flight velocities, when aerodynamic surfaces are not effective. Installing the jet controls only for decision of given task is not rationally.

Technical solution, which is proposed in this work, is based on Patent [4].

The task is solved by the fact that the system of automatic stabilization of the aircraft with its gas-dynamic take-off and landing, which consists of a carrier platform, control unit, ground radio equipment, contains a block of sensors of the UAV position relative to the carrier platform, connected to ground radio equipment, three-stage block of the corner UAV position with roll, yaw and pitch sensors, which is located on the UAV and connected to the radio communication device, and each of the gas-dynamic plants: the main and auxiliary, has a matrix structure, with each element of the matrix independent of other, i.e. each element of the matrix creates own air jet.

Before take-off in the stabilization system of the UAV, the given take-off angles of the roll, yaw and pitch are set. Upon the take-off of the UAV, the artificial air flow (AFF) is created in such a way that it is directed vertically upwards and has the required speed so that the UAV starts to rise upwards under the action of the ram-air flow. When lifting UAV, signals from the block of UAV position sensors, which are proportional to the flying angles of the roll, yaw and pitch, are fed to the comparison unit. In case of the UAV deviation from a given position, signals are transmitted using the radio communication device to the control unit of the ground equipment, after which a redistribution of the velocity field of the AAF from the auxiliary gas-dynamic device (GDD) is carried out. Redistribution of the field of speed of the AAF occurs in such a way as to eliminate the deviation of the UAV from the given position without changing the total speed pressure on the UAV in the given direction.

When the UAV reaches the middle of the platform, a signal from the block of sensors of the UAV position relative to the carrier platform, simultaneously activates the air jets on the main GDD and engines of the UAV. In the long run, according to the programmatic trajectory of movement, the UAV is accelerated in a horizontal plane to a given value, and stabilization of the angular position is carried out at the expense of the AAF matrix.

The functional scheme of the automatic stabilization system of the aircraft (Fig. 1.) with its gas-dynamic take-off and landing contains a carrier platform 1, which houses the main 2 and auxiliary 3 matrix type GDDs, control unit 4, connected on the one hand with the ground equipment of the radiocommunication 5, and on the other with a sensor unit 6 for measuring the position of the UAV 7 relative to the carrier platform 1. In addition, the control unit 4 is connected to the main 2 and the auxiliary 3 matrix type GDDs.

The aircraft 7 for automatic stabilization during take-off and landing comprises a control system 8, which is connected to the setting device of the roll, yaw and pitch angles 9, with the block of 10 angular position sensors and angular velocities of the UAV 7, with the equipment of the radio communication 11, and the block 12 compares the signals from the setting device of the roll, yaw and pitch angles 9 and from the block 10 of the angular position sensors and the angular velocities of the UAV 7. When the UAV deviates from the set angle position from the block 12, a signal is sent to the control system 8, otherwise a signal is sent to the data registration unit 13.

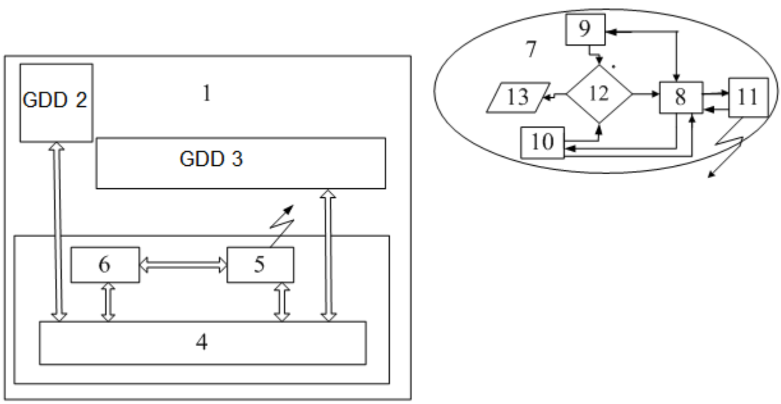

Fig. 1. Functional scheme of the system of automatic stabilization of the aircraft with its gas-dynamic take-off and landing

The main matrix type GDD 2 at the UAV 7 take-off (Fig. 2.) contains N sources of air jets (in fig. 2 the number N=50) each of which is an integral part of the main GDD 2, and perpendicular to the main GDD 2 an auxiliary GDD 3 and a perforated plate 16 are placed, and the aircraft 7 (front view) is in the air flow of the main GDD

2, which creates twenty-eight sources of air jets of the main GDD 2, and this jet is limited to an elliptic curve 14.

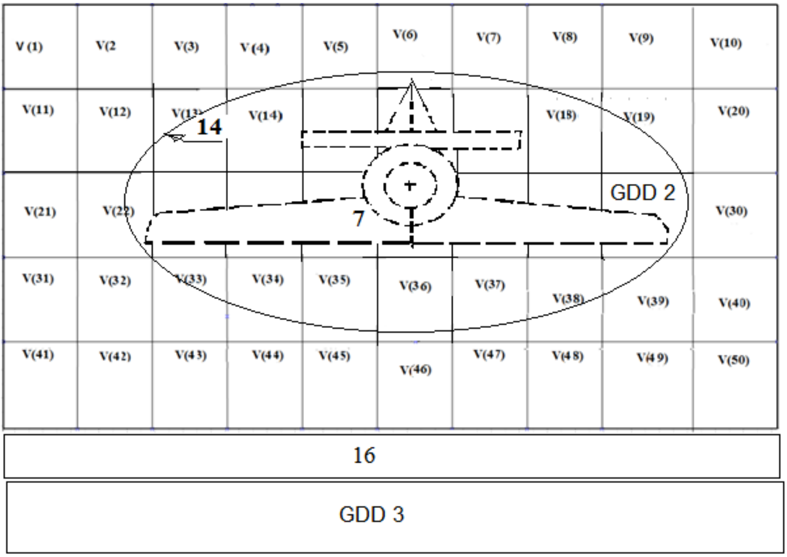

Fig. 2. The main matrix type GDD at the take-off of the UAV

The auxiliary matrix type GDD 3 at the UAV 7 landing (Fig. 3) contains the *M* air jet sources (in Fig. 3, the number *M*=50), each of which is an integral part of the auxiliary GDD 3, and the main GDD 2 is located perpendicular to the auxiliary GDD 3 and the perforated plate 17, and the aircraft 7 (top view) is in the air jet from the GDD 2, which creates thirty-five sources of air jets, and this total jet is limited to the elliptic curve 15.

The automatic stabilization system of the aircraft 7 with its gas-dynamic take-off and landing operates as follows. During the take-off of the UAV 7 which is in stationary position before take-off on the perforated plate 16 of the platform 1, an auxiliary GDD 3 is launched on command from the control panel 4, which can parry the deviation of the UAV 7 from the set position on the roll and the pitch.

After a setting from the control system 8 to the setting device 9 of the roll, yaw, and pitch and lifting of the UAV 7 over the perforated plate 16 at a given height, the main GDD 2 is started which can parry the deviation of the UAV 7 from the set position by the yaw.

When the UAV 7 deviates from a set position by yaw, that is, at the discrepancy between the set yaw angle from the block 9 and the measured yaw angle from the block 10, the signal from the signal comparison unit 12 is output to the radio equipment 11. The signal from the unit 11 is received by the ground equipment of the radiocommunication 5 and transmitted to the control unit 4, from which a signal is sent to the main GDD 2 to parry deviation of the UAV 7 from a set position of yaw by changing the values of velocities $V(23)$, $V(24)$, $V(25)$ relative velocity values $V(27)$, $V(28)$, $V(29)$. In this case, the total velocity of the air, forming the sources of air jets of the main GDD 2, which are limited to the elliptic curve 14, remains unchanged.

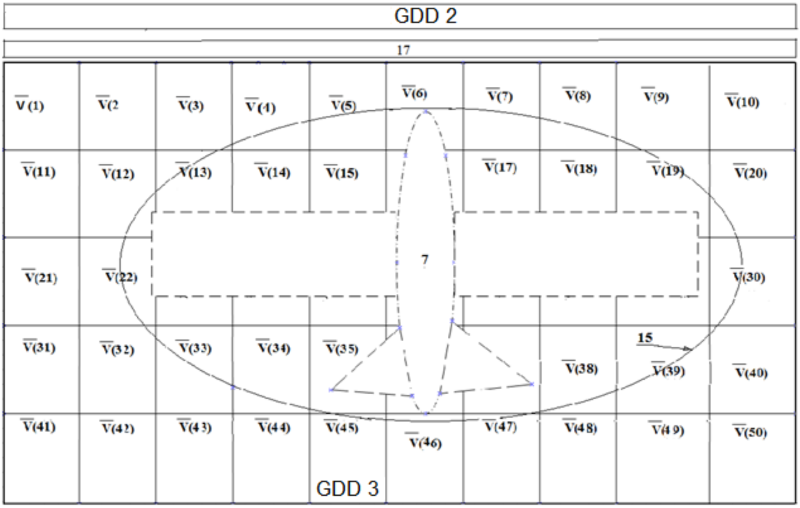

Fig. 3. The auxiliary matrix type GDD during UAV landing

When the UAV 7 deviates from a set position by roll, that is, at the discrepancy between the set roll angle from the block 9 and the measured roll angle from the block 10, the radio communication equipment 11 outputs a signal from the signal comparison unit 12. The signal from the unit 11 is received by the ground equipment of the radiocommunication 5 and transmitted to the control unit 4, from which a signal is sent to the auxiliary GDD 3 to parry deviation of the UAV 7 from a set position by roll due to changes in velocity values $\bar{V}(13),\bar{V}(14),\bar{V}(15),\bar{V}(23),\bar{V}(24),\bar{V}(25)$ relative velocity values $\bar{V}(17),\bar{V}(18),\bar{V}(19),\bar{V}(27),\bar{V}(28),\bar{V}(29)$. In this case, the total velocity of the air that forms the air jets of the auxiliary GDD 3, which are limited by the elliptic curve 15, remains unchanged.

In the absence of a deviation from the specified angle position of the UAV 7 signals from the signal comparison unit 12 are sent to the data registration unit 13.

For the prevention of emergencies during gas-dynamic take-off and landing, for example, when the UAV 7 approaches to the perforated plate 17, from the block of sensors 6 to measure the position of the UAV 7 relative to the carrier platform 1, on the control unit 4 a signal for change of the air jets of the main GDD 2 and the auxiliary GDD 3 or to control the movement of the UAV 7 through radio communication is sent.

This system can be used for automatic stabilization of UAV 7 at its gas-dynamic take-off and landing. When performing these operations, the sources of air jets of the matrix type of the main GDD 2 and the auxiliary GDD 3 may be used more rationally than when using single source air jets of the main GDD 2 and the auxiliary GDD 3. For example, as follows from Fig. 2, there are actually only twelve air jet sources in place to ensure coverage of the entire plane of the UAV 7 in the cross section.

The choice of the design parameters of the UAV's takeoff and landing system depends on the choice of a particular type of UAV and the selected elements of the GDD of the device for take-off and landing.

With aim of operating capacity checking for proposed technical solution a mathematical model and algorithm for calculation of UAV motion at GDD is developed. Also, conducted calculation of the angular motion of the UAV with given aerodynamic characteristics with the included angular stabilization system is executed.

References

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