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A.V. Bondar, E.S. Plakhotniuk
(National Aviation University, Ukraine)

EVALUATION OF THE STABILITY DERIVATIVES IN A LONGITUDINAL, LATERAL AND TRANSVERSE MOTION OF THE UNMANNED AERIAL VEHICLE IN THE CURVILINEAR FLIGHT WITH ROTATION

The results of evaluation of the stability derivatives in the longitudinal, lateral and transverse movement of the curvilinear flight to the rotation of the example of unmanned aerial vehicle

Evaluation of stability derivatives in the longitudinal and lateral movement of unmanned aerial vehicle is required to determine the dynamic stability and control characteristics, the development of automatic control systems, mathematical modeling of the flight simulator for use in equipment and certification.

In Fig. 1 shows a general view adopted for the calculation scheme unmanned aerial vehicle. As the figure shows this aircraft is a unit normal scheme with a high wing, vertical tail fin of the two. Therefore, to assess the stability of the derivatives in the longitudinal and lateral movement in the curvilinear flight to the rotation will use the well-known approach to the classical scheme of the aircraft.

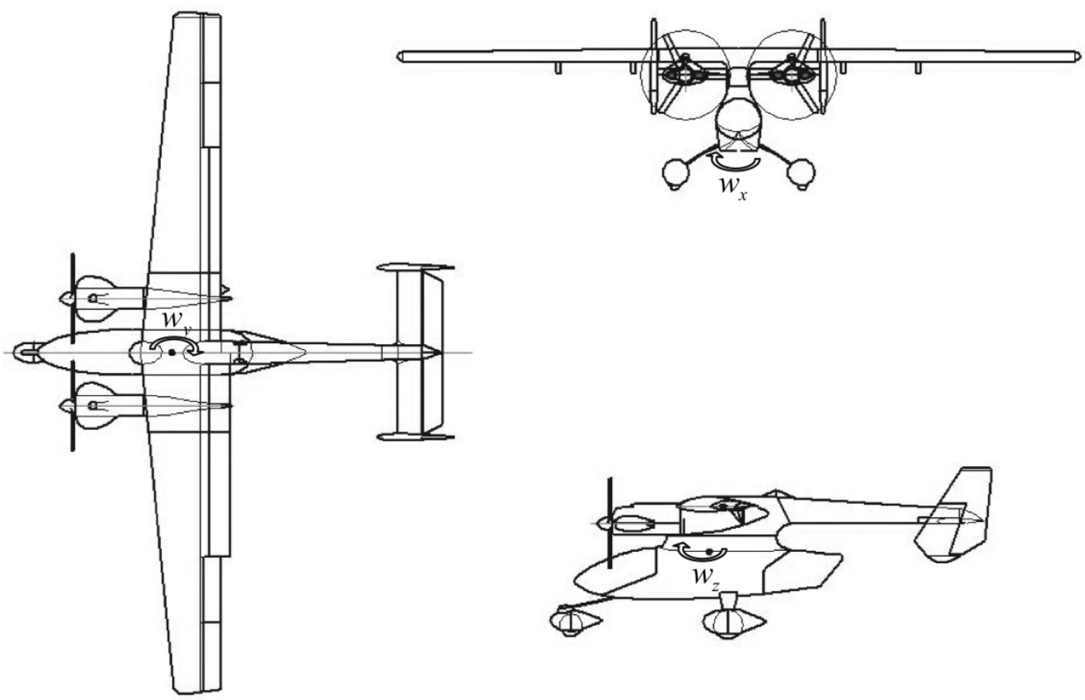

Fig. 1. The General view of the unmanned aerial vehicle

To determine the aerodynamic derivatives of unmanned aerial vehicle used by the classical approach [1] and the formulas of [2], [3].

The paper presents the results of calculations of the following derivatives:

$m_{z\,кр.}^{\overline{w}_z}$ - a wing;

$m_{z\,Г.О.}^{\overline{w}_z}$ - a horizontal tail;

$m_{z}^{\overline{w}_z}$ - the resulting damping factor;

$m_{z}^{\overline{\dot{\alpha}}}$ - derivative of pitching moment on $\dot{\alpha}$;

$m_y^{\overline{w}_y}$ - yaw damping coefficient;

$m_x^{\overline{w}_x}$ - roll damping coefficient;

$m_x^{\overline{w}_y}$ - roll damping during rotation.

The coefficients are determined without taking into account the wing propellers blowing at various angles of attack, flap and elevator. The results are shown in Fig. 2 (a-f) without blasting. The developed program allows you to analyze the influence of various factors on the magnitude of the coefficients.

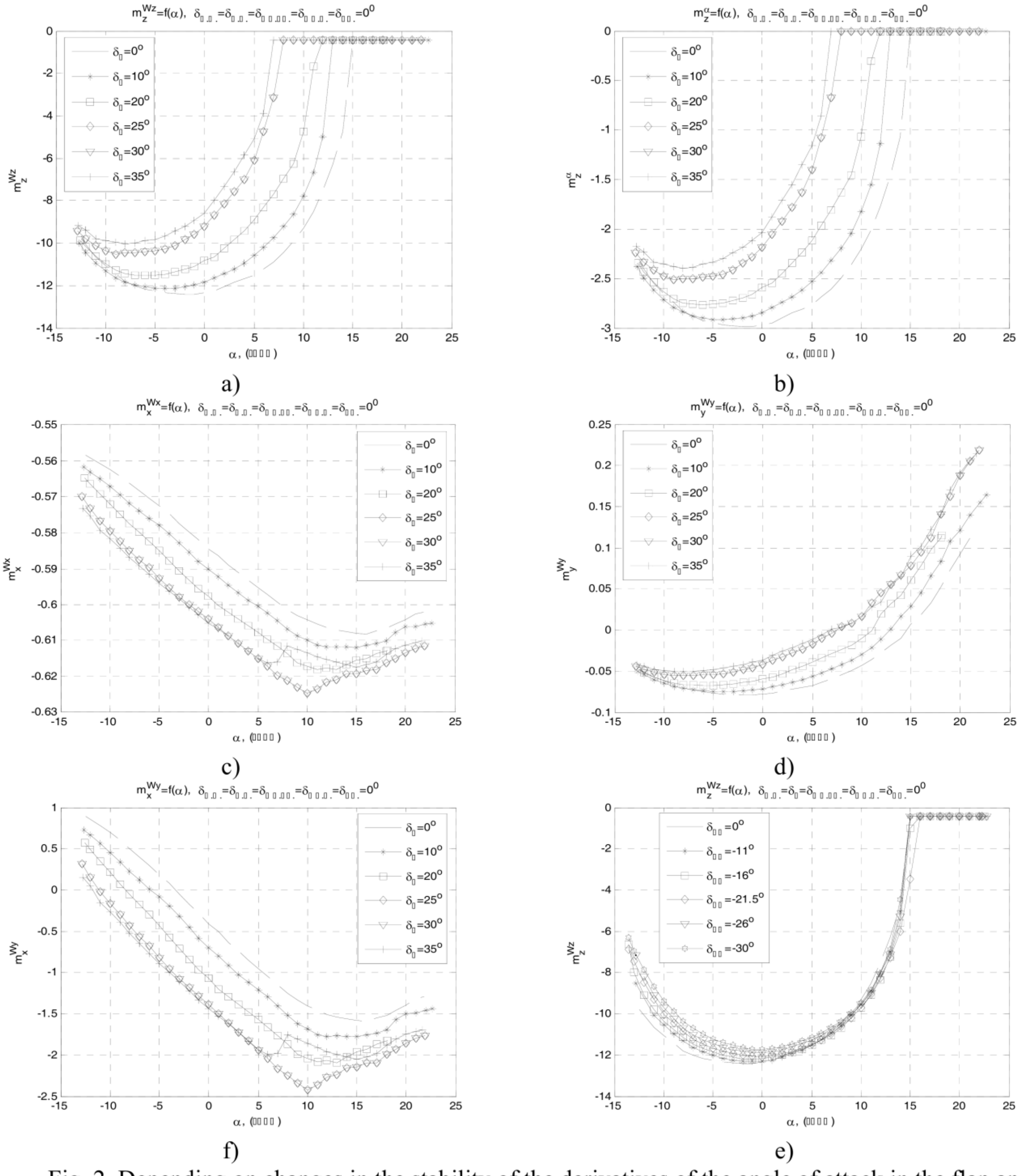

Fig. 2. Depending on changes in the stability of the derivatives of the angle of attack in the flap and elevator

Here is an example of estimating the coefficients of the stability derivatives in the longitudinal, lateral and transverse movement of the curvilinear flight with rotation. The initial data for the calculation shall use the following: $c_y^{\alpha} = 5.02(1/\text{рад})$; $\bar{x}_T = 0{,}249$; $\lambda = 10{,}8$; $\chi = 4{,}3^{\circ}$;

$c^{б}_{Г.О.} = 4{,}3(1/рад)$; $S_{Г.О.} = 0{,}56(м^2)$; $L_{Г.О.} = 2{,}25(м)$; $S = 3{,}34(м^2)$; $b_A = 0{,}57(м)$; $B = 0{,}55$; $a = 0{,}075$; $S_{BO} = 0{,}7(м^2)$; $L_{BO} = 1{,}936(м)$; $l = 6(м)$; $k_{BO} = k$; $\lambda_{BO} = 1{,}4$; $\chi_{BO} = 30^{\circ}$; $\alpha = 6^{\circ}$; $\eta = 1{,}72$; $B = 0{,}55$; $D = 3{,}99$.

We consider two cases of flight conditions, taking into account the first case of blowing tail propellers propulsion of the aircraft, the second without blowing (engine failure). For both cases the adopted altitude 3000 (m), speed is equal to 34.8 (m / s). The following are calculated values derived resistance:

1) taking into account the propellers blowing ($c_x = 0{,}08$; $c_y = 0{,}97$; $k_э = 0{,}8$):

$m_{z\,кр.}^{\overline{w}_z} = $-0,44;

$m_z^{\overline{\dot{\alpha}}} = $-2,98;

$m_{z\,Г.О.}^{\overline{w}_z} = $-9,96;

$m_y^{\overline{w}_y} = $-0,06;

$m_z^{\overline{w}_z} = $-12,39;

$m_x^{\overline{w}_x} = $-1,98;

$m_x^{\overline{w}_y} = $-1,23

2) without blowing propellers ($c_x = 0{,}07$; $c_y = 0{,}83$; $k = 0{,}66$):

$m_{z\,кр.}^{\overline{w}_z} = $-0,44;

$m_z^{\overline{\dot{\alpha}}} = $-2,69;

$m_{z\,Г.О.}^{\overline{w}_z} = $-8,99;

$m_y^{\overline{w}_y} = $-0,06;

$m_z^{\overline{w}_z} = $-11,23;

$m_x^{\overline{w}_x} = $-1,78;

$m_x^{\overline{w}_y} = $-1,05

Conclusions

1. Shown method for estimating stability derivatives in the longitudinal, lateral and transverse movement of unmanned aerial vehicle flight in the curvilinear to the rotation can be used to profit the design of new unmanned vehicles;

2. The obtained results of calculations on the example of a specific unmanned aerial vehicle made it possible to establish the range of variation of stability derivatives;

3. The analysis of the results, which gave the opportunity to show the nature of the relationship between derivatives and the stability of the parameters of motion device;

4. These results agreed well with results obtained by other authors [1], [2], [3].

References

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