UDC 681.5

IDENTIFICATION OF UAV MODEL FOR ROLL ANGLE

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Identification. The identification may be of two types: structural identification, when one finds the structure of the object's mathematical description, or parameter identification, when the values of parameters comprising the model's equation are determined for a known structure [1].

The scope of identification is to determine, based on observing the input u(t) and output y(t) signals at a certain period of time, the type of the operator connecting the input and the theoretical output signals. Before the experimental research, a pretest analysis of the list of input variables is made in order to choose and to include into the model the priority (or limiting) variables that exercise the strongest influence on the output variables y(t). First of all, controlling input variables are included, with help of which regulating action is performed over the operated object [2].

During identification, we'll comply with the following requirements:

1) The obtained model of the unmanned aerial vehicle as transfer function should reproduce the response data as precisely as possible;

2) The obtained model of unmanned aerial vehicle should approximate the response data as precisely as possible (by more than 99%).

Using the ident function of the MATLAB package, we obtain the transient graphs for the roll (Fig. 3 and Fig. 4) and the corresponding transfer functions.

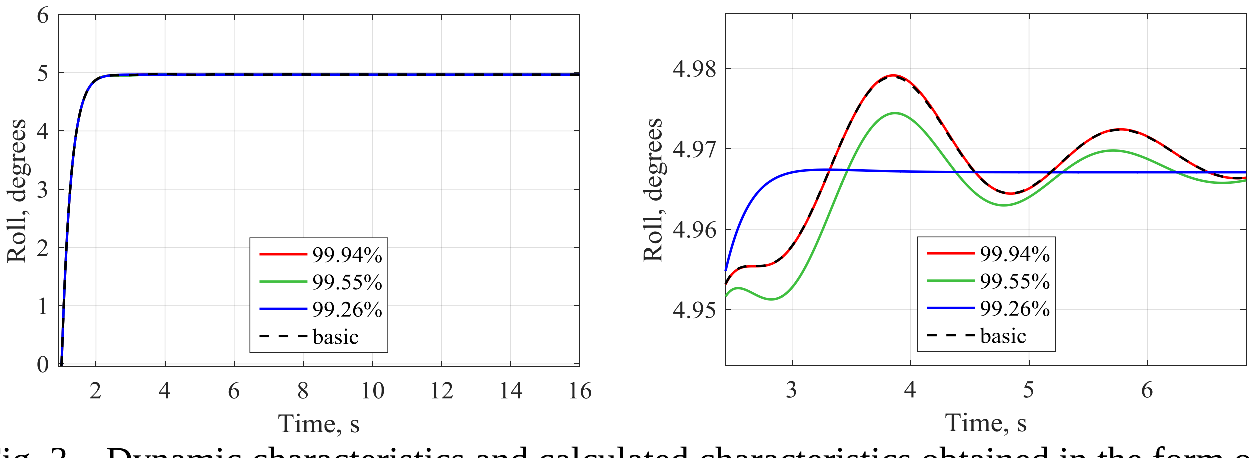

Fig. 3 – Dynamic characteristics and calculated characteristics obtained in the form of transfer functions with respect to the bank angle 5 degrees.

Transfer functions for roll:

$$W(s) = \frac{0.3543s^2 + 478s + 1612}{s^3 + 135.9s^2 + 913s + 1623} -- 99.26\%;$$

$$W(s) = \frac{1.156s^3 + 308.5s^2 + 369.9s + 3685}{s^4 + 86.23s^3 + 420.3s^2 + 1370s + 3709} -- 99.55\%;$$

$$W(s)=\frac{0.9065s^6+356.5s^5+888.8s^4+4789s^3+}{s^7+100.7s^6+612.8s^5+2213s^4+6573s^3+}$$
$$\frac{+6431s^2+4123s+349.9}{+7587s^2+4243s+352.3}--99.94\%.$$

Robust stability. Kharitonov's theorem. In order for a system with a characteristic polynomial $Q(\lambda)=a_0\lambda^n+a_1\lambda^{n-1}+...+a_n$ to be robustly stable on the set $A=\{a:\underline{a}_i\le a_i\le\overline{a}_i \quad i=0,1,...,n\}$, it is necessary and sufficient that all Kharitonov polynomials are stable [3].

For roll angle:

$$Q(\lambda)=0.0028\lambda^7+0.29\lambda^6+1.74\lambda^5+6.3\lambda^4+$$
$$+18.7\lambda^3+21.5\lambda^2+12\lambda+1.$$

Coefficients of the characteristic equation for the angle of roll in the range of ± 10%:

$$0.00252\le a_0\le 0.00308;$$
$$0.261\le a_1\le 0.319;$$
$$1.6\le a_2\le 1.914;$$
$$5.7\le a_3\le 6.93;$$
$$16.8\le a_4\le 20.6;$$
$$19.4\le a_5\le 23.7;$$
$$10.8\le a_6\le 13.2;$$
$$0.9\le a_7\le 1.1.$$

Kharitonov polynomials:

$$Q_1(\lambda)=2604.3>0;$$
$$Q_2(\lambda)=3131.6>0;$$
$$Q_3(\lambda)=379.12>0;$$
$$Q_4(\lambda)=355.79>0.$$

The obtained model of unmanned aerial vehicle as transfer functions for was verified for conformity by comparing the response of the model with that of the real system to one and the same action.

It was further established that since the Kharitonov polynomials for the resulting transfer functions are> 0, the model is robustly stable, in the range of variation of the coefficients of the characteristic equation ± 10%.

References

1. Grop D. Metody identifikatsii sistem // D. Grop. – Moscow: Mir. – 1979. – 302 p.
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3. Kim D.P. Collection of problems on the theory of automatic control. Linear systems // D.P. Kim, N.D. Dmitrieva. – Moscow: FIZMATLIT. – 2007. – 168 p.