EVALUATION OF THE INERTIA OF THE CHANGE IN THE SPEED OF ROTATION OF THE LIFTING ROTORS ON THE DYNAMICS OF THE MOTION OF A HEAVY QUADROCOPTER

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Unlike a helicopter, which uses a swashplate for control, which changes direction of the lifting rotor thrust, and the total pitch and adequately the magnitude of the rotor thrust, in the quadcopter (QC) the thrust direction relative to the body and the pitch of the rotor blades are unchanged.

To change the flight trajectory or angular orientation of the quadcopter, the rotation speed and, accordingly, the magnitudes of the thrust of all four rotors change in a certain way. Thus, the control of QC is reduced to the control of the rotor rotation speed, which greatly simplifies the design of the control system.

When analyzing the dynamics of the controlled motion of a miniature QC, the inertia of the change in the rotor speed is usually ignored. However, there is also "heavy" QC [2], the total weight of which is about 15 ... 20 kg and which have massive lifting rotor blades with a large span. Naturally, the inertia of change in the speed of rotation of such rotors can significantly affect the quality of control of the QC.

The purpose of this work is to study the effect of the time delay of the change in the lifting rotational speed of the rotor on the dynamics of automatic control loops QC. PD-control based control loops were used to investigate automatic QC motion control. Matlab Simulink software environment was used for mathematical modeling.

The simulation results show that the inertance effect of control is especially pronounced in the pitch angle control loop and manifests itself in an increase of the transient process oscillativity. The flight altitude control loop is practically not affected by the control inertia.

Efforts to eliminate this effect by increasing the portion of the damping signal leads to the fact that an exponential component appears in the transient process, on which the oscillatory component is superimposed.

The paper proposes to eliminate the inertance effect of control by introducing a forcing component $K_{p\omega z}\,(p+1)/(0{,}1p+1)$ into the signal circuit of the angular velocity sensor. The proposed variants of control laws eliminate the influence of the control inertance effect.

References:

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