ABSTRACT

Influence of the construction parameters of the unmanned aerial vehicle in gyrodyne configuration on its energy consumption essential for monitoring of linear-punctual infrastructure

The PhD thesis refers to experimental and numerical aerodynamic characteristics of the unmanned aerial vehicle in the gyrodyne configuration.

Demand on new, more efficient solutions for unmanned aerial vehicle (UAV) is in constant crescent. The particular situations for which UAV can be applied are linear-punctual monitoring missions, namely aerial power line, gas pipes, railway infrastructure. These missions consist of two phases of flight: hover on characteristic spots (e.g. electric towers) and forward flight between characteristic points. Insufficient performances of hitherto used UAVs in various aerodynamic configurations constituted a barrier for their broad use in that type of missions. A solution for this problem might be an adoption of thus far not used aerodynamic gyrodyne configuration.

From the conducted study of literature emerges lack of approachable data relating to gyrodyne aerodynamic for small Reynolds numbers and low rotor advance ratio corresponding to the mission's specificity and UAVs size of the mass up to 25 kilograms. Therefore, to answer the question whether the energy consumption of gyrodyne which transfers on the time and range of flight is better than in the currently used solutions it was necessary to conduct research on its aerodynamic characteristics in hover and forward flight. As part of work, both wind tunnel experiments and numerical analysis of aerodynamic characteristics were carried out. Those tests were concentrated on specifying the impact of position and wing incidence on forward flight and hover characteristics of gyrodyne. The tunnel tests were performed on specially in this purpose designed and built model. Numerical calculations were executed in Fluent with the use of rotors modeling with the VBM module tool. Results of the numerical analysis were consistent with experimental tests and allowed for more detailed analysis of the interferation phenomenon between wing and rotor in state of autorotation.

The research outcomes confirmed the significant impact of wing position and angle of incidence on gyrodyne aerodynamical characteristics alike in the hover and in forward flight. The bigger was a distance between wings and rotor the better aerodynamic gyrodyne characteristics arised.

On the basis of determined numerical characteristics the energy demand for the helicopter and gyrodyne systems was calculated for the hypothetical mission of linear-punctual infrastructure test. It was stated that in the mission where the time of hover and forward flight are equal gyrodyne has a lower energy demand than a helicopter by about 10%.

Key words:

UAV, gyrodyne, tunnel tests, CFD analysis, VBM, aerodynamic interference.