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Composite compensation control method for airborne opto-electronic platform mounted on multi-rotor UAV

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Airborne opto-electronic platform mounted on multi-rotor unmanned aerial vehicle.

Abstract: Recently, multi-rotor unmanned aerial vehicle (MUAV) has been widely used in military and civilian fields. Airborne opto-electronic platform (AOEP) is the key to the application of MUAV, such as target reconnaissance, identification and tracking. The imaging quality, recognition accuracy and tracking accuracy of airborne opto-electronic devices, to a large extent, depend on the stable control performance of the AOEP. Unfortunately, the AOEP is vulnerably affected by air disturbance, vibration and other unknown disturbance factors during the flight operation process, which seriously influences the stability and accuracy, and even leads to reconnaissance and tracking tasks failure. Therefore, how to improve the anti-disturbance ability of the AOEP has become the key problem, which restricts the development and applications of the MUAV severely. It has been one of the hot research directions in recent years.

For the problem of disturbance compensation of airborne stabilized platform, the control method based on disturbance observer (DOB) has been widely used. To a certain extent, the stability control performance of the airborne stabilized platform is improved. However, the compensation effect of DOB on high frequency noise is not ideal. Simultaneously, disturbance usually has strong nonlinearity. It is difficult to obtain ideal tracking control performance by using DOB method only. Fortunately, neural networks and fuzzy systems are real-time, robust, and can approximate any function. They have been widely used in the tracking control system of stabilized platform.

Aiming at the disturbance compensation and stability control of AOEP, a composite compensation control method for AOEP mounted on MUAV is proposed. First, to eliminate the effects of high frequency noise, by introducing a compensation control into the original DOB structure, an improved disturbance observer (IDOB) based on the velocity signal is proposed. Second, considering the nonlinearity of the disturbance, the radial basis function neural network (RBFNN) is used to estimate and compensate the nonlinear disturbance. In order to realize the stable control of AOEP, a composite compensation control system based on IDOB and RBFNN is designed by using Lyapunov stability principle. It is proved that the proposed control system is asymptotically stable and the tracking error is bounded. It has good stability and robustness. Finally, the effectiveness of the method is verified by experiments. The experimental results show that the IDOB structure has better disturbance rejection ability and has higher stability accuracy. The proposed method can restrain the effect of disturbance to the AOEP system. The AOEP has higher stability and tracking precision. The composite compensation control system completely satisfies the requirements of tracking control of AOEP.

Keywords: multi-rotor unmanned aerial vehicle (MUAV); airborne opto-electronic platform; disturbance observer; radial basis function neural network; composite compensation

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