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Title

Nonlinear model predictive guidance for tilt-rotor UAV performing terrain-following flight for mine detection

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Abstract

The use of unmanned aerial vehicle (UAV) in both the military and civilian area is becoming increasingly popular as the drone technology advances. Recently, research is being conducted to develop a system where the UAV is used for detecting land mines buried in the ground. Using the UAV for the mine detection has an advantage in that it can cover the area more safely and efficiently than other traditional methods. In the mission, the UAV flies over the areas that are suspected of containing mines, where the mines can be detected by sensors such as magnetic field sensors, chemical sensors, ground-penetrating radars, or multi-spectral cameras mounted on the UAV.

The UAV is required to fly over the terrain at a specified altitude above the ground while maintaining the attitude to ensure the accuracy of the detection devices. For this purpose, a tilt-rotor UAV with electric propulsion system is considered in this study. The UAV has the capability of adjusting altitude without changing attitude much owing to its tilting rotors and aerodynamic control surfaces, but extent of the adjustment may be constrained. Therefore, a proper guidance and control system should be developed considering the capability of the UAV and mission conditions.

In this study, a nonlinear model predictive guidance is designed for the terrain-following flight of the tilt-rotor UAV performing a mine detection mission. A kinematic model is discretized and used as the prediction model, and the cost function is defined in terms of the altitude tracking error. The guidance command is computed by iterative linearization [1]. The dynamic model, cost function, and constraints are approximated using the increment of the control input and the previous control input trajectory. At each iteration, the increment of the control input is obtained by convex optimization and the control input trajectory is updated. The performance of the proposed guidance law is demonstrated by numerical simulation.

References

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