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Title

A method to generate a constrained terrain following trajectory using circular path

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Abstract

In military aviation, the method to avoid the enemy's air dense network is one of the important strategies.[1, 2] Terrain following(TF) requires an accurate trajectory to reduce the risks of being revealed to the enemy while maintaining the clearance height.[2] The accurate trajectory stems from the accurate terrain profile. The fighter aircrafts usually utilize not only its own radar but also the digital terrain database. The terrain profile can be generated by using radar scan data, digital terrain database, or both. While using radar scan data, gathered radar scan data can have a limitation because of the radar max range. As a result, terrain profile is generated within a certain frequency. In this case, the trajectory also needs to be generated within a certain frequency. It refers that there are some constraints including the initial and terminal position of TF trajectory. Also, the direction of the initial velocity should be considered. In this paper, the constrained TF trajectory generation algorithm is proposed. While generating the TF trajectory, there are several requirements such as the normal acceleration limits, climb/dive angle limits, and clearance height. The generated TF trajectory should satisfy the requirements and the constraints. In this paper, it is assumed that the terrain profile is generated by using radar scan data, and these radar scan data are gathered in the DTED Level 2 environment. The terrain profile maintains a similar altitude with the terrain (DTED Level 2) until 4km away from the aircraft position. Generally, TF only considers longitudinal motion along the aircraft's path.[2] Therefore, TF trajectory is generated based on the 2-dimensional terrain profile of 4km. TF trajectory can be converted from TF path maintaining the concept of time. After the generation of TF path, TF trajectory can be generated. As a first step, 3-mask morphology[3] is used to generate the basic TF path, which satisfies the clearance height and clime/dive angle limits. Next, the circular path is used to make TF path smooth, and it satisfies the normal acceleration limits and climb/dive angle limits. Due to the trajectory and terrain profile generation frequency, the terminal position of the past path and the initial position of the present path can be different. Likewise, the direction of the velocity can be different. To complement this circumstance, the improved circular path is used while generating TF path. The circular path is utilized under the constant aircraft speed. Therefore, the time of the aircraft flight can be calculated. For example, the time when the aircraft flies over the peak of the mountain can be known easily. As a result, TF trajectory is generated from the terrain profile. The proposed method can be utilized regardless of the terrain type such as smooth, moderate, and rough terrain, and it satisfies the requirements such as clearance height, climb/dive angle limits, and normal acceleration limits.

References

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