An Improved Artificial Potential Field-based on Repulsive Various Gain for UAV path Planning

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Abstract—A safe and collision-free in the environment with obstacles is an important issue need to be taken into account in Unmanned Aerial Vehicles(UAVS) while employed a mission from its start position to the target point. An improved Artificial Potential Field(APF)-based on Various Gain method was developed in unknown environment to overcome the issues. This paper improves the APF through the gain of the repulsive potential function. The performance of the simulation shows the improved APF can avoid the UAV collisions with obstacles effectively and find the completeness and sub-optimal path relatively.

Keywords—unmanned Aerial Vehicle(UAV), path planning, artificial potential field, collision avoidance, unknown environment.

I. INTRODUCTION

Path planning is an important criteria that need to be considered in enhancing the UAV autonomy level in order to generate a collision free and optimal path.

There are many approaches have been widely used for path planning including visibility graph, cell decomposition, voronoi diagram, probabilistic roadmap (PRM), rapidly exploring random tree (RRT) and potential field and etc.

Potential field method has been used by many researchers in path planning problem because of its simplicity, high safety and elegance. Besides that, it is also suitable for real-time application due to its fast computation time. In potential field approach, the robot is considered as a point under the influences of the fields produced by goals and obstacles in search space. In this method, there are repulsive force generated by obstacles and attractive force generated by goals. Hence there is less effect at a distance at the stronger force near the goals or obstacles, meanwhile the resultant force on the robot will determine its direction of motion. However, the potential field method has a drawback in producing local minimum causing the robot to get trapped [1].

The improved artificial potential field (APF) is proposed in this paper. By using the various gain in repulsive force, the improved APF can overcome the local minimum problem thus the UAV can safely arrived at the goal[2].

II. METHODOLOGY

A. Potential Field Function based on original APF

Referring to the traditional APF, the value of gain Ko in repulsive potential field method is above 0 which is a fix number. The Figure 1 below shows the UAV cannot reach the goal without collision with the obstacles in unknown environment based on traditional APF.

Figure 1. Simulation based on original APF

B. Potential Field Function based on improved APF

In improved APF, the gain of repulsive potential function is considered. The value of gain Ko is proportional to the several parameters such as number of obstacles(noObs), range (R), number of discrete point along the perimeter of obstacles(p) and the interval between two grid points (inc) which are mean the value of gain Ko is a various number. figure 2 show simulation based on the improved APF.
The criteria need to be considered in path planning are completeness, computational time and path length. In this paper, only parameter of completeness and path length are taken into account. In this paper, the environment has been set up to range=20 and number of obstacle =20. The environment is shown in two-dimensional. Although the result of the traditional APF shows that, the total length from start point to target point is better than the improved APF total length, however the improved APF still qualify the criteria of path planning problem because its succeed in solving the collision avoidance with the obstacles and reached at the goal without trapped into the local minimum, meanwhile the traditional APF is trapped in local minimum and cannot avoid the collision with the obstacles.

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