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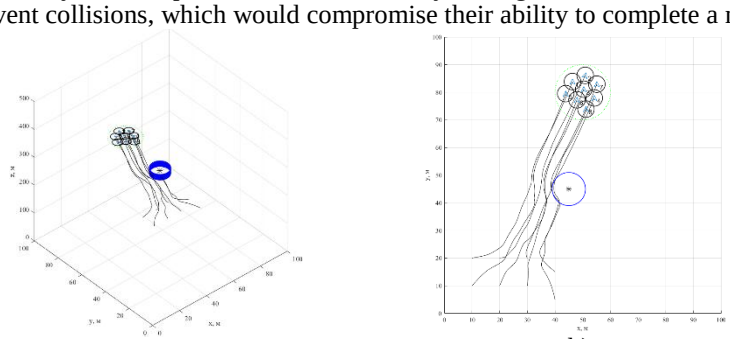
MODELLING OF AUTONOMOUS UNMANNED AERIAL VEHICLES SWARM MOTION IN THREE DIMENSIONAL SPACE

The self-organization ability of the dynamic objects group to form a swarm is an intelligent characteristic. Hundreds and even thousands of UAVs can comprise an intelligent swarm. Through self-organization, the individual UAVs working together as a swarm can accomplish tasks that could not have been possible by a single machine. Logistically, the individual members of the swarm are easier to design and build, so these UAVs potentially can cheaply replace, interchange, or dispose.

The concept of UAVs swarm control lies in principle that, the swarm does not have to travel as a synchronous flock toward a destination zone but keep the shape of group at the same time. To find a destination zone, the UAV can simply try to find the shortest distance between itself and the destination zone. The movement organized by keeping a constant velocity and the direction of UAV heading change rather than the velocity. Control approach should be simpler and more stable since the UAVs will not quickly change their headings and positions. Such algorithm provides faster computational times, and a straightforward simulation easily scaled for a larger search space. The issue solution based on an artificial potential field algorithm application in order to determine how each UAV should move. In a real group, each UAV has the ability to gather and evaluate data from the environment with sensors. Sensors allow communication with the other UAVs and determine distances between objects.

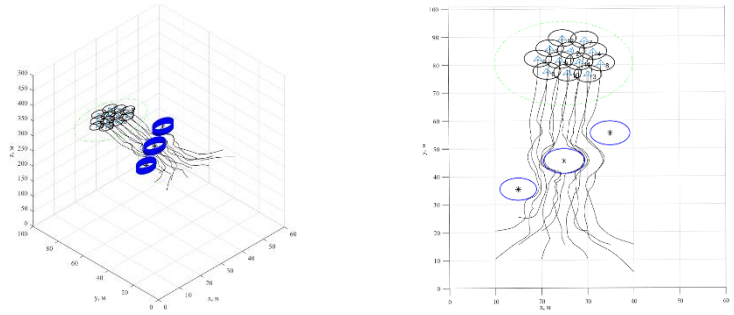
Avoidance other UAVs and obstacles in the space is the foremost function. Avoidance is crucial so that the UAV can survive to carry out the mission. Each UAV has a protection zone and alert zone with specified radius, so any UAV entering the alert zone will cause both UAVs to avoid each other. To avoid an obstacle the UAV will turn until obstacle leave the alert zone in the path of the UAV. This heading change is a product of attraction and repulsion forces action. The attraction force is required to direct the heading of the UAV toward the destination zone and repulsion to avoid collisions with static and dynamic obstacles. The UAV is constantly correcting its position and heading to minimize the distance to the target. The swarm of UAVs proceeds in a realistic manner. The UAVs maintain a constant velocity, and the simulation incorporates the aerodynamic capabilities of the UAV by setting a maximum turn angle. Most importantly, they avoid each other to prevent collisions, which would compromise their ability to complete a mission (Fig. 1a-b).



a) b)

Figure 1. UAVs swarm motion modelling in three dimensional space (a) and horizontal plane view (b) with 8 UAVs and 1 static obstacle

The modelling focuses on the UAVs swarm motion, so it does not include all aspects needed for autonomous control. A major part of autonomous control is movement, but the maneuvers are in response to attraction and repulsion forces action, where UAVs or obstacles are positively charged particles and destination zone is negatively charged (Fig. 2a-b).



a) b)

Figure 2. UAVs swarm motion modelling in three dimensional space (a) and horizontal plane view (b) with 12 UAVs and 3 static obstacles.

As a conclusion, it should be remarked, that multiple conflicts that appear in swarm motion with other obstacle using artificial potential field method can be solved in vertical plane by altitude change. The next step of work will be addition of dynamic obstacles and change of static obstacles shape to complex figures. Also alert zone should be modified in order to provide enough space for maneuvers with respect to flight characteristics.