Drone Swarm Scenario

Introduction

Drones – unmanned aerial vehicles – are ideally suited for many rescue or emergency situations: they can fly into dangerous or uncertain conditions and go where manned vehicles cannot. We wish to design and develop fleets (or swarms, as we call them) of drones to be used in situations like:

- Surveying and monitoring the extent of forest fires,
- Surveying the extent of earthquake damage and locating survivors
- Dropping medical supplies and equipment to survivors or isolated people

Having human beings manually controlling individual drones not only requires a large number of trained personnel, but is often not even technically possible because of erratic radio communications around mountains and other terrain. As a result, each swarm has to be able to act autonomously to achieve its objectives. Swarms should be able to be used both nationally and internationally.

High-Level Requirements

Error! Reference source not found. shows an example deployment of two swarms, both sent out on search and rescue missions beyond a large fire.

Each swarm consists of

- One “leader”: this drone contains radio equipment which attempts to maintain communication with a base station. The leader is the only drone which has this equipment – the other drones can communicate with each other but won’t reliably be able to reach the base. As a result, if the leader fails the entire mission will fail. Leaders aren’t generally customized for the particular mission.
- One or more “followers”: these drones usually have customized equipment for the mission – video cameras, medical-equipment payload carriers, etc. They are in radio communication with the leader, but not the base. Depending upon the mission, one or more of them might be required to successfully complete the assigned task, but generally one or more can fail and still have the mission succeed. Followers don’t have the equipment necessary to be “promoted” to leader mid-mission.

A swarm when deployed is given a list of physical co-ordinates (checkpoints), each of which must be reached by a given time. The leader will alert the base when each checkpoint is reached. The leader tracks time via an onboard clock; if any checkpoint is not reached in time, the mission is aborted and the drones return to the base. This list of checkpoints may be changed mid-mission by the base. The swarm will alert the base if it is running low on fuel and it may not be able to achieve its mission as a result. Naturally, this isn’t the only criteria for mission success: conducting the survey, dropping medical supplies, etc, is the ultimate success criteria. The mission checkpoints merely ensure that if flying

conditions are much worse than anticipated that the drones won't vainly struggle to get to a location too late to be useful or be unable to return.

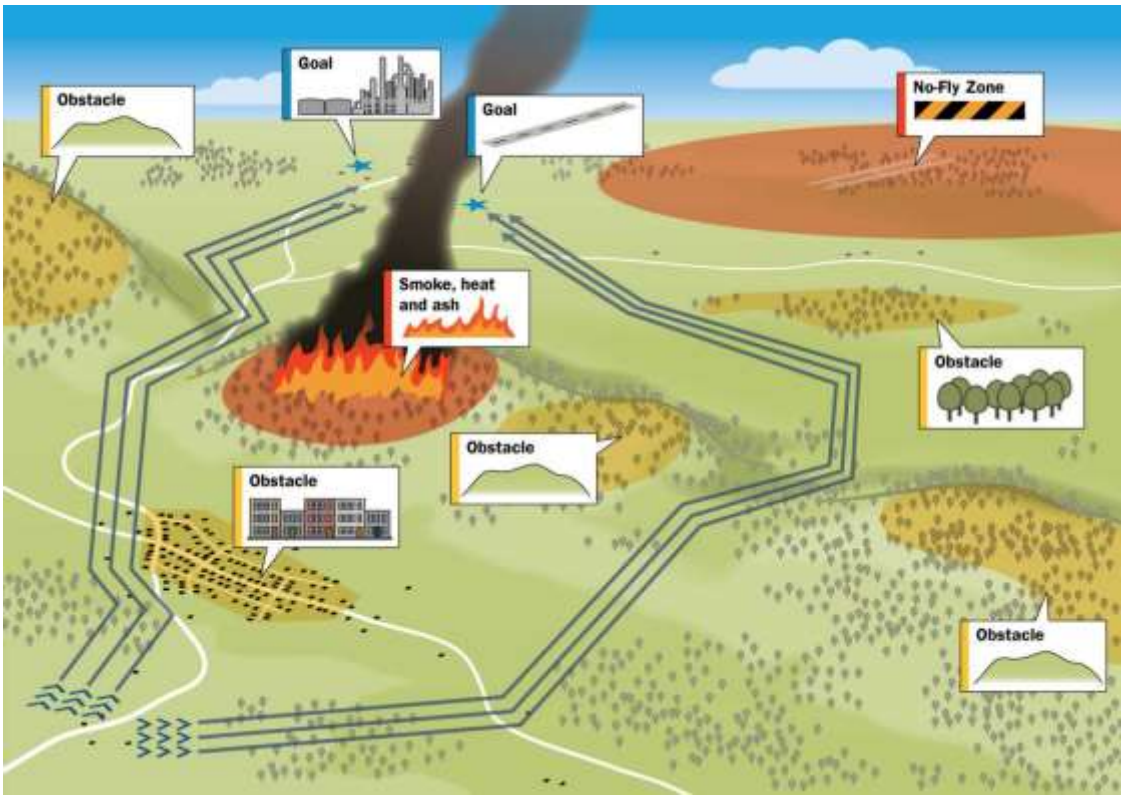
The drones should not collide with each other or with the ground. To enable this, all drones are equipped with altimeters (to determine their height) and GPS; all of this information is periodically communicated to other drones in the swarm as well as to the base. If contact with the base is lost, the leader attempts to re-establish communication but the swarm continues to perform based on the most recent information.

Environmental Constraints

Because swarms will be flying in areas with smoke and debris, it is expected that drones will have to operate even if they are in non-perfect physical condition, or become damaged during the mission.

The follower drones should fly in formations so as to try to protect the leader from bird impacts and debris as much as possible. Also, poachers and scared people have been known to try to shoot drones. The swarm will also be given a map of "dangerous flying" areas. These areas are where flying conditions are expected to be poor, and so the swarm should fly slower and the followers should stick closer to the leader to protect it from harm. The flying formation and logic for preventing collisions will be managed by an algorithm running onboard the drones themselves; the base does not determine the formation.

Political borders or no-fly zones (such as around Washington DC's capital buildings) have to be observed, and the swarm cannot fly into these areas. The drones themselves, and their low-level software, will be built and supplied by a third-party company.



1 Example Deplyment of Two Swarm