**Cooperative Drones**

**Proposer:** Antoine Bagula

**Abbreviation: UAVNET**

**Research Lab: Intelligent Systems and Advanced Telecommunication (ISAT)**

1. **Brief Description:**

The use of multi-robot teams is justified in situations where the task to be performed is too dangerous, expensive or difficult to be performed by humans [2], or, if not too difficult, can in any case be performed more cheaply and/or efficiently. There are many such applications which are the subject of ongoing research and development. Target search is a common application for the purposes of rescue [3][4], monitoring [5][6] or destruction [7][8]. Another popular application is that of area coverage or exploration for multiple purposes such as environment mapping [9][10], surveillance [11][5][12][13], sensor deployment [14], acting as communications hubs for immobile wireless sensor networks [14][15] or aerobiological sampling [16]. These and other research works mention applications such as weather forecasting, fire detection and observation (in both urban and rural environments), environmental clean-up, space exploration, traffic surveillance, logistics in warehouses and factories, agricultural monitoring and interior surveillance of buildings. New and unforeseen applications also continue to surface; there have been efforts in Israel and Australia to search for groundwater through the use of aerial drones. The applications detailed here are mostly ones using Unmanned Aerial Vehicles (UAVs) as team members. The use of a robot team instead of a single robot is possible when the mission to be performed can be decomposed into primitive tasks, i.e. the mission `is inherently distributed in terms of space, time and functionality' [17]. The use of multiple robots has some obvious advantages:

1. Efficiency: it is especially advantageous to use multiple robots when tasks are not order-dependant, because then multiple tasks can be performed simultaneously and the mission will take less time to complete.
2. Robustness through redundancy: the energy and computation required to perform the mission is distributed across team members, so if one member ceases to function, its role can be assigned to another.
3. Flexibility: the required functionality can be distributed across robots, although this advantage only becomes apparent when the mission is composed of diverse tasks: a team of robots with different specialisations, i.e. a heterogeneous team, can be engineered more cheaply and easily than a single robot capable of performing each kind of task [17].
4. **The Main Tasks:**
* **Task 1:** **Target search or visitation**. Target search is a common application for the purposes of rescue [3][4], monitoring [5][6] or destruction [7][8]. This task includes the following subtasks:
	+ **Task1.1:** Modelling the target search or visitation problem.
	+ **Task1.2:** Simulation of the target search problem.
	+ **Task1.3:** Experimentation at UWC using a real drone
* **Task 2:** **Multi drone task allocation (MDTA)** consisting of coordinating a team of drones to cover any given set of areas in a near-optimal manner with the objective of achieving environment mapping [9][10], surveillance [11][5][12][13], sensor deployment [14], acting as communications hubs for immobile wireless sensor networks [14][15] or aerobiological sampling [16]. This task includes the following subtasks:
	+ **Task2.1:** Mathematical modelling the MDTA problem.
	+ **Task2.2:** Simulation of MDTA problem.
	+ **Task2.**3: Experimentation at UWC using two or more drones.
1. **Computer Science Content:**

Graph theory, Distributed systems, Evolutionary optimization, and Visual sensor networks.

1. **Specific Learning Outcomes:**
2. **Skills Required by the students working on the project:**
* **Theory:** Mathematical modelling of dynamic systems, Auction mechanisms, Genetic algorithms, and computer graphics.
* **Implementation:** Implementation intensive project.
1. **Facilities Needed:**
* Simulation environment for multi-robot optimization.
* Drone equipment with Visual sensors
1. ***Supervision:***
* Regular meetings will be scheduled for interaction with the supervisor and co-supervisors.
* Members of the ISAT group at UCT working on similar IoT projects can be consulted.
1. **Maximum number of students**: 2
* One student for task 1
* One student for task 2
1. **Related work**



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