Multi-Application Task Allocation for Drone Networks

Introduction

Unmanned Aerial Vehicles (UAVs), commonly known as drones, are being seen as the most promising type of autonomous vehicles in the context of Intelligent Transportation System (ITS) technology. A key enabling factor for the current development of ITS technology based on autonomous vehicles is the task allocation architecture. This approach allows tasks to be efficiently assigned to robots of a Multi-Agent System (MAS), taking into account both the robots' capabilities and service requirements. There are different types of algorithms that are employed in state-of-the-art drone-based ITSs, including auction (market)-based approaches, game-theory-based algorithms, optimization-based algorithms, and Machine Learning (ML) techniques. One of the key aspects of task allocation algorithms is that, because of their different features, they must be carefully designed depending on both the application's characteristics and the goal of the task allocation itself. The objective of this thesis is to propose a generalized task allocation framework applicable to the problem of allocating different tasks (with different requirements) to different UAVs (with different capabilities).

Expected Outcome of the Thesis

The expected outcome of the thesis is defined as follows:

- → Design of a generalized (multi-goal) task allocation architecture (possibly merging different types of algorithms) that can efficiently allocate different tasks to a heterogeneous fleet of UAVs.
- → Validation of the proposed approach by means of simulation results with a well-defined use case that includes a set of drones that has to carry out different tasks (e.g., parcel delivery, inspection, traffic monitoring, etc.) within a certain time frame.

A Few References from the Literature

Poudel, S.; Moh, S. Task assignment algorithms for unmanned aerial vehicle networks: A comprehensive survey. *Vehicular Communications* **2022**, *35*, 100469. https://doi.org/10.1016/j.vehcom.2022.100469

Rinaldi, M.; Wang, S.; Geronel, R.S.; Primatesta, S. Application of Task Allocation Algorithms in Multi-UAV Intelligent Transportation Systems: A Critical Review. *Big Data and Cognitive Computing* **2024**, *8*, 177. https://doi.org/10.3390/bdcc8120177

Rinaldi, M.; Primatesta, S.; Bugaj, M.; Rostáš, J.; Guglieri, G. Urban Air Logistics with Unmanned Aerial Vehicles (UAVs): Double-Chromosome Genetic Task Scheduling with Safe Route Planning. *Smart Cities* **2024**, *7*, 2842-2860. https://doi.org/10.3390/smartcities7050110

Rinaldi, M.; Primatesta, S. Comprehensive Task Optimization Architecture for Urban UAV-Based Intelligent Transportation System. *Drones* **2024**, *8*, 473. https://doi.org/10.3390/drones8090473

Qamar, R.A.; et al. TRMaxAlloc: Maximumtask allocation using reassignment algorithm in multi-UAV system. *Computer Communications* **2023**, *206*, 110-123. https://doi.org/10.1016/j.comcom.2023.04.025

Yang, M.; Bi, W.; Zhang, A.; Gao, F. A distributed task reassignment method in dynamic environment for multi-UAV system. *Applied Intelligence* **2022**, *52*, 1582–1601. https://doi.org/10.1007/s10489-021-02502-3

Reference Persons

Dr. Stefano Primatesta (Assistant Professor): stefano.primatesta@polito.it

Ing. Marco Rinaldi (Research Assistant): marco_rinaldi@polito.it