technische universität dortmund

computer science 12

Master Thesis

Drone Deployment and Workload Offloading in Decentralized Drone Networks

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March 28, 2022

A drone network is a cyber-physical system consists of several Unmanned Aerial Vehicles (UAVs) with sensors, which can be implemented in a *centralized* or *decentralized* manner. In a centralized drone network, every drone reports to the host node. Based on the status of all drones, the host node makes decisions for the entire network, e.g., adjusts the position of each drone. A host node can be one of the drones, or a base station on the ground. In contrast, each drone in a decentralized drone network makes it's own decisions based on the network information it has.

A drone network can be applied to various scenarios, such as terrain mapping, area monitoring, emergency assistance in a disaster zone, and signal relaying. In this thesis, we consider a general scenario where drones are deployed to collect and process data from data sources that are scattered across the map. The objective is to generate an allocation plan for the drones that maximize the amount of data being processed.

Based on the assumptions and settings, there are different approaches for deploying the drones. For example, under the assumption that the positions of all the data sources are known beforehand, and every drone has unlimited computation capacity in a centralized drone network, we can simply deploy the drones based on the K-means clustering algorithm. On the other hand, if drones have heterogeneous computation capacities, a deployment strategy with workload offloading may be able to achieve better overall performance. It is also possible that the position of a data source and/or it's data generating rate changes over time. Therefore, the allocation of drones must be adjusted accordingly.

In this thesis[1], the student is expected to develop drone deployment strategies for a decentralized data-processing drone network. As the first step, the student should survey and study the state of the art in deploying and coordinating drones in a drone network. Afterwards, the student should define one or more scenarios with clear and reasonable assumptions as target scenarios. Based on the target scenarios, the student should propose drone deployment strategies to achieve the objective, such as maximizing the amount of data being processed. Eventually, the student should evaluate the proposed strategies, and compare the results with the state of the arts under reasonable configurations in the simulator to conclude the studied topic. Depending on the results of the thesis, the student might also experience how to write a scientific article.

Students should note that, the source code related to this thesis will be publicly released and should be fully documented to comply the rationale of open-source software development.

[1] Other suggestions and related topics are also welcome. Please do not hesitate to make an appointment.

Required Skills:

- Knowledgeable of C/C++ programming
- Knowledgeable of clustering algorithms

Acquired Skills after the thesis:

- Knowledge about drone system and simulator.
- Knowledge about distributed computing.

References:

[1] M. Hai, S. Zhang, L. Zhu and Y. Wang, "A Survey of Distributed Clustering Algorithms," 2012 International Conference on Industrial Control and Electronics Engineering, 2012, pp. 1142-1145, doi: 10.1109/ICICEE.2012.303.

[2] H. Huang and A. V. Savkin, "A Method for Optimized Deployment of Unmanned Aerial Vehicles for Maximum Coverage and Minimum Interference in Cellular Networks," in IEEE Transactions on Industrial Informatics, vol. 15, no. 5, pp. 2638-2647, May 2019, doi: 10.1109/TII.2018.2875041.

[3] F. Al-Turjman, J. P. Lemayian, S. Alturjman and L. Mostarda, "Enhanced Deployment Strategy for the 5G Drone-BS Using Artificial Intelligence," in IEEE Access, vol. 7, pp. 75999-76008, 2019, doi: 10.1109/ACCESS.2019.2921729.

[4] Koubâa, A., Ammar, A., Alahdab, M., Kanhouch, A., and Azar, A. T. (2020). "Deepbrain: Experimental evaluation of cloud-based computation offloading and edge computing in the internet-of-drones for deep learning applications". Sensors, 20(18), 5240.

[5] Ouamri, M. A., Oteșteanu, M. E., Barb, G., and Gueguen, C. (2022). "Coverage Analysis and Efficient Placement of Drone-BSs in 5G Networks". Engineering Proceedings, 14(1), 18.

[6] W. Shi et al., "Multiple Drone-Cell Deployment Analyses and Optimization in Drone Assisted Radio Access Networks", in IEEE Access, vol. 6, pp. 12518-12529, 2018, doi: 10.1109/ACCESS.2018.2803788.