**CIS 4930 – Mobile Networks: Paper Review**

**Leeson Chen, Andy Liu, Ricky Clarke**

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Paper Title: *Distributed Fog Computing for Latency and Reliability Guaranteed Swarm of Drones*

Link: <https://ieeexplore.ieee.org/document/8950036>

Authors: Xiangwang Hou, Zhiyuan Ren, Jingjing Wang, Shuya Zheng, Wenchi Cheng, Hailin Zhang

Summary:

This paper proposes, discusses, and presents a model for “fog computing” in drones. A swarm of drones used for purposes such as military or reconnaissance requires a large amount of computing power, for tasks such as object recognition, machine vision, path planning, and so on. For computing-heavy tasks such as these, performing these calculations locally on the drone is infeasible, because the singular drone carries a relatively low amount of computing power. At the same time, the cloud computing model is also insufficient, because the latency of uploading raw data to a cloud server, waiting for the server to perform the computation, and then receiving the processed data back has too long of a wait time for time-sensitive tasks. Therefore, the authors propose this model of “fog computing,” wherein the entire swarm of drones shares the workload. This model is extremely similar to the client-server versus peer-to-peer network model of thinking.

The authors also discuss task allocation, as individual drones are sensitive to energy/battery constraints, similar to constraints discussed in this class regarding mobile on-device computation. The resulting algorithm the authors propose is called a Proximal Jacobi ADMM based distributed task allocation algorithm. In simulations, it uses the same amount or less energy than current models but supports larger data and higher reliability with far less latency.

Strengths:

* The authors of this paper clearly have a strong mathematical foundation, as most of this paper discusses the various algorithmic tweaks that go into their final result. The majority of the paper is mathematical, beginning with a benchmark algorithm (centralized LP-based algorithm), moving to two Proximal Jacobi ADMM algorithms, and then a simulation. The computational complexity is *O*((2*N*+2)3.5∗(*N*+3)2).
* The authors also clearly know the current findings of their field and create several different models to address weaknesses. They have a latency model, a reliability model, and an energy consumption model.
* All the findings are represented clearly with easy to understand graphs and charts.

Weaknesses:

* This paper is extremely mathematically dense, which makes it hard for me to point out a weakness. One could argue that this is a weakness in itself, though I think that highly academic papers are not obliged to be written accessibly for a broader audience.
* For all the math involved, it does not ultimately feel like the paper leads to very much. They present a mathematical model, say that in simulations it is more efficient than other models (cloud computing and local computing), then conclude by arguing it should be adopted. This may be the norm for papers in this academic genre, but I expected the paper to keep going after their model was simulated to be more efficient than the competition.

Points and suggestions of improvement:

* Similar to the first weakness listed, I believe the paper would benefit from more diagrams showing how the mathematical models and algorithms they were contesting and creating translated to real life. The authors already include one diagram, but it only appears at the beginning to generically describe drone swarms, not how the algorithms are used.
* When comparing their algorithm and model to cloud and local computing, the authors seem to treat the competition as homogenous—i.e. only one type of cloud computing and only one type of local to compare theirs to. I am far from an expert on this topic but I assume there are different ways to optimize cloud and local computation for certain tasks, drone swarms one of them. I think the paper would benefit from comparing their model to highly optimized cloud and local computation to prove their algorithm was still even better.
* The middle section of this paper is very hard to understand for someone not versed in mathematics and this topic, but the graphs at the end bring the comprehensibility back around. While not compromising the academic level or writing of the current paper, more of the graphs could be integrated with the technicality to assist less-versed readers on the paper.

Exam Question:

* Q: What is fog computing, and why do the authors argue in its favor for drone swarms?
* A: Fog computing is the process of performing computation neither locally (on-device) or in the cloud (on a separate server). Fog computing distributes the computational load across a swarm of homogenous CPUs which alone could not perform the computation. The smaller CPUs, which may belong to drones in such a scenario, communicate via a peer-to-peer ad hoc network. The fog computing model avoids the latency of cloud computing, while also avoiding the load issue of local computation.