Optimization of UAV Heading for the Ground-to-Air Uplink

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In this paper we consider a collection of single-antenna ground nodes communicating with a multi-antenna unmanned aerial vehicle (UAV) over a multiple-access ground-to-air wireless communications link. The UAV uses beamforming to mitigate the inter-user interference and achieve spatial division multiple access (SDMA). First, we consider a simple scenario with two static ground nodes and analytically investigate the effect of the UAV heading on the system sum rate. We then study a more general setting with multiple mobile ground-based terminals, and develop an algorithm for dynamically adjusting the UAV heading in order to maximize a lower bound on the ergodic sum rate of the uplink channel, using a Kalman filter to track the positions of the mobile ground nodes. Fairness among the users can be guaranteed through weighting the bound for each user's ergodic rate with a factor inversely proportional to their average data rate. For the common scenario where a high K-factor channel exists between the ground nodes and UAV, we use an asymptotic analysis to find simplified versions of the algorithm for low and high SNR. We present simulation results that demonstrate the benefits of adapting the UAV heading in order to optimize the uplink communications performance. The simulation results also show that the simplified algorithms perform near-optimal performance.

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