CAREER: Co-Design of Networking and Decentralized Control to Enable Aerial Networking in an Uncertain Airspace

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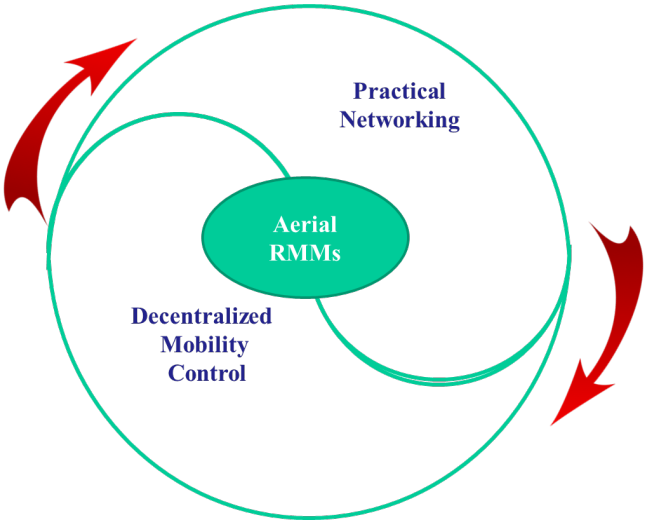
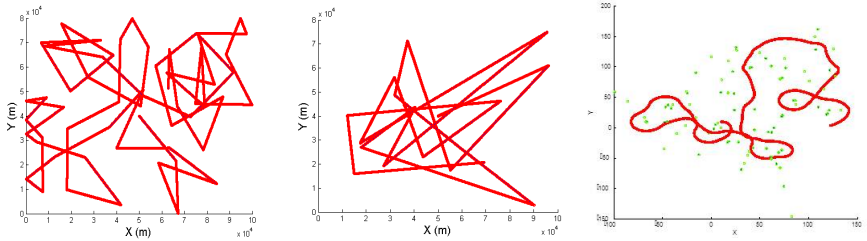
Description

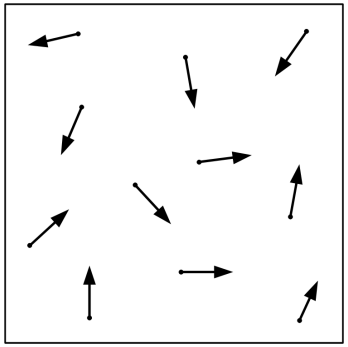
- Airborne networking utilizes direct flight-to-to-flight communication for flexible information sharing, safe maneuvering, and coordination of time-critical missions.
- The objective of this project is to establish an innovative cyber-physical system (CPS) paradigm that exploits the mutual benefits of networking and decentralized mobility control in an uncertain heterogeneous environment.

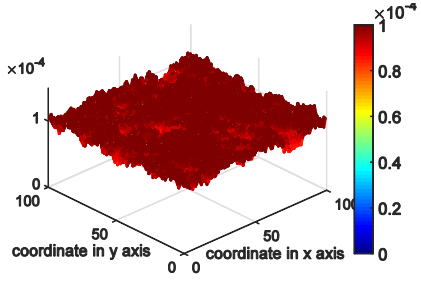


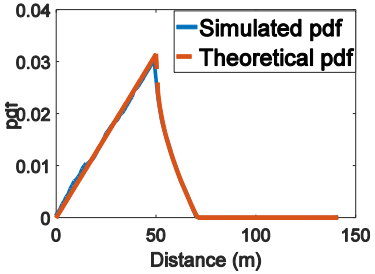


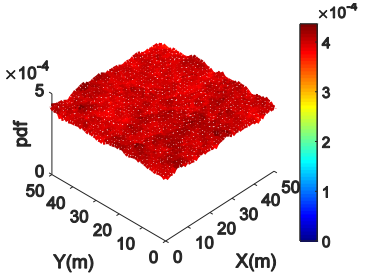
Findings

- One Recent Interesting Finding: The sense-and-avoidance protocol (sense-and-stop) becomes not effective when UAVS are of very high mobility
- Approach: We enhanced the Random Direction RMM with a commonly used decentralized sense and avoid protocol—sense-and-stop (S&S) and provided analytical results on critical networking statistics such as stationary node distribution and inter-vehicular distance distributions.

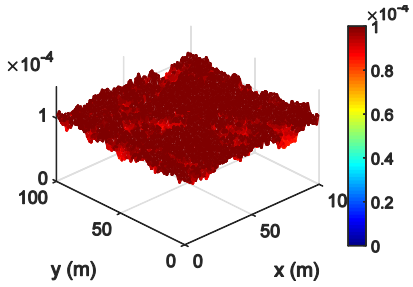


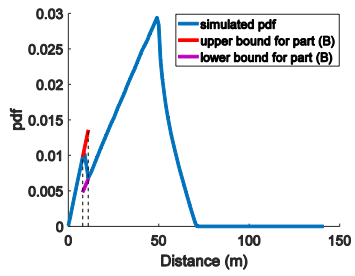


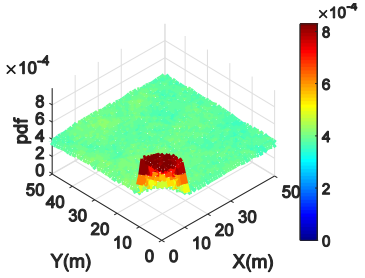




$$\begin{cases} \frac{1}{2}\pi dp_{1min} < f_D(d) < \frac{1}{2}\pi dp_{1max}, & 0 \leqslant d \leqslant d_o - V \\ \frac{1}{4}\pi dp_{1max} < f_D(d) < \frac{1}{2}\pi dp_{1min}, & d_o - V < d \leqslant d_o + V \\ \frac{1}{4}\pi dp_{1min} < f_D(d) < \frac{1}{4}\pi rp_{1max}, & d_o + V < d \leqslant \frac{B}{2} \\ \frac{1}{2}\left(\frac{\pi}{2} - 2arccos\left(\frac{B}{d}\right)\right) dp_{1\min} < f_D(d) & \\ < \frac{1}{2}\left(\frac{\pi}{2} - 2arccos\left(\frac{B}{d}\right)\right) dp_{1\max}, & \frac{B}{2} < d \leqslant \frac{\sqrt{2}B}{2} \end{cases}$$







First row: Without the sense and avoid protocol. Second row: With the sense and avoid protocol. From left to right: Node distribution, pdf of inter-vehicular distance, density of inter-vehicle relative position