Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Real-time Estimation of the Gaseous Plume Using a Formation of Unmanned Aerial Vehicles[1] MICHAEL DEMETRIOU, TATIANA EGOROVA, NIKOLAOS GATSONIS, WPI — This work proposes an approach for the real-time estimation of gaseous plume caused by a source moving along an unknown trajectory using a formation of seven unmanned aerial vehicles (UAVs) with concentration sensors onboard. The process of gas release is modeled with unsteady advection-diffusion equation and is solved numerically using a finite volume method (FVM) with total variation diminishing (TVD) scheme. The concentration estimator is based on the Luenberger observer. The UAVs are assumed to maintain a rigid flying formation throughout the process. The UAVs dynamics is described by the point-mass model of a fixed wing aircraft. The guidance of the leader UAV is coupled to the performance of the estimator through Lyapunov redesign methods. An appropriate choice of the Lyapunov functional results in the desired direction for the leader UAV, which is expressed in terms of the concentration estimation error and the error gradients at the sensors locations. For computational efficiency in the real-time applications the computational grid for the estimator is adapted dynamically to provide higher resolution near the flying formation. Numerical tests are implemented to illustrate the performance of the proposed approach.

[1]The work is supported by the Dynamics and Control Program at AFOSR, grant FA9550-12-1-0114.

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Date submitted: 31 Jul 2015 Electronic form version 1.4