Operations Research Seminar

Cooperative Graph-Based Model Predictive Search

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An interesting and difficult problem in unmanned air vehicle (UAV) control is that of cooperatively routing a team of UAVs to search for one or more targets in a bounded region. This talk will present a receding-horizon cooperative UAV search algorithm that attempts to minimize the time required for any UAV in a cooperative team to detect the target(s). By sampling the area of interest (AOI) at locations with high target likelihood, the continuous search problem is reduced to an optimization on a finite Euclidian graph. Graph vertices and edges may not be uniformly distributed in the AOI, but this algorithm can fairly compare paths of varying length using a weighted optimization criterion. Optimal UAV paths are computed with a receding horizon approach. Optimization of the UAV sensor orientations is also considered as an additional component of the UAV routing optimization problem. Using this algorithm for the single-target search problem, it is shown that the UAV team will discover the target in finite time with probability one. Simulations verify that the algorithm makes effective use of multiple UAVs, and performs better than previously proposed search algorithms. Hardware testing results using two UAVs with gimbal-mounted cameras will also be presented.

Bio: Gaemus Collins received M.S. and Ph.D. degrees in mathematics from University of California, Santa Barbara (UCSB) in 1999 and 2002 respectively. Dr. Collins' graduate research included analysis of the Orr-Sommerfeld and Squire operators that model viscous fluid flow in a parallel channel. Following his graduate work, Dr. Collins held a two-year post-doctorate position at University of California, San Diego (UCSD), studying Hamilton-Jacobi equations using max-plus algebraic techniques, and developing algorithms for DARPA's Mixed Initiative Control for Automa-teams (MICA) program. As an analyst at Toyon Research Corp., Dr. Collins leads two STTR projects sponsored by the Air Force Office of Scientific Research (AFOSR). He is working with faculty and graduate students from UCSB to develop cooperative multi-agent, multi-sensor UAV search and tracking algorithms.