PROJECT TITLE: Distributed Cooperative Navigation and Path Planning in GPS-denied and Resource Constrained Environments using Factor Graphs

Physical Requirement: No such requirements
Project's Technical Skills Requirement: Matlab and Python Programming Exp, ROS, RC Flying Drones

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Project Description

The objective of this work is to develop distributed cooperative localization algorithms for Unmanned Aerial Vehicles (UAVs) to support missions like surveillance, mapping, target tracking in GPS-denied environments. In our previous work, we have developed centralized cooperative localization algorithms for absolute and relative navigation in GPS-denied areas. Although centralized CL is the golden standard in terms of localization performance, it introduces new challenges such as single point failure, communication and computation costs, etc. Furthermore, we have used EKF-based sequential estimation approach for state estimation. However, EKF have several limitations when comes to nonlinear state estimation with non-Gaussian sensor and model noise. In this work, we will use Factor Graph based batch estimation framework to develop a distributed cooperative localization algorithm. Along these lines, we will find answers to the following fundamental questions:

1. What information (what portion of the local factor graphs) should each vehicle communicate with its neighboring vehicles?
2. How should each vehicle combine information (factor graphs received) from other vehicles combined with its own local factor graph?
3. What will be the impact of sensing communication topology on the state estimates as compared to centralized solution?
4. What constraints are imposed by an application, sensors, and area of operation on the localization algorithms?
5. Can vehicles collaboratively predict/generate joint factor graphs in a distributed manner while satisfying application and sensing constraints to improve the localization accuracy?

The main objectives of the proposal are as follows:

1. Develop centralized and distributed factor graph-based cooperative localization algorithms.
2. Develop distributed factor-graph communication strategy to enable distributed cooperative localization.