Vision-Aided Navigation: Improved Measurement Models and a Data-Driven Approach

Doctoral Dissertation Defense

Dylan Conway
BS, 2012 University at Buffalo

Chair of Advisory Committee: Dr. John L. Junkins
Committee members: Drs. John E. Hurtado, Daniele Mortari & Jinxiang Chai

September 27th, 2016
1:00 pm – 3:00 pm
H.R. Bright Building - HRBB 702

Abstract

Vision-aided navigation is the process of fusing data from visual cameras with other information sources to provide vehicle state estimation. Fusing information from multiple sources in a statistically optimal manner requires accurate stochastic models of each information source. Developing such a model for visual measurements presents a number of challenges.

Vision-aided navigation systems rely on a set of computer vision methods known as feature detection and tracking to abstract visual camera images into a data source amenable to state estimation. It is nearly universally assumed that the measurements produced by these methods have independent and identically distributed (IID) errors. This study presents evidence that directly contradicts these assumptions. Novel models for visual measurements that eliminate the IID assumption are developed. Estimators are designed around the models and tested. Results demonstrate a significant performance advantage over existing methods.

En route to accomplishing the primary contributions of the study, a set of flexible and robust data-driven estimation techniques are developed and demonstrated on both canonical problems and problems in vision-aided navigation.

Dylan Conway is a PHD candidate in the Aerospace Engineering Department working under the supervision of Professor John L. Junkins. His research interests are in the areas of estimation and vision-aided navigation. He will be employed as a Guidance & Control engineer at the NASA/Caltech Jet Propulsion Lab.