State Estimation Improvement for Tag-based Indoor Localization of UAVs using the Kalman Filter

Mohammad Nahangi[1,2], Navid Kayhani[1,2], Adam Heins[2], Wenda Zhao[2], Brenda McCabe[1], Angela P. Schoellig[2]

[1] Department of Civil and Mineral Engineering, University of Toronto
[2] University of Toronto Institute for Aerospace Studies (UTIAS)

Abstract

Indoor localization and navigation of unmanned aerial vehicles (UAVs) is a critical module for autonomous flight and automated visual inspection of construction elements in continuously changing construction environments. The key challenge for indoor localization and navigation is that the GPS signal is not sufficiently reliable for state estimation. Having used the AprilTags for indoor localization, we showed a proof-of-concept that a camera-equipped UAV can be localized in a GPS-denied environment; however, the accuracy of the localization was inadequate for some circumstances such as take-off and sudden change in flight direction due to the detection of tags. This study presents implementation of the Extended Kalman Filter (EKF) for improving the state estimation module of the previously developed framework using AprilTags for localization. An experimental set up is used to verify the accuracy of the framework compared to the previous state estimation method and the ground truth data. Results show that the state estimation and indoor localization are improved substantially using the EKF. The framework can now be tested in real world environments given that continuous localization is now sufficiently robust and reliable.

Keywords: unmanned aerial vehicles (UAV), building information model (BIM), indoor navigation, autonomous flight, visual inspection, construction automation