Nonlinear Observer for Visual-Inertial Navigation Using Intermittent Landmark Measurements

The development of reliable orientation, position and linear velocity estimation algorithms for the 3D visual-inertial navigation system (VINS) is instrumental in many applications, such as autonomous underwater vehicles (AUVs), and unmanned aerial vehicles (UAVs). It is extremely important when the global position system (GPS) is not available in GPS-denied environments. Recently, observers design for VINS using landmark position measurements from Kinect sensors or stereo cameras has been increasingly investigated in the literature.

The aim of this work is to design a nonlinear observer for VINS under the assumption that landmark position measurements are intermittent. In practice, the landmark measurements are not continuous due to computation cost from image processing, which is different from most of the existing results relying on continuous landmark measurements. The proposed nonlinear observer, motivated from the classical linear Kalman filter, has two parts: continuous prediction using inertial measurement unit and previous landmark measurements, and instantaneous state updating upon the arrival of new landmark measurements.

Almost global asymptotic stability (AGAS) has been achieved by applying the framework of the hybrid dynamical system, which means that the estimated state will asymptotically converge to the real state of the visual-inertial navigation system for almost all initial conditions. We strongly believe that our developed estimation tool will not only benefit the area of aerial vehicles engineering but also the robotics and biomedical engineering community.