Estimation of 3D Orientation From Inertial Sensors With Different/Nonuniform Sampling

Background

The ability to estimate the orientation (attitude) of an autonomous vehicle (*e.g.* Unmanned Aerial Vehicle (UAV)) from on-board sensors is important for its operation. As such, the attitude estimation problem has attracted the attention of many researchers and industrials for several decades. The attitude information is usually reconstructed using a set of body-frame measurements of known inertial vectors. In this work, the attitude estimation problem is considered under the assumption that the sensors measurements have (possibly) different bandwidths and are subject to packet dropouts.

Methods

We propose an attitude estimation scheme designed directly on $SO(3)$ (the mathematical group of 3D orientations). The angular velocity measurements (gyroscope readings) are used to continuously predict the attitude which is corrected, via an instantaneous jump mechanism, upon the arrival of new measurements.

Results

Virtual timers are introduced to capture the contraints on the sensors transmission times which results in a hybrid dynamical model. Under an adequate gain tuning, the attitude estimation error is shown to converge exponentially to zero from almost all initial conditions.

Discussion & Conclusion

This paper dealt with the problem of attitude estimation using intermittent sensors measurements which takes into account some practical constraints related to the sensors bandwidth and packets loss. The structure of the proposed observer as well as the parameters are adequately designed to guarantee the convergence of the attitude estimates to the true attitude values.

Interdisciplinary Reflection

The proposed attitude estimation algorithms will not only benefit the area of aerial vehicles engineering but also the robotics and biomedical engineering community in large.