Inertial/magnetic sensors based orientation tracking on the group of rigid body rotations with application to wearable devices

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Abstract: In this work the problem of orientation tracking based on inertial/magnetic sensors is restated in geometric terms, in particular an intrinsic observer, i.e. an observer whose performance does not depend on a specific choice of coordinates, is derived on the Lie group of rigid body rotations SO(3). Measurements of the gravitational and geomagnetic fields are used to estimate orientation errors. A coordinate-free control law is defined on the Lie algebra and fed back in terms of angular velocity that steers the observer towards the correct attitude. A proof of stability for the proposed estimator is provided which relies on the natural (bi-invariant) metric of SO(3). The observer results stable for almost the whole configuration space. Presence of unstable equilibria as a limitation for global stability is also discussed. Based on the proposed intrinsic control law, a filter is designed which implements the observer. Simulations are presented that test the numerical implementation of the proposed observer.

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