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PROBABILISTIC ORBIT DETERMINATION FOR REAL-TIME MULTI-MODALITY DATA FUSION

Abstract

Traditional statistical orbit determination techniques rely on approaches such as the batch least squares and Kalman filters. These statistical approaches are either unable to update solutions with new information in real-time or sensitive to becoming trapped in local minima. In addition, the processing required to leverage these techniques scales with the number of objects and observations. This paper presents a mathematical formulation to leverage probabilistic computer vision and computational intelligence to fuse any and all modalities simultaneously for state estimation agnostic to the dimensionality of the domain. These modalities include sensor and anecdotal information sources. The formulation leverages both negative and positive detections, unlike most statistical approaches. The processing speed of this process is independent of the number of objects, instead only dependent on the size of the domain, the resolution desired in all dimensions, and the computational architecture. Most importantly, the approach provides live stream (milliseconds) updates to the most probable solutions based on all available observations and processing resources. The mathematics specific to a two dimensional problem and the seven dimensional (position, velocity and time) two body inverse square gravity field will be presented. Real-time simulation results will be shown for the two dimensional problem using C++, MongoDB, and OpenGL. The authors also present the next steps for demonstrating probabilistic orbit determination in simulation and in practice with real data.