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Author: Dr. Tat-Jun Chin
University of Adelaide, Australia

Dr. Huan Do
The University of Adelaide, Australia
Mr. Nicholas Moretti
Inovor Technologies, Australia
Dr. Matthew R. Tetlow
University of Adelaide, Australia

ROBUST GEOMETRIC ALGORITHMS FOR SPACE OBJECT DETECTION

Abstract

Arguably the detection of potential man-made space objects from sensor measurements forms the start of the long chain of processing to mitigate the harmful effects of space debris. In many cases, the problem of detecting space objects reduces to identifying particular geometric shapes among a substantial clutter of measurements unrelated to the objects of interest (e.g., finding lines in a star field or finding dots in a field of line segments). Many existing algorithms in the literature, however, are heuristic in nature, i.e., they do not give any guarantees of accuracy or bounds on runtime. The reduces the confidence in the computed results, and raises questions regarding the efficacy of the overall pipeline.

This paper introduces techniques for space object detection which draw inspiration from the field of robust geometric optimization. Unlike heuristic algorithms, robust geometric algorithms have a clear cut objective function, which makes clear the actual problem being solved, and thus gives a good idea of the scenarios in which the detection module is expected to work. Second, the objective function is optimized using algorithms that are amenable to rigorous analysis, which leads to confident predictions in the accuracy and runtime of the algorithms.

Several concepts from robust geometric optimization are touched upon in this paper: duality, plane sweeping, robust criteria. We show how these can be applied to construct space object detection algorithms with the above desirable properties.