THE UNIVERSITY OF ARIZONA

SIE Seminar

Conjunction Prediction, Conjunction-avoiding Maneuver Planning, and Related Optimization Problems

Deok-Soo Kim

Hanyang University, Seoul, Korea

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2:00-3:00 PM

ENGR 210

In this talk, we want to discuss the following two issues for Earth orbiting objects:

1) **How to predict all conjunctions for a given prediction time window?**
2) **How to plan a (optimal) conjunction-avoiding maneuver?**

under the seemingly contradicting conditions of: i) No solution miss, ii) Real-time prediction (on a desktop/laptop machine), and iii) Without-a-big preprocessing. In addition, we emphasize the following: “Conjunction” is only one of the critical spatial events that the proposed method can accommodate. These two issues together can be used to generate alternatives for strategic decision-making in Earth orbit. We show the same technique can be used for **space surveillance** and **path planning for drone swarm**. The orbit equations for moving objects are assumed.

We solve the two issues using the Voronoi diagram: The Voronoi diagram of a set G of generators is the tessellation (or tiling) T of the space, where each cell c in T is the set of locations which is closer to the owner of c than any other generator in G. The ordinary Voronoi diagram of point generators has long been used to efficiently solve application problems such as finding two nearest points, three nearest points, etc. Up to here, the Voronoi diagram is static in that generator particles are fixed: i.e. no motion, no pop-up, no delete, and no size change.

Suppose that particles move and each has a unique motion equation (Other assumptions can be similarly relaxed). If we can construct the dynamic Voronoi diagram (DVD) of the moving particles, we can take advantage of the powerful computational properties of the static Voronoi diagram for each moment in the predicted future. We use DVD for solving the two issues above. Of course, a bug-fixing and code-optimization period needs to be reserved for its production run. Software demonstration will be given to show how these two critical issues can be handled. Solution methods for other hard optimization problems, e.g. disk packing problems, which can take advantage of Voronoi diagrams will also be presented.

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More info contact Mia Schnaible 621-6551 http://www.sie.arizona.edu