Rendezvous & Docking Vision System for Satellite Servicing:
Problem SOLVED

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TriDAR: An Off-the-Shelf Solution to Rendezvous & Docking on DARPA's Phoenix Program

Since 2004, Neptec Design Group has developed and flown TriDAR, a revolutionary vision system that provides accurate relative pose data to the navigation system enabling medium to close range rendezvous with a non-cooperative vehicle in space. The vision system does not require targets, such as retro-reflectors, for the rendezvous; instead, it uses solely the geometry of the targeted spacecraft.

TriDAR is a version of a random access scanning LIDAR which directs the beam anywhere within its field-of-view (FOV) rapidly. The outcome is direct 3D measurements that are matched to a referenced geometry model of the targeted satellite, which in turn produces a relative 6 degree of freedom (DOF) pose of that spacecraft. The pose is generated at 5 Hz and the software algorithm includes autonomous initialization, autonomous tracking, and autonomous re-initialization after a loss of track, all of which are essential elements for truly autonomous rendezvous & docking.

TriDAR contribution to DARPA's Phoenix Program would be a great advantage as TriDAR provides an off-the-shelf solution to rendezvous & docking with a targeted satellite that was not meant to be serviced or reused with or without cooperative targets attached to it. If no blueprint of the satellite is available, an initial closeby flyaround can be used to gather 3D model data of the satellite and plan the rendezvous mission.

TriDAR is totally immune to any lighting conditions and can be used in full sunlight or in total darkness. Additionally, it can be used for other robotics tasks such as:

- 3D inspection of the targeted satellite
- Tele-operation of robotic arms (e.g. during assembly operations)
- Other spacecraft tracking (i.e. in the vicinity of TriDAR)

Neptec proposes to leverage its current state-of-the-art and flight history of TriDAR to the next level, which is to directly tailor it and integrate it within the Phoenix Program. The problem of acquiring relative data of the targeted satellite and transmitting it to the navigation system is SOLVED.

Flight Heritage, In-the-loop Demonstration and Experience with DARPA

TriDAR has successfully flown 3 times on the NASA Space Shuttle Program as a Detailed Test Objective (DTO) experiment. On STS-135, it was successfully used by the crew on the flight deck as a cross-checking verification measure to other rendezvous & docking systems.

TriDAR was selected as the primary navigation vision system by Orbital Science Corporation Cygnus COTS vehicle as part of the navigation system.

It has been demonstrated that TriDAR can easily be integrated within a navigation system to which it provides the main relative pose data. It has been integrated within the major 6 DOF rendezvous & docking test facilities in North America including Lockheed Martin in Denver, Marshall Space Flight Center, Johnson Space Center, Goddard Space Flight Center, Naval Research Laboratories (NRL), and the Canadian Space Agency.

A TriDAR unit has been delivered to NRL and was used in their facilities to refine their satellite servicing concept SUMO-FREND and support related rendezvous & docking demos and tests. SUMO-FREND aimed at demonstrating the techniques needed in order to autonomously rendezvous and capture customer satellites in geosynchronous orbits.

In addition to NASA, Orbital, and other large prime contractors, Neptec has also conducted work with DARPA. Neptec participated in the URGENT project, sat on the defining committee for standards on the GRID project, and was a member of the 'Industry 10' group, which had the mandate to develop an innovative business model for working with DARPA.