Safe Rendezvous and Proximity Operations

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Emergent Space Technologies
Company Overview

• We provide engineering services and consulting to the civil, commercial, and military space industry

• Our core competencies include:
  – Spacecraft guidance, navigation and control
  – Command, control, and information systems
  – Mission operations automation and autonomy

• We became an AGI business partner in 2006
  – Focusing on systems integration of AGI products
    • Real-time implementations of ODTK, STK, etc.
Background

• Founded August 2001
  – 100% growth per year since inception

• Headquartered in Greenbelt, Maryland
  – Planning for expansion to Colorado and Texas

• Highly educated workforce
  – 30% PhD, 30% MS, 40% BS

• Experienced in multi-satellite development and operations
  – Globalstar, Iridium, HST HRV, ANGELS, EO-1/LS-7, SMEX

• Diverse customer base
  – NASA, NOAA, Air Force, DARPA, Private Industry
  – Cleared for DoD work

• Prime contractor partners
  – Lockheed Martin, Orbital Sciences, Northrop Grumman, Honeywell
    Technical Services, Swales Aerospace, General Dynamics, SpaceDev
Program Overview

• Commercial Orbital Transportation Services (COTS)
  – Supported the SpaceDev Team
    • On-Orbit Navigation and Rendezvous and Proximity Operations
  – SpaceDev’s Dream Chaser (DC), a variant of NASA’s HL-20 lifting body, is the proposed crew/cargo transfer vehicle
  – With the International Space Station (ISS) as the destination, safe rendezvous and proximity ops are paramount
  – Emergent developed algorithms for safe DC/ISS rendezvous and proximity operations and used high-fidelity modeling and simulation to visualize their performance
Challenge

• Compute safe approach maneuvers for DC/ISS approach, prox ops and docking

• Interface in-house algorithms with AGI software for visualization

• Create animation of approach trajectories and docking
  – Using SpaceDev-provided model
  – Displaying a “keep out” ellipsoid

• Do this rapidly since we were on a tight schedule
Solution Criteria

- Provide visualization as rendezvous trajectories are computed
  - Ability to accept maneuver data from in-house software
- Display relative trajectory between ISS and DC
- Utilize accurate spacecraft models and textures
- Display ISS “keep out” ellipsoid
- Intuitive user interface for rapid development
Alternative Solutions

• Celestia
  – Only provided visualization

• In-House visualization software
  – Too much time required for development

• STK product suite
  – Provides clean interface for quick integration
  – Provides excellent graphical displays
  – Provides means to generate post-simulation movies for marketing purposes
Solution

• STK/Advanced VO
  – Provides accurate visualization of proximity operations and docking
  – Accurate models and textures

• STK/Connect
  – Provides interface with in-house algorithms
  – Easy to use and implement in a short development period

• STK/Astrogator
  – Provides multiple maneuver propagation capability

• ODTK for future work
  – Provides navigation algorithms
Results

• Time Savings
  – In-House
    • Customer model conversion: 10 hours
    • In-house visualization software development: 120 hours
    • Interface with in-house algorithms: 40 hours
    • Capture animation: 25 hours
    • Total Hours: 195 hours
  – STK/In-House
    • Customer model conversion: 15 hours
    • In-house visualization software development: 0 hours
    • Interface with in-house algorithms: 10 hours
    • Capture animation: 20 hours
    • Total Hours: 45 hours
  – Total Savings: 150 hours

* Numbers are approximate
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