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Automated Conjunction Assessment System (AutoCAS)

Assessing and mitigating risks of space collision

The Automated Conjunction Assessment System (AutoCAS) provides conjunction risk assessment and mitigation for 24 Goddard Space Flight Center (GSFC) and NASA based missions including the geosynchronous Tracking and Data Relay Satellite System (TDRSS) fleet and the low-earth orbit Earth Observation System (EOS) Constellation. The a.i. solutions-developed AutoCAS assesses collision threat from objects in the Space Object Catalogue, which is maintained by US Strategic Command (USSTRATCOM). AutoCAS monitors daily conjunction activity for the 24 NASA asset spacecraft and anticipates the list of supported mission to grow to 30 by late 2008.

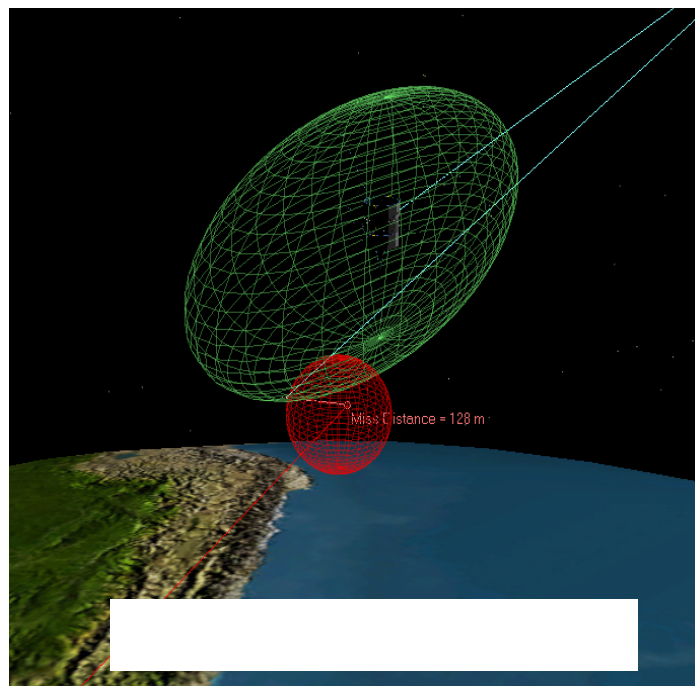
The Process

GSFC provides orbit state data for its asset spacecraft to USSTRATCOM, which then performs an initial conjunction screening to determine if any objects in their database (of over 13,000 tracked objects) violate a pre-defined 3-dimensional ellipsoid around each spacecraft. If so, the separation distance is computed and the results are passed back to AutoCAS for further risk assessment and mitigation analysis. In a given day, up to 40 conjunction threats are identified, requiring AutoCAS to perform detailed risk assessment and mitigation analyses for each individual conjunction threat.

The automated risk assessment performed by AutoCAS consists of:

- Trending miss distance and specific orbit determination related parameters.
- Computing collision probability using either high or low relative velocity theory and via Monte Carlo for independent verification.
- Performing collision probability sensitivity analysis.

Risk assessment analysis results are then automatically



formatted into user-friendly PDF reports and distributed to analysts and mission stakeholders via email and the EOS Portal web site for review. If the analysis indicates a high likelihood of collision, then evasive action is planned.

The Tools

At the heart of the AutoCAS system is the Risk Assessment and Mitigation Tool suite, which is used to assess the collision risk and perform a risk mitigation maneuver if necessary. The tool suite is comprised of *FreeFlyer*[®] and MATLAB[™] and consists of 6 modules:

1. Visualization Script
2. 2D Collision Probability Tool
3. Curvilinear Collision Probability
4. Monte Carlo Simulation
5. Risk Mitigation Maneuver Trade Space Utility
6. Trending Tool





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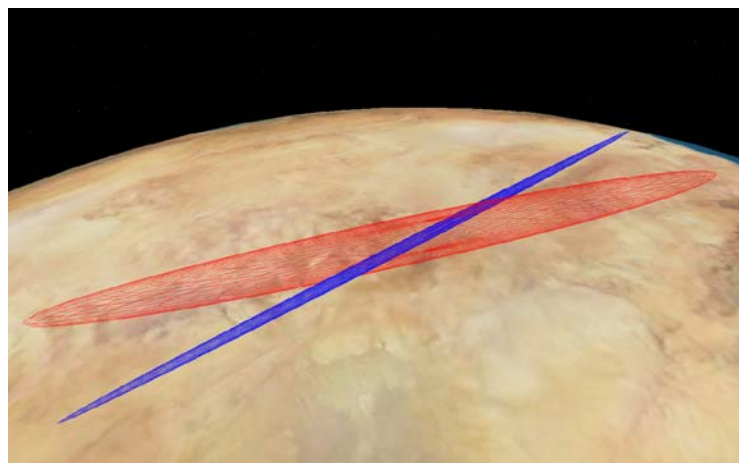
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The utilities in the tool suite can be used for any orbit regime. In particular, the Curvilinear Collision Probability Tool is suited for encounters at geosynchronous or for satellites flying in formation. The current tool and architecture design can be easily modified based on changing requirements and mission needs.

System Highlights:

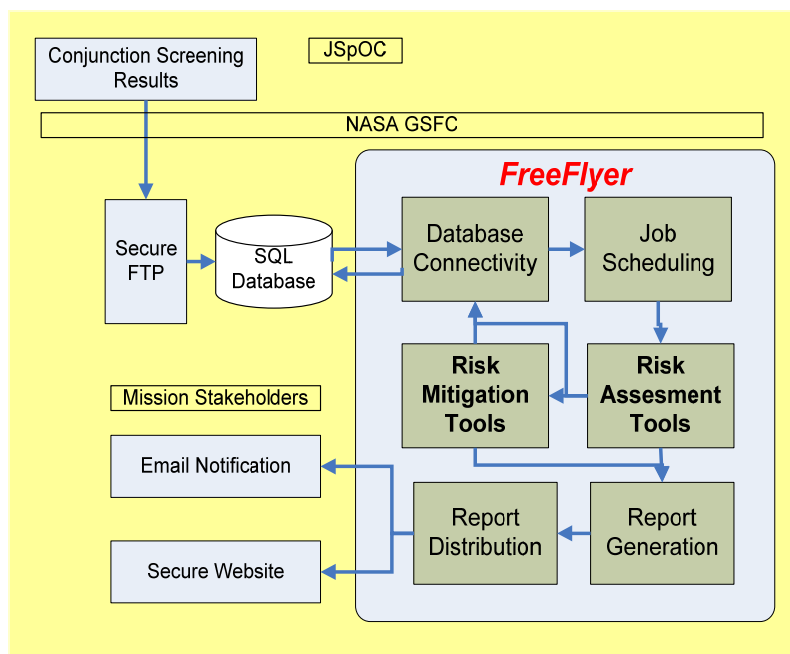
- End to end automated processing from data ingest to email distribution of final reports.
- Conjunction geometry and orbit visualization.
- Collision probability calculations and Collision Probability sensitivity analysis.
- Monte Carlo simulation to verify Collision Probability.
- Risk Mitigation Maneuver trade space plotting miss distance as a function of maneuver magnitude and phasing time.
- Low relative velocity Collision Probability tool.
- Orbit determination and conjunction geometry trending.
- Integrated database for storing of large amounts of data.
- Applicable for any number of satellites in any orbit regime.
- Provides comprehensive tool set for off-line analysis.



Covariance Visualization

AutoCAS Collision Avoidance History

Conjunction Event	Operational Impact
Terra Vs. 31410	Risk Mitigation Maneuver (Jun, 2007)
SAC-C Vs. 13435	Risk Mitigation Maneuver (Feb, 2007)
Parasol Vs. 81257	Risk Mitigation Maneuver (Jan, 2007)
Terra Vs. 01716	Drag Make-up (DMU) Maneuver waived off (Jan, 2006)
Aqua Vs. 24097	DMU Maneuver waived off (Dec, 2005)
Terra Vs. 14222	Risk Mitigation Maneuver (Oct, 2005)
Aqua Vs. 03927	DMU Maneuver waived off (May, 2005)



AutoCAS Architecture

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