Tumbling Space Debris Capturing Using a Net

Contact: Minghe Shan, Jian Guo, Eberhard Gill
Faculty of Aerospace Engineering
Delft University of Technology
Delft, the Netherlands
Email: m.shan@tudelft.nl, j.guo@tudelft.nl, e.k.a.gill@tudelft.nl

Background photos credited to Sron, Dukeo and Orbiter forum

Background

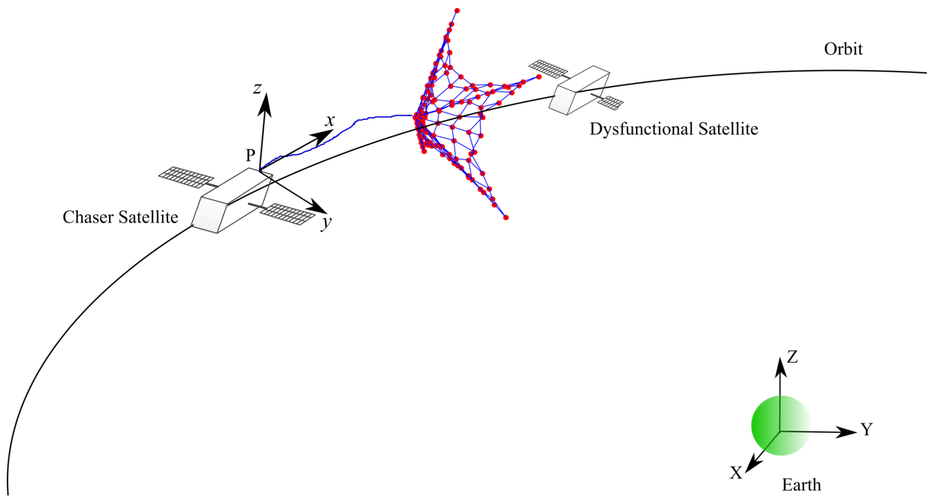
Millions of space debris are orbiting the Earth and threatening operational space missions. Net capturing has been one of the most promising methods dealing with space debris due to its flexibility and compatibility with the unknown topology of a target. Moreover, it offers a safe capturing distance, and the capturing mechanism is lightweight and cost efficient.

Approach

In the developed simulator, the flexibility of the net is modelled by a series combination of mass-spring elements. The contact dynamics are based on the penalty-based method, and the contact forces are evaluated based on the Hertzian contact theory. In this poster, a successful capture by a net is defined as a capture in which the net closes and wraps up the target and will not re-open again.

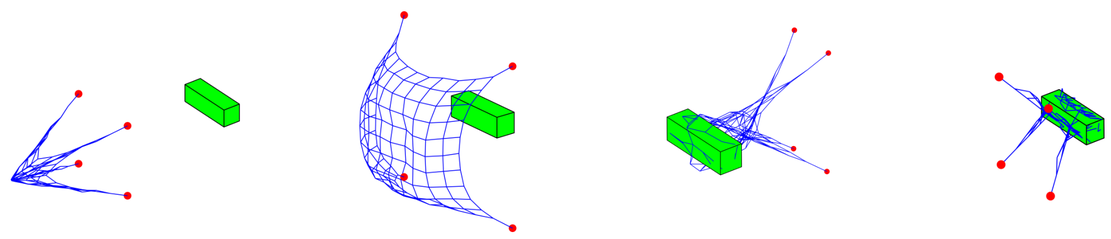
Results

Cases in terms of a floating 3-Unit CubeSat, tumbling CubeSat (tumbling rate 1.5 rad/s and 5 rad/s) are studied respectively. When capturing a floating target (case 1), the net will wrap up the target and the bullets will surround the target for several rounds. It is always a successful capturing. Furthermore, the motion of the target is hardly affected by the net since the contact force is small. When capturing a tumbling target (case 2 and 3), the net will tumble with the target after contact. It still can be a successful capture when the tumbling rate is not high enough (case 2). Case 3 describes a failed capture that results from a high tumbling rate. According to the simulation results, an available tumbling rate range for a tumbling 3-Unit CubeSat capturing by a net is 0~3 rad/s.

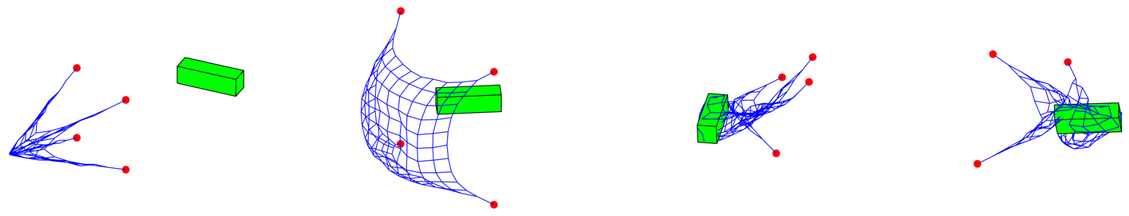


Parameters	Values
Net size [m*m]	0.8*0.8
Mesh square [-]	10*10
Bullet mass [kg]	0.03
Shooting velocity [m/s]	2
Shooting angle [°]	25
Target size [m]	0.1*0.3*0.1
Target mass [kg]	6
Tumbling rate [rad/s]	0~3
Capture distance [m]	1.5
Contact Stiffness [N/m]	750
Friction coefficient [-]	0.1
Circular orbit at altitude [km]	300

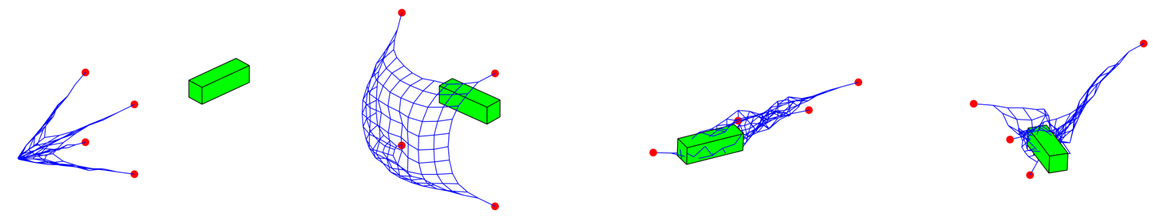
Case1: Floating Target Capturing



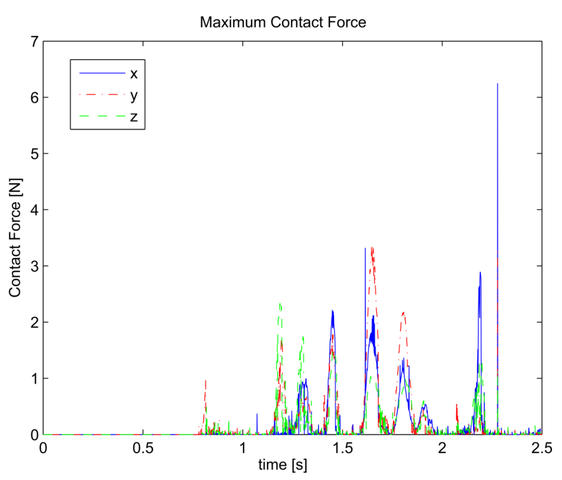
Case2: Tumbling Target Capturing (Tumbling Rate: 1.5 rad/s)

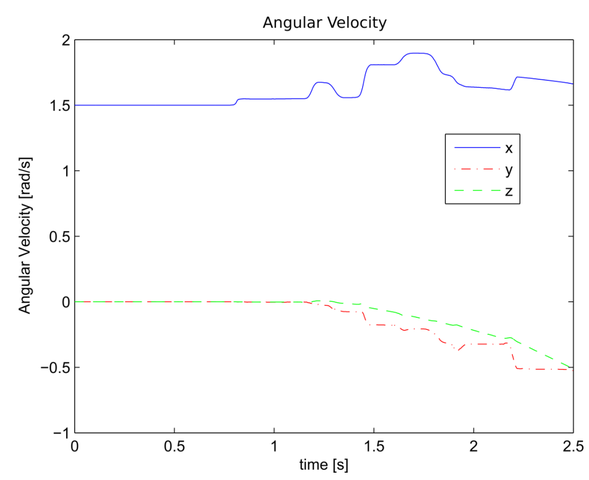


Case3: Tumbling Target Capturing (Tumbling Rate: 5 rad/s)



Post-Analysis





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