Novel Method for the Identification of High-Risk Space Debris

Vielmetti, Thomas (School: Nicolet High School)

Every passing year, more and more material is introduced into Earth's orbital environment. While regulations regarding end-of-life removal have steadily evolved over the past decades, hundreds of satellites exist with no means for safe removal. Concurrently, anti-satellite tests, orbital collisions, and the increasing commercialization of space further threaten the sanctity of the orbital environment. This study builds on the work of Donald Kessler and others who've worked to model the development of the orbital debris environment by using modern data, comparing the results to those of past studies, and introducing novel mathematical modeling approaches to identify debris objects that pose the greatest threat to the most orbital infrastructure in the event of a catastrophic collision event. To achieve this, a mathematical model was created that factored in 5 key attributes, including the spatial density of an orbit, risk of orbital instability, and length of debris life, to determine which specific debris objects pose the greatest threat. This model was able to rank every piece of debris by this weighted risk level. These rankings should be used in the future to inform decisions regarding debris removal as those technologies begin to come online. In future studies, additional information could be used to improve the accuracy and usefulness of the model's results. Information, specifically relating to the mass and size of specific debris objects, could be used to estimate the amount of debris objects created in a collision event, as well as improve the accuracy of orbital modeling.

Awards Won:
Fourth Award of $500
Air Force Research Laboratory on behalf of the United States Air Force: Glass trophy and USAF medal for each recipient
Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Regeneron ISEF Category