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Status of Space Debris : What To Do? And What Not To Do?

P. VENKATA RAMU[1]*, Y. SREEKANTH[2**]
[1*]*Department of Physics, Hindu College, Guntur - 522003, A.P., India.*
[2**]*Department of Mathematics, Hindu College, Guntur - 522003, A.P., India.*

I. Introduction

Space debris also known as orbital debris, space junk and space waste is the collection of defunct objects in the orbit around the earth. This includes everything from spent rocket stages, old unused satellites, fragments from erosion and collisions. Since the first space object Sputnik was sent to space, the number of satellites in the use the earth orbit is steadily increasing which in turn increases the space waste. This waste left unchecked, will eventually poses a serious hazard to near earth, also causes danger to space vehicles, space stations, space shuttles and other space crafts with humans aboard. Space activities, which may cause serious environmental problem in earth orbit. This debris poses growing threat to the satellites and could prevent use of valuable orbits in future. There are 4,600 launches in 54 years of space exploration.

Ben Greene, head of Australia's Space Environment Research Centre which is hosting the two-day conference of international space environment scientists in Canberra, told *AFP* that "the space junk problem has been getting worse every year,". "We're losing three or four satellites a year now to space debris collision. We're very close, NASA estimates, of within five to 10 years of losing everything." He added in a statement that "a catastrophic avalanche of collisions which could quickly destroy all orbiting satellites is now possible", noting that more collisions were creating extra debris. With society heavily dependent on satellites for communication and navigation, and powering key industries such as transport, finance and energy, the growing cosmic junkyard could threaten economies. "The Australian economy is entirely dependent on space," Greene said. "We're a big country with few people and the only way we can service it, whether it's with surveillance, safety or search-and-rescue, is from space."

The barriers to entry for building spacecraft were also falling, making it easier for firms to launch their own objects, said space debris expert Moriba Jah from the University of Texas, who is at the conference. "I believe that we are certainly on a path to what I call a tragedy of the commons," he told the *ABC*, adding that a major collision was "inevitable" without action to tackle the problem. "You've driven on the roads here when you have a lot of mist or fog, and you have to go really slow, and you just don't know what's really around you. That's the perfect analogy to space right now," Jah said.

Greene said scientists were developing technologies set to be operational in 18 months to track all debris so spacecraft could move around them. Another idea in the works was Earth-based high-powered lasers that could be fired into space to "push the debris around a little bit", with the programme 75% ready, he added. An experimental Japanese mission to clear space junk using an electro-dynamic 'tether' to "The space junk problem has been getting worse every year," "We're losing three or four satellites a year now to space debris collision. We're very close, NASA estimates, of within five to 10 years of losing everything."

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II. What Is Done

As of 5th July 2016, the US strategic command tracked a total of 17,852 artificial objects in above earth, which including 1419 operational satellites. However these are just objects larger enough to be tracked. As on July 2013, more than 170 million debris smaller than 1cm, about 6,70,000 debris of 1-10cm, around 29,000 larger debris were estimated to be in orbit. Collision with debris has become hazard to space crafts, they cause damage akin to sound blasting especially to solar panels and optics like telescopes or star trackers that cannot be covered with a ballast whipped shield. In 1996 a French satellite was hit and damaged by debris from a French rocket that had exploded a decade ago. On February 10, 2009 a defunct Russian satellite collided with and destroyed a functioning US communication satellite. This collision added more than 2000 pieces of trackable.

III. How It Harms

Objects of size more than 10cm can be tracked by the space surveillance network and can be avoidable for collision. But there are millions of debris of size below that such as solar panel pieces, paint strips are orbiting around the earth orbit. Most orbital debris is within 2000 km of earth surface. The greatest concentrations of debris are found at 750-800km above the earth. These junks are hurtling around the earth at speeds of up to 17,400 miles per hour just like rings of Saturn.

The Kessler syndrome, a runaway chain reaction of collisions exponentially increasing the amount of debris, has been hypothesized to ensure beyond a critical density. When satellite reaches end of life, most of satellites were normally boasted in to a medium altitude called “Grave yard orbit”. According to Edward Tuft’s book “Envisioning information” the space debris including a glove, a camera, a thermal blanket, garbage bags of cosmonauts, tooth brush, tool bag, a wrench, etc.

Specifically, most debris due to the rocket stages. On September 22, 2011 a bus sized upper atmosphere research satellite plunged in to earth over the pacific, apparently causing no damage or injuries. In the same year orbital debris came with couple of hundred yards of international space station. In-orbit risks are due to collisions with operational spacecraft, or with decommissioned spacecraft or rocket bodies. Impacts by debris larger than 10 cm are assumed to cause catastrophic break-ups, which cause the triggering of a coalitional cascading process − the Kessler syndrome. Collisions with debris larger than 1 cm would disable an operational spacecraft, and may cause the explosion of a decommissioned spacecraft or rocket body. Impacts by milli metre-size debris may cause local damage or disable a subsystem of an operational spacecraft.

Large space-debris objects (e.g. spacecraft, rocket bodies or fragments thereof) that reenter into the atmosphere in an uncontrolled way can reach the ground and create risk to the population on ground. The related risk for an individual is, however, several orders of magnitude smaller than commonly accepted risks, such as driving a car, that we all accept in day-to-day life. The International Space Station has debris shields deployed around the crewed modules. These shields are composed of two metal sheets, separated by about 10 cm. The outer bumper shield exploits the impact energy to shatter the debris object, such that the inner back wall can withstand the resulting spray of smaller-sized fragments.

Between the walls, fabric with the same functionality as in bullet-proof vests is deployed. This design enables the shield to defeat debris objects up to 1 cm in size.

The orbits of debris objects that are large enough to be contained in the US Space Surveillance catalogue can be predicted and compared with the Space Station’s orbit to determine whether a close approaches will occur. Assuming that both orbits can be determined with sufficient accuracy, then a predicted flyby, or conjunction, distance can be translated into a specific in-orbit collision risk. If this risk exceeds the ISS threshold level, as set under the flight rules, then the Station performs an avoidance man oeuvre. By the end of 2012, the Station had performed more than 15 of these man oeuvres, some by using the engines of ESA’s Automated Transfer Vehicle when one happened to be docked to Station.

IV. What To Do

NASA takes the threat of collisions with space debris seriously and has a long standing set of guide lines on how to deal with each potential collision threat. These guide lines, a part of a larger body decision making aids known as Flight rules, specify when the expected proximity of a piece of debris increases the probability of collision enough that evasive action or other precautions to ensure the safety of the crew are needed.

The placement of ion engines on the satellites in order to direct them back to Earth would have the same problems as the previously mentioned strategies and, in addition, would require significant, long-term power and attitude control sub-systems. Current manned spacecraft cannot reach the key orbital regimes above 600 km and are even more expensive than robotic missions. The use of ground-based lasers to perturb the orbits of the satellites is not now practical because of the considerable mass of the satellites and the consequent need to deposit extremely high amounts of energy on the vehicles to effect the necessary orbital changes. Hence, the success of any environmental remediation policies will probably be dependent on the development of cost-effective, innovative ways to remove existing derelict vehicles. The development of this new technology may require both governments and the private sector working together. Without environment remediation and the wide implementation of existing orbital debris mitigation policies and guidelines, the risks to space system operations in near-Earth orbits will continue to climb.

Within a given projection time step, once the explosion probability is estimated for an intact object, a random number is drawn and compared with the probability to determine if an explosion would occur. A similar procedure is applied to collisions for each pair of target and projectile involved within the same time step. Because of the nature of the Monte Carlo process, multiple projection runs must be performed and analyzed before one can draw reliable and meaningful conclusions from the outcome. The use of Triple-cubesat miniature satellites called "Doves" as payloads on other rocket launching missions is one of the possible way to overcome the problem space debris. Each Dove earth observation satellite continuously scans earth, sending data once it passes over a ground station. Doves form a satellite constellation to provide image of earth at 3-5m optical resolution. Recently ISRO put 88 Dove satellites into orbit in February 2017. The future is of these Dove satellites and as they contributes very less junk material.

V. Conclusion

Post-mission disposal of vehicles(for example, by limiting post-mission orbital lifetimes to less than 25years) is now advocated by the major space-faring nations and organizations of the world, including NASA, the Department of Defense, the Department of Transportation, and the Federal Communications Commission in the United States; the Inter-Agency Space Debris Coordination Committee ; the European Space Agency ; and the Japan Aerospace Exploration Agency. Post-mission disposal will slow down the growth of future debris populations. However, this mitigation measure will be insufficient to constrain the Earth satellite population. Only remediation of the near-Earth environment—the removal of existing large objects from orbit—can prevent future problems for research in and commercialization of space. For the near term, no single remediation technique appears to be both technically feasible and economically viable. The space junks objects are made out of very specific materials that are very expensive to produce, and it is tempting to think of them as resource just waiting to be used. The thing is, we continue to contribute to space debris even as we ponder how to resolve it. Whether or not we figure out a way to use space junk as a resource, it's imperative that we do something about it. Perhaps sooner rather than later.

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