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Space Debris- An increasing Junk Yard

Disha Saxena*

The subject of Space Debris, not the 2015 US TV Series but the real junk left in outer space which is headed into our future is a matter of grave concern and requires immediate attention of the National and International Authorities. Since 1957, more than 4,900 space launches have led to an on-orbit population today of more than 18,000 tracked objects. Only 1,100 are functional spacecraft. The remaining 94% are space debris, i.e. objects which no longer serve any useful purpose. This paper focuses on the risks associated with space debris and how it can be controlled.

Keywords: Space debris, atmosphere, man-made objects, space based methods

INTRODUCTION

Why is space junk such a growing problem?

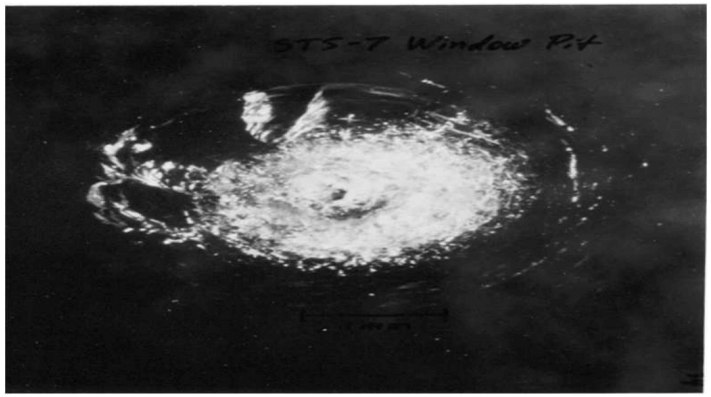
Taking a tangent from the topic of environmental pollution(If you know people in NCR - Delhi you know what happened after Diwali'16, Air pollution levels left us unsettled) - let's give some thought to Space pollution. According to NASA, America's space agency, the skies high above the Earth are cluttered up with around 23,000 pieces of man-made space junk measuring 10cm or more across, zipping along at great speed and posing a threat to working satellites. The European Space Agency reckons that collision alerts arising from worn-out satellites, defunct rockets and other clutter (such as launch adapters, lens covers, copper wires and the odd glove) have doubled in the past decade. Every such collision spawns more junk – a phenomenon known as the Kessler syndrome, named after Donald Kessler, an American physicist who postulated it in the 1970s. Low-Earth orbit, the region between 160 and 2,000km above the Earth, is crucial to space exploration. It is home to about half of the roughly 1,300 satellites which scan the Earth in great detail for both military and civilian purposes. It is also littered with "around 5,000 objects that are either rocket bodies or dead payloads," says Kessler. This is dangerous. A fleck of paint travelling at an orbital velocity of 17,500kph can dent a spacecraft, kill an astronaut or do enough damage to throw a satellite off course. Inoperative rockets are prone to random explosions of the unused fuel they carry.

"Space debris are all man-made objects, including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense layers of the atmosphere that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorized."

Wikipedia says "collection of defunct man-made objects in space – old satellites, spent rocket stages, and fragments from disintegration, erosion, and collisions – including those caused by debris itself".

As of December 2016 there were 5 satellite collisions with space waste. About 64% of the routinely tracked objects are fragments from some 250 breakups, explosions and collisions of satellites or rocket bodies. In addition, there is evidence of a much larger population of debris that cannot be tracked operationally. An estimated number of 700,000 objects larger than 1 cm and 170 million objects larger than 1mm are expected to reside in earth orbits.

**Manager, Axtria, Gurgaon*



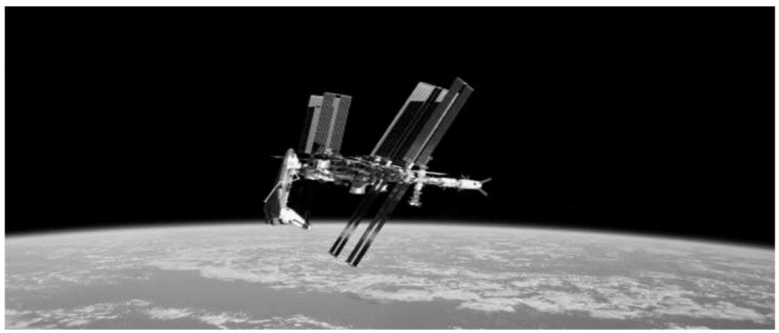
How do we measure space debris?

Space debris mitigation measures, if properly implemented by spacecraft designers and missions operators, can curtail the growth rate of the space debris population. Active removal, however, has been shown to be necessary to reverse the debris increase.So how do we measure these objects? Ground based (Radar and Optical) methods along with Space based methods are put in place to collect data. Objects are divided into LEO, and HEO; Lower Earth Orbit and Higher Earth Orbit. We have been able to measure objects as small as 10cms in LEO.Small debris objects (smaller than a few millimeters in diameter) have already caused some damage to operational space systems. These impacts have had no known effect on mission success. This damage can be divided into two categories. The first category is damage to surfaces or subsystems. The second category is the effect on operations.Wide field Imaging for observations get degraded due to debris, this pollutes the measurements and hence operations.

Space Debris Mitigation Measures

It is a big problem and an issue as to how to clean up the space debris. Schudder (2016) made the observation that, “I can tell you the worst way to clean up a dead satellite, which unfortunately happened in 2007; the Chinese military decided to test their anti-satellite technology on one of their dead weather satellites. This test successfully exploded the dead satellite, and created over two thousand new pieces of space debris, which, at the time, increased our space junk tally by 25%. (We had another spike in the space debris population after a dead, but intact, Russian spacecraft managed to collide with a not-dead privately owned satellite - that produced another 2000+ large pieces of debris.)”

Japan Aerospace Exploration Agency (JAXA) recently launched into orbit a space junk collector to clean up space debris. Kounotori, which means stork in Japanese, blasted off from the southern Japanese island of Tanegashima on Dec. 9 onboard an H-IIB rocket, Phys.org reports.



NASA envisions autonomous rendezvous in the future, making refuelling and servicing satellites possible even without human participation. (Photo : Paolo Nespoli - ESA/NASA via Getty Images)

Collected data comes in handy while applying Risk Mitigation methods for short term and long term models. Space debris models provide a mathematical description of the distribution of objects in space, the movement and flux of objects and the physical characteristics of objects (e.g. size, mass, density, reflection properties and intrinsic motion).

The scope of the long-term modelling of the space debris environment is the long-term (up to 100-year) prediction of the number of objects as a function of time, of altitude, of inclination and of object size. These projections are important for assessing the necessity and the effectiveness of debris mitigation techniques and the impact of new space activity. Risk assessments in LEO are routinely utilized to enhance the safety of space operation. In cases involving human space flight, risk assessments have proved invaluable in ensuring the safety of shuttle operations. Shuttle missions are operationally reconfigured whenever a pre-flight risk assessment indicates that the risks of space debris are at an unacceptable level.

Risk assessments were utilized to design the location and type of space debris shielding that would protect the crew as well as the crucial subsystems on the International Space Station. Space agencies and private companies from various countries have proposed a variety of methods to clean up the mess. Scientists in Japan have recommended installing lasers on the International Space Station to nudge debris into the Earth's atmosphere, where it would burn up harmlessly. NASA scientists have proposed doing the same thing using ground-based lasers. In March 2015, the European Space Agency experimented with nets designed to capture moving debris. Japan Aerospace Exploration Agency has devised an electrodynamic tether which, when tied to a piece of space junk, would cause it to slow down and fall into a lower orbit. Space agencies across the globe are considering other options too. Dead satellites located in geosynchronous orbit (about 36,000km above the surface of the Earth) are sometimes pushed into a “graveyard orbit” about 300km further out. New technologies allow rockets that have delivered their payloads to reignite their engines, lower their orbits and then burn up in the Earth's atmosphere. Many countries have agreed that satellites should be designed to burn up harmlessly in the atmosphere within 25 years of their operational lifespan coming to an end.

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