# Scenario Of Space Debris Management: A Review

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**Abstract:** Space is always a curiosity for the human being, therefore to understand the space infinity, many countries are actively busy to do deep research in space and trying to develop new technology. But, our active involvement in the space has created a huge quantity of debris in the space. Nowadays, space debris has become one of the major problems for the countries actively engaged in space research and innovations. Therefore, its management is necessary for future space innovation. The present review article focuses on the various possible methods prescribed by some agencies which can be implemented for the removal of space debris. This article is also shown the current scenario of space debris and its management activities tried to carry out by some space research agencies. This review work also summaries that, Space debris management industries have a very great scope in the nearby future.

**Index Terms:** Space Debris Management, Lasers, Space Tugs, Tethers, Ion Beam shepherd, Solar Sail, Net Capturing.

## 1. INTRODUCTION

Space debris comprises millions of pieces of man-made material orbiting with the speed of several km per second around the Earth, these space debris poses a growing threat to satellites as well as it may cause serious problem for operational space missions. However, certain measures have been taken to address this global issue, such as internationally adopted debris mitigation guidelines are reducing the introduction of new fragments into Earth's orbit. Still, growing consensus within the space debris community that mitigation is insufficient to constrain the orbiting debris population. In this context, present review article try to show the possible strategies in space debris management.

## 2 CURRENT STATUS AND CHALLENGES

According to the judgment published by Roger Thompson in 2015, about more than 128 million fragments of debris smaller than 1cm to be in January 2019. There are about 900,000 pieces from one to ten cm. The current rate of large debris is 34,000 were estimated to be in orbit all over the earth [9].

***Fig.1*** *Space Debris*
(Credit: Business Insider India, 2019)

Due to Earth rotation orbital debris can reach speeds up to 56000 km/h. In recent years, consciousness of the space debris issue has increases considerably by and significant pursuit have been made to reducing the production of new debris through compliance with national and international guidelines. The space safety index identify that the existing normative framework for outer space activities is insufficient to address the current challenges facing the outer space domain.

## 3 PROBLEM FORMULATION

As one of the major reasons behind formulation of space debris is the race among the countries for the inventions in space research by sending satellites in the space for development purposes like communication, educational, atmospheric study, defense etc. Most space debris comes from breakup events caused by explosions and collision, many of them deliberate. Fragmentation debris is the largest source of space debris. Three countries in particular are responsible for roughly 95% of the debris currently in earth's orbit, viz China (42%), the United States (27.5%) and Russia (25.5%) [8]. The most serious consequence of collisions with space debris is the possibility of a cascade effect or chain reaction in which debris proliferates as collision generate more and more debris indented of any further introduction of man-made objects.[11].

## 4 IMPACT OF SPACE DEBRIS

Although debris smaller than 1cm in size does not generally pose a danger to space craft, a space craft may survive being hit by fine debris, but such hits can still result in adversity and mission failure. Some times because of the intensive heat space debris can produce nitric oxide, which can deplete ozone [7] and sunlight penetration on earth is reduced. The space debris also can impact on social economics and political aspect [2]. Interference with scientist and other observations can occurs as a result of orbital debris. Debris may also contaminate stratospheric cosmic dust accumulation experiments.

## 5 SPACE DEBRIS MANAGEMENT

There are two basic classes of action that can minimize the orbital debris burden:

**5.1 Preventive measure**
**5.2 Proposed Space Debris Removal Methods**

### 5.1 Preventive Measures:

The most effective near term measure are to design and operate launch vehicles and space craft so they have minimum potential for exploding or breaking up.

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**5.1.1 Key aspects of space debris mitigation guidelines:**
a) Spacecraft and orbital stages should be designed not to release debris during normal separation.
b) Move satellites in higher orbits which are too far away to re-entry the atmosphere, into a graveyard orbit well outside the region used by active satellites. This would create a protected zone of a few hundred km either side of the geosynchronous orbit ring. [8]

**5.1.2 Collision Avoidance:**
Tracking information can be used to predict a collision in time for a satellite to manoeuvre out of the way, like, The International Space Station (ISS) performs around one avoidance manoeuvre each year. The Indian space agency told that foundation stone for a Centre to monitor and protect high value space assets from space debris.

**5.2 Proposed Space Debris Removal Methods**
A few observers have proposed active removal of existing debris. According to NASA, following are some of the proposed methods of debris removal [5].

**5.2.1 Lasers:**
This method is used to slowing objects using high powered lasers fired from earth where space debris can be vaporized so that they move out of orbit. China has a plan to clean up space Junk with Laser-universe today.

***Fig. 2*** *Lasers Method*
(Credit: Fulvio314/NASA/Wikipedia Commons)

**5.2.2 Space Tugs:**
Space tugs refers to using a robotic grappling device on another spacecraft to tug an object to a new orbit or to cause it to re-enter the atmosphere destructively. A space tug is actually a spacecraft that is used to move multiple pieces of debris to disposal orbits in geosynchronous orbit. Artificial Intelligence applications should be used in this type of method.

**5.2.3 Tethers:**
Tethers refers to using a momentum exchange tether which acts like a swing to pull on objects out of orbit or using an electrodynamics tether which cause a drag on the satellite due to the magnetic field of the earth. A conductive tether also known as an electrodynamics tether which is a long conducting wire that generates electric potential by its motion through the earth's magnetic field. Such tether can be attached to the targeted piece of orbital debris. The current generated by the tether produces a charge that de-orbits the objects causing it to re-enter the earth's atmosphere more quickly can be effective for de-orbiting large objects in low Earth orbit. This method is complex and costly to use.

**5.2.4 Ion Beam shepherd (IBS):**
The space dynamics groups of the technical university of Madrid (SDG-UPM) are the pioneer in exploring this concept by developing analytical and numerical control models. It is concept in which the orbit or aspects of a spacecraft or a generic orbiting body is modified by having a beam of quasineutral plasma have an effect or impact against its surface to create a force and or a torque on the target. Ion and plasma thrusters commonly used to drive spacecraft placed in vicinity of the target without physical attachment with the latter provides an interesting solution for space applications such as space debris removal and asteroid deflection[2].

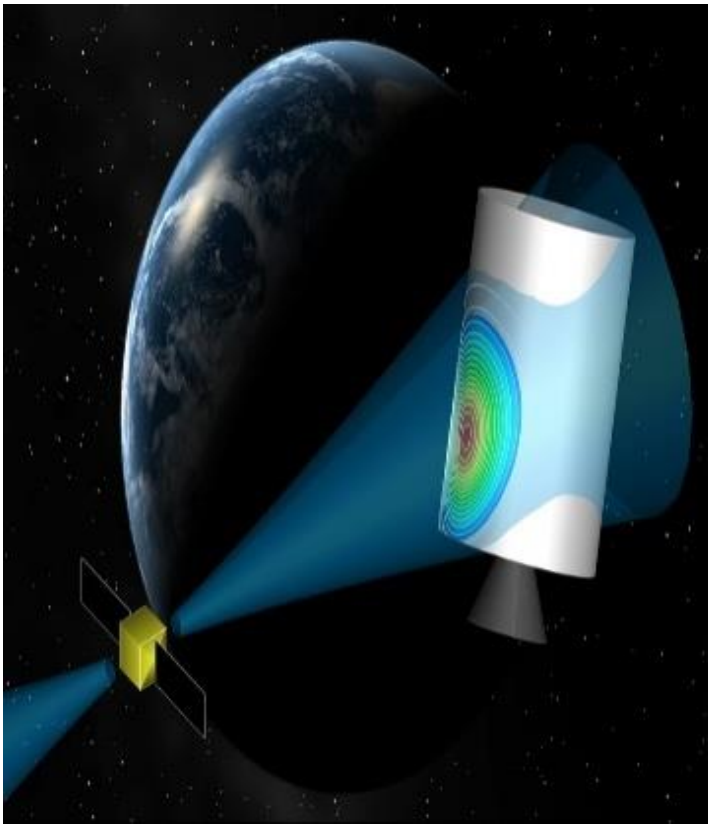

***Fig.3*** *Ion Beam Shepherd*
(Credit: https://leosweep.upm.es/en/ibs/ibs-concept-applications/31-the-ion-beam-shepherd-concept)

**5.2.5 Solar Sail:**
Solar sail is also called as light sail or photon sail. This is a method spacecraft, impulse using radiation, pressure, influences by sunlight large mirrors. The cube sail would use the drag of solar sail and to push orbiting space debris down

to the lower orbits.

$$\int_0^{r_2} F(r,\varphi)\, dr\, d\varphi = [\sigma r_2 / (2\mu_0)] \cdot \int_0^{\infty} \exp(-\lambda\,|z_j - z_i|)\, \lambda^{-1} J_1(\lambda r_2)\, J_0(\lambda r_i)\, d\lambda . \qquad (1)$$

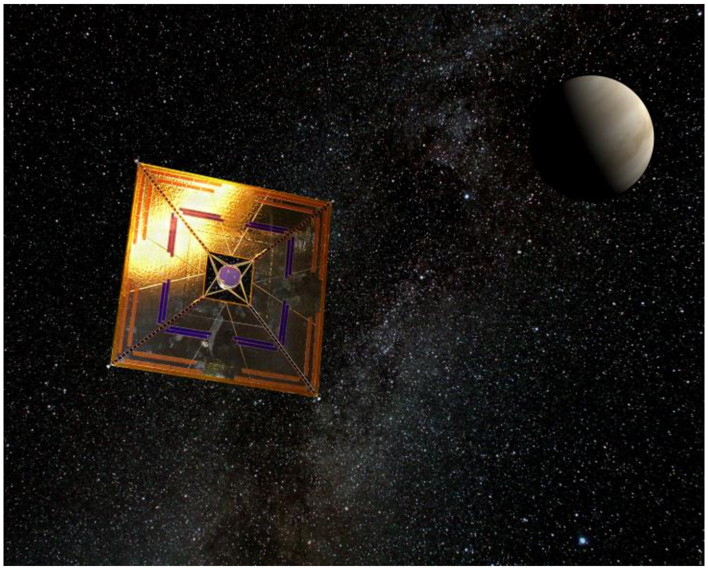

***Fig.4*** *Solar Sail*
(Credit: https://en.wikipedia.org/wiki/File:IKAROS_solar_sail.jpg)

**5.2.6 Net Capturing:**
The net is supposed to rotate around the earth and collect the orbital debris, ones the net is pull on the earth gravity would pull it down to the earth-and it well burn up as it is re-entered the atmosphere in the earth. A British satellite has successfully deployed a net in orbit to demonstrate how to capture space debris.

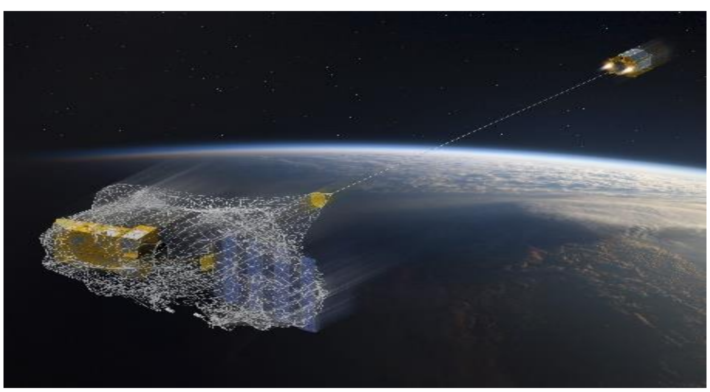

***Fig.5*** *Net Capturing*
(Credit: ESA's 3.Deorbit mission is developing robotic arms and nets to capture Envisat, the ESA Earth observing satellite that completed its mission in 2012)

## 6 CONCLUSION

The present review article suggests that space debris management need to be considered as one of the important global issues which will create very high negative and destructive impact on the earth. Space debris management by sustainable manner should be necessary part of space research plan of every country and possible methods need to be applied for the removal of space debris. It may also be concluded that Space debris management industries have very great scope in nearby future.

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