International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 3, May-June-2020, ISSN (Online): 2395-566X

Advance Methods For Space Debris Management

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***Abstract* – To removing space debris from space there are various methodology are present as well as various techniques also used. There are many ways that this problem might be addressed. In short, this means that active debris removal with a focus on the largest debris elements in low earth orbit as the first priority needs to be given priority. Space situational awareness and maneuvers to avoid collision and perhaps the use of ground or space based directed energy systems to avoid collisions (or near conjunctions) must also likely be a part of this overall strategy to preserve long-term and save access to outer space. This combined need for debris removal as well as collision avoidance is probably essential. In addition to this prime objective, there will be supplementary information provided with regard to in-orbit servicing and space situational awareness.**

In this paper studied the advance space debris management methods for effective used.

***Keywords* – Space debris, space debris management, space debris types.**

I. INTRODUCTION

1. Defination

Space debris, also known as orbital debris, space junk and space waste, is the collection of defunct objects in orbit around Earth. This includes everything from spent rocket stages, old satellites, and fragments from disintegration, erosion, and collisions. Since orbits overlap with new spacecraft, debris may collide with operational spacecraft. Since the number of satellites in Earth orbit is steadily increasing, space debris, if left unchecked, will eventually pose a serious hazard to near-Earth space activities, and so effective measures to mitigate it are becoming urgent above mentioned definition are declare by various researchers of space exploration event.

2. History

Space debris began to accumulate in Earth orbit immediately with the first launch of an artificial satellite into orbit in 1957.After the launch of Sputnik 1 in 1957, the North American Aerospacedefence Command (NORAD) began compiling a database (the Space Object Catalog) of all known rocket launches and objects reaching orbit satellites, Protective shields and upper- and lower-stage booster rockets. NASA later published modified versions of the database in two-line element set, and during the early 1980s the CelesTrak bulletin board system re-published them. In addition to approaches to debris reduction where time and natural gravitational/atmospheric effects help to clear space debris, or a variety of technological approaches that have been proposed (with most not implemented) to reduce space debris, a number of scholars have observed that institutional factors political, legal, economic and cultural "rules of the game" are the greatest impediment to the clean-up of near-Earth space.

3. Debris Growth

During the 1980s, NASA and other U.S.groups attempted to limit the growth of debris. One effective solution was implemented by McDonnell Douglas on the Delta booster, by having the booster move away from its payload and vent any propellant remaining in its tanks. This eliminated one source for pressure build up in the tanks which had caused them to explode and create additional orbital debris in the past.

4. Debris History In Particular Years

As of 2009, 19,000 debris over 5 cm (2 in) were tracked. As of July 2013, estimates of more than 170 million debris smaller than 1 cm (0.4 in), about670,000 debris 1–10cm, and approximately 29,000 larger pieces of debris are in orbit. As of July 2016, nearly 18,000 artificial objects are orbiting above Earth, as including 1,419 operational satellites. As of October 2019, nearly 20,000 artificial objects in orbit above the Earth, including 2,218 operational satellites.

II. TYPES OF ORBITS

1. Low Earth Orbit (LEO)

LEO (Low Earth Orbit, which means low orbits). Orbiting the Earth at a distance Between 500 and 2000 km.They are used to provide geological data on the movement ofEarth's plates, remote sensing, spatial investigation, metereology, vigilance and the phone industry satellite. Allow the determination of space debris and the utilization of the Electromagnetic spectrum.

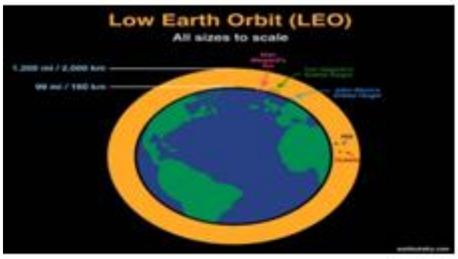

Fig.1 Lower Earth Orbit

Most satellites the International Space Station, the Space Shuttle, and the Hubble SpaceTelescope are all in Low Earth Orbit (commonly called "LEO"). This orbit is almostIdentical to our previous baseball orbiting example, except that it is high enough to miss all the mountains and also high enough that atmospheric drag won't bring it right back home again.

2. Medium Earth Orbit (MEO)

MEO (Medium Earth Orbit, stockings orbits). Moderately of about 20000 km.Its use is intended for mobiles communications, navigation (GPS), measurements of space experiments and effective use of the electromagnetic spectrum. A fleet of several MEO satellites, with orbits properly coordinated, can provide global Wireless communication coverage Because MEO satellites are closer to the earth than.

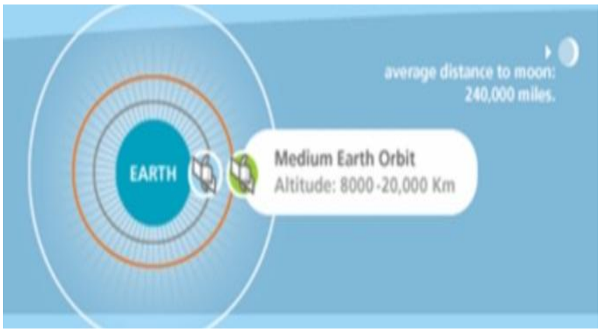

Fig.2 Medium Earth Orbit (MEO).

3. Higher Earth Orbit (HEO)

HEO (Highly Elliptical Orbit, highly elliptical orbits).This implies that much greater distances reached at the point furthest from the orbit. They are often used to map the surface of the Earth, as they can detect a wide angle of Earth's surface. Remember Kepler's second law an object in orbit about Earth moves much faster when it is close to Earth than when it is farther away. If the orbit is very elliptical, the satellite will spend most of its time near the furthest point in its orbit where it moves very slowly. Thus it can be above home base most of the time, taking a break once each orbit to speed around the other side.

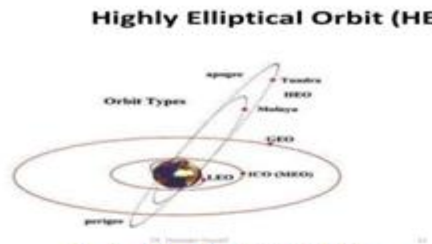

Fig.3 Higher Earth Orbit (HEO)

III. TYPES OF SPACE DEBRIS

Space debris, generally, refers to man-made material in orbit that no longer serves a useful purpose. Because of the high speeds of objects in orbit (7.5 km s-1 is typical in low earth orbit),even small pieces of debris can be very damaging in a collision. There are several types of collision defunct spacecraft, such as satellites that have ended their useful life. Commercial satellites have an average lifespan of around 15 years due to the harsh radiation environment in space; Spent rocket bodies used to launch satellites into orbit. Objects released during missions such as waste vented from the Space Shuttle; Small fragments Caused by collisions, explosions or deterioration of active satellites or larger pieces of debris.

Fig.4 Different types of space debris.

IV. OVERVIEW OF THE MANAGEMENT

Currently there is about six metric tons of space debris in earth orbit and about 45 % of that is in low-earth orbit and polar orbits where the threat of collisions continues to increase. This process can lead to an escalating cascade of more and more debris. Today we are very much at risk of such a cascading build-up that is known as the “Kessler Syndrome”. Two events in recent years have particularly contributed to Orbital space debris build-up. One event was the collision of the defunct Russian Kosmos 2251 weather satellite with the Iridium 33 low earth orbit mobile communications satellite. The other was the shooting down of an old and defunct Chinese Fen Yun weather satellite by the Chinese military. These incidents raised concerns to a much higher level of Urgency on the world stage. The first act occurred on January 11, 2007.

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This event was the intentional launch of a Chinese missile to destroy an obsolete polar-orbiting? Chinese weather satellite, the Fen Yun 1C. A missile using an anti-satellite (ASAT) System was launched from near the China's Xichang Space Centre on 11 January and reached its target at an altitude of 865 km (or 537 miles). There are a number of private companies and institutions that are intent on seeking to address the space debris problem.

1. Clean Space One

This is a project of the Swiss Space Centre and the Federal Polytechnic School of Lausanne or the Ecole Polytechnique Federale de Lausanne (EPFL). It began with Student designing a cube sat for scientific measurements with the mission to observe and map airglow a light phenomenon found in the upper atmosphere. This project was launched in 2009 and completed its mission after several years in orbit. In February 2012 Professor Volker Gass, Director of Swiss Space Centre (SSC) decided it would be desirable to try and design a small satellite capability that could Track and retrieve the original cube sat.

Fig.5 Clean Space one planned trajectory for deorbiting the original cubesat (Graphic courtesy Of Swiss Space Center and EPFL)

2. Robotic Capture And De-Orbit

The range of technical approaches that might be used to remove orbital debris are quite diverse and the innovative concepts continue to grow and diversify. The main Line approach which a number of aerospace companies and space agencies are now proceeding involves a basic strategy of sending up a robotic satellite to attach to a Debris element and then de-orbiting the compositesystem. The various projects that are being developed with this type of capability. These Developments are on one hand conceived as a way to remove major debris elements From low earth orbit and on the other hand they are seen as a possible mechanism For capturing operational satellites and servicing them by providing new batteries And fuel.

3. Spacecraft With Multiple De-Orbit Kits

This proposed approach that provides a variation on the above theme with the intent of being much more efficient and less costly involves a capture spacecraft that was capable of attaching to a number of defunct satellites one after another and attaching to each one a "de-orbit kit". The idea behind the "de-orbit kit" is that there is a concentration of debris in the range of 600 to 2,000 km altitudes that could be addressed by a robotic spacecraft that could attach de-orbit units. One such concept is to equip a robotic spacecraft with a number of "remotely operated semi-self-attaching de- orbiter modules".

4. Tether-Deployed Nets

One of the most common concepts consistently put forward for de-orbiting of debris envisions that a net would be draped over the derelict satellite or upper stage rocket so as to create substantially more atmospheric drag. This is the technique anticipated by the EDDE system described below.

This approach has most exotically been described as the RUSTLER system for "Round up of Space Trash Low Earth orbit Remediation". Despite the frequency with which there have been references to tether-deployed nets as a de-orbit mechanism this approach has only be simulated on computer models and not actually demonstrated in actual practice.

5. Glues, Adhesives, Foams And Mists

A less complicated version of the deployed nets would be to deploy a satellite that would be capable of shooting at close range adhesives, epoxies, foams or mists on to the surface of the debris object. Some have envisioned what might be called very sticky balls or expanding balloon like foams. These balls might be constituted from epoxies, resins or foaming aerogels. Once these adhesives are attached to space debris objects they would expand in volume and in time alter the debris orbits so that they would eventually degrade and presumably burn up in the Earth's atmosphere. A variation on this theme would be spaying of mists on the debris spacecraft or defunct rocket stage so that the mists would freeze and create orbital drag. Again although these various ways of shooting or spaying materials onto debris elements have been simulated and modelled they have not actually been tested in space.

6. Terminal Tape Or Tether

In addition to tether systems or nets to create drag there have also be proposals to attach to debris what is call a "Terminator Tape". This tape would have an adhesive to cling to the satellite and then it would be deployed just like a gravity gradient antenna to create the maximum gravitational pull. The longer the tape, the greater the gravitational attraction. It would also create some atmospheric drag as well. Again this would be an approach suitable only to low earth orbit satellites.

7. Space Harpoon System

The concept of a space harpoon system as opposed to a robotic grasping system would appear to have several advantages.

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The proximity of the "chaser" satellite would not need to be nearly as great and thus minimizing the risk of on-orbit collision. Also the "connection" to derelict space objects, whether an upper stage launcher, space craft or other type debris, can be in any shape or size. Finally a harpoon system connection can be connected to a free-flying propulsion system that allows a repetitive process to initiate the de-orbit of multiple satellites rather than a single debris element. There are, of course, alternative de-orbit systems that could be attached to the harpoon tethers such as a passive net system that could create atmospheric drag as opposed to an active propulsion system that could be a chemical rocket system or ion thrusters. Prototype systems have been conceived with a four harpoon deployment mechanisms, but in theory the number of harpoons could be much larger.

8. Ion Beam To De-Orbit Debris

Ion beam projection systems represent yet another means to steer debris into a de- orbiting mode. Such an ion beam could be focused on a debris object over a period of time so that it would steer the targeted space debris to a controlled de-orbit. This technique is being studied by the European Space Agency, NASA, and the Japanese Space Agency (JAXA).

Some of these studies are focused on high powered lasers, others on ion beams, and other higher powered particle beams that might be developed as part of a planetary defence system against potentially hazardous asteroids.

There are concerns about the use of such mechanisms in space since they could be seen as anti-satellite weapons and as such may be considered to be contrary to Article 4 of the Outer Space Treaty. One solution to this issue, that has been recently proposed, is that the country that is recorded as the "Launching State" would be given control of the laser or particle beam ionic stream for the de-orbit operation.

9. Electro Dynamic Propulsion Systems For Space Debris Removal

There are other concepts that suggest the electrical-generating capability of the Earth to power an orbital debris removal mechanism. The alternative ideas is to create a more targeted system that would provide a "passive vacuuming" of space as discussed above. There are suggestions that one could utilize the Earth's magnetic field to generate electric propulsion to create a new electro-magnetic "space tool" that could search out and remove debris. At least two quite different variations on this approach would be possible. The least ambitious means would be to have a conventional satellite with chemical propellant that would maneuver in low earth orbit to simply attach tethers to multiple satellites to help de-orbit derelict space objects. This may or may not include an electric ion thrust motor along with the tether to accelerate the de-orbit process.

This approach by relying on conventional chemical rockets could likely be designed more quickly and this effort mounted in the not too distant future. A much more ambitious technological approach would attempt to create a large scale electro-magnetically driven device that would undertake this type of operation for potentially hundreds of orbital debris pieces. This system has been given the name of an Electro Dynamic Debris Eliminator (EDDE). The scale of these systems would be quite large (i.e. kilometres in length), but the mass would be small.

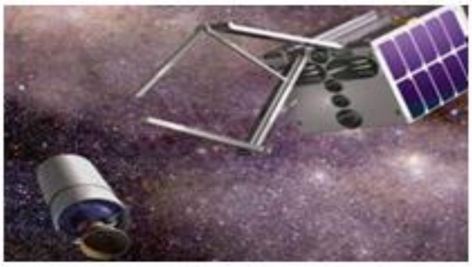

Fig.5.8.b the EDDE Net manager at end of tether system.

V. FUTURE WORK

A phased array radar for LEO target detection and tracking has been discussed in this paper. Two different approaches for managing the radar resources have been analysed in order to assess their performance with respect to SSA requirements. Monte Carlo simulations of real objects have been carried out in order to derive performance indicators, which are the percentage of detected objects, and the tracking accuracy. The analysis provides useful indications on the advantages and the drawbacks of the two techniques, even though a more complete simulation of the LEO objects population needs to be performed for a definitive assessment of the achievable performance.

VI. CONCLUSION

There are many methods for active debris removal and some of the important methods have been listed here. These methods can effectively help in removing the active debris in space and thus improve operations of satellites by not interfering in their operation. This will also help in reducing dangers of satellites collision with space debris. The Removal of existing space debris have been explored to minimize the space debris Threat .However, the realistic and effective method to solve space debris problem is to Avoid any new debris generation. The space system so have becomes very vital .that if we were suddenly denied access to our space based infrastructure for weather forecasting and warming, for space based navigation and timing, for various other applications like military, civil etc. In the management of radar system.

Studies indicate that usage of propulsion systems by decelerating spacecraft's is not an effective solution as it increases complexity, mass and cost. Electro-dynamic tether technique has been proposed as an innovative solution to deorbit the spacecraft's after useful lifetime .So our space exploration agencies like ISRO, NASA, JAXA & ROSCOSMOS should explore the possibilities to prevent orbital space debris by using efficient and economic techniques like to management of radar resources for space debris tracking of LEO keep our space environment safe for the future scientific space explorations.

ACKNOWLEDGMENT

I wish to thank my professor R.E.Gite his assisted in research and review of the content. I whould like to thanks my college for inspiring students to research different topics.

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