Engine uses debris as propellant in concept to clean space junk

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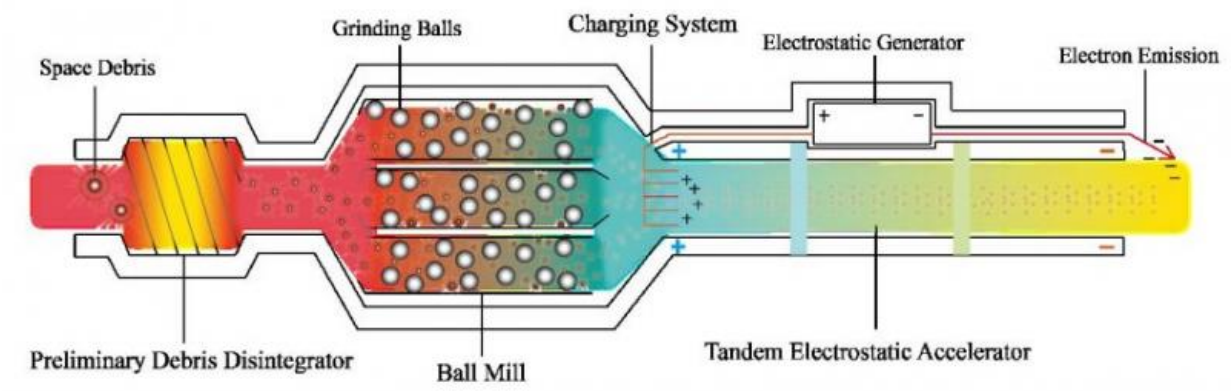

Debris engine. Credit: arXiv:1511.07246 [astro-ph.IM]

Space debris is a pressing problem for Earth-orbiting spacecraft, and it could get significantly worse. It threatens satellites and craft; now scientists at Tsinghua University in Beijing are looking at an approach that could draw more attention among those looking for solutions.

Space debris refers to an unhappy situation resulting from human activities in the space—defunct rockets and satellites, ejection from rockets and spacecraft, the waste of manned space missions and products of collisions from other debris.

A collision between space junk and an operating satellite can result in

the loss of equipment worth hundreds of millions of dollars, along with the general business disruptions.

Actually, "problem" is too light a word. *MIT Technology Review* illustrated the serious effects of space debris with an incident in 2009 which involved an Iridium communications satellite and a defunct Russian satellite. A high speed collision caused space debris such that the "impact created over 1,000 fragments greater than 10 centimeters in size and a much larger number of smaller pieces. This debris spread out around the planet in a deadly cloud." The situation could get worse.

In an arXiv paper reported on by *MIT Technology Review,* three scientists, Lei Lan, Jingyang Li and Hexi Baoyin wrote about their work in the paper titled "Debris Engine: A Potential Thruster for Space Debris Removal."

The authors noted that as more and more satellites have come into service, the threat to in-orbit satellites coming from more and more space debris have been grimmer.

What about a spacecraft that could convert junk to fuel? Cleaning up the skies? Their design concept calls for debris as the propellant.

Christopher Klimovski wrote in *Engadget* that the concept involves a spacecraft that collects the debris "in a wide-cast net and uses it as fuel to propel itself forward. This technically means it could keep cleaning forever, unless an unforeseen event brings its efforts to an untimely end."

Lindsey Kratochwill in *Popular Science*: "The concept, posted to arXiv, details an engine that could ingest debris, break it into tiny pieces (if it happens to be a large chunk), and then grind it (or blast with a laser) into a powder. Heating that powder up could then render it into a plasma, to

be used as fuel."

Why not lasers? The limitation with lasers, said Klimovski, is that that they are designed for smaller bits. The smaller bits are difficult to find.

"Pieces that are less than 10cm (approximately four inches) in size are caught in a net and then passed through a ball mill. This is a rotating cylinder that pulverizes the junk into a fine powder. It is then heated and passed through a system that sorts out the positive from the negatively charged ions. The positive are pushed through an electric field which increases their overall energy, generating thrust, while the negative are expelled into the surrounding space."

At present, major space organizations are monitoring debris but elimination is a theoretical target, said the authors of the paper.

They said that "Huge fuel consumption is the biggest inhibitor to space cleaners' lifetime and makes the mission cost increase sharply. Why don't we just obliterate the debris in the space locally and make full use it, so that fuel used to come back to inner atmosphere can be saved for cleaners."

MIT Technology Review discussed their paper and raised the question about a source of power. It said, "while the spacecraft does not need to carry propellant, it will need a source of power. Just where this will come from isn't clear. Lei and co say that solar and nuclear power will suffice but do not address the serious concerns that any nuclear-powered spacecraft in Earth orbit will generate." Still, "the work provides food for thought. Space debris is an issue that looks likely to get significantly worse in the near future. It is an area where new ideas are desperately needed before the next big collision fills Earth's orbits with even more debris."

Elsewhere, in a report earlier this month from the AAP (Australian Associated Press), Canberra-based EOS Space Systems' chief executive, Professor Craig Smith, said the amount of space junk was growing at an alarming rate as junk collides with other junk. Even a tiny piece of junk travelling at high velocity can punch a hole through an operating satellite, making it inoperable.

More information: Debris Engine: A Potential Thruster for Space Debris Removal, arXiv:1511.07246 [astro-ph.IM]
arxiv.org/abs/1511.07246

Abstract

We present a design concept for a space engine that can continuously remove the orbit debris by using the debris as a propellant. Space robotic cleaner is adopted to capture the targeting debris and to transfer them into the engine. Debris with larger size is first disintegrated into small pieces by using a mechanical method. The planetary ball mill is then adopted to grind the pieces into micrometer or smaller powder. The energy needed in this process is get from the nuclear and solar power. By the effect of gamma-ray photoelectric or the behavior of tangently rub of tungsten needles, the debris powered is charged. This behavior can be used to speed up the movement of powder in a tandem electrostatic particle accelerator. By ejecting the high-temperture and high-pressure charged powered from the nozzle of the engine,the continuously thrust is obtained. This thrust can be used to perform orbital maneuver and debris rendezvous for the spacecraft and robotic cleaner. The ejected charged particle will be blown away from the circumterrestrial orbit by the solar wind. By digesting the space debris, we obtain not only the previous thrust but also the clean space. In the near future, start trek will not just a dream, human exploration will extend to deep universe. The analysis shown, the magnitude of the specific impulse for debris engine is determined by the accelerating electrostatic potential and the charge-to-mass ratio of the powder.