SPACEWORM PROJECT

A. Hemmati, Sh. Ghorbani

ABSTRACT

Simultaneously with the rapid and significant progress of human beings in mastering space in recent decades, a new problem has arisen which, unfortunately, so far, no tangible progress has been made to solve it. The creation of space debris, which has started from the very beginning of entering space and its amount is increasing day by day, is a very important problem that as one of the major and unresolved issues of space development, to date only in the form of lectures, Articles, ideas and non-operational plans remains. Although, perhaps, even though some of them may have been effective, but due to insufficient attention of the international community or necessary funding, they have been forgotten or left out over time, which as a result, this area still faces a lack of ideas and the necessary importance.

Introduction

Certainly, space debris will be one of the potential dangers and obstacles to space development, at the gate of the entry of human daily life into space in the coming years, for which a fundamental solution must be designed and implemented as soon as possible through international efforts.

Based on the above, as those interested in this field, we considered it our duty to introduce the SPACEWORM project to you as a practical and efficient plan. Perhaps, we can take a small step, to attract the attention of the space community and scientists in this field, and together with you, provide a part of the solution to the problem of space waste.

The SPACEWORM project is basically a proposed design of a convertible and reusable satellite that has the ability to trap space debris inside its body. The satellite is designed to act like a vacuum cleaner and, with a replaceable waste tank, is placed in space debris orbit and traps them inside its tank. And when its volume is full, it separates the tank from the main body and directs it into the Earth's atmosphere.

Due to its unique design, this satellite can easily be placed inside a launcher and after being transferred to the desired orbit, it can carry out its mission by changing the

shape and increasing the volume of the waste tank. The satellite needs to be launched only once, but the waste tanks can be placed in orbit with either the same initial launch or subsequent launches due to their special and flexible design.

Method

The satellite consists of five separate parts that are connected to complete the body of the satellite.

The first part is the front body of the satellite, which is designed in a cylindrical shape and most of its inner part is hollow and serves as an input channel to direct the waste to the waste tank, while other necessary equipment such as propulsion system They are installed on its outer part. It is necessary to explain that the waste, before entering this section, first passes through the shredder that is installed at the beginning of it and after turning into smaller components, it is directed to the waste tank.

The second part is a robotic arm that is mounted on a ring on the outer body of the first part (the front body of the satellite) and can rotate 360 degrees on this ring. In addition, the ring itself has the ability to move through the longitudinal grooves on the outer body of the first part, which provides a complete cover for maneuvering and performing the robotic arm mission in the space around the satellite. The robotic arm has two main functions. One of its tasks is to catch the garbage around the satellite and direct it to the shredder inside the front body and the other is to help replace the garbage tank by directing it from the orbit to the satellite and vice versa.

The third part is the rear body of the satellite, which is also designed in a cylindrical shape, but with the difference that both sides are closed and all the necessary equipment, including electronics, communication, batteries, solar panels, propulsion systems, etc. It is installed inside and on it. The front and rear body next to each other are defined as the main body of the satellite.

The fourth part is called the connecting pillars and they are placed parallel to each other on both sides of the satellite, and they connect the end of the front body to the beginning of the rear body. These pillars themselves consist of three parts. One large rectangular cube pillar and two smaller rectangular cube pillars connected to the two ends of the larger pillar in such a way that they can rotate 90 degrees around the end of the larger pillar. The other end of the two small pillars is connected to the front and rear body. At the place where the pillars are connected to the body of the satellite,

there is a hydraulic pump which, like the hydraulic pump behind the trucks, is responsible for raising and lowering these pillars. The task of the connecting pillars is to integrate the body of the satellite in general and, more importantly, the task of opening the flexible waste tank to increase its volume. In the resting position, the three pillars are in the same direction - parallel and close to the satellite body - but in the case of increasing the volume of the waste tank, the larger pillar is farther away from the satellite body but still parallel to it and at the same time the two smaller pillars are perpendicular to the body of the satellite and larger pillar are placed. Obviously, after removing the tank, the pillars return to their original state and are ready to install a new tank.

The next part, or the last and replaceable part of the satellite, which is also considered as a part of the satellite body, is the satellite waste tank, which is inspired by the structure of the umbrella, is designed in such a way that it can be opened and closed (As a result, it changes the volume of the tank). This tank, in the resting state (closed state), is a cylinder that has a diameter equal to the diameter of the cylinder of the main body of the satellite, but after activation (open state), it becomes a cylinder whose diameter can (according to the defined need) up to several times the diameter of the main body Satellite, increase. The beginning and the end of the tank are made of two rings with a diameter equal to the diameter of the cylinder of the main body. On the perimeter of these rings, bars with a certain distance are installed that can rotate 90 degrees at their connection point. These rods are exactly like the connecting pillars, consisting of 3 parts, and have the same property of size (length) and connecting the pillars. Between these rods, a durable but flexible cover (such as carbon fiber or ...) is placed - a cover that can be bent or folded. As a result, after opening the tank, it brings an integrated and cylindrical body to it.

The two beginning and end rings of the tank mentioned earlier, will be located exactly in the middle of the two bases of the newly created cylinder after opening the tank, with the difference that the beginning ring - the one facing the front body - has a door similar to the camera aperture, but the end ring is completely covered and closed. The waste tank and the main body of the satellite are connected by connecting devices at the location of the waste tank rings. The function of this section (waste tank) is very clear (integrity of the body and the place of accumulation of waste) and does not require additional explanation.

How to send this satellite into space and also how it works in space will be as follows: Satellite after connecting and assembling its five parts (Fig. 1) - while the waste tank, connection pillars and robotic arm are in the resting state (closed state) - the satellite will be placed inside the carrier rocket and launched into space. (If there is enough space in the carrier rocket, several additional closed waste tanks can be sent into space with the main satellite for later use). As soon as the satellite is in the designated orbit (Fig. 2), the hydraulic pumps and propulsion systems start working simultaneously. By pressing on the pillars and the waste tank, they become active (open state) and the volume of the tank increases (Fig. 3). (Hydraulic pumps by moving small pillars and propulsion systems with acceleration in opposite directions, causing small pillars to be perpendicular to the body of the satellite, as well as bringing the front and rear bodies closer together). Simultaneously with this process, the robotic arm also starts working (Fig. 4).

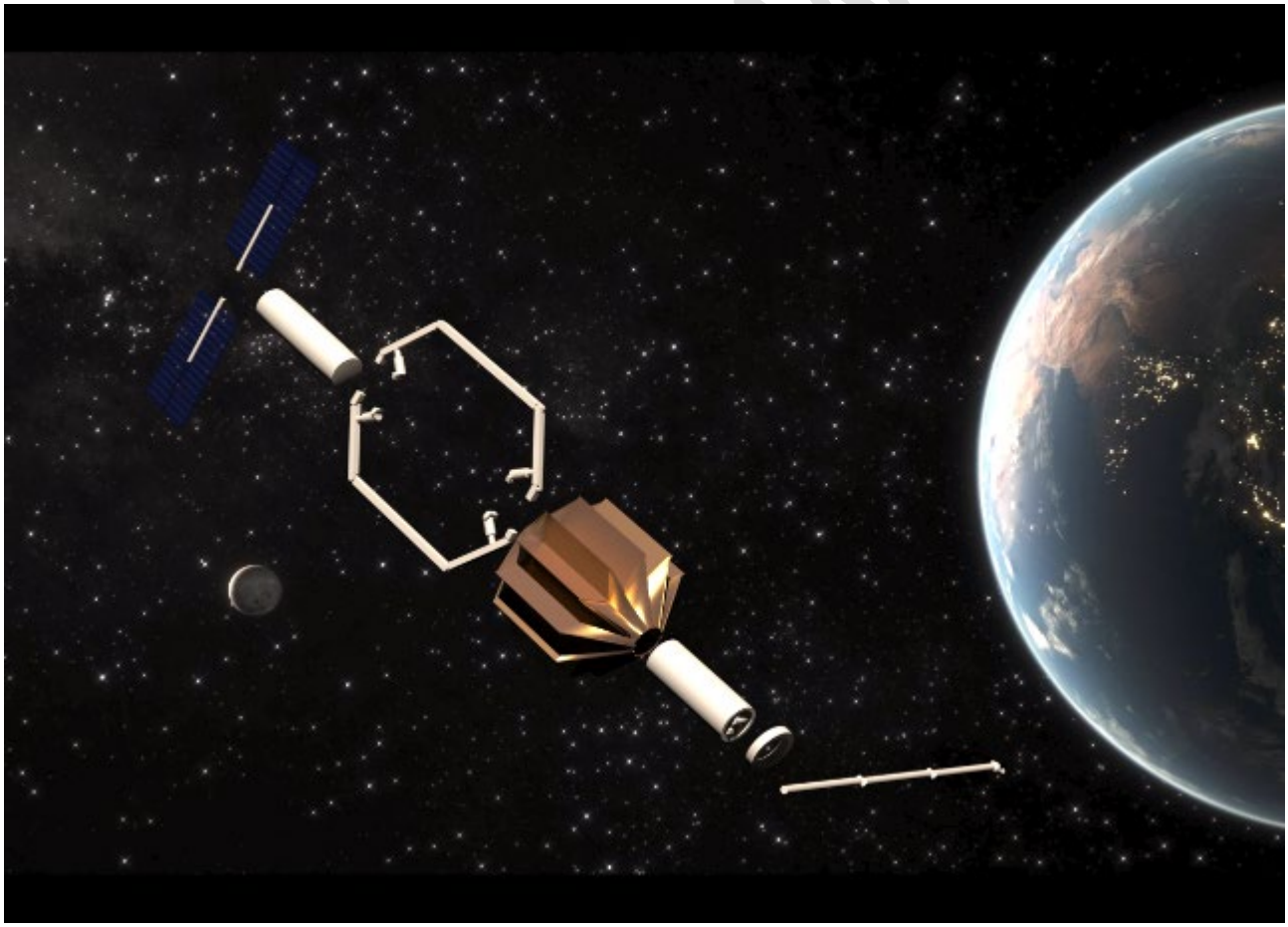

Fig. 1. Satellite - five separate parts.

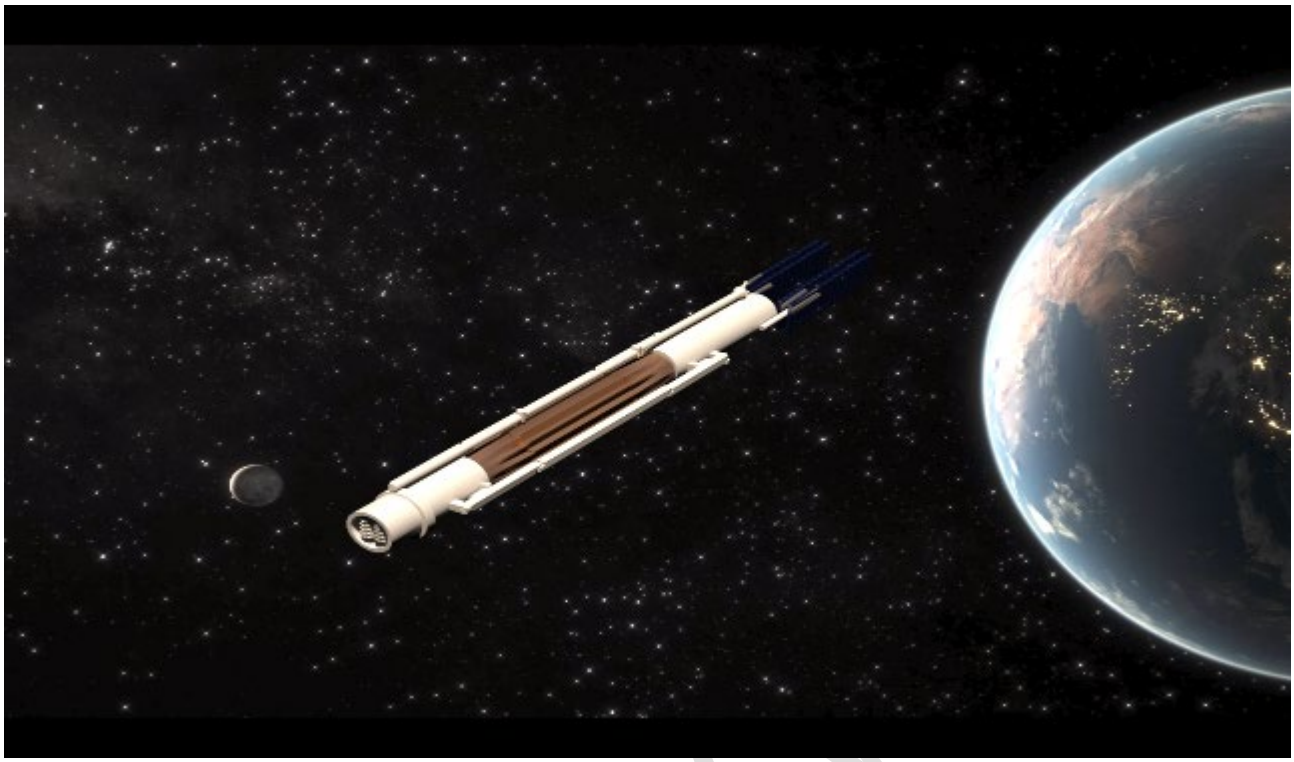

Fig. 2. Satellite - closed state.

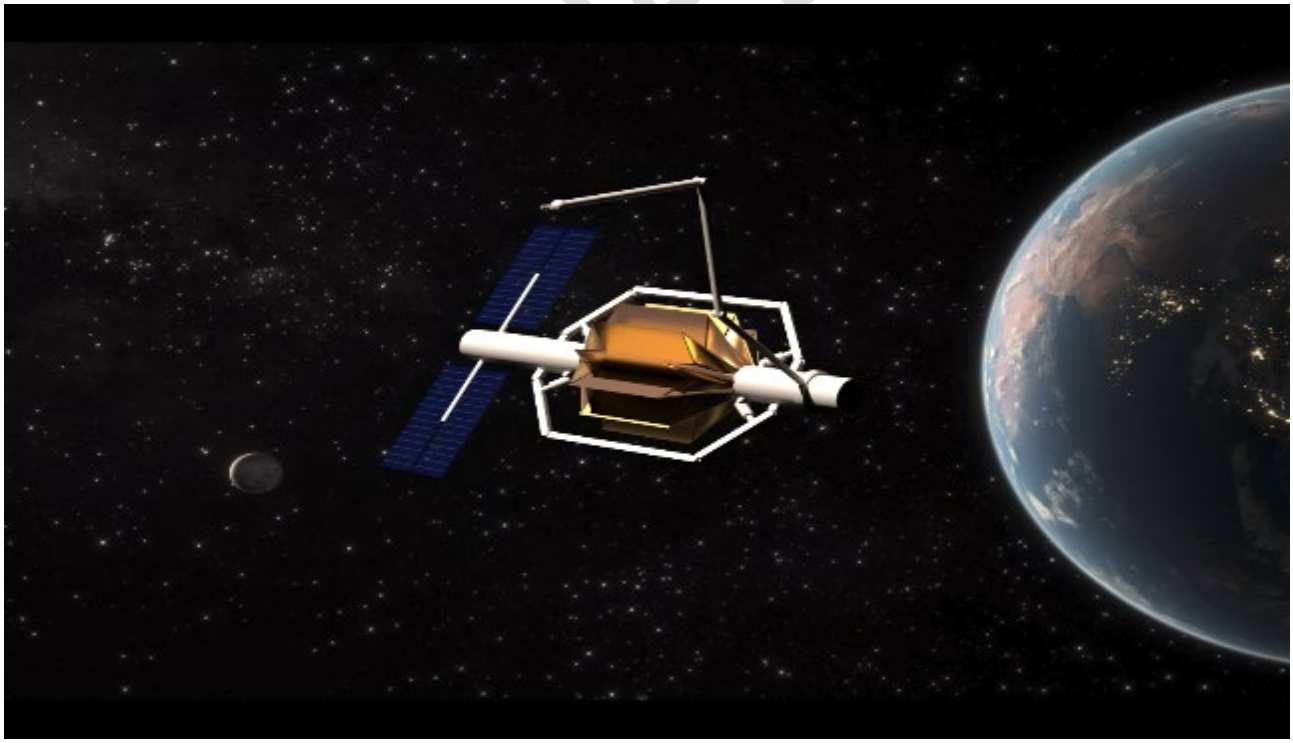

Fig. 3. Satellite - opening state.

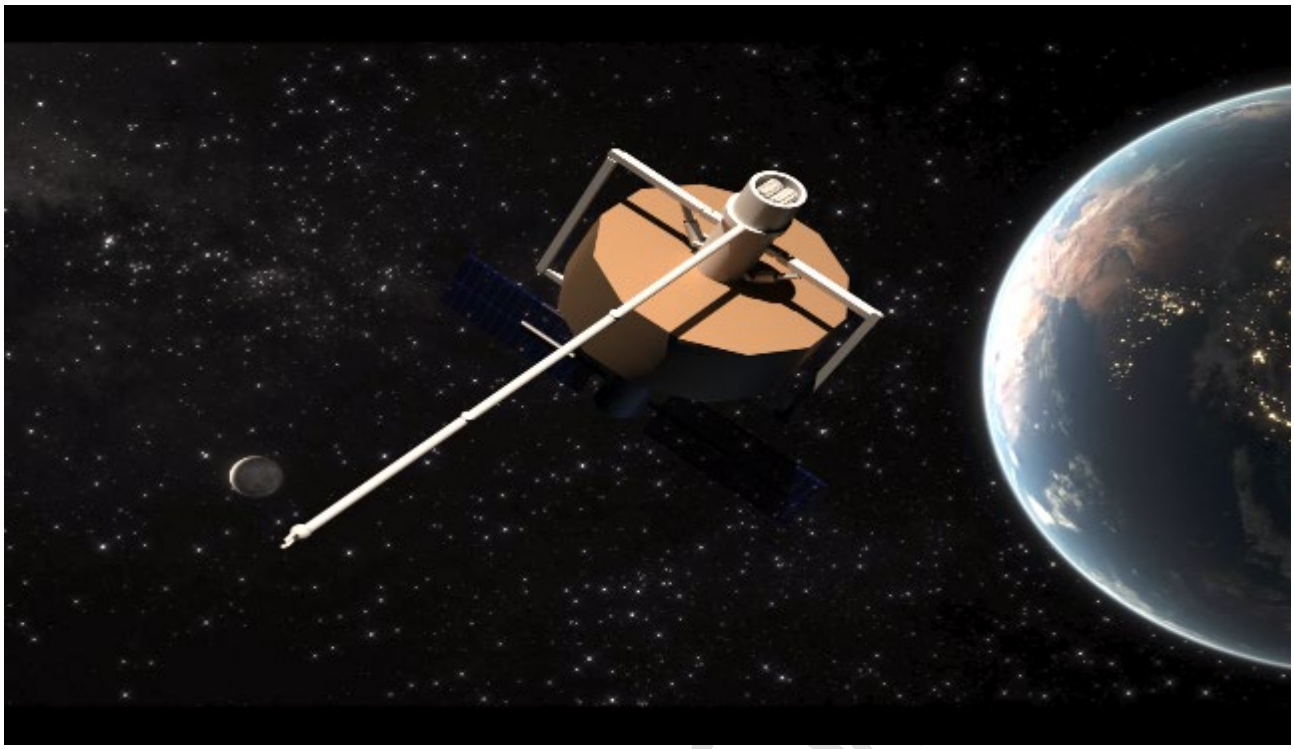

Fig. 4. Satellite - open state.

Results

The satellite can be sent into the orbit of space debris from the very beginning or placed in their path by changing the orbit, in both cases the satellite must be programmed in such a way that it is in the same direction and speed as the debris, because according to the law of Physics, when two objects are moving along same directions with same speed, in fact, these two objects have zero relative velocity to each other. Therefore, based on this law and considering that the speed of garbage and the satellite will be the same, there will be no problem to move the garbage into the satellite and the problem of confronting the high speed of the garbage.

As soon as the satellite approaches the space debris, using its robotic arm, it directs the debris to the entrance of the satellite. (Due to the 360-degree coverage of the robotic arm and the length defined for it, it is possible to clean a space far away from the surface of the satellite). As mentioned, there is a shredder at the entrance of the satellite, where the waste will be cut into pieces as soon as it enters and will be directed into the waste tank and accumulated there. When the waste tank is full, the

tank door is closed and the connecting tools of the tank and the main body are released and the tank is separated from the body by the robotic arm and directed to the atmosphere and burned. At the same time, the connection pillars return to the initial state so that the satellite is ready to connect the new tank. The new tank, which is placed in orbit either through another launch or with the same initial launch, is reinstalled using a robotic arm and prepares the satellite for the continuation of the mission.

Discussion & Conclusion

Undoubtedly, due to the unique features that distinguish this satellite from other possible designs (the ability to increase the volume of the satellite body to increase the volume of garbage cleaning - the high flexibility of the satellite in sending - repeated and optimal use), This design can be proposed as a new platform in the space industry and implement this project at a very low and affordable cost. In addition, the operationalization of this project can smooth the issues, problems, challenges and obstacles to the development and progress of this field and existing plans in this field.

It should be noted that by providing 3D designs and also sending the attached video, our team has done all its efforts to create a clear and expressive image of the explained content and tangible presentation of project details.