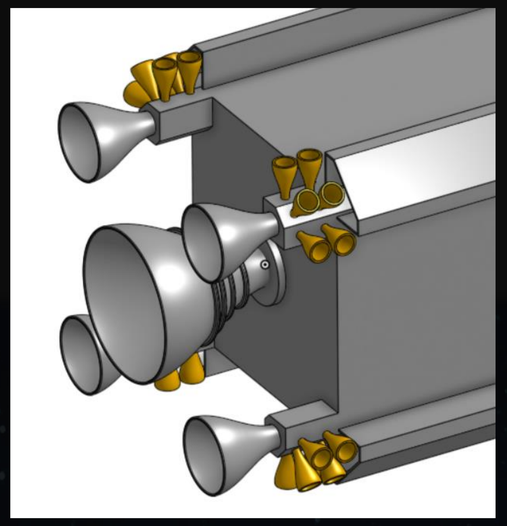
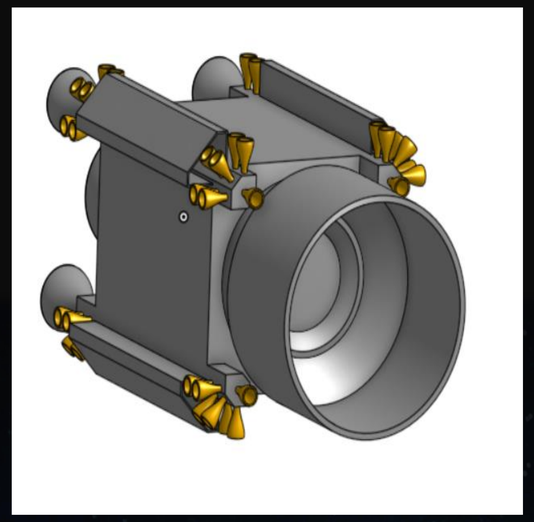
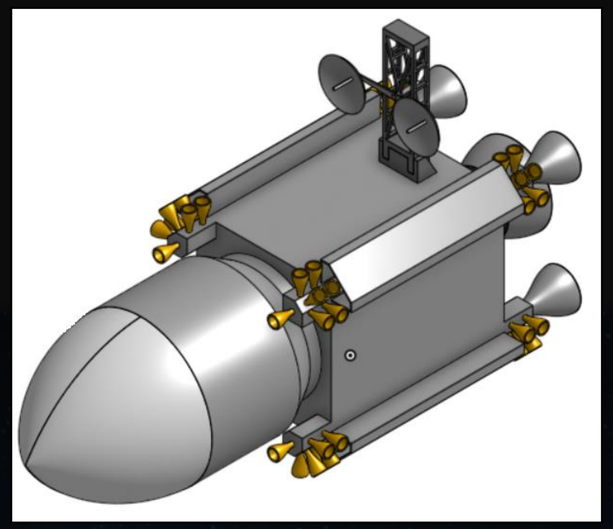
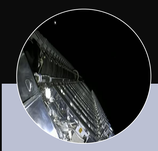
Deorbiting Debris

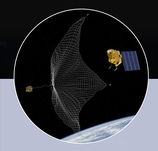




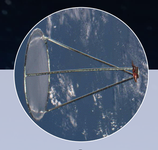




Launch



Capture



Take down

Abstract

This project addressed a pressing issue that affects the future of space travel and further development of telecommunication systems in Earth's orbit. If unsolved, the problem of rapidly accumulating debris -- composed of rocket upper stages, other defunct satellites, and over 130,000,000 microscopic objects -- will push beyond the tipping point and wreak havoc on the multi-billion-dollar infrastructure meticulously placed in low earth orbit. Millions of pieces of debris will create an impassable field of shrapnel, which will impair future space vehicles' launch attempts into Earth's orbit. In order to prevent this cataclysm, humanity must act now and begin to remove as many risk factors from low earth orbit as possible. One must implement a solution that does not exacerbate the problem -- that is, a newly designed debris cleaner should not accidentally create more debris in the process. To this effect, our group is proposing a design of a capture-and-return style satellite that will achieve the goal of removing large orbital debris in four steps. The device will be launched or deployed using an efficient rideshare program like SpaceX's SmallSat system. The device will then orbit around the Earth as it locates the intended targets. After entering a specific range, the device will then capture the debris using a large net made of Kevlar. After capturing the debris, our satellite will then perform a takedown, where it will deploy an inflatable structure and slow the debris down by applying a drag force, effectively deorbiting the object. Conceptualizing this technology, our group hopes to target larger aerospace companies and encourage them to invest in our design in order to prevent the inevitable demise of the aerospace industry.

Price Analysis

As of now, the total cost of the satellite is estimated to fall around $200,000,000, plus or minus $20,000,000. Our pricing will not be fully precise because the cost of production relies heavily on the firm that produces the device. Factors such as internal contracts for supplies, amount of work outsourced, and quantity & quality of in-house production facilities will all contribute to the final cost of that specific firm's design. These factors are the reason our pricing is a ball-park range, rather than a specific value. Our satellite also falls under the 300kg weight limit to launch for the base price of $1,000,000 with no additional fees.

Background

- Minimum orbit level: low earth orbit (LEO)
- Rocket stages at that orbit are called: Upper stages
- Falcon 9, Delta 4, and Atlas 5 maintain stationary orbit to deploy satellite
- Far enough to stay up there for years until other pieces of debris or other stage 2's collides into each other, causing more debris and staying up even longer

Objectives

- Captures debris successfully
  - Does not create more debris
  - Net does not break
- Deorbits Successfully
  - Does not fall in random location
  - Burns up completely
  - Or the remainder is tracked and located

Product

- Bus made of space grade aluminum, holding several nets with tethers made of Kevlar.
- The CubeSat would house the capture nets, and the inflatable structure
- To navigate the CubeSat it uses an ion cannon to propel itself
- To deorbit the captured debris, an inflatable space structure will inflate upon capture, which will create enough drag force to slow down the debris. The debris, along with the net and the inflatable structure will burn up in the atmosphere.
- Once CubeSat has ejected all of it's nets, the CubeSat will propel itself toward earth, either burning up completely in the atmosphere or landing in the ocean to prevent any harm

Conclusion

- With space debris worsening each year, a solution that can reduce the threat of endangering future space endeavors both commercial and government organizations interested in furthering development in space

References

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Taillefer, Zachary. Personal Interview. 4 November 2019.
Dunbar, Brian. "What Is Orbital Debris?" *NASA*, NASA, 1 June 2015, https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-orbital-debris-58.html.