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NASA INTERNATIONAL SPACE APPS CHALLENGE

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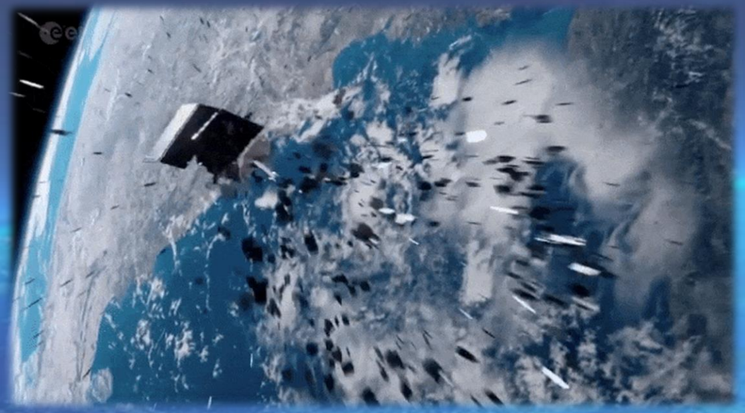
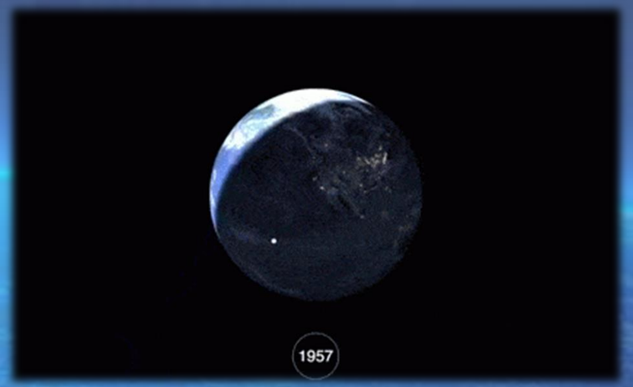
PROBLEM STATEMENT

The global problem at hand is the significant harm inflicted by space debris, endangering space missions, satellites, and the International Space Station.
Space debris, including defunct satellites and fragments, poses a growing risk, yet widespread awareness of its extent and consequences remains limited. This issue is a concern for the entire world, demanding collective solutions to mitigate its harm and ensure the safety and sustainability of activities in Earth's orbit.



Space Debris hitting satellite



Space Debris around Earth as years pass by.

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PROBLEM DEFINITION

What is the problem briefly?

- **Space debris** contributes to **environmental concerns** due to **its potential to remain in orbit for long periods and its potential risk to other spacecraft and the International Space Station**.
  (**Source** : "Space debris implications for future space exploration" by T. Schildknecht et al. (2007))

- Its importance lies in the growing risks to operational satellites, space missions, and our celestial perspective as more objects occupy Earth's orbit, demanding urgent attention and innovative solutions.

Why the problem exists ?

- Over decades, human space missions have left behind defunct satellites, spent rocket stages, and fragments in Earth's orbit, contributing to the issue of space debris that grows over time.
- As these objects accumulate, they increase the risk of collisions, creating more debris and endangering both space activities and the visibility of celestial wonders, necessitating immediate **attention and in**novative solutions.

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ANALYSIS

Market Study in brief

- The market for space debris tracking and mitigation is on the rise due to the growing number of satellites and space ventures. Space agencies, satellite operators, and emerging players are seeking solutions. This presents significant growth opportunities in an evolving sector.

Existing solutions

- Brief explanation of existing products in space debris tracking and mitigation:

1. **DebrisShield**: Mitigation technology for satellite protection.
2. **OrbitCleaner**: Autonomous debris removal spacecraft.
3. **LeoSweep Services**: Space debris removal solutions.
4. **DebrisTracker API**: Data access for space debris tracking.

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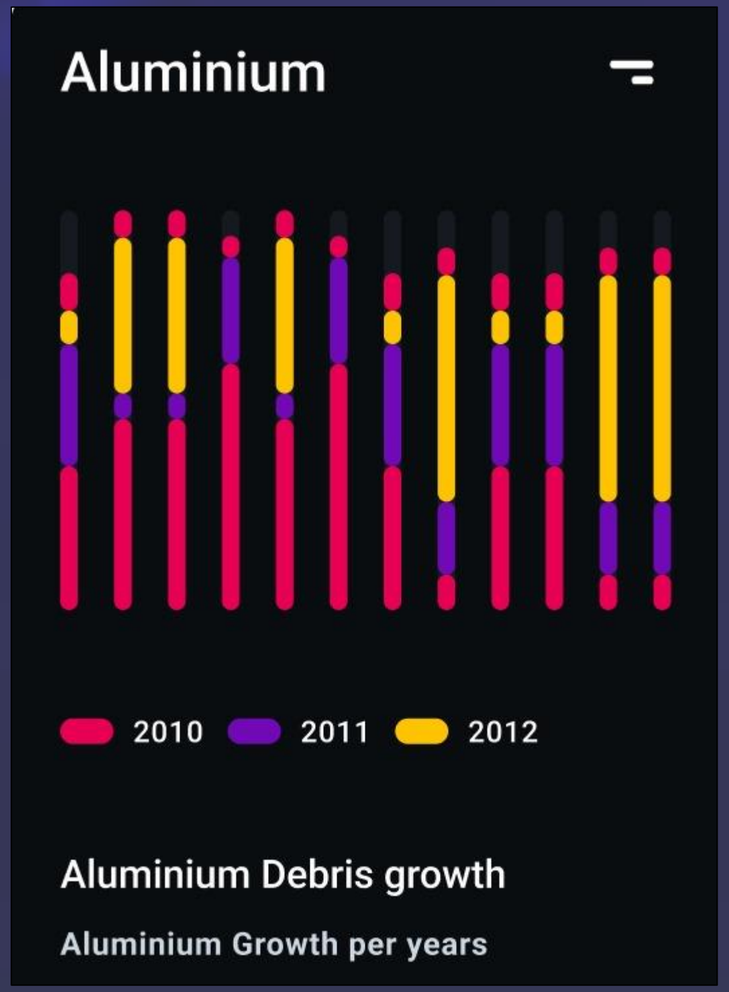
Statistics Related to Space Debris



Statistics of each elements

Statistics of Space Debris

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Social Benefits

G-20 & Sustainable Development Goals

- **Priority Orbits**: G20 identifies high-priority orbits for debris cleanup, including those used by active spacecraft.
- **Tech Development**: G20 supports the development of advanced debris removal technologies.
- **Responsible Space Use**: G20 promotes guidelines to reduce the creation of new space debris and encourages responsible space practices.

USP

Creating a "**space salvage yard**" to recycle and reuse valuable materials from captured debris.

Remove debris from orbits that are used by active spacecraft, making these orbits safer.

Protect spacecraft from collisions with debris.

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Recycle and Reuse

- Use debris capture and reuse to repurpose debris for new missions, or to build space habitats.
- Use 3D printing to use recycled material to create new spacecraft parts.
- Use electrodynamic tethers to use the debris as a conductor to generate electricity.
- Use ion beam shepherding to use charged particles to move debris out of orbit.

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PROTOTYPE

Space Debris 3-D Visualization

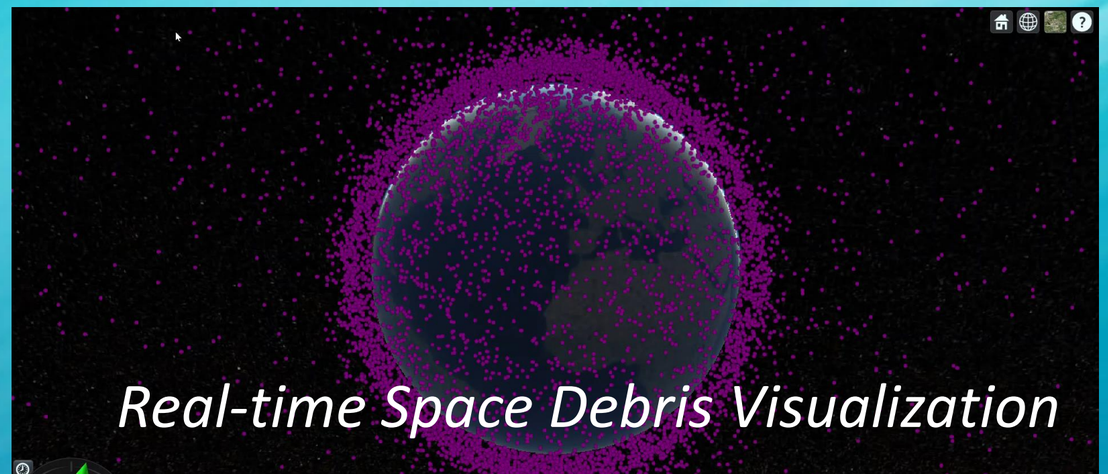
Purpose: This website aims to educate the general public about space debris and its impact on space exploration and Earth's orbit. It provides an engaging 3D visualization of space debris to enhance awareness.

Key Features:

1.Interactive 3D Visualization: Users can explore and interact with a 3D representation of space debris in Earth's orbit.

2.Educational Content: The website offers informative articles, videos, and infographics about space debris, its causes, and potential solutions.

3.Real-Time Tracking: Users can access real-time data on the current location and movement of space debris.



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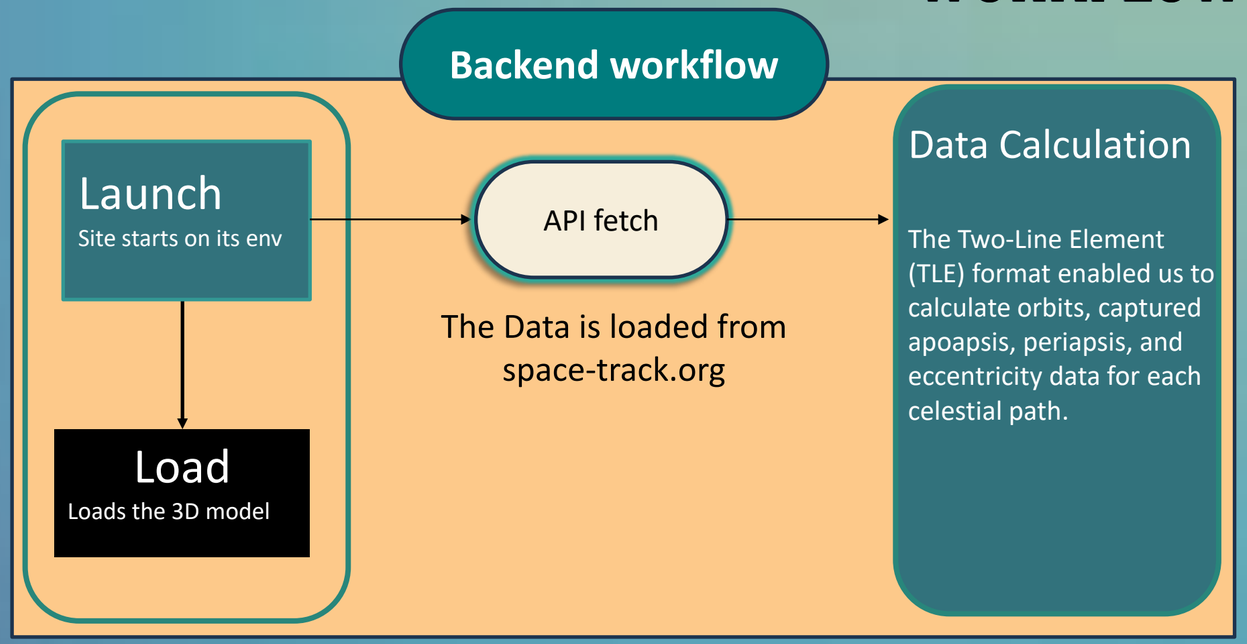
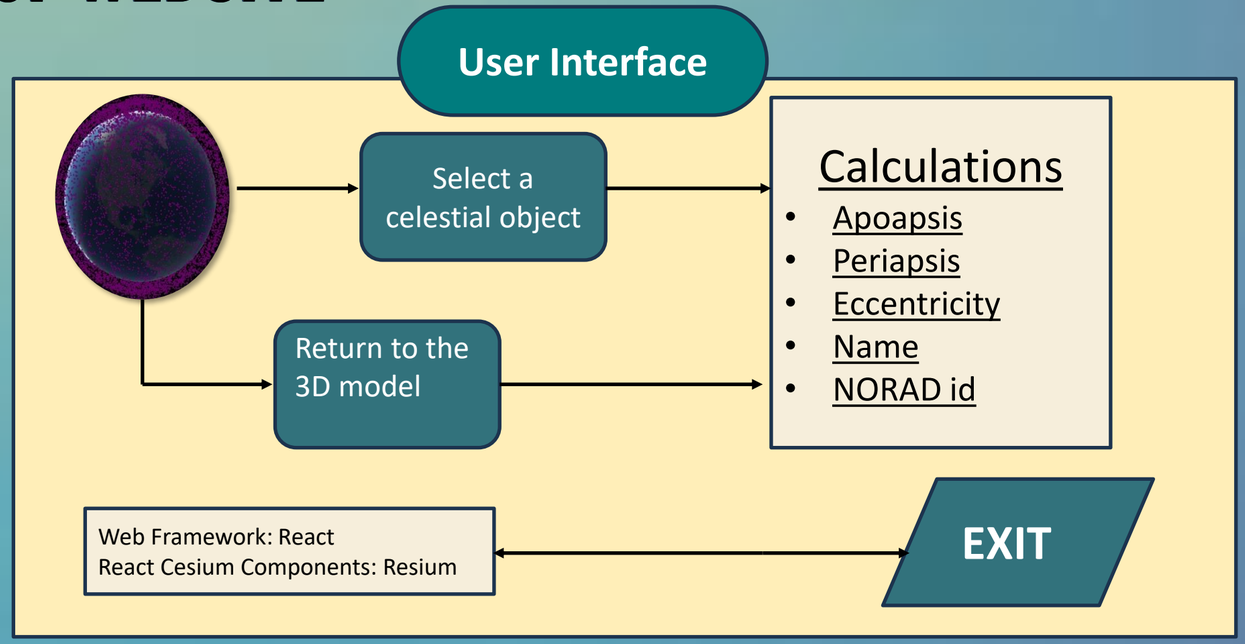
PROPOSED SOLUTION

WORKFLOW OF WEBSITE





Backend: Serve educational content, real-time data, and facilitate user engagement.

Frontend: Engage users with interactive 3D space debris visualization.

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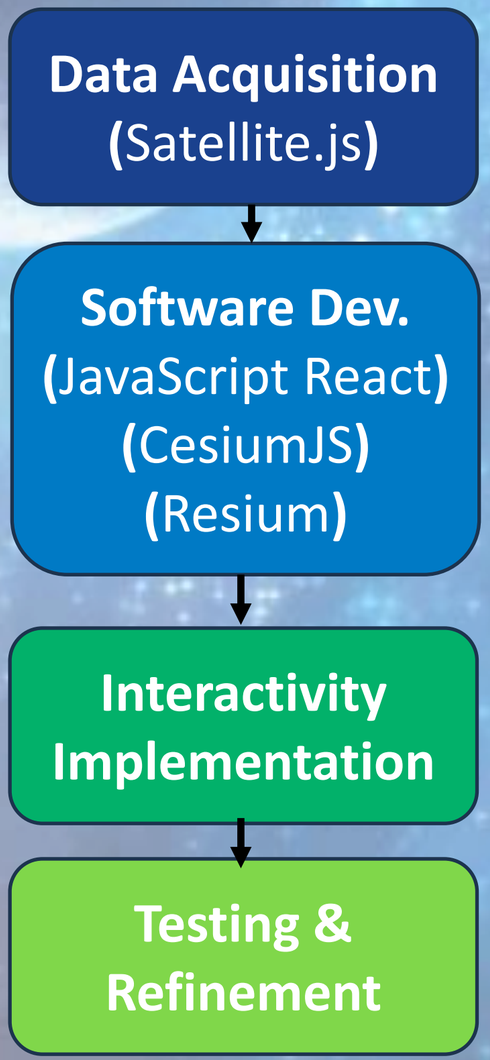
Methodology for Website

Our project methodology consists of four key steps:

1. **Data Acquisition:** Gathering space debris data from reliable sources, enhanced by Satellite.js for real-time accuracy.
2. **Software Development:** using JavaScript and React for a user-friendly interface with CesiumJS and Resium for 3D Earth visualization.
3. **Interactivity Implementation**: Enhancing user engagement by allowing interactions with celestial objects to access detailed information.
4. **Testing & Refining**: Rigorous testing to ensure data accuracy and application reliability, refining the tool for an effective space debris visualization solution.



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PROPOSED SOLUTION

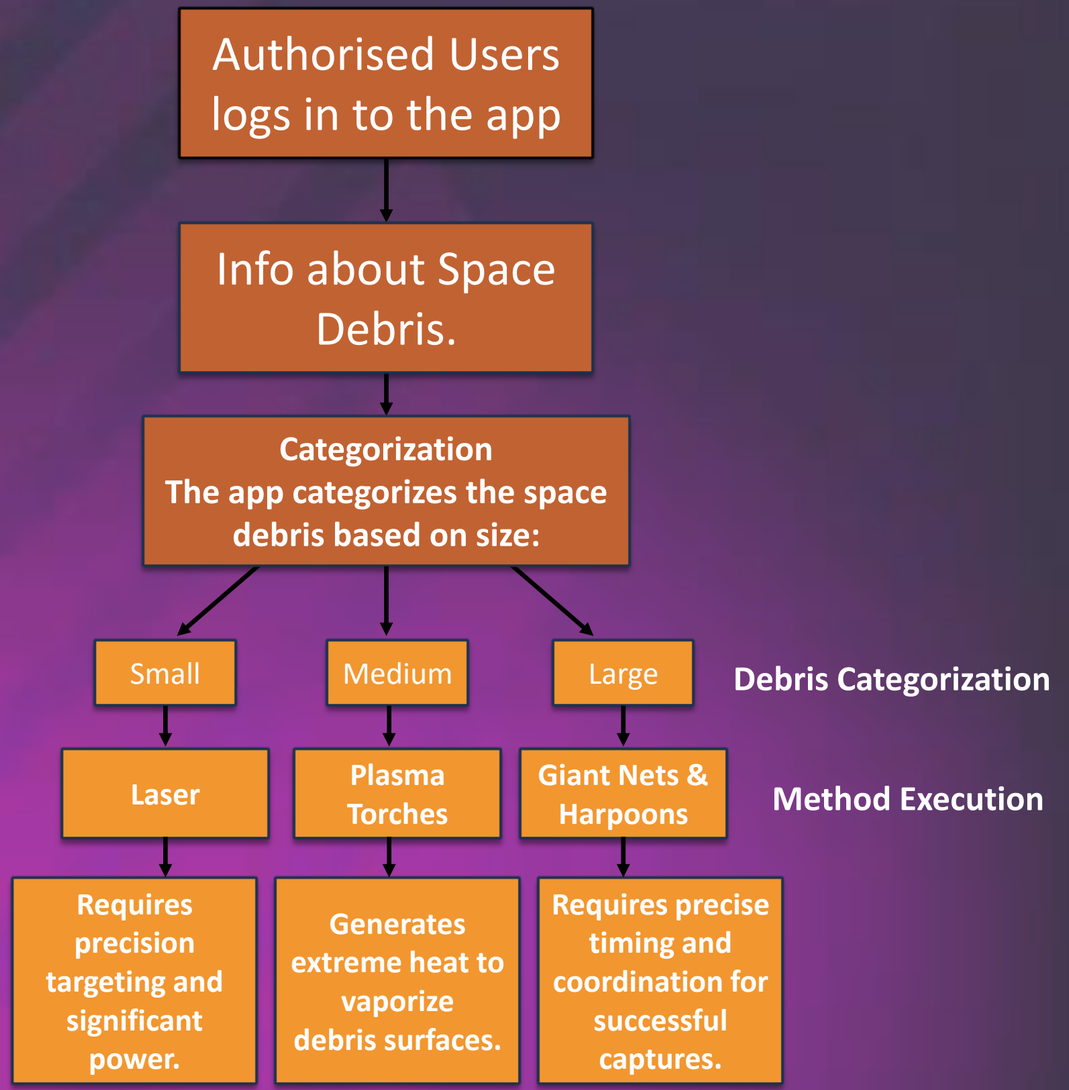
Space Debris Decomposition App

Purpose: The app is designed exclusively for NASA officials to support their work in space debris management, spacecraft materials, and decomposition techniques.

Key Features :

- **Decomposition Techniques**: The app proposes innovative techniques for decomposing space debris, potentially including ideas such as robotic arms, lasers, or other technologies.
- **Risk Assessment:** It may include features for assessing collision risks and recommending preventive measures.
- **Secure Authorization:** Access to the app is restricted to authorized NASA officials to ensure data security and accuracy.

App Workflow



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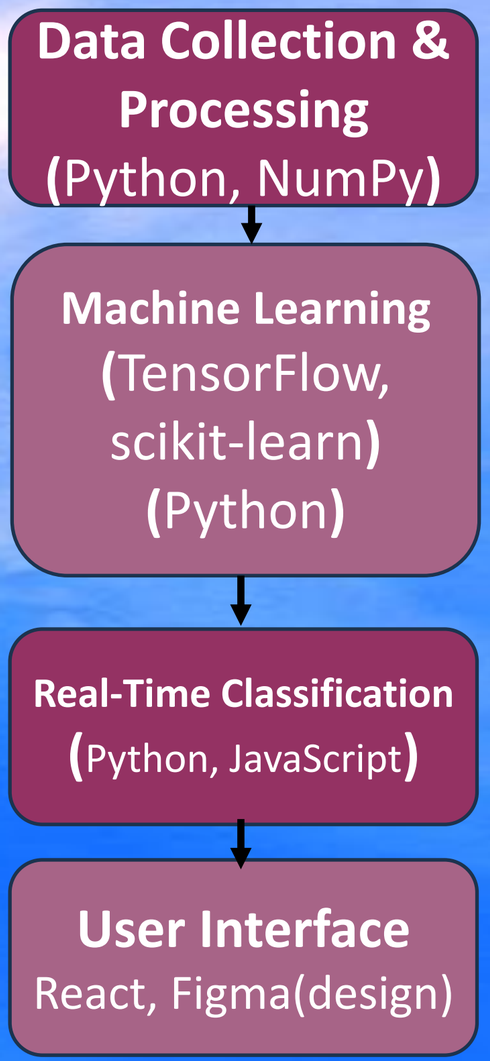
Methodology for APP

Our project methodology consists of four key steps:

1. **Data Collection and Processing:** Gather data on space debris characteristics, including size, mass, and composition.
2. **Machine Learning Model:** Develop a machine learning model, such as a decision tree or neural network.
3. **Real-Time Classification**: Integrate the trained model into the app for real-time classification. Continuously analyze newly detected debris objects and assign them to appropriate categories.
4. **User Interface**: Design an intuitive app interface displaying classification results.



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RESEARCH WORK

Purpose of Research:

- Investigate methods for breaking down heavy metals (nickel, titanium, gold, aluminum) used in spacecraft construction.
- Explore alternative materials like aerogels, biodegradable polymers, nanostructured particles, and self-destructing materials to replace these heavy metals.
- Contribute to reducing the risk posed by space debris to functioning spacecraft and the environment in Earth's orbit.

Results Obtained:

- Identification of techniques for decomposing heavy metals in space, including laser ablation, plasma torches, and microwave plasma, offering efficient methods for space debris reduction.
- Acknowledgment of challenges such as energy requirements and byproduct management that must be addressed for practical implementation.
- Proposal of alternative materials like aerogels and biodegradable polymers for spacecraft construction, offering lightweight, durable, and environmentally friendly options.

Results obtained in paper used in apps.

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CHALLENGES TO BE TACKLED

1. **Space debris is constantly moving:** Space debris is constantly moving at high speeds, making it difficult to capture and remove.
2. **Space debris is often very small:** Some space debris is very small, such as paint chips and metal fragments. This makes it difficult to detect and remove.
3. **Space debris is often located in high orbits:** Some space debris is located in high orbits, making it difficult and expensive to reach.
4. **Space debris can be dangerous:** Space debris can be dangerous to astronauts and spacecraft. It is important to ensure that any debris cleanup system does not create additional hazards.

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