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Zero-G Operable Interplanetary Delivery Based Ergonomics Grabber (ZOIDBERG)

Davlin Jacob

Camille Eddy

John Cashin

Eli Andersen

Scott Warren

See next page for additional authors

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Abstract

The collection and storage of float samples without cross contamination is one of many challenges facing the National Aeronautics and Space Administration (NASA). The proposed tool will be able to retrieve rock samples with a series of sample collection clamshells attached to a rotating belt positioned on a shaft. There will be one clamshell per sample collection sight. The tool will meet all safety requirements and be able to retrieve the samples without compromising the integrity of the surrounding area. After thorough design review, a prototype will be tested at the Neutral Buoyance Lab (NBL) at NASA's Johnson Spaceflight Center in Houston, TX the first week of June. Feedback from the test will provide a foundation for future improvements to the design and operation of the device. Prior and post testing to the NBL tests will be key for precise design, fabrication, and operation. In the future, NASA may be able to use this tool to collect rock samples during asteroid missions.

Authors

Davlin Jacob, Camille Eddy, John Cashin, Eli Andersen, Scott Warren, Zachary Chastaine, Colton Colbert, Christopher Ruby, and Marina Autina

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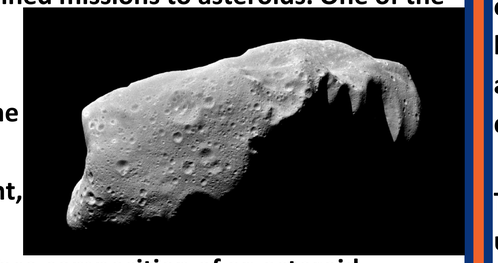
Motivation

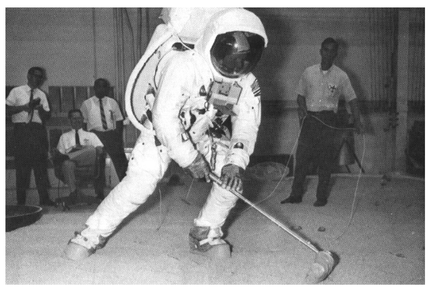
Design and fabricate a float sample grabber tool that can be used by astronauts on manned asteroid missions. The space tool needs to be capable of collecting float samples from at least three different worksites without cross-contamination of the samples and meet all of NASA's safety and design requirements.

Background

NASA is in the process of sending astronauts beyond Earth's orbit to explore celestial bodies within our solar system. A major step in space exploration will be manned missions to asteroids. One of the key aims of such missions would be to take geological samples which gives a timeline of the history of the Astronomical body. At present, there is no definitive method of determining the exact surface composition of an asteroid. Astronauts may deal with a pile of loose gravel held together by its own weak self gravity, or potentially find samples that are solid chunks of some miscellaneous metal (ReelNasa). As of now, it is thought that asteroid features contain float samples which are loosely adhered surface rocks that can be sampled and brought back to Earth.

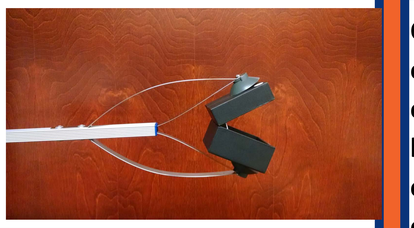


The manned Apollo space missions used a variety of simple tools to accomplish the task of collecting different lunar samples. A collection of tongs, rakes, scoops and collection bags were used to obtain rock samples ranging from tiny pebbles to inch sized rocks.



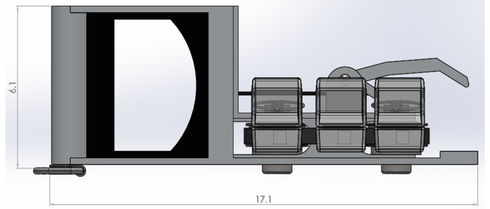
Concept Design

We got our concept from a simple claw object grabber. But because our grabber has to collect three samples we decided to rotate the clamshells into position using a belt and pulleys.

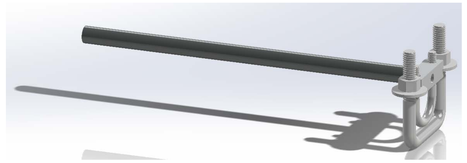


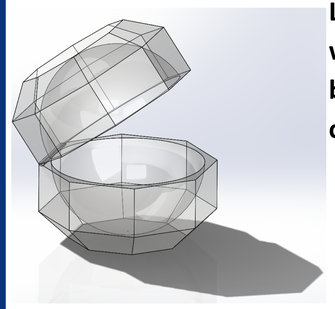
Design & Simulation

Our current design has changed somewhat from the concept. The handle now has a safety to prevent the accidental triggering of the device. The safety was inspired by a caulking gun safety.

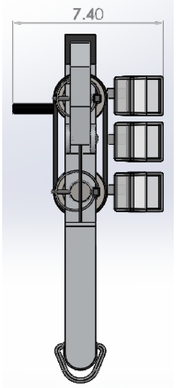


The claw is gone in favor of a u-channel mounted to the top of the clamshells. When the trigger is squeezed, a rod on top of the device is pulled back, and the clamshell opens. To close the clamshell, the trigger is released and the springs in the trigger push the rod and in turn the lid back forward. The rod hits the clamshell and it snaps close using the springs in the lid.





Lastly we've added a shield with brushes to cover the belt and reduce cross-contamination from dust.



Design Challenges

Our greatest design challenge was figuring out how to open the clamshell boxes. In our original design we had them open, and the claw mechanism served only to close the box. In order to fix this we had to resign the entire end of the tool. A lot of options were considered including wedges, rails and magnets. Ultimately we came up with the rod/u-tooth idea which is simple and doesn't require high tolerances.

The safety mechanism was hard to decide on as well. We considered slotted buttons, safeties akin to a gun safety and captured quick release pins which would move in the way of the trigger. The caulking gun safety won out because it was one-handed operation would be comfortable to use with the large astronaut gloves and was simple to implement.

We've also added a shield with brushes to help with contamination, a wedge to help locate the box in place, and changed the single attachment point of the box to belt to two in order to help keep the box securely attached to the device. The pull rod which advances the belt now has slots to slide into to help with precision.

Future Work

- More safety features in both pulling mechanism and design to further remove edges and open mechanisms.
- Redesign of the clamshell to allow for a variety of different angles to pick up float samples.
- Redesign of the clamshell rotation mechanism that will be one handed operation

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