Long Duration Experiment Technical Report

Dev D. Patel

Virginia Aerospace Science and Technology Scholars

Abstract

Long duration experiments are one of the most important parts of scientific research in space. The ability to perform an in depth study on an external body is important as it opens up new possibilities for discovery, and more importantly, it provides accurate data directly from the data source, which limits error. For a Mars exploration, a redesign of the Apollo 17 “Metric and Panoramic” Cameras would be needed, in order to provide updated image datasets compatible with modern hardware, and deep learning ready image sets. This experiment would follow MEPAG rule 3, as it would understand the geological evolution of Mars by collecting advanced topographical map data, and surface images (NASA Astrobiology).

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Photography and Geological Mapping are two of the most important mission aspects of any planetary mission. A redesign of the Apollo 17 Mars and Panoramic Camera experiment would provide a sophisticated, low cost, long duration experiment to collect imaging data. Technology like low cost camera arrays, and LIDAR sensors combined with software algorithms could process images, building a continuous, complex dataset, and keeping costs low.

Materials

The main difference between the redesign and the original experiment would be the camera hardware used. During the Apollo 17 mission, the Metric and Panoramic Camera mission used three separate cameras that used film canisters to store footage. They used a dedicated panoramic camera, a Steller Mapping Camera to help localize the ship, and a Metric Camera for surface photos ("Apollo 17 Experiments - Metric and Panoramic Cameras"). The Stellar camera and the Metric Camera were similar in many regards, but differed in a few key ways. Although the lens were of similar size and spec, they had a different f-aperture, with the Metric Camera having f/4.5, and the Stellar Camera having f/2.8 ("The Fairchild Lunar Mapping Camera"). The lens aperture measures how much light is allowed to enter the Camera system, affecting the final photo ("Understanding Aperture - A Beginner's Guide", 2018). In addition, the physical size of the two camera modules vastly differs. For a Mars redesign, the overall system size could be greatly reduced. By using an array of cheap, robust modern camera systems, the pictures taken could be digitally stitched together, emulating a large panoramic lens. With technologies like LIDAR scanning, photo quality could also be artificially generated using AI algorithms, increasing the quality of topographical maps and images as well as keeping costs low (LIDAR |

Remote Sensing Branch, 2016). The stellar camera would have to be a seperate camera, but by leveraging existing star location datasets and satellite data, the quality of the photo needed for the approximation would be lower, which would result in a cheaper method for localization, resulting in a more accurate map. The metric camera array system and the stellar camera could be housed in a low orbit satellite, similar to the system used in the Apollo 17 ("Apollo 17 Experiments - Metric and Panoramic Cameras"). The costs saved in the camera module system could be diverted to processing systems. This would consist of several computer clusters, dedicated to unsupervised learning algorithms to process the dataset, and image manipulation algorithms to stitch and process the photos together, creating a vast, modern dataset. After an image has been labelled and processed, it would be sent through an encrypted satellite link to a Mars Base, enabling fast, secure, high bandwidth communication.

Power

All systems would get power through the low orbit satellite besides the storage systems, which would be powered by the base. Power on the Satellites would be generated by Solar Panel arrays, would use supercapacitors and high power lithium batteries to store charge. A similar system on a larger scale would be implemented for the surface base. Graphene batteries would not be implemented because of their high cost, and unproven reliability.

Time Factors:

The nature of the photo array system and the computer clusters would mean that no astronauts would interact with the satellite directly. They would interact with the post processed data, so they could visualize patterns and draw conclusions. The majority of the work would be done by the computer cluster system, so only 1 or 2 astronauts would be needed on base to run various types of analysis and corroborate with other data from different experiments. The data would constantly be flowing into the base, and by implementing unsupervised learning algorithms, the machines would help with pattern detection, further limiting the amount of work needed. The scientists would mostly be there to confirm the accuracy of the data, and convert it into usable topographical maps, and image datasets.

Theorized Results

The experiment would mostly be to generate a modern, usable dataset, so the size of the dataset would steadily grow. At 3 months, we would have a nearly complete dataset of images. At about 6 months, error checking, and multiple copies would be added, and at about 12 months, all error checking and duplicates would be finished, with a complete, usable dataset.

Differences

The key difference in long term vs short term duration of this project would be storage. Camera array systems use large amounts of resources to store the raw photo. Storing the processed photo as well would use even more bytes, and that storage system uses up a lot of space. In a short duration experiment, most of the data would be stored on the satellite, and then extracted all at once to be processed. This would be the most cost effective solution, as building a semi-permanent settlement for a short mission would be very costly. A long term mission requires much less onboard storage, as the semi-permanent base required for long term study would have all the necessary storage room.

Conclusion

One of the first steps that needs to be taken in a long duration mission to mars is to begin mapping the surface. Rather than start fresh, a simple redesign of the Apollo 17 Mars and

Panoramic Camera experiment would suffice. Innovative technology like low cost camera arrays, and LIDAR sensors could replace aging, expensive, bulky hardware. Advanced software algorithms could process images, all while further driving down costs. And by limiting onboard storage, and building a continuous, complex dataset, a strong foundation can be built for future Mars Research.

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