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Designing the Mission Operations for the Pointable Radiometer for Observation of Volcanic Emissions (PROVE) Pathfinder Payload

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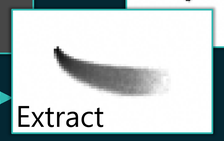
The PROVE Pathfinder CubeSat payload is a 2U Visual and TIR imaging payload optimized for observation of volcanic ash clouds for 3D reconstruction. Three of the main challenges for the mission operations of payload are optimization of the observation geometry (num. images, angles, etc.), data management of a high data rate payload, and observation scheduling for sporadic eruptions. Example solutions to these problems are presented below.

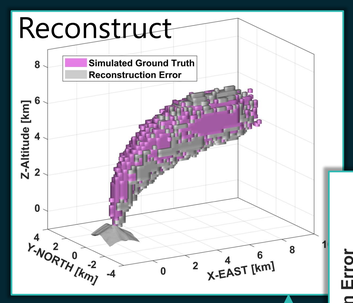
1. Optimization of Volcanic Observation Geometry

The payload will employ a 'point-and-stare' scanning method, tracking a single ground target from horizon to horizon, generating image data from multiple viewing angles. This multi-angle imagery will enable 3D reconstruction. The distribution of images and viewing angles can be optimized for accuracy.

Simulation of Satellite Imagery

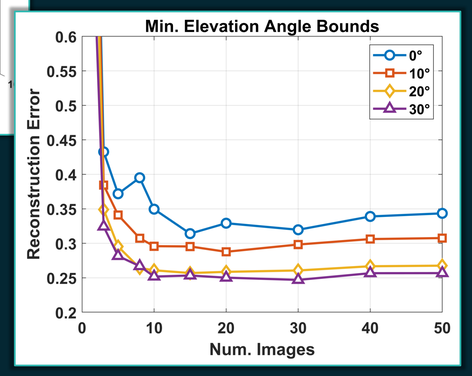
Simulation is used to generate sample imagery and test reconstruction performance.





Optimization of Num. Images and Angles

Observation geometry can be optimized before launch, e.g. number of images and viewing angle bounds.

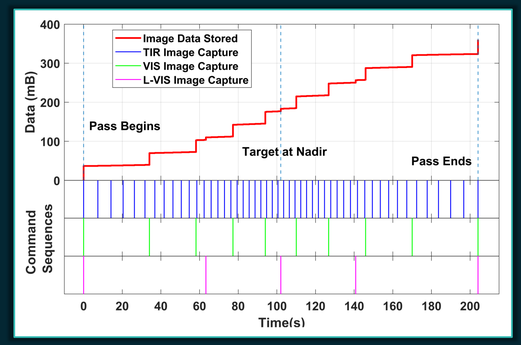


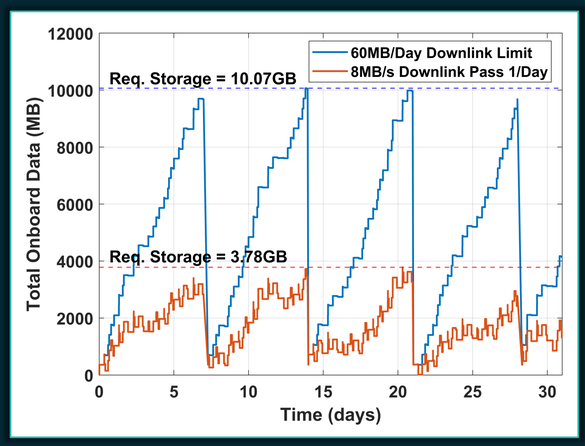
2. Data Management

Due to the high number of images required for 3D reconstruction, not all observation passes will be downlinked. By downlinking 'thumbnails', the passes can be evaluated and those with most scientific value prioritised.

Single Pass Data Management

During a single observation pass the Visual and TIR cameras rapidly capture a number of images, producing ~360MB.





Downlink Limits

With a daily downlink limit of 60MB, it would take roughly one week to downlink a single observation pass.

Thumbnailing

By downlinking low quality 'thumbnails' for each pass, low quality observation passes (cloud cover, no plume, etc.) can be ignored, downlinking only the most interesting passes.

3. Observation Scheduling

As large volcanic eruptions are sporadic and rare, observations cannot be pre-planned. Due to limited TT&C, a scheduler will be implemented to observe a number of volcanic targets as baseline, with the ability to upload new high-priority targets in response to predicted or observed volcanic activity.

Conclusion

It is hoped that this example of an Earth Observation payload's mission operations will provide some useful ideas on scheduling and downlinking multi-angle imagery for future CubeSat teams.

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