INTRODUCTION

Rover traverse distances are increasing at a faster rate than downlink capacity is increasing. As this trend continues, the quantity of data that can be returned to Earth per meter of traverse is reduced. The capacity of the rover to collect data, however, remains high. This circumstance leads to an opportunity to increase mission science return by carefully selecting the data with the highest science interest for downlink. We have developed an onboard science analysis technology for increasing science return from missions. Our technology evaluates the geologic data garnered by the rover, and prioritizes this data for transmission, so that the data with the highest science value is transmitted to Earth. Although our techniques are applicable to a wide range of data modalities, our initial emphasis has focused on image analysis, since images consume a large percentage of downlink bandwidth.

We have further focused our foundational work on rocks. Rocks are among the primary features produced by the Martian environment. Characterization and understanding of rocks on the surface is a first step toward more complete in situ regional geological assessments by the rover. To support this, we have constructed and evaluated an algorithm for assessing the data and the use of these features to assess the scientific value of the data. In our current application, we classify Martian rocks into image data and then extract properties of each rock, including albedo, visual texture, and shape. These properties are then used to prioritize the rocks and thereby prioritize the images of the rocks.

Three prioritization methods have been developed: identification of key target signatures, novelty detection, and sampling representative rocks. The use of these three methods ensures that three exploratory science objectives are met. First, objects known to be of very high interest, such as indicators of water, will be immediately recognized if encountered. Second, vegetation objects that may lead to key discoveries will be cited. R. H. however, it important to have an understanding of the typical characteristics of the region. Our final prioritization method assesses the most representative rocks for the identified spares.

As NASA continues to increase the number of high data volume missions simultaneously operating, an onboard mechanism for the prioritization of data tagged for downlink that can increase the science return furnished by a fixed bandwidth will be invaluable to scientists who will continue to compete for downlink time.

FEATURE EXTRACTION

Albedo

Texture

Shape

PROCESS DIAGRAM

INPUTS

Image Data

Stereo Range Map

OUTPUTS

List of Prioritized Images

Stop and Take Anchor Measurement

Stop and Collect Home to Report Surveillant Find

Stop, Ask Path, Send Contact Measurement

AUTOMATION LEVEL 1

AUTOMATION LEVEL 2

AUTOMATION LEVEL 3

AUTOMATION LEVEL 4

PRIORITY TECHNIQUES

Key Target Signature

Scientists have studied areas extensively and have an idea of what they want to target. However, using only a route vision during an in-situ mission. As a result, the自豪s that have been carefully selected to collect information that will provide valuable insight into the history or current conditions are used. This" when only limited data can be sent to Earth. It is very important to scientists that any data containing these signatures is among the data that is returned.

We have implemented a method for modeling science in order to enable efficient and effective prioritization of the science itself.

Novelty Detection

Sometimes the most interesting scientific discoveries occur when we detect objects that are not identified. We have developed a method for detecting novel rocks that is based on a detailed rock types classification. In this approach we treat a set of rock data as an "attribute set" and mine the distribution's boundary that encloses all data in feature space. The rock data is essentially considered as a cloud of points in the feature space and the boundary of the cloud is learned a region being scanned is considered novel if it is feature vector falls outside of the cloud boundary.

Representative Rock Sampling

One of the objectives for rover traverse science is to gain an understanding of the region being traversed. As such, it is desirable to have information on rocks that are typical for a region, and fast information on potentially very interesting unusual rocks, returned to Earth. A region is likely to be populated by several types of rocks with each type having a different abundance. A uniform sampling will be biased towards the common class of rocks, and space-time constraints and the terrain of the region will severely limit the number of science returns. We have implemented a method for identifying representative rocks that are not only novel but also typical of the region.