Improved Access to Kaguya Hyperspectral Image Data

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Background

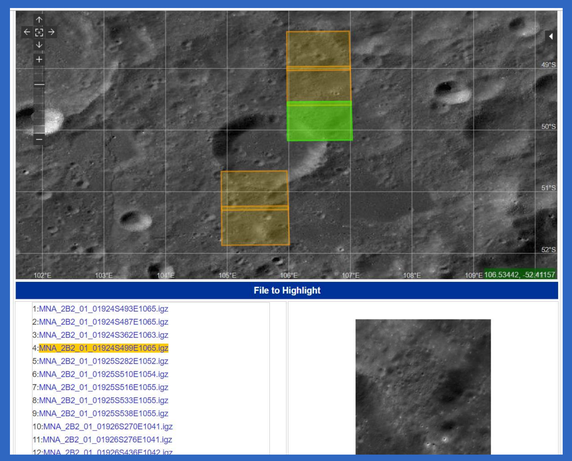
In September 2007, the Japan Aerospace Exploration Agency (JAXA) launched a lunar orbiter, Kaguya (SELENE) carrying the Spectral Profiler (SP) sensor which collected hyperspectral observations of the Moon. SP collected reflectance spectra from the visible and near infrared spectrums at high spatial and spectral resolution. The continuous spectral data captured can be used by planetary scientists to identify the type and breakdown of materials on the lunar surface.

Problems

The entire SP dataset, comprised of individual hyperspectral data points and the associated metadata is ~1.4 terabytes.

JAXA maintains the SELENE data archive, which is the primary access method for the SP dataset. There are three major issues with this method:

- Results are aggregated by image, which is redundant for spatially aware SP data.
- Map based spatial searches are impossible.
- Results are offered in individual image downloads.



Objectives

The client, USGS, wants a Web 2.0 application that will compensate for the problems in the SELENE data archive.

- Generate a global plot of the distribution of observations
- Generate a graph of observation data automatically for each point when selected
- Allow users to explore the entire data set using standard motions such as pan and zoom
- Filter displayed data based on incidence and emission angles

Vector vs Raster

There are two image types with which the backend can serve the data to the client. Raster images are represented in pixels. Vector images are mathematical calculations that form shapes Each data type has its advantages and disadvantages listed below.

Vector

- More accurately reflects points as individual data points
- Allows users to interact with points in the context of the map
- Poor performance with more than ~1000 points

Raster

- Visualizes the points into a static image (bitmap)
- Better for slower connections and clients
- Does not allow does not allow for easy visualization of individual data points
- Poor resolution at high zoom levels

Solution

Kaguya Spectral Profiler Explorer (KASPER)

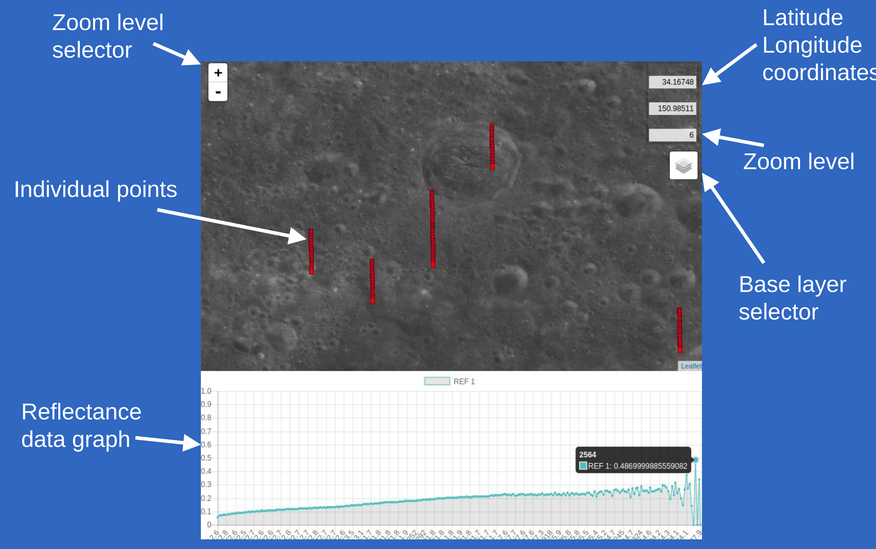
KASPER is a software system made up of three modules:

- Frontend – A Leaflet application that provides an interactive map using standard interaction features.
- Middleware – Node.js server that provides an API to facilitate interaction between the frontend and the backend.
- Backend – MongoDB is the database that stores all of the individual point data. When the database is queried, GeoServer converts the raw point data into map tiles that Leaflet uses.

In order to deliver fast load times at global level and also provide accurate information at a high zoom level, KASPER uses both raster and vector data.

Raster data is used on high level views, which allows for a faster loading time for generating a global plot of the observation. Vector data is used when zoomed in to provide accurate individual point interaction. In order to dynamically change the type of data being served according to the zoom level and the number of points in the map tiles displayed, gsconfig, a python library, is used to change the configuration the GeoServer.

KASPER



Additional features to KASPER

- Click to zoom in/out
- Change base layer – This changes the map underneath the points
- Query box – This allows a user to perform queries on the database such as near queries which zooms in and displays all points within a certain coordinate range.

Conclusion

KASPER provides a highly interactive web application for the visualization and analysis of the Kaguya Spectral Profiler data. It allows users to visualize the entire data set, as well as the specific hyperspectral data associated with each point. KASPER cuts out a large portion of the overhead associated with the current system, and provides the tools to analyze the dataset in an exploratory way.

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