2014 HICO Annual Report

An Enterprise Architecture for Transferring Remote Sensing Algorithms from Research to Operations

Hyperspectral applications in the littoral zone

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Overview

This project will demonstrate the functionality and capabilities of a prototype web-enabled, scalable, geospatial data processing system based on the ENVI Services Engine using remote sensing scenes collected by the HICO sensor on the International Space Station (ISS).

The overall vision is to utilize the advantages of cloud computing to provide an integrated online system for remote sensing image processing, including capabilities for rapidly integrating new algorithms, tools for selecting the most appropriate algorithms for a given task, and application services for image processing and delivering derived products. The resulting processing framework will provide a pathway for rapidly implementing new remote sensing algorithms and applications, as well as making these applications readily available to a global user community.

The resulting prototype will be hosted on a cloud computing platform, with access provided for testing and evaluation by members of the HICO science community for up to 6 months. Hosting is currently scheduled to begin in mid-2014.

Background

This project is a partnership between HySpeed Computing and Exelis Visual Information Solutions (Exelis VIS), with funding provided by the Center for the Advancement of Science in Space (CASIS).

Exelis VIS recently released the *ENVI Services Engine*, a cloud-based image analysis solution that allows an organization to create, publish, and deploy advanced ENVI image and data analytics to any existing enterprise infrastructure (Fig. 1). Using ENVI- or IDL-based image processing services, the ENVI Services Engine allows deployment of traditional ENVI/IDL desktop capabilities into on-line, on-demand environments. Once a routine is developed in IDL (a high level programming language), it is simple to wrap it as a service and deploy it in the ENVI Services Engine for consumption by remote end users or other applications and services running in the enterprise. Results delivered back from the ENVI Services Engine can be saved as data or files, or displayed in a variety of clients including web browsers, desktop apps and mobile devices, depending on the specific implementation.

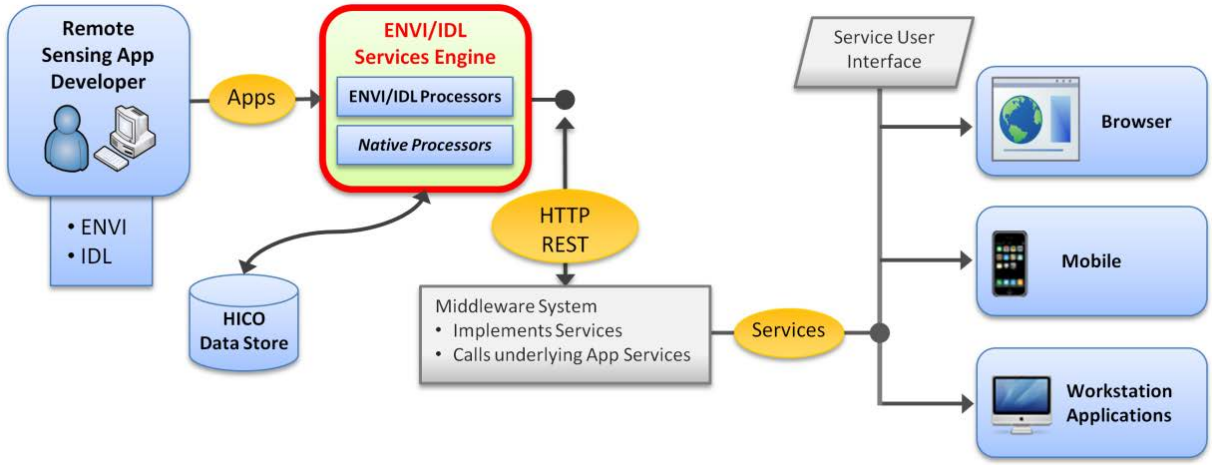

Figure 1. Schematic of the ENVI Services Engine concept.

HySpeed Computing and Exelis VIS are currently using the ENVI Services Engine to develop and implement a prototype online processing system for HICO. Tasks for this project include transforming a small collection of example algorithms into IDL routines, deploying these routines in the ENVI Services Engine, and building an interactive online interface for users to apply these algorithms using sample HICO images.

Project Updates

Algorithm Selection and IDL Development

The prototype processing system will include 4-6 remote sensing algorithms that have been transformed into operational software applications to run as plug-in modules in both ENVI and the ENVI Services Engine. Progress on this task includes the following:

- Conducted a literature review of HICO and other associated coastal remote sensing scientific publications, including review of active HICO research projects as listed on the HICO website.

- Identified 25 different candidate algorithms amongst four general topic areas: image pre-processing; ocean color algorithms; coastal characterization of water properties, bathymetry and seabed features; and image post-processing.
- Completed beta development of 6 selected algorithms in IDL:
  - land/water mask (NDWI; McFeeters 1996)
  - surface glint correction (Goodman et al. 2008; Goodman and Ustin 2007)
  - chlorophyll a estimation (OC4; O'Reilly et al. 2000) & (OCI; Hu et al. 2012)
  - quasi-analytical algorithm for absorption and backscattering (QAAv5; Lee et al. 2009, 2002)
  - inversion model for coastal characteristics (Lee et al. 1999, 1998)
  - change algorithm for comparing images (difference)
- The IDL algorithms are designed to run within ENVI, and include a user interface for input selection, a progress bar to visualize algorithm completion rate, and automatic display of output when the algorithm is complete.
- Algorithms are also being implemented such that users can readily follow a sequential image processing workflow when deriving output products (Fig. 2).

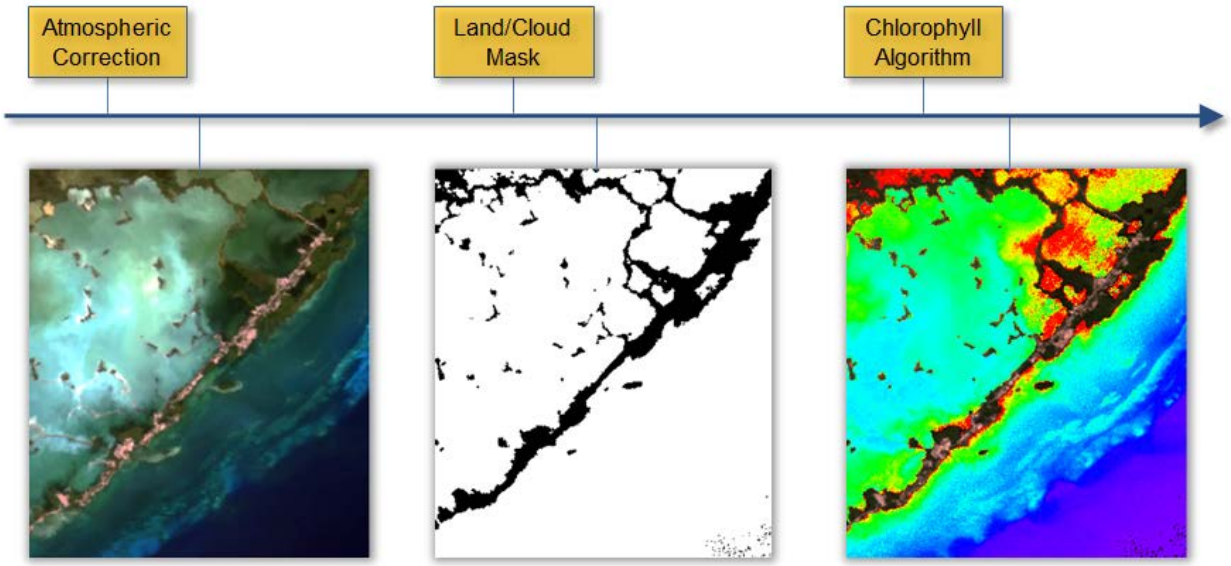

Figure 2. Example image processing workflow for deriving chlorophyll concentration in the Florida Keys.

Image Selection and Pre-Processing

Included with the prototype will be 10-20 example HICO images representing a range of geographic areas, water conditions, habitat characteristic and potential research applications. Pre-processing steps being performed on these images prior to deployment on the server include both atmospheric correction and improved geo-location. Progress on image selection and pre-processing tasks include the following:

- Conducted a review of the archived HICO scenes and associated research applications, and identified a list of 20 top-priority high-quality scenes from diverse locations in: Argentina, Australia, Bahamas, China, England, Italy, Korea, New Caledonia, New Zealand, Turkey and the United States.

- Evaluated the relative performance of FLAASH and QUAC, two commercial-off-the-shelf atmospheric correction tools, versus a modified version of Tafkaa (Montes et al. 2004; available courtesy of the HICO team at Oregon State University). Based on the results of this comparison, selected the modified version of Tafkaa for atmospheric correction of the scenes used in this project.
- Created a protocol for opening HDF5 formatted HICO scenes downloaded from NASA GSFC into ENVI/IDL and saving them in ENVI format for further processing and analysis. A summary document describing this process, along with example IDL code, was created and posted on the HySpeed blog (http://wp.me/p2onry-gq) for use by any interested HICO data users.
- Developed a methodology for improving the geo-location of HICO scenes using the ENVI Image Registration Workflow to align the scenes with high-accuracy L1T Landsat 7 base images (Fig. 3). A summary description of this process, including example output for a HICO image of the Florida Keys, was posted on the HySpeed blog (http://wp.me/p2onry-hf) for use by the HICO community.

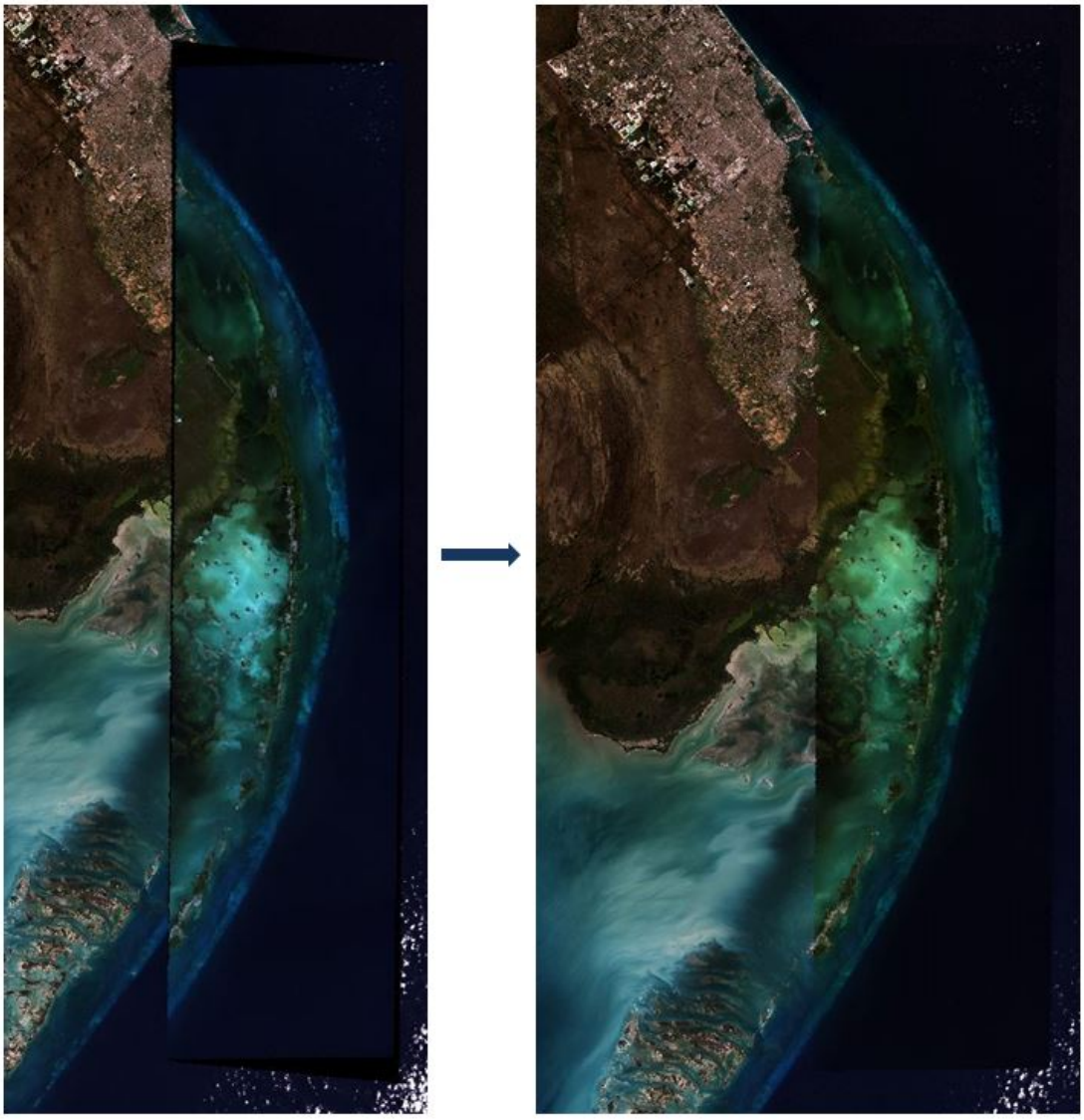

Figure 3. Example output of improved geo-location of HICO image of the Florida Keys.

ENVI Services Engine Deployment

Deployment of the web-based HICO image processing system using the ENVI Services Engine includes design of the user interface, algorithm integration, middleware components, and server architecture. Progress on these tasks includes the following:

- Developed the preliminary design of the overall system architecture, including considerations for server and hosting requirements, middleware components, user platforms and operating systems, algorithm integration, image database needs, user access, and user interface design.
- Created a draft user interface for the prototype system (Fig. 4), which uses OpenStreetMap as the base layer for image display, and provides menu options for users to select specific algorithms and data for processing.

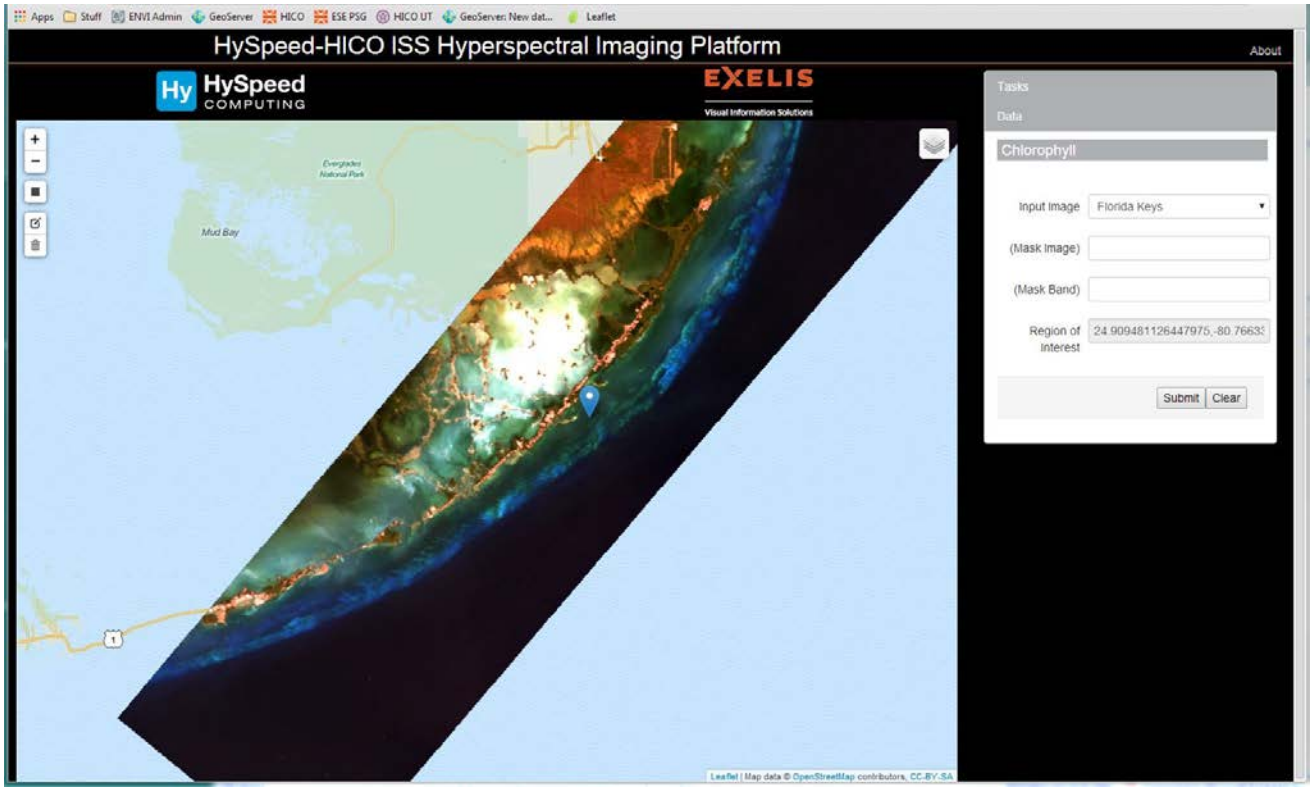

Figure 4. Draft user interface of prototype ENVI Services Engine implementation for HICO processing.

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