The 2014 IEEE GRSS Data Fusion Contest

Description of the datasets

Presented to Image Analysis and Data Fusion Technical Committee

IEEE Geoscience and Remote Sensing Society (GRSS)

February 17th, 2014

Introduction

Few datasets of long-wave infrared (LWIR) hyperspectral are currently publicly available. The interpretation of such measurements requires new approaches and it is a very current research topic, even before fusion.

In May 2013, Telops made airborne measurements over a small city closed to an open pit mining area. The following data are made available for the contest:

- LWIR hyperspectral dataset of the city
- High resolution visible data of the same area, with sparse ground coverage
- Ground reference data (LWIR hyperspectral) at a ground sampling point

Thetford Mines Area Description

The region included in the mosaic includes a variety of natural and man-made objects. It is located in Black Lake area of Thetford Mines, province of Québec, Canada (46.047927N, 71.366893W). The image below illustrates the general region which was surveyed.

The Thetford Mines region, a serpentine rich, rocky formation of oceanic origin, gives the region an international status in the extraction and export of chrysotile or white asbestos. The ground topography of this physiographic region is a little more rugged than the foothills, with hills whose altitudes generally vary between 400 to 600 m. Till deposits, which dominate the Appalachian Plateau are usually thick and undifferentiated.

Maple trees account for about 50% of the wooded area. Other forests in this area are largely dominated by coniferous trees. Finally, the area is covered by the balsam fir- yellow birch. Throughout the territory, the stations with poor drainage (water and organic) are populated by forests of fir, cedar, black ash, black spruce, spruce or cedar grove.

In Thetford Mines, asphalt is used to cover the roads. Concrete is the material most often used for the sidewalks. Roofs are generally made of asphalt shingles and flat roofs are often covered with an elastomeric membrane. In some cases as for garages or sheds, roofs are made of sheet metal. People have above ground and inground pools in their backyards which can be seen in the broadband airborne images.

Datasets Overview

The contest involves five datasets – a group of three airborne datasets and a group of two ground reference datasets.

Table 1 gives a summary of the datasets for the 2014 Data Fusion contest.

Table 1. Summary of datasets

Dataset #	Dataset type	Associated files	Comments
1a	Airborne, LWIR hyperspectral	TelopsDatasetCityLWIR.img TelopsDatasetCityLWIR.hdr	ENVI binary image (georeferenced), 751 x 874 pixels, 84 bands, BSQ, floating point format with 32 bits per pixel and channel, 100% ground coverage, Line-of-sight close to nadir

1b	Airborne, visible (digital)	TelopsDatasetCityVisible.img TelopsDatasetCityVisible.hdr	ENVI binary image (georeferenced), 3769 x 4386 pixels, BSQ, RGB uncalibrated data, unsigned integer format with 8 bits per pixel and channel, sparse ground coverage, Line-of-sight close to nadir
1c	Airborne, LWIR hyperspectral	Ortho_MissionB_Lx_20130521_?????????.img Ortho_MissionB_Lx_20130521_?????????.hdr	74 ENVI binary images, BSQ, floating point format with 32 bits per pixel and channel
2a	Ground, LWIR hyperspectral	TelopsDataset2a_LWIRFTS.dat TelopsDataset2a_LWIRFTS.hdr	ENVI binary image (unreferenced), 200 x 200 pixels, 177 bands, BIP, floating point format with 32 bits per pixel and channel, Line-of-sight approximately parallel to horizon / ground surface
2b	Ground, visible	TelopsDataset2b_Visible.dat TelopsDataset2b_Visible.hdr	ENVI binary image (unreferenced), 2592 x 1936 pixels, BIP, RGB data, unsigned integer format with 8 bits per pixel and channel, Line-of-sight approximately parallel to horizon / ground surface

Airborne Datasets (#1a & #1b)

The two airborne collected datasets were acquired over a low-density urban area in the neighboring of an open pit mining area and forest areas.

The first airborne data set (TelopsDatasetCityLWIR.img) has been acquired using the Telops' Hyper-Cam, an airborne long-wave infrared hyperspectral imager, which is based on a Fourier-transform spectrometer (FTS). The hyperspectral imager was integrated to a gyro-stabilized platform inside a fixed-wing aircraft. A digital color camera (2 MegaPixels), mounted on the same platform, was also used to acquire simultaneously a visible imagery data set.

The airborne LWIR hyperspectral imagery consists of 84 spectral bands in the 868 cm^{-1} to 1280 cm^{-1} region (7.8 µm to 11.5 µm), at a spectral resolution of 6 cm^{-1} (full-width-half-maximum). It has been calibrated to at-sensor spectral radiance units, in $W/(m^2\ sr\ cm^{-1})$. The data in the dataset represents the "at-sensor spectral radiance" in $W/(m^2\ sr\ cm^{-1})$ and is on a spectral grid in wavenumbers (cm^{-1}). Both axes are fully calibrated.

The airborne visible imagery (TelopsDatasetCityVisible.img) consists of uncalibrated, high spatial resolution, digital data with sparse ground coverage over the same area as the LWIR hyperspectral imagery.

Both airborne data sets are georeferenced images that are mutually registered.

The average height of both the LWIR and visible sensors above ground was 2650 ft (807m), resulting in an average spatial resolution (GSD) of approximately 1m for the LWIR hyperspectral imagery and 0.1m for the visible imagery. The visible data used for the contest have been sampled at 0.2m spatial resolution to partly reduce the resolution ratio between the two data sources.

The two airborne data sets were acquired simultaneously on May 21, 2013, between the time 22:27:36 to 23:46:01 UTC. A nearby meteorological station, located at geographic coordinates 46°02'57.002" N, 71°15'58.004" W (430.0m elevation), has recorded the data that is presented in Table 2.

Table 2. Environmental data during acquisition of datasets #1a and #1b

UTC Date & Time	Temperature [°C]	Dew Point Temp. [°C]	Rel. Hum. [%]	Pressure [kPa]
May 21, 2013, 22:00:00	14.2	9.6	74	96.41
May 21, 2013, 23:00:00	13.1	9.4	78	96.48
May 22, 2013, 00:00:00	12.5	9.3	81	96.43

Figure 1 gives an overview of the content of the dataset #1a (TelopsDatasetCityLWIR.img) by showing the spectrally-averaged image of bands #18 to #38 (952 cm^{-1} to 1052 cm^{-1} spectral range).

Figure 2 presents an overview of the content of the dataset #1b (TelopsDatasetCityVisible.img).

Figure 1. Spectrally-averaged mosaic of the airborne LWIR hyperspectral data set (#1a)

Figure 2. Mosaic image of the airborne visible data set (#1b)

Airborne Dataset (#1c)

In addition to the mosaic, we provide the 74 individual hypercubes which are an orthorectified version of the original airborne hypercubes. The filenames are as follow: Ortho_MissionB_Lx_20130521_?????????.img, where x represents the flight line number (4 to 8), and the ????????? is a numeric value (timestamp). An ENVI header accompanies each hypercube in a separate file (extension .hdr). These hypercubes were processed to produce the mosaic given as the dataset #1a.

Ground Datasets (#2a & #2b)

The ground datasets (#2a & #2b) have been acquired on October 3, 2013 at the time 21:15 UTC (17:15 local time).

The dataset #2a (TelopsDataset2a_LWIRFTS.dat) has been obtained using a similar LWIR hyperspectral imager as the one used for the acquisition of the airborne data set. The measurement was done at a higher spectral resolution and with averaging to produce a better SNR.

The hyperspectral imager was installed on a tripod on the ground, the line-of-sight of the instrument being approximately parallel to the horizon. A digital visible camera was taking visible images of the same scene. These imagers were installed at a geographic position (46.049053N,-71.363289W) which is located inside the ground area that is covered by the airborne datasets #1a and #1b.

The ground-based LWIR hyperspectral imagery (#2a) consists of 177 spectral bands in the 877 cm^{-1} to 1317 cm^{-1} region (7.6 µm to 11.4 µm), at a spectral resolution of 3 cm^{-1} (full-width-half-maximum). It has been calibrated to at-sensor spectral radiance units, in $W/(m^2\ sr\ cm^{-1})$.

The ground-based visible imagery (#2b) consists of an uncalibrated digital picture with wider coverage of the same scene as the LWIR hyperspectral imagery (context camera).

Figure 3 shows the thermal image (broadband) of the dataset #2a.

Figure 3. Broadband thermal image of the ground LWIR hyperspectral dataset (#2a)

The image shown in Figure 4 is an overview of the content of the ground visible dataset #2b (TelopsDataset2b_Visible.dat).

Figure 4. Image of the ground visible dataset (#2b)

Notes

All files of the datasets are ENVI readable. Equivalently, they can be read through common programming languages as conventional binary files (see Table 1 and the .hdr files for information on image sizes, data types, and interleaving). For instance, included with the data package, there is a MATLAB® script file "demo_script_telops.m" showing an example of how to open the data within MATLAB®.

For the sake of completeness, the data subset, which was released on January 22nd, 2014, and included subsets of the #1a and #1b airborne data sets, is also enclosed (IEEE_GRSS_IADFTC_Contest2014_subset.zip). The training map for the Classification Contest is included along with the data subset. The formats of the LWIR and visible subsets are analogous to those of the corresponding full data sets #1a and #1b, respectively. The training map is registered to the visible subset and is provided in both ENVI binary and GeoTIFF formats. Details

on the formats of the data subset and of the training map can be found in the “ReadMe.txt” file included in “IEEE_GRSS_IADFTC_Contest2014_subset.zip.”

Further information can be found on the IEEE GRSS website:

http://www.grss-ieee.org/community/technical-committees/data-fusion/data-fusion-contest/

and the Contest website:

http://cucciolo.dibe.unige.it/IPRS/IEEE_GRSS_IADFTC_2014_Data_Fusion_Contest.htm