

OBJECT-BASED FUSION OF VERY HIGH RESOLUTION OPTICAL IMAGES AND THERMAL HYPERSPECTRAL IMAGES FOR CLASSIFICATION OF URBAN AREAS

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Background

- While analyzing very high resolution (VHR) images of urban areas, spectral-spatial approaches have been shown to provide superior classification results compared to traditional pixel-based classification techniques.
- Spectral-spatial approaches utilize spatial features such as shape, size, texture, context, etc. along with the spectral information to aid in the classification, and are therefore more suitable for VHR data.

P. R. Marpu, M. Pedernana, M. Dalla Mura, S. Peeters, J. Benediktsson, and L. Bruzzone, "Classification of hyperspectral data using extended attribute profiles based on supervised and unsupervised feature extraction techniques," *International Journal of Image and Data Fusion*, 3 (3), 269-298, 2012.

Background

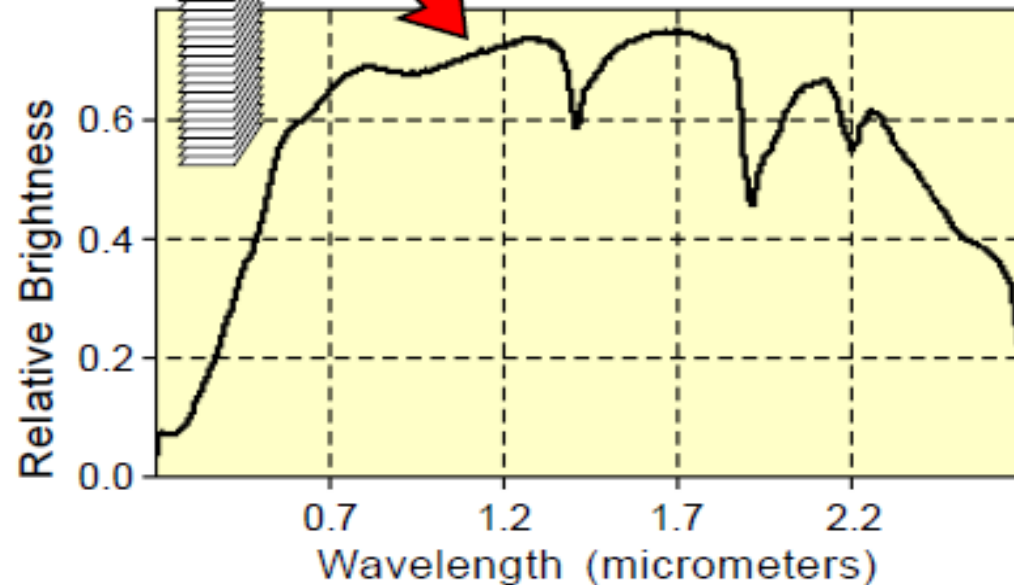
- Characteristics of urban surfaces are normally very complex as they are a mix of different materials.
- Additional information will be required to further characterize the surfaces through remote sensing images.
- The radiance in the thermal infrared bands observed by the sensor is a function of the temperature and emissivity of the surface which depend on the physical characteristics of the surface.
- Temperature and emissivity variations within a scene can be related to the targets identification, mapping and monitoring applications.
- Therefore, fusion of optical and thermal infrared images can provide useful information to remove possible ambiguity due to heterogeneity of surfaces.

Hyperspectral Imaging

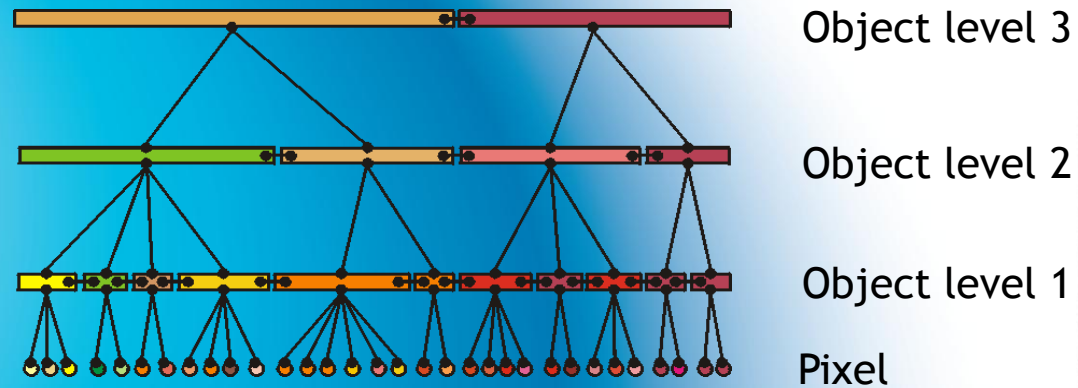
Images acquired simultaneously in many narrow, adjacent wavelength bands.

Set of brightness values for a single raster cell position in the hyperspectral image.

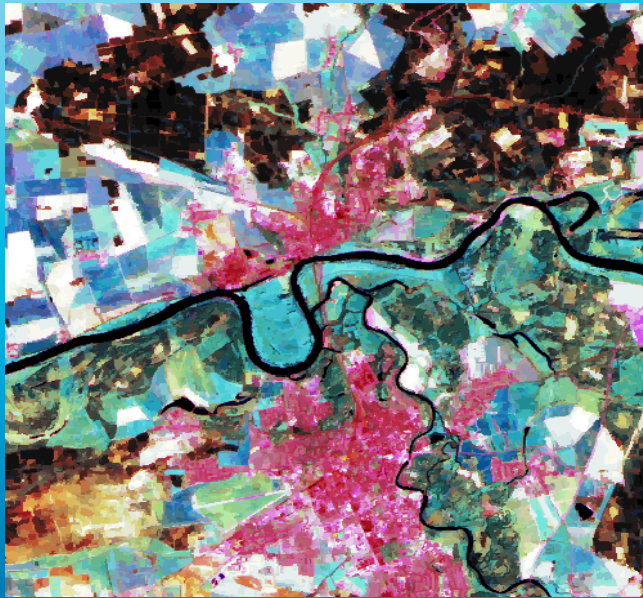
A plot of the brightness values versus wavelength shows the continuous spectrum for the image cell, which can be used to identify surface materials.



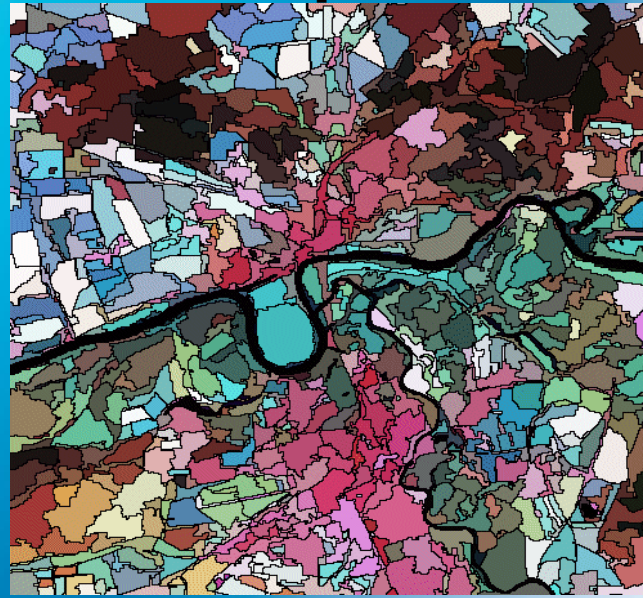
Object-based image analysis



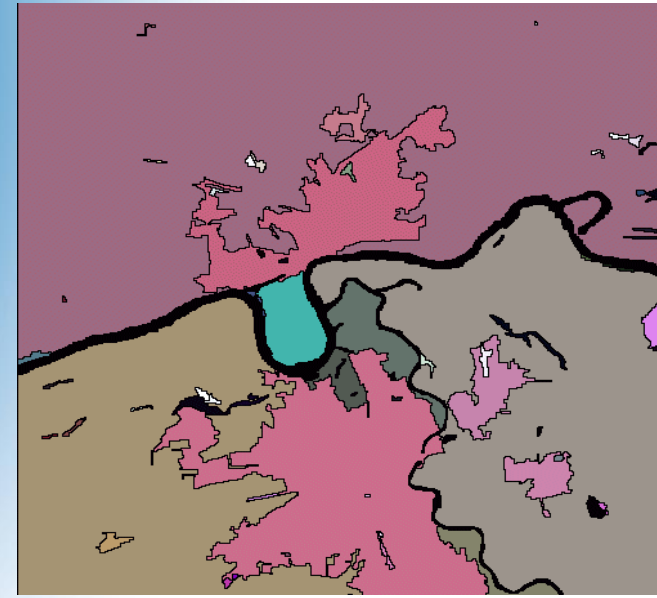
[Baatz et al. 2000]



Object level 1



Object level 2



Object level 3

Segmentation



Proposed Method

1. Register the thermal data to the optical data and perform up-scaling of thermal data to match the spatial resolution of the optical data.
2. Perform hierarchical image segmentation of optical data at different scales.
3. The median value of the pixels in the image object is considered as the representative spectral value of the image object.
4. The median value is also considered while deriving the representative spectral value of the thermal data (or the corresponding derived features such as the principal components).
5. Finally, classification is performed by stacking all the features using a non-linear classifier. In this study, we use Random Forest classification method.

Accounting for misregistration

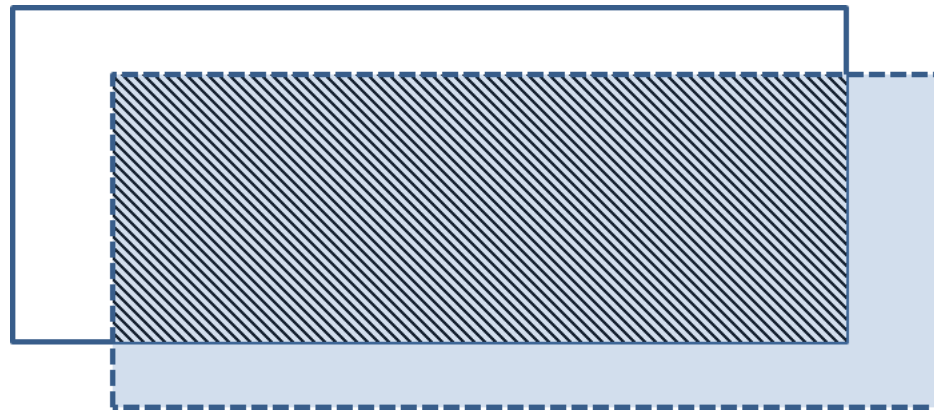
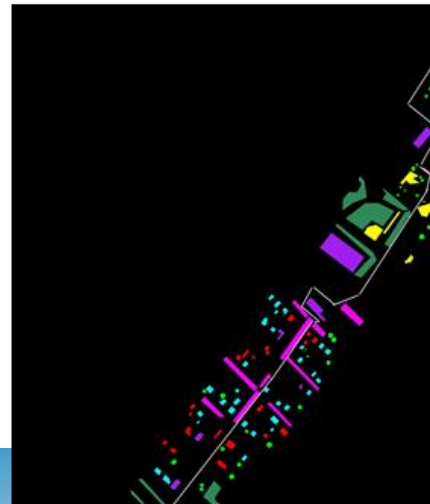


Illustration of misregistration of optical and thermal data. By considering the median, the actual spectral value of the object is assigned to it.

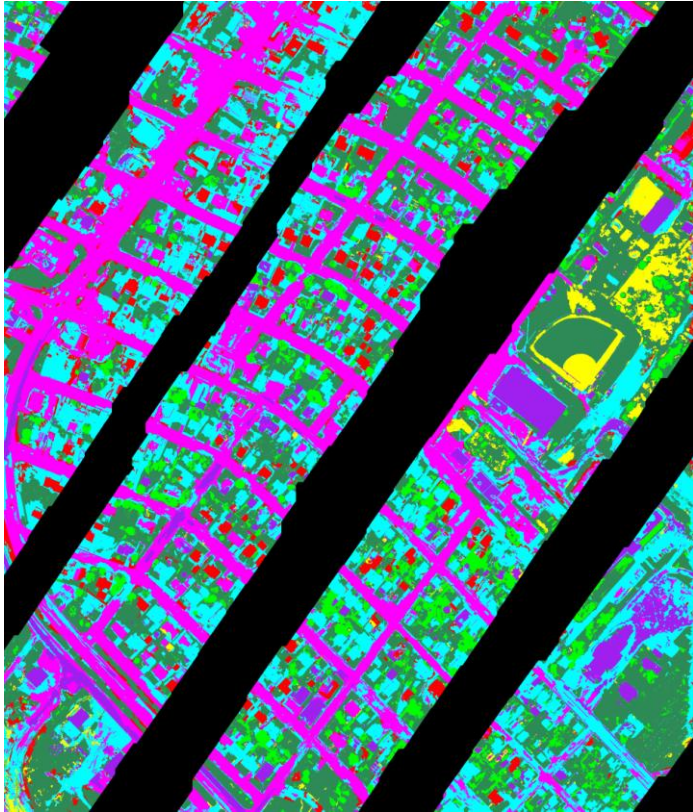
Data used

The data used in this study consists of a VHR optical dataset and a thermal hyperspectral dataset provided as a part of the IEEE Geoscience and Remote Sensing Society Data Fusion Contest 2014.

- The spatial resolution of the airborne VHR data is 20 cm.
- The airborne LWIR hyperspectral imagery consists of 84 spectral bands in the 7.8 μm to 11.5 μm region at a resolution of 1 meter.



Results



Class	RGB	RGB+PCA	RGB+ Seg	RGB+PCA +Seg
road	79.78	78.51	73.25	75.31
trees	76.14	73.33	90.64	89.16
red roof	50.12	52.20	41.26	48.49
grey roof	89.99	90.80	88.45	93.88
concr. roof	72.28	44.86	90.30	85.55
veg.	98.42	97.72	98.39	98.70
bare soil	82.46	84.68	83.92	85.94
Overall Accuracy	81.22	76.90	80.67	82.58
Kappa	0.77	0.72	0.77	0.79

Conclusion

- We present an approach for feature level fusion of very high resolution optical and thermal hyperspectral data, which provide highly complementary information.
- Classification is performed using pixel-based and segmentation-based techniques.
- It has been found that segmentation-based classification provides the best results while combining optical and thermal data.
- Furthermore, it is shown that the issue of small misregistration errors can be overcome to an extent by using the median value to represent the object feature while fusing optical and thermal data based on segmentation.

THANK YOU!