Chapter 8.1

On segment based image fusion

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ABSTRACT: The new generation of satellite and aircraft sensors provides image data of very and ultra high resolution which challenge conventional aerial photography. The high-resolution information, however, is acquired only in a panchromatic mode whereas the multispectral images are of lower spatial resolution. The ratios between high resolution panchromatic and low resolution multispectral images vary between 1:2 and 1:8 (or even higher if different sensors are involved). Consequently, appropriate techniques have been developed to merge the high resolution panchromatic information into the multispectral datasets. These techniques are usually referred to as pansharpening or data fusion. The methods can be classified into three levels: pixel level (iconic) fusion, feature level (symbolic) fusion and decision level fusion. Much research has concentrated on the iconic fusion because there exists a wealth of theory behind it. With the advent of object or segment oriented image processing techniques, however, feature based and decision based fusion techniques are becoming more important despite the fact that these approaches are more application oriented and heuristic. Within this context, the integration of GIS based information can easily be accomplished. The features can come from a specific segmentation algorithm or from an existing GIS database. Within the context of feature and decision based fusion, we present two exemplary case studies to prove the potential of decision and feature based fusion. The examples include:
- Decision based integration of panchromatic high resolution data with multispectral images for the identification of settlement areas;
- Rapid image enhancement merging GIS and multispectral satellite data; and
- NDVI based segmentation.

1 Introduction

The availability of remote sensing data that are needed for global, regional and local monitoring has greatly increased over the recent years. While the increase in spatial resolution for digital images has been hailed as a significant progress, methods for their automated analyses (i.e. land cover mapping, change analysis, GIS integration) are still in the process of being developed. Object (or segment) based preprocessing techniques seem to be an adequate methodology because inter-class variances can be minimized and the image interpretation techniques of the human eye be mimicked. However, the question of appropriate data fusion techniques within this context has hardly been addressed.

Over the last years, image fusion techniques have gained a renewed interest within the remote sensing community. The reason for this is that in most cases the new generation of remote sensors with very high spatial resolution records image datasets in two separate modes: the highest spatial resolution is obtained for panchromatic images whereas multispectral information is associated with lower spatial resolution. The ratios between panchromatic and multispectral imaging modes of one sensor vary between 1:2 and 1:8. For multisensor fusion, ratios can exceed 1:20 (e.g. Ikonos and SPOT merge). Consequently, for analyses that require both, high spatial and spectral information, fusion techniques have to be developed to extract ‘the best of both worlds’. The term fusion is used by the image community to address the problem of sensor fusion, where images from different sensors are combined. The term is also used by the database community for parts of the interoperability problem. Generally, fusion exists in different forms in different scientific communities (see, for example, Edwards and Jeansouline 2004).

Usually, the imaging community uses it to address the problem of sensor fusion, where images from different sensors (or different modes of one sensor) are combined. They can be classified into three levels: pixel level (iconic), feature level (symbolic) and knowledge or decision level (Pohl and van Genderen 1998).