

# DATA FUSION IN URBAN CARTOGRAPHY

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## ABSTRACT:

The set of images of the various operating orbital sensors is not enough to meet all the needs of the users, as there are applications which require high spatial and spectral resolutions. For this reason, aiming at overcoming some original data restrictions, image processing is used to generate improved quality products. Data fusion is the generic name given to techniques which allow to integrate images of different spatial and spectral characteristics in order to obtain synthetic images which have the advantages presented by their components, making the extraction of information easier.

In this paper, the processing applied to the original data (panchromatic and multispectral HRV-SPOT images) made the photointerpretation easier as well as the mapping of intra-urban areas, within a methodology of cartographic updating at 1:50,000 scale. Such processing started by applying a high-pass filter to the panchromatic image, to enhance edges. Later the IHS transformation was used, following a methodology which intended to generate a synthetic product preserving the spectral characteristics of the multispectral component, without losing the spatial resolution of the filtered panchromatic image. The results obtained through this processing show that in the synthetic image, the intra-urban areas were considerably improved.

## 1. INTRODUCTION

The set of images of the various operating orbital sensors is still insufficient to solve all the problems of Remote Sensing users, as there are applications that require high resolutions, spatial as well as spectral. An example of this is the urban areas mapping in topographic maps updating, because the current cartographic norms demand greater thematic information than that offered by the original images obtained from the current sensor systems. For that reason it is necessary to use image processing techniques in an attempt to generate products that allow as much extraction of thematic information as possible.

Data fusion is the generic name given to techniques that integrate data sets of different spatial and spectral characteristics, obtained or not by different sensors, aiming at generating synthetic products of improved quality when compared with the original data separately. The images thus obtained have the informative content of the component products, profiting from the advantages presented by each one of them and making it possible to extract more complete and accurate information (Chavez, 1986; Dutra et al., 1988; Kurkdjian et al., 1989; Brum, 1989; Kurkdjian, 1990; Carper et al., 1990; Candeias, 1992).

In this paper, the IHS transformation technique was used to merge panchromatic and multispectral (BGR 1,2,3) HRV-SPOT digital data generated by INPE and identified in Table 1. The image processing was made at SITIM (Integrated System of Image Treatment developed at the same Institute). The

resulting product was used to update the intra-urban areas of a topographic map at 1:50,000 scale.

K/J	Mode	Date
717/396	P	03/14/90
717/396	XS	08/18/89

Table 1 - Original HRV - SPOT images identification

The working area was a module of "São José dos Campos" (São Paulo State, Brazil) topographic map at 1:50,000 scale (sheet SF-23-Y-D-II-1) published by IBGE in 1973. This area includes part of the city and is limited by the following geographic coordinates: S23°07'35" and S23°14'06"; W45°52'07" and W45°50'06".

## 2. METHODOLOGY

The processing applied to the original images aimed at facilitating the photo-interpretation of the intra-urban areas included in the module under study. To do so, the following methodology was applied:

### 2.1 Filtering

A high-pass isotropic filter was applied to the original panchromatic SPOT image which allowed to generate an edge enhanced image. The filter used (Figure 2) did not produce any image dislocation effect or geometric alteration.

0	0	0	-2	0	0	0
0	0	1	-2	1	0	0
-2	-2	-2	25	-2	-2	-2
0	0	1	-2	1	0	0
0	0	0	-2	0	0	0

Figure 2 - High-Pass Filter used (Godoy Júnior, 1993).

## 2.2 IHS transformation

This technique, frequently used to integrate images obtained from different sensors, allows to substitute the Intensity channel of the multispectral component in IHS domain, by a better spatial resolution band.

In this paper, the IHS transformation was applied to generate the synthetic image resulting from the fusion of the multispectral SPOT image with the filtered panchromatic SPOT image. The following procedure was used, aiming at preserving the spectral characteristics presented by the urban areas in the original multispectral image, without losing the spatial resolution of the panchromatic image previously filtered:

- In RGB domain, the histograms averages of the three multispectral SPOT image bands were read (Figure 3). This multispectral component had been previously resampled in the registration operation with the panchromatic SPOT image.
- These averages were equalized to 128.
- The transformation of this equalized image to the IHS domain was performed.
- The IHS image statistical parameters were read, so that the component I average was 127.45.
- The statistical parameters of the filtered panchromatic SPOT image were read and its average was 40.61.
- This average was equalized to the multispectral SPOT image band I average, which would in turn substitute it.
- The statistical parameters of the filtered panchromatic SPOT image were read and the equalized average was equal to 126.58.
- In the IHS domain, the component I of the multispectral SPOT image was replaced by the panchromatic SPOT image whose average was equalized.
- This synthetic image was transformed from the IHS to the RGB domain.
- The statistical parameters of the new RGB image were read. They had the following values: Band R=125.00; Band G=125.84; Band B=126.56.

- From each band average, the necessary values were subtracted in order to return to the original resampled multispectral SPOT image averages, before the equalization.
- The final synthetic image statistical parameters were read, with the following average values for each band (Figure 4): Band R=39.98; Band G=31.83; Band B=41.81.

## 3. RESULTS

The high-pass filter application, previously described, allowed to refine the original panchromatic image visual quality. The filtered image enhanced the river banks, as well as the intra-urban features of São José dos Campos city and also the roads, bridges and railways.

The comparison between the histograms of the resampled multispectral SPOT image (Figure 3) and the synthetic image (Figure 4) enables one to see that through the described processing a final image was obtained with spectral characteristics very similar to those of the original multispectral component. However, the synthetic product appeared with a slight alteration in its spectral characteristics, thus originating some shape and size changes of certain features, specially in areas of dense vegetation. This was due to the substitution of the multispectral image channel I by the filtered panchromatic band, as it has a low spectral response to the close infra-red and therefore, in the synthetic image, areas with vegetation as well as other targets which have a high degree of reflectance in the infra-red band, appeared with a somewhat different spectral response as opposed to that of the original multispectral image bands. That results in a certain degree of spectral information loss in those areas. On the other hand, the intra-urban areas were considerably improved.

## 4. CONCLUSIONS

Based on the results obtained, the following conclusions can be drawn:

- A. The edge enhancement obtained through the high-pass filtering of the original panchromatic image, favoured a better discrimination as well as the digitalization of several linear and punctual features which did not appear well defined in the original image, proving to be very efficient to obtain more enhanced synthetic bands.
- B. The merging, in the synthetic image, of the spatial resolution of the filtered panchromatic image with a spectral resolution very similar to that of the original multispectral component, allowed a better identification and extraction of targets such as industrial areas, urban areas limits, street sections and other intra-urban features.
- C. It is interesting to emphasize that in this methodology the original multispectral bands, without altering the contrast nor any kind of enhancement, were used. The original bands histograms, as well as those of the translated original bands to the average value used for the equalization (128) did not exceed the superior limit of 255 to avoid information loss.

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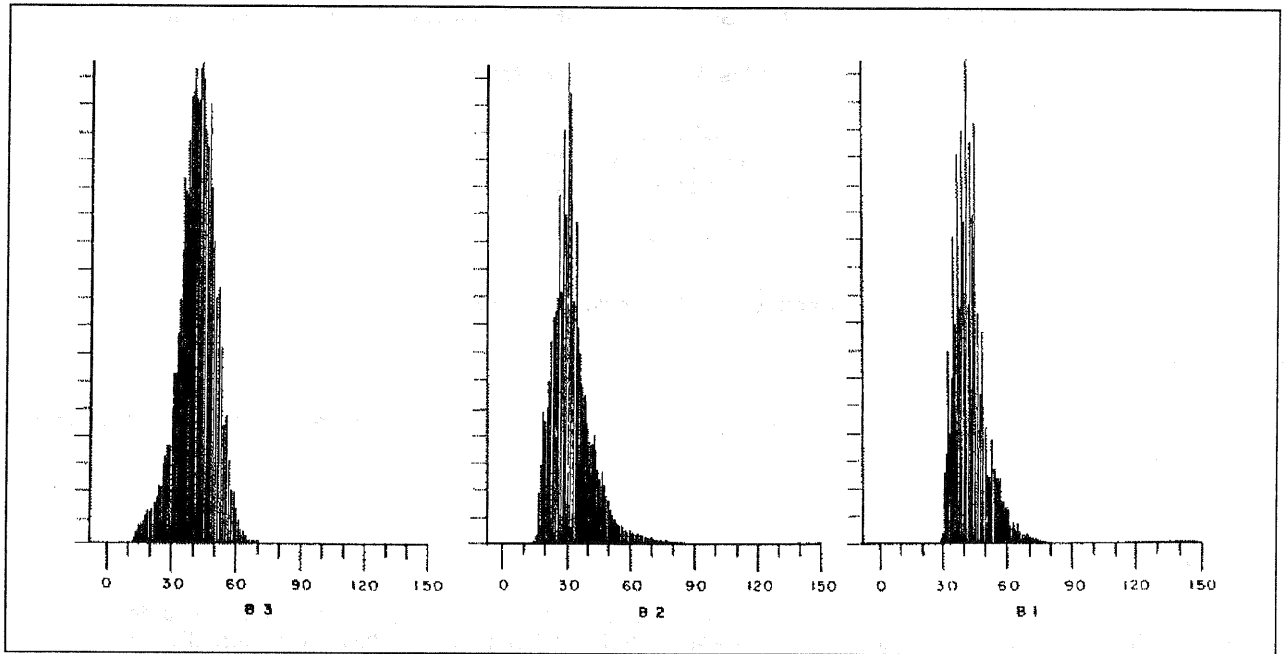


Fig. 3 - Original SPOT-XS bands 3, 2 and 1 histograms..

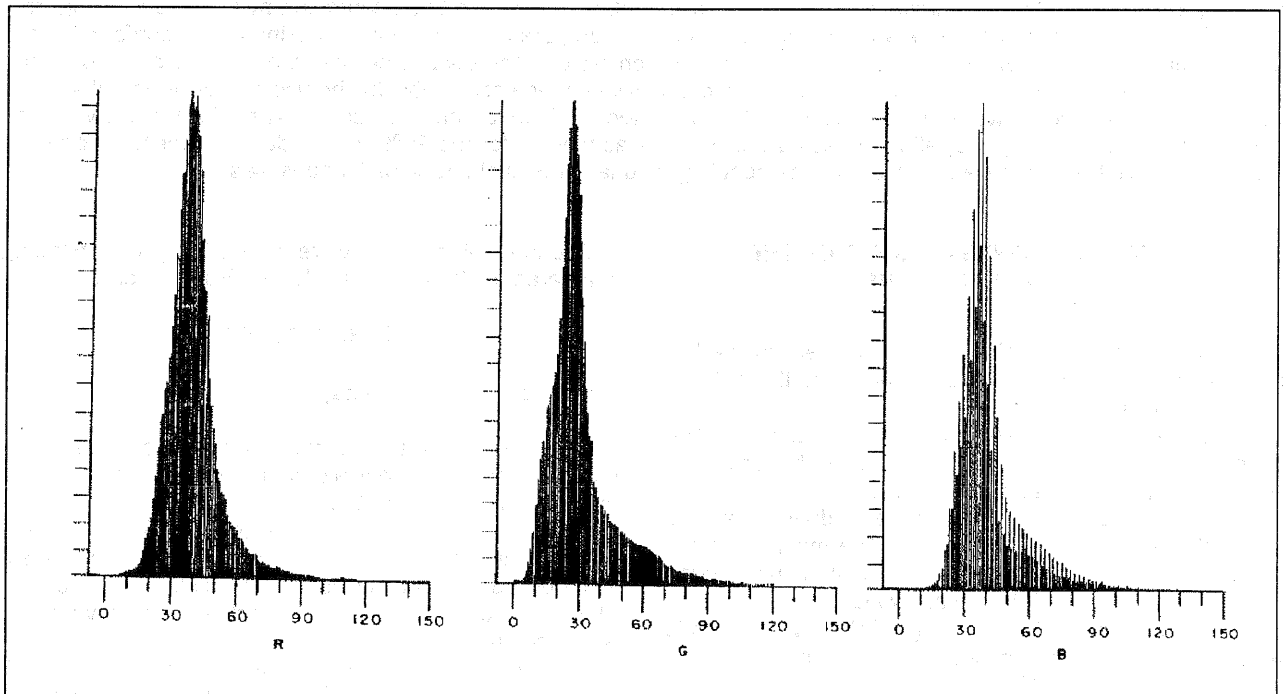


Fig. 4 - Synthetic Image bands R, G and B histograms.