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Habitat carthography using color infrared and hyperspectral images

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Abstract

This study sought to deepen the information derived from hyperspectral (MIVIS) and multispectral (IR) images to obtain a map of meadow-pasture types and a map of the biomass amount present in the Nature Park of Mont Avic.

MIVIS (Multispectral Infrared and Visible Imaging Spectrometer) is a modular tool with four spectrometers which covers visible, near infrared and heat wavelength (102 bands). The pixel size is lied to flying height, in our case (altitude 2000 meters) is equivalent to 4 meters for 4 meters square while IR images were aquired with a Zeiss RMK TOP 30 camera that returns a better soil resolution (15 cm), but cover only the infrared wavelength.

MIVIS georeferenced images using the software Trafo (ReSe applications) and the warp of ENVI were initially pre-treated by the MNF (Minimum Noise fraction) and then be classified using samples collected in situ and incorporated into a specific algorithm called SAM (Spectral Angle Mapper) where we have find eight classes; IR georeferenced images were classified using the biomass indicator's NDVI (Normalized Difference Vegetation Index) and then separated in three classes with stretching (low, intermediate and high).

MIVIS classification was validated through the verification of accuracy on 158 samples collected randomly in the area.

Finally we have obtained a first MIVIS classification with eight classes and a first NDVI classification which included in the Park's Geographic Information System have improved the territory's knowledge.

Keywords

Remote sensing, Geographical Information System, MIVIS, NDVI, IR, infrared, multi-spectral images, hyper-spectral images, cartography, SIC, Park, Mont Avic

Introduction

The "vegetation analysis, statistics and multitemporal of hyperspectral data (MIVIS) and multispectral (visible, infrared), compared with the database of the Natural Park of Mont Avic Information System " project was financied by Fondazione CRT in Turin behind the "Alfieri" project with the collaboration of the Mont Avic Natural Park; during the year of funding (June 2008 June 2009) hyperspectral images (MIVIS) were processed in order to produce a first herbaceous typologies map. Especially the analysis of grass-pasture typologies was focused on the south, south-west of the Park because there was a greater concentration of these elements. In parallel another analysis was conducted, where IR images were used to gain in relative terms the biomass values through the use of the NDVI vegetation index.

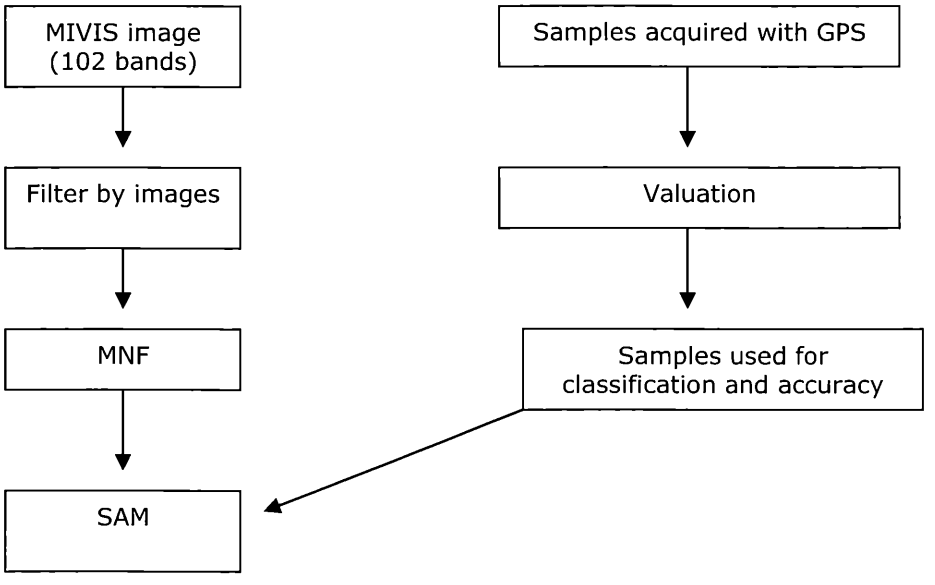
Mont Avic Natural Park is born on 1989 to conserve and protect environmental, natural and historical resources; initially the Protected Area consisted in 3522 ha situated on Champdepraz municipality but after may 2003 the territory increase to 5747 ha including Dondena Valley on Champorcher municipality.

Methods

Starting from the thesis work "Remote sensing in support of the management of a protected area: the Mont Avic Natural Park " it was possible to use hyperspectral images (MIVIS) georeferenced by software PARGE (Parametric Geocoding e Orthorectification for Airborne Optical Scanner Data by ReSe applications Schläpfer e RSL, University of Zurich), correlating images with data acquired at time of flight (ancillary file), ground control points and digital terrain model (DEM) has given an image comparable with Park's layer. Where geometric distortions were more pronounced, particularly near elevation changes, it was further correcting images through warping. The use of additional control points has reduced georeferencing error, reaching thus a 3 pixels maximum.

MIVIS non-georeferenced images are initially filtered considering the 102 bands individually. It was then applied a specific algorithm of noise reduction called MNF (Minimum Noise Fraction) which helped to improve the classification's accuracy. Parallel analysis was carried out in situ, which has allowed the acquisition of ROI (Region Of Interest) with GPS used for the classification.

ROI and images MIVIS treated are included in a classification algorithm called SAM (Spectral Angle Mapper) which determining the spectral similarity between the two spectra by calculating the 'corner' which they form, thus treating them as vectors in a space with dimensions equal to the number of bands. Angular parameter is the algorithm tolerance, with a small angle value the classification is more accurated therefore algorithm detects and classifies all pixels whose signature spectral part of this tolerance.



Samples are catalogued into eight classes ("Guide des milieux naturels de Suisse" DELARZE R., GONSETH Y. (2008)) and validated by the botanist:

- Elynion
- Nardion
- Festucion variae
- Caricion curvulae
- Salicion herbaceae
- Juniperion nanae
- Loiseleurio-vaccinion
- Drabo-seslerion

In order to confirm the data acquired, we have considered other factors such as height and lighting. We have also decided to use a fixed angle for all classes in order to maintain greater homogeneity on classes.

Classification was finally georeferenced, mosaics and inserted into a geographical information system where layers already presents have made possible a first data verification.

The statistical analysis was conducted on 5 classes that were available to the greater amount of data to the ground.

In order to remove the maximum error of GPS (8 meters) and georeference (12 meters equivalent to 3 pixels) was chosen for the creation of a twenty meters buffer strip with the following results:

ALLIANCE	SAMPLES	ERRORS	ACCURACY
CARICION CURVULAE	39	0	100
ELYNION	22	2	91
FESTUCION VARIAE	35	6	83
NARDION	45	7	84,5
SALICION HERBACEAE	17	0	100
TOTALI	158	15	

Using information in near infrared derived from the flight IR HABITALP directly correlated to the vegetation, we have decided to use a specific biomass indicator, NDVI (Normalized Difference Vegetation Index) based on reflectance values; it measure green cover and is directly related to photosyntesis. The leaf structure affects the relationship between the absorption spectrum of chlorophyll in the red (0.63 µm - 0.69 µm) and reflection in the near infrared (0.76 µm - 0.90 µm).

$$\text{NDVI}= \frac{IR - R}{IR + R}$$

We have calculated NDVI on each table and then get a mosaic of the entire area of the park, displayed in three levels of stretching.

The excellent resolution of the instrument made possible to produce a biomass map of the Park; in order to facilitate the subsequent application we have chose for three different maps:

stretching "broad" where we moved deliberately limit the amount of biomass per pixel to very high values in order to understand if in some pilot areas there may be a correlation with fauna, not obtainable with other levels of stretching;

stretching "tight" where we tried to give a card that put in evidence in "quantitative" biomass found throughout the park, thus providing a tool used throughout the Park;

stretching "medium" produce of the average values obtained from the two previous limit.

Results

Georeferencing of the adjoining park in 2003 and named "Dondena Valley " for a total of 2225 ha.

Classification of eight types of grass-pasture Park through images MIVIS for 1999, calibrated and verified through a survey carried out in situ in the summer of 2008.

Assessment of the amount of biomass present in the park through the indicator NDVI applied to the IR HABITALP flight and return of 3 levels obtained through the stretching of images.

Establishing a Geographical Information System that contains the information layer of the Park and data processed.

Discussion

Hyperspectral and multispectral images have a great amount of ground data. In particular, the advanced level of detail achieved in discriminating grass-pasture types has helped to first base in the transposition of information still difficult to interpret the photo. The use of vegetation index (NDVI) was also to create a database widely used in future studies related to fauna, allowing to relate more of the variables in the environment system. The vast amount of information generated will facilitate the future of the environment, providing an effective means interfaced with the data already present.

The products obtained thus far can provide a basis for further study, including:

Analysis of the classification of lithologic present in the park by using more detailed data and verification in situ.

Evaluations of detail in specific areas of spectral response "distorted" in order to analyze and solve problems associated with sensor

Analysis of classes derived from the biomass of the vectorial NDVI emphasis on possible correlations with maps produced.

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