USING MACHINE LEARNING ALGORITHMS FOR LAND COVER CLASSIFICATION OF IKONOS IMAGERY

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ABSTRACT

The opportunity to use high spatial resolution satellite images allows remote sensing scientists to experiment several approaches in order to generate always best classification results and final thematic maps. At present, it is not yet defined, among classification methods and available satellite data, which are the best ones to create an enough accurate land cover map and, above all, no automatic processing method has been proved to be so reliable. From this point of view machine learning algorithms seems to be really interesting respect to traditional methods and remote sensing literature of the last 5 years refers high quality in the achieved results and advantages in terms of costs. Satellite platforms like IKONOS and Quickbird provide lots of information in spectral and spatial context, and machine learning algorithms have the capability to take advantage of both components. The method combines results coming from a standard supervised classification based on pixel spectral characteristics with a second process in which spatial information of each class is involved to refine result.

In this study the first results obtained exploring *Foveal Vision* technique on IKONOS multispectral data are illustrated.

METHODOLOGY

The information contained in high resolution satellite data allows to discriminate a high number of features in the same acquired scene. Moreover, this allows a general increase of internal variability of identifiable land use classes and thus a decrease of accuracy level when using automatic per-pixel classification techniques.

Machine learning algorithm, a valid alternative at using the only intrinsic information, automatically develops a model which correlates a-priori known information (spectral, spatial , temporal and ancillary) to targets of interest, and this allows afterwards, recognizing of all the features within the area as well as the deletion of errors.

With this goal, this work group carried out several classification trials on satellite data acquired by different high resolution sensors, in order to evaluate if the method could be successful over one or more kind of data, and how much. First exploitation was made on IKONOS multispectral data, 4 m resolution and, in particular, on the area close to Bari airport, extended 25 square kilometers. The used scene was acquired on 12 of May 2000. In Fig. 1 the scene is shown in true color composite (RGB 321).

The particular localization of the study area (Bari Palese airport) has steering analysis into recognition and extraction of artificial surfaces (roads and asphalt surfaces).

Fig. 1 : IKONOS Multispectral, RGB 321

(provided by Planetek Italia)

The method belongs to neural networks groups and it also works with a preliminary objects recognition, in order to train the calculation system. Learning agents recognize attributes till now accessible only to human photo interpretation such as Shape, Association, Pattern and Shadow.
Starting phase of machine learning method, is similar to the supervised classification one.
Thus, training areas were selected for each chosen class of land cover, in order to "train" the system.
In order to follow the main goal of recognizing artificial surfaces (roads and asphalt surfaces) , 6 land cover classes were selected because significant for the study area and suitable to enlighten heterogeneous classes of interest :

- Vegetation
- Built-up areas
- Agricultural areas
- Bare soils
- Roads and asphalt surfaces
- Water.

The advantage of hierarchic method resides on the opportunity to improve first obtained results. In fact, you can operate on the first processing results, identifying objects correctly classified , incorrect (*clutters*) and "missing".

Flow chart in Fig. 2 explain the carried out steps in the hierarchic classification. In this way it is possible , performing more iterations on the basis of several objectives (classes to distinguish, spectral and geometric content of data , study area and its complexity etc.), the result is more and more improved.

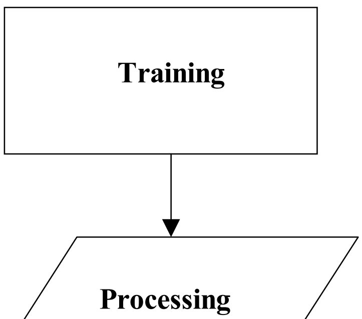


Fig. 2 Hierarchic classification

RESULTS

After 15 iterations, an interesting result was reached (Fig. 3). This invited to make further observations, and a validation "on field" .

To calculate the accuracy of the map, a field work was done on 6 different points included in the study area. All these points are located in main crossroads.

The field work allowed to observe classes around the crossroad. For each point , digital photography are also available.

In Table 1 the analysis on the 6 observation points and 18 validation points are shown, with related correspondence or not with respect to the map. To each correspondence, a percentage weight of 5, 55% is assigned.

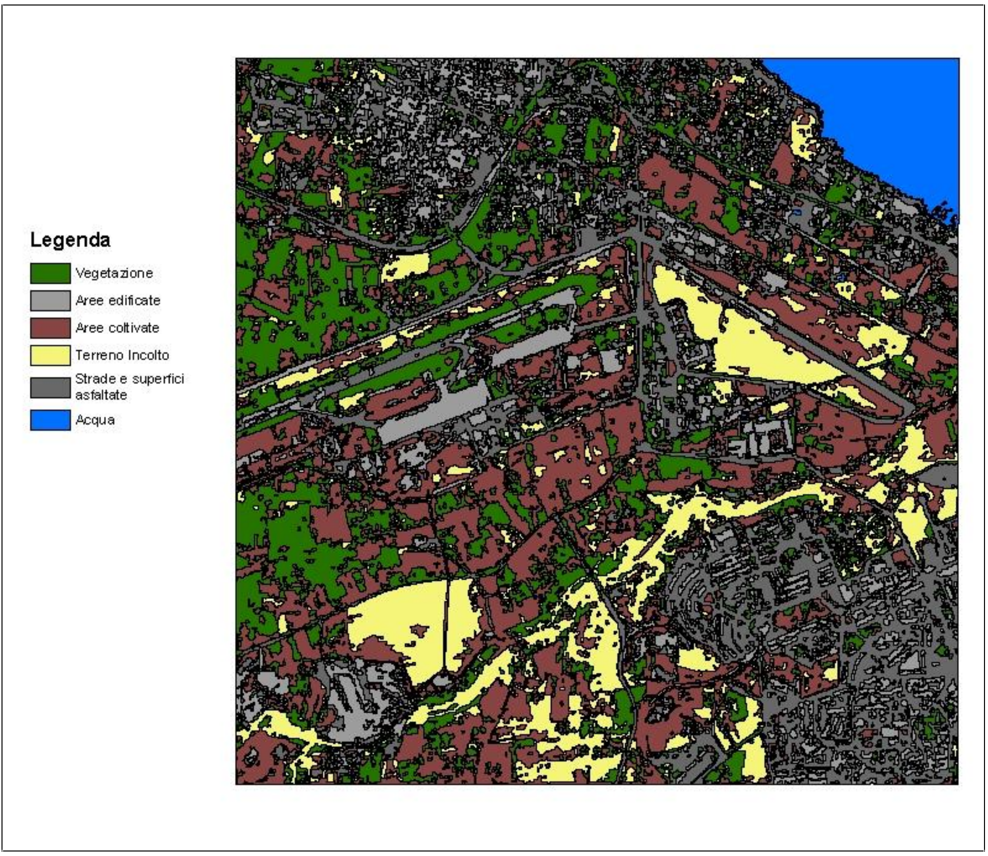
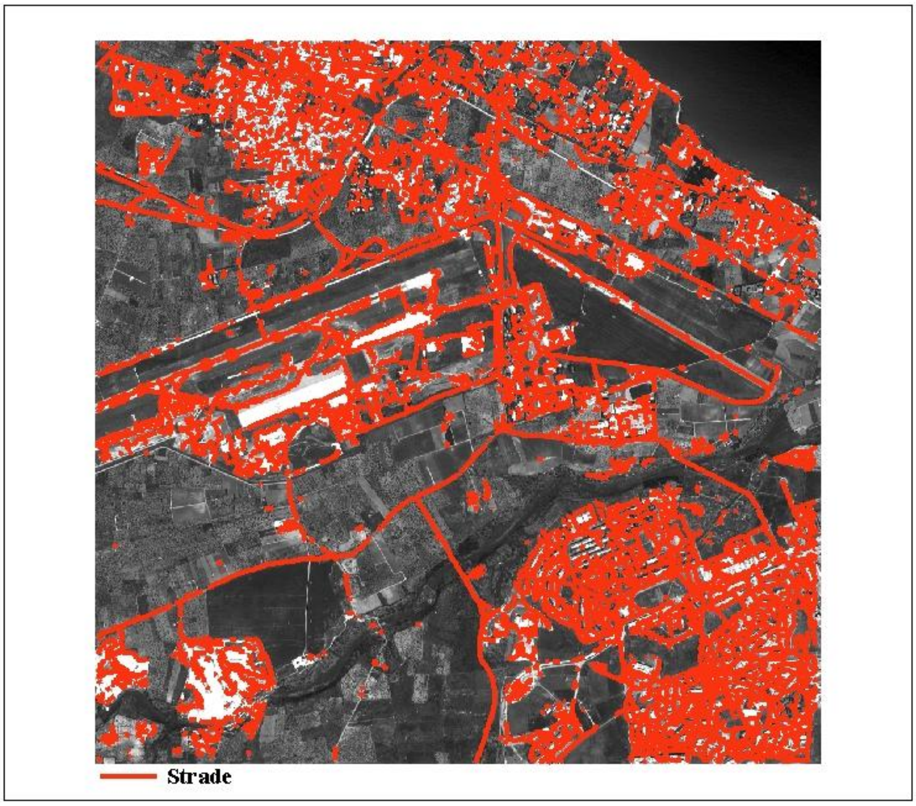


Fig. 3 Land cover map obtained by hierarchic method

Point name	**Observation on the left**	**Observation on the right**	**Observation in the point**	**Correspondence on the map**
1 (Oil factory)	Olive yard	Built-up area (Oil factory)	Road	No/yes/yes
2 (Crossroad s.p. 156 s.p. 210)	Crops	Olive yard	Road	No/No/yes
3 Viale Europa, vicinanze Pal. Finanza	Built-up area	Bare area / Vegetation	Road	yes/yes/yes
4 Capo Scardicchio Viale delle Regioni	Bare area	Bare area	Road	yes/yes/yes
5 Strada da Ponte , Passaggio a livello FS	Crops	Built-up area (soccer fields)	Road	yes/yes/yes
6 Crossroad Cola di Cagno Complanare 16 BIS	Crops	Built-up area	Road	yes/yes/No

Table 1 – Validation points



a)

b)

Fig. 4 Classification of road map from IKONOS (a) and a technical cartography 1:5000 (b) of study area.

The map accuracy is resulted of 14 check points on 18 observation points (77,77%). On the point n. 2 the area results cultivated since one year, whilst in the past it was a waste land. Afterwards the map accuracy really was above 77,77%. The class Road and asphalted surface demonstrated the best results. The procedure adopted produced the typical input for a database GIS: a set of spatial entities with attributes. In fact, the software used (Feature Analyst) allowed to extract the class Road and asphalted surface and the next transformation from polygon to lines. In this way it was possible to compare the result with technical cartography at the scale of 1:5000 (date year 2004) by means of visualization Figure 4 shows the road network superimposed on IKONOS Panchromatic data and the equivalent road network deduced from the technical cartography.

CONCLUSIONS

The first results on hierarchical method experimentation were interesting and satisfactory, even if only generic classis were considered in this study.

The possibility to iterate the processing phase many times, in order to improve the accuracy of these first results, lead us to carry on the test on this method. The workshop is going to carry on analyses on the IKONOS data and to extend them to data acquired by other VHR satellite imagery (QuickBird, Spot5, etc.) on the same area. In this way the quality and the utility of such data in cartographic elements extraction will be compared.

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