COMPLETELY AUTOMATIC CLASSIFICATION OF SATELLITE MULTI-SPECTRAL IMAGERY FOR THE PRODUCTION OF LAND COVER MAPS

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ABSTRACT

One of the primary methods for updating land cover and land use maps has been, and in some case still is, through human observation and interpretation. In this process, the full range of human interpretation capabilities can be employed, including the interpreter's own knowledge of the area. However, this technique is time consuming, subject to errors of omission, and subject to the interpreter's abilities. In particular, this approach cannot be standardized and therefore lacks uniform outputs.

In last decade significant effort has been dedicated to the design of semi-automatic supervised techniques such as artificial neural networks and support vector machines, capable of reducing the manual acting on the image in favor of a more automated approach [1]. However, the selection of a suitable training set that represents all of the different types of surfaces is still mandatory for the success of the classification process. Moreover, the generation of an appropriate training set is usually a difficult and expensive task which again requires manual (and often non-uniform, depending on the image analyst's experience) interaction. Finally in most cases the selected training set is effective only for the primitive image and cannot be used for other images, even if they are taken over the same site but at a different time. In a time when, due to the already planned and forthcoming space missions, the number of available satellite images is increasing ever and ever, a processing methodology that, even partially, relies on the action of an operator seems be inadequate.

In this paper we try to pursue the ambitious goal of designing a completely automatic (no human intervention) supervised scheme for the classification, in terms of land-cover, of a multi-spectral image. The procedure exploits an off-line expert system which supplies most of the actions generally carried out by human interpretation. In particular the whole scheme can be divided into two phases. The first phase is dedicated to the extraction from the image of a statistically meaningful number of pixels representative of the land cover classes present in the image [2][3]. This is the phase where the expert system plays a crucial role. In the second phase the training set and the validation set automatically generated in the first phase are used for the learning of a neural network algorithm. The training phase of the neural net is automatically stopped when the error on the validation set starts to increase [4]. In the first phase, to extract and label the significant pixels the expert system uses three main types of features: spectral features, textural features and geographic features. The spectral features are based on Tasseled Cap transformation [5], the textural ones are based on the Gray Level Co-occurrence Matrix [6][7] while the geographic feature are derived from the image headers as we are assuming that the image basic geographic information are available [8]. These features are compared with those already stored in the expert system which returns with which probability the analyzed pixel is representative of one land cover class. The number and the detail of the considered classes have been established on the base of the CORINE level two standards.

The methodology has been assessed on a dataset consisting of about 20 LANDSAT TM/ETM+ images, acquired on urban areas belonging to very different countries in the world such as Australia, Austria, China, France, Germany, Italy, Mexico, Netherlands, U.S.A., U.K. To quantitatively prove the efficiency of this methodology with respect to the currently most advanced automatic approaches, the overall accuracies and the relative confusion matrices for different images were computed and critically analyzed.

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