MULTISPECTRAL CLASSIFICATION OF REMOTE SENSING IMAGERY FOR ARCHAEOLOGICAL LAND USE ANALYSIS: PROSPECTIVE STUDY

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ABSTRACT

Much of human history can be traced through the impacts of human actions upon the environment. The use of remote sensing technology offers the archeologist the opportunity to detect these impacts which are often invisible to the naked eye. The extraction of remote sensing signatures from a particular geographical region allows the generation of geophysical signature maps; this can be achieved using an accurate and recently developed multispectral image classification approach based on pixel statistics for the class description, which is referred to as the Weighted Pixel Statistics method. This paper presents the prospective study of the effectiveness that this approach provides for supervised segmentation and classification of sensed archaeological signatures for land use analysis. The results obtained with this study uses real multispectral scenes obtained with remote sensing techniques (synthetic aperture radar with high-resolution) to probe the efficiency of the classification technique.

I. INTRODUCTION

Considerable progress has been made generally in the application of remote sensing (RS) techniques to both research and operational problems for urban assessment/planning and natural resource management. Modern applied theory of signal and image processing for land cover and land use analysis is now a mature and well developed research field, presented and detailed in many works ([1] thru [4] and the references therein are only some indicative examples). Although the existing theory offers a manifold of statistical techniques to tackle with the particular geophysical monitoring problems, in many applications areas there still remain some unresolved crucial theoretical and data processing problems. One of them is particularly related to the extraction of physical characteristics for applications in archaeological land use analysis.

Modern digital signal and image processing techniques are currently used by archaeologist to detect the impacts of human actions upon the environment. This information can be used to address issues in human settlement, environmental interaction, and climate change [5]. Archeologists want to know how ancient people successfully adapted to their environment and what factors may have led to their collapse or disappearance. Remote sensing can be used as a methodological procedure for detecting, inventorying, and prioritizing surface and shallow-depth archeological information in a rapid, accurate, and quantified manner [6].

The application of an accurate tool recently developed in [7] for supervised segmentation, classification and quantification of the sensed archaeological signatures (SAS) using multispectral remote sensing (MRS) imagery for land use analysis is based on the analysis of pixel statistics, and is referred to as the weighted pixel statistics (WPS) method.

II. WEIGHTED PIXEL STATISTICS METHOD

The weighted pixel statistics (WPS) classification rule is computationally simple. An extensive study was performed in [7] to probe that the accuracy obtained with this classification process is more efficient (both qualitatively and quantitatively) compared with other more computationally intensive algorithm (as the weighted order statistics method [4]). It is characterized by the mean and variance values of the sensed archaeological signatures (SAS) to be classified (defined as classes) and the Euclidean distances based on the Pythagorean Theorem.

Fig. 4. Original MRS Image for the second scene.

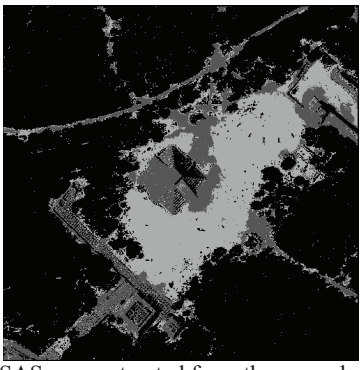

Fig. 5. SAS map extracted from the second scene for archaeological land cover analysis.

III. SAS SIMULATION EXPERIMENT

In the reported here preliminary simulation results, a SAS electronic map is extracted from the MRS high-resolution image using the WPS method. Three level SAS are selected for this particular simulation process, moreover, unclassified zones must be also considered (2-bit classification) as

– SAS relative to natural land cover zones of the MRS.
– SAS relative to archaeological land zones of the MRS.
– SAS relative to modern land use zones of the MRS.
– Unclassified zones of the SAS map.

Figure 1 shows the scene: MRS high-resolution *1024x1024*-pixels RGB image in TIFF format borrowed from the real-world [8] corresponding to the Temple of Kukulkan from the pre-Hispanic city of Chichen-Itza located in the state of Yucatan, Mexico. Figure 2 shows the SAS map extracted from Figure 1 and obtained applying the WPS method for the adopted ordered weight vector. The WPS method employs the three RGB bands from the original image; therefore, using the statistical pixel-based information the SAS map obtained shows a high-accurate classification without unclassified zones.

IV. CONCLUDING REMARKS

From the simulation results one may deduce that the applied WPS classifier provides a high-accurate classification without unclassified zones because it uses more robust information in the processing (several image spectral bands). The reported here simulation results shows the qualitative analysis of the overall performance of the WPS method for land use analysis as an auxiliary tool in archaeological information retrieval. The quantitative analysis and data interpretation are a matter of further studies.

REFERENCES

[1] S.W. Perry, H.S. Wong, and L. Guan, *Adaptive Image Processing: A Computational Intelligence Perspective*, CRC Press, U.S.A., 2002.

[2] R. Porter, D. Eads, D. Hush, and J. Theiler, "Weighted order statistics classifiers with large rank-order margin", in *Proceedings of the 20th International Conference on Machine Learning*, Washington U.S.A., 2003.

[3] P.M. Mather, *Computer Processing of Remotely-Sensed Images,* John Wiley & Sons, U.S.A., 2004.

[4] Y. Shkvarko, and I. Villalon-Turrubiates, "Remote sensing imagery and signature fields reconstruction via aggregation of robust regularization with neural computing", in *Advanced Concepts for Intelligent Vision Systems*, J. Blanc-Talon, W. Philips, D. Popescu and P. Scheunders, Springer-Verlag, Germany, pp. 865-876, 2007.

[5] R. Williamson, "Remote Sensing Methods", *Advances in Science and Technology for Historic Preservation*, Plenum Press, U.S.A., 2008.

[6] F. Miller, and D. Lee, "Applications of Ecological Concepts and Remote Sensing Technologies in Archeological Site Reconnaissance", *Applications of Space-Age Technology in Anthropology*, C. Behrens, and T. Sever, NASA Press, U.S.A., 1991.

[7] I.E. Villalon-Turrubiates, "Weighted Pixel Statistics for Multispectral Image Classification of Remote Sensing Signatures: Performance Study", *Proceedings of the 5rd IEEE International Conference on Electrical Engineering, Computing Science and Automatic Control (CCE),* Mexico City, pp. 534-539, 2008.

[8] GeoEye – *Innovative Geospatial Products and Solutions*, http://www.geoeye.com, 2009.