DYNAMICAL PROCESSING OF GEOPHYSICAL SIGNATURES BASED ON REMOTE SENSING DATA FROM SPOT 5 SATELLITE

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ABSTRACT

An intelligent post-processing computational paradigm based on the use of dynamical filtering techniques modified to enhance the quality of reconstruction of geophysical signatures extracted from remote sensing imagery based on the Spot 5 satellite is proposed. As a matter of particular study, a robust algorithm is reported for the analysis of the dynamic behavior of geophysical indexes extracted from the real-world remotely sensed scenes. The simulation results verify the efficiency of the approach as required for decision support in resources management.

I. INTRODUCTION

Intelligent post-processing of the environmental monitoring data is now a mature and well developed research field, presented and detailed in many works (see for example, recent studies [1] thru [9] and the references therein). Although the existing methods offer a manifold of efficient statistical and descriptive regularization techniques to tackle with the particular environmental monitoring problems, in many application areas there still remain some unresolved theoretical and data processing problems related particularly to the extraction and analysis of the dynamical behavior of geophysical characteristics for decision support applications. In particular, the crucial data processing aspect is how to incorporate a geophysical remote sensing signatures (GRSS) extraction method with a robust dynamic analysis technique for evaluation and prediction of the behavior of the particular index monitored in environmental processes. A robust filtering method is verified via computational simulations, which provides the possibility to track, filter and predict the dynamical behavior of the GRSS extracted from remote sensing (RS) Spot 5 scenes provided with the use of the recently developed Weighted Pixel Statistics (WPS) method [9]. The proposed methodology aggregates the WPS method with the robustified dynamic filtering technique recently developed [3] via the Hydrological Dynamics method (HDM). In the simulations, the process is tested with the use of Spot 5 imagery. This study intends to show the foundations in understanding the basic theoretical and computational aspects of how to aggregate the end-user-oriented intelligent post-processing of GRSS hydrological electronic maps with the dynamic filtering paradigm (via HDM) for intelligent analysis of the dynamical behavior of the remotely monitored scenes.

II. DYNAMICAL HDM COMPUTING

The crucial issue in application of the modern dynamic filter theory to the problem of reconstruction of the desired GRSS in evolution time is related to modeling of the RS as a random field that satisfies some dynamical state equation. Following the typical linear assumptions for the development of the GRSS in evolution time [8] its dynamical model can be represented by a stochastic differential state equation of the first order $\frac{d\mathbf{z}(t)}{dt} = \mathbf{F}\mathbf{z}(t) + \mathbf{G}\xi(t)$, $\mathbf{\Lambda}(t) = \mathbf{C}\mathbf{z}(t)$, where $\mathbf{z}(t)$ is the so-called model state vector, $\mathbf{C}$ defines a linear operator that introduces the relationship between the RSS and the state vector $\mathbf{z}(t)$, and $\xi(t)$ represents the white model generation noise vector. The dynamic model equation that states the relationship between $\mathbf{B}(t)$ and the desired RSS map $\mathbf{\Lambda}(t)$ can now be represented [8] as $\hat{\mathbf{B}}(t) = \mathbf{H}(t)\mathbf{z}(t) + \mathbf{v}(t)$, $\mathbf{H}(t) = \mathbf{L}\mathbf{C}(t)$, where $\mathbf{L}$ is the linearized approximation to the inverse of the RSS operator.

Fig. 1. Original high resolution MRS image.

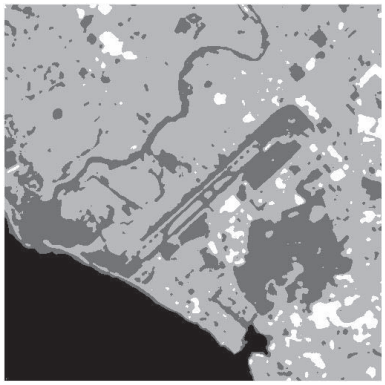

Fig. 2. RSS hydrological map extracted with WPS.

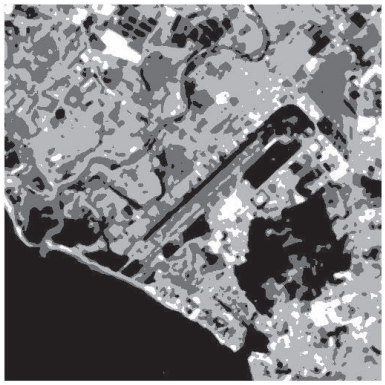

Fig. 3. Dynamic RSS hydrological map obtained with HDM.

III. SIMULATIONS

A hydrological GRSS electronic map is extracted from the Spot 5 image using the WPS methods. Three level RSS are selected for this particular simulation process, moreover, unclassified zones must be also considered as

– RSS relative to the wet zones of the image.
– RSS relative to the humid zones of the image.
– RSS relative to the dry zones of the image.
– Unclassified zones of the GRSS map.

Fig. 1 shows the MRS high-resolution *1024x1024*-pixels RGB image in TIFF format borrowed from SPOT 5 Imagery corresponding to the Banderas Bay in the city of Puerto Vallarta in Mexico. Fig. 2 shows the hydrological RSS map obtained applying the WPS method for the adopted ordered weight vector. Fig. 3 shows the results of the dynamical analysis obtained after the processing of 40 hydrological RSS maps with the application of the HDM algorithm.

IV. CONCLUDING REMARKS

The dynamical approach for solving the nonlinear inverse problems of high-resolution dynamical reconstruction of the GRSS of the Spot 5 scenes is presented via processing the finite-dimensional space-time measurements of the available sensor data. The dynamical GRSS post-processing scheme reveals some possible approach toward a new dynamic computational paradigm for high-resolution fused numerical reconstruction and filtration of different GRSS maps.

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