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Multifractal analysis of the optical remote sensing imagery

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Multifractal formalism creates great opportunities to describe and extract information from various types of data, including remote sensing images. The multifractal approach is based on the assumption that to describe the heterogeneity of data it is necessary to use the group of non-trivially mixed fractals, each with a different dimension of self-similarity. Moreover, multifractal analysis can be connected with many functional characteristics and quantitative parameters, the utility of which in the context of remote sensing data analysis has not been fully researched so far.

Therefore, the aim of our study is to verify the usefulness of multifractal parameters as global characteristics of optical remote sensing imagery, both in the context of their processing and analysis. In particular, we perform systematic studies devoted to: (I) the classification of fragments of satellite images from WorldView-2 and EROS-A carried out using multifractal parameters and machine learning methods; (II) the comparison of multifractal features with widely used textural parameters; (III) the verification weather high-pass and low-pass image filtering, preceding fractal and multifractal features calculations may improve the accuracy of classification. In general, the analysis applied to the tasks of hyperspectral data structure learning, optical imageries change detection and contextual analysis of terrain complexity show the potential and should be the subject for further investigation. The results proved the superiority of multifractals as global image descriptors in comparison to fractals. What's more, multifractal parameters used together with histogram-based features allow to achieve a high classification accuracy. In addition, the separation of four basic land cover classes (water, urban areas, forests, and agriculture) can be improved by the use of the Sigma filter and median filter before the calculation of multifractal features.

We hope that our studies will help to develop approaches relevant to remote sensing data analysis and other disciplines related to image processing.

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