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Original article

Kriging-based subdivision schemes: Application to the reconstruction of non-regular environmental data

Jean Baccou [a], Jacques Liandrat [b,*]

[a] *IRSN, Centre de Cadarache, 13115 Saint Paul-Lez-Durance, France*
[b] *Centrale Marseille and LATP, Technopôle de Château-Gombert, 13451 Marseille Cedex 20, France*

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Abstract

This work is devoted to the construction of new kriging-based interpolating position-dependent subdivision schemes for data reconstruction. Their originality stands in the coupling of the underlying multi-scale framework associated to subdivision schemes with kriging theory. Thanks to an efficient stencil selection, they allow to cope the problem of non-regular data prediction while keeping the interesting properties of kriging operators for the quantification of prediction errors. The proposed subdivision schemes are fully analyzed and an application to the reconstruction of non-regular environmental data is given as well.

Keywords: Kriging; Subdivision scheme; Non-regular data prediction

1. Introduction

Data modeling methods play a key role in the treatment of environmental problems. The information about the phenomenon under study is often discrete since it is provided by experimental measurements or numerical processing and therefore, modeling (or prediction) is required. Among data modeling methods, stochastic kriging-based approaches [7] are often used. Their main advantages compared to deterministic methods stand in the possibility to quantify the precision of the prediction thanks to an underlying probabilistic model. However, these methods usually assume that the phenomenon to predict is regular, which is not the case in practice such as in risk analysis where reliable reconstruction methods are crucial for the decision-making process. This paper is therefore devoted to the design of new stochastic modeling methods that improve the accuracy of the reconstruction of non-regular data. Contrary to classical approaches, their construction will be performed in two steps: a segmentation of data into different zones and a local kriging-based data prediction according to the information coming from the previous step. Taking apart the problem of data segmentation that refers to the wide literature of edge detector, we focus in the sequel on the construction of a new kriging-based subdivision scheme [8] for data prediction integrating local strategy according to the segmentation. Our work is organized as follows: Section 2 deals with the construction of our new subdivision schemes. Convergence results are provided in Section 3. Section 4 is devoted to applications to synthetic or real data.

* Corresponding author.
E-mail addresses: jean.baccou@irsn.fr (J. Baccou), jliandrat@ec-marseille.fr, jacques.liandrat@ec-marseille.fr (J. Liandrat).

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