On estimating errors for gradient approximations in surface interpolation

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Surface interpolation finds application in many aspects of science and technology. Two specific application areas of interest to the authors are surface reconstruction techniques for research in plant architecture and gradient approximations for accurate discrete flux decomposition in finite volume strategies for solving partial differential equations. An important requirement of both applications is the ability to approximate local gradient information accurately. In surface reconstruction, local gradient information is used to generate a surface interpolant with a continuously turning surface normal via the notion of Clough-Tocher bases, while in the finite volume framework second order gradient information is necessary to ensure the spatial accuracy of the entire discretisation method retains second order.

This work sees an investigation of the use of least squares methods to approximate the required gradients. Two slightly different approaches are investigated and the error incurred by each method is identified. In particular, the relationship between the methods is elucidated and the more accurate approach distinguished. Carefully chosen case studies highlight the accuracy of the chosen techniques and the validity of the error bounds.