PhD-Project title:

Multivariate Daubechies-type wavelets and PDE-Methods in Image Processing and Geometric Modeling

Principal Investigator:

Dr. Hermann Render (University College Dublin)

Project Abstract:

This PhD-project focuses on new mathematical techniques in the area of wavelet analysis, image processing and geometric modeling and their applications. The approach depends on a new data concept in these areas which is motivated by techniques for solving boundary value problems for elliptic operators in PDE, see e.g. [6].

The main aim is the construction of new multivariate Daubechies-type wavelets and applications to image processing which has been investigated by our research group for the case of parallel hyperplanes, see [2,3]. In this project the applicant has to modify these results for the case of concentric spheres which requires a deeper understanding of spherical harmonics. A further topic is the connection to new multivariate subdivision schemes based on polyharmonic interpolation on concentric spheres.

The applicant may profit from an established cooperation of the principal investigator with leading experts in Subdivision Schemes and Geometric Modeling (Prof. N. Dyn and Prof. D. Levin (University of Tel Aviv, Israel) and Prof. O. Kounchev (Bulgarian Academy of Sciences).

Required knowledge: Solid background in Real and Complex Analysis, Functional Analysis and Partial Differential Equations. Basic knowledge in wavelet analysis will be helpful. For first reading we recommend:

(1) I. Daubechies, *Ten lectures on wavelets*, SIAM, Philadelphia 1992.
(2) N. Dyn, O. Kounchev, D. Levin, H. Render, *Non-stationary Daubechies type wavelets for exponential polynomials and their regularity,* Applied Comp. Harm. Analysis 37 (2014), pp.288-306
(3) N. Dyn, O. Kounchev, D. Levin, H. Render, *Polyharmonic interpolation and subdivision schemes,* in progress.
(4) N. Dyn, D. Levin, A. Luzzatto, *Exponentials reproducing subdivision scheme*, Found. Comput. Math. 3 (2003), 187–206.
(5) N. Dyn, D. Levin, *Subdivision schemes in geometric modelling*, Acta Numerica (2002). pp. $73 - 144$.
(6) O. Kounchev, *Multivariate polysplines: Applications to Numerical and Wavelet Analysis,* Academic Press, San Diego-London, 2001.
(7) O. Kounchev, H. Render, *Cardinal interpolation with polysplines on annuli,* J. Approx. Theory, 137 (2005), 89–107.