Institut für Geometrie

Johannes Wallner
Univ.-Prof.

Kopernikusgasse 24
A-8010 Graz

Tel +43(0)316 873-8440
Fax +43(0)316 873-8448

j.wallner@tugraz.at
http://www.geometrie.tugraz.at/wallner

DVR: 008 1833 UID: ATU 574 77 929

To:
Hungarian Academy of Sciences
c/o László Amand Palkovics

Nádor utca 7
H-1051 Budapest

Graz, December 22, 2015

Review, dissertation by Miklos Hoffmann (Ref. number 58.092/5/2014)

Dear colleagues,

it is a pleasure to give a review of the cumulative doctoral thesis "New methods in computer aided modelling of curves and surfaces" which has been submitted by Miklos Hoffmann to the Hungarian Academy of Sciences.

This thesis represents the author's work which has been previously published in an impressive number of papers in refereed international journals. It covers three areas which are sections of the thesis: *Knot modification of B-spline and NURBS curves and surfaces* (correspondong to 7 publications), *new curve types and their properties* (6 publications), and non-control-point-based methods (7 publications). This work spans the period from 1998, which is the year of Miklos Hoffmann's Ph.D., to 2014. Most publications have coauthors, of which there are eight in total, the most frequent one being Imre Juhasz of the University of Miskolc.

In this case it is easy for the reviewer to answer the question which parts of the dissertation can be clasified as new scientific results: All individual publications have undergone peer-reviewing in the usual way and therefore have been new scientific results at their time of publication. Since the field of spline curves and surfaces during the height of its bloom has produced a great many results, I must honestly admit that without this convenient fact my reviewing task would have been considerably more difficult.

In order to describe the contents of Miklos Hoffmann's dissertation, let me start with the first section on B-splines and NURBS (i.e., non-uniform rational B-splines). These terms refer to a certain construction of piecewise-polynomial and piecewise-rational spaces of smooth functions, and a distinguished basis of these spaces which is used to construct curves and surfaces by linear combination. The *knots* occuring in the title of this section denote interval boundaries. Miklos Hoffmann in a series of papers studied the effects which a change of knots has on geometric modeling. Since these effects are nonlinear, it is not straightforward to utilize the degrees of freedom inherent in the knots in geometric design.

The second chapter contains work on generalizations of the concept of B-spline. For the purposes of geometric modeling, the usual spaces of polynomial splines, with their canonical B-spline basis, can be replaced by any space enjoying the relevant properties (like approximation power) and any basis which supports geometric modeling (e.g., via the variation-diminishing property), which is practical (e.g., via the subdivision property) and last, but not least, has good numerical propeties. The interest in generalizations is not purely mathematical, but also originates in the desire to be able to exactly represent important objects of geometric modeling. For this reason spline spaces involving trigonometric functions were among the first to be proposed. In a series of papers, Miklos Hoffmann studied in detail the shapes and shape parameters of curves generated by several such constructions.

The third chapter of this thesis is concerned with topics of geometric modeling which go beyond the usual definition of spline curves and surfaces by basis and control points (the control points are the coefficients in a linear combination which produces that curve or surface). One is to use neural networks for the "parameter assigment" preprocessing step which is necessary to convert a geometric approximation problem into a nicely solvable L^2 approximation problem. Another topic is to apply the tools developed for geometric modeling in the affine space of oriented spheres. Here the abstract geometric modeling is not difficult, but the interpretation of the results in ordinary Euclidean space requires additional thought. Section 3.2. in particular describes the implementation developed by Miklos Hoffmann to enable the practical use of modeling with spheres.

There is no doubt at all that this dissertation, which represents a significant part of Miklos Hoffmann's scientific work, is indeed authentic, does substantially enrich and contribute the development of the discipline, and is therefore eligible for public debate.

Sincerely,

Johannes Wallner