DOCTORAL CANDIDATE:	Oliver Joseph David Barrowclough
DEGREE:	Philosophiae Doctor
FACULTY:	Faculty of Mathematics and Natural Sciences
DEPARTMENT:	Department of Informatics
AREA OF EXPERTISE:	Computer aided geometric design
SUPERVISORS:	Tor Dokken, Knut Mørken
DATE OF DISPUTATION:	18th March 2013

DISSERTATION TITLE: *Approximate methods for change of representation and their applications in CAGD*

Denne avhandlingen undersøker metoder i geometrisk modellering og dataassistert konstruksjon (CAD). Hovedmålet for oppgaven er å utvikle metoder som kan brukes til å forandre matematiske representasjoner av kurver og flater. Metodene utvider eksisterende algoritmer for å oppnå bedre hastighet og mer nøyaktige approksimasjoner. Industrielle anvendelser av algoritmene inkluderer både robotikk, datagrafikk og animasjon.

In modern computer aided design (CAD) systems there are two main representations of curves and surfaces: parametric and implicit representations. The two representations complement each other in the sense that their properties can be used to solve different geometric problems. Parametric curves are well suited to point generation, whereas implicit representations efficiently determine whether or not a point lies on a curve or surface. The availability of both representations is of great advantage in answering geometric queries, such as intersection and trimming problems. Methods for change of representation are thus of great practical importance.

In this thesis we study several methods for implicitization: the process of changing from the parametric to the implicit representation. The emphasis is on developing methods which are numerically stable and computationally efficient on modern hardware. We first present a variety of approaches to approximate implicitization and study the connections between them. In particular, we introduce algorithms for approximate implicitization using orthogonal polynomials, which exhibit strong approximation behaviour. Although the main application of the algorithms is for rational parametric representations, we also explore the possibility of efficient implicitization of envelopes - a type of curve or surface which often has no simple parametric representation.

In the final part of the thesis we introduce a new basis for generating implicit representations of rational cubic Bézier curves. The method exhibits a good level of numerical stability and the coefficients are invariant under affine transformations. Finally, simple formulas for detecting the location and nature of the curve singularity are presented.