Robust generation of constrained B-spline curves based on automatic differentiation and fairness optimization. (English) Zbl 1381.65011


Summary: This paper details the use of automatic differentiation in form parameter driven curve design by constrained optimization. Computer aided design, computer aided engineering (CAD/CAE), and particularly computer aided ship hull design (CASHD) are typically implemented as interactive processes in which the user obtains desired shapes by manipulation of control vertices. A fair amount of trial and error is needed to achieve the desired properties. In the variational form parameter approach taken here, the system computes vertices so that the resulting curve meets the specifications and is optimized with respect to a fairness criteria. Implementation of curve design as an optimization problem requires extensive derivative calculations. The paper illustrates how the programming burden can be eased through the use of automatic differentiation techniques. A variational curve design framework has been implemented in Python, and applications to CASHD curve design are shown. The new method is robust and allows great flexibility in the selection of constraints. Offsets, tangents, and curvature may be imposed anywhere along the curve. Form parameters may also be used to define straight segments within a curve, require the curve to enclose specified forms, or specify relationships between curve properties.

MSC:
65D17 Computer-aided design (modeling of curves and surfaces)
65D07 Numerical computation using splines
65D25 Numerical differentiation

Keywords:
form parameter design; fairness optimization; automatic differentiation; B-spline; Python; curve design; constrained optimization; computer aided design; computer aided engineering; computer aided ship hull design

Software:
PyCppAD; CasADi; pyadlc; PyADOL-C; Theano; ad; Python; AlgoPy

Full Text: DOI

References: