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Nadim EL HAYEK, Olivier GIBARU, Mohamed DAMAK, Hichem NOUIRA, Nabil ANWER, Eric NYIRI - Fast B-Spline 2D Curve Fitting for unorganized Noisy Datasets - 2014

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Fast B-Spline 2D Curve Fitting for unorganized Noisy Datasets

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Context
1. Optical and Tactile Metrology for Absolute Form Characterization (EURAMET project IND10)
2. Fast polynomial spline curve reconstruction from very large unstructured datasets

Objective
Curve reconstruction of freeform shapes, specifically turbine blades, from data with unknown topology

Objective function
\[
\min_{t_1, t_2, \ldots, t_m} \sum_j \left( (MT_j^m) - \delta_j \right)^2
\]

Discrete B-Spline Convection scheme

Methodology
Coincide new B-Spline curve at iteration (i+1) with data points by minimizing the distances

The B-Spline (green) is initialized by a few control points around the data.

Distances \( \delta_j \) are calculated with geometrical and topological considerations.

 Concavity minimization \( \rightarrow \) translation vectors \( (t_1, t_2, \ldots, t_m) \) by which control points must move.

If the minimization does not meet the error tolerance, point insertion is applied locally.

Experimental results
Invariance to point-set orientation
\( \varepsilon \) = mean of residual errors

Conclusions
1. The B-Spline convection algorithm is founded on discrete computations.
2. The algorithm is robust regarding the relative initial position of both the B-Spline and the data.
3. The algorithm is tested on several shapes and returns residual errors below threshold if not too small.
4. The number of control points must be minimal.
5. The algorithm can be subject to time complexity improvement.
6. Precision is not yet controllably achievable.

Acknowledgement:
The authors sincerely thank the EMRP organization. The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.

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