FROM SURFACE PROFILE TO RESIDUAL STRESS USING THE CONTOUR METHOD

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The contour method has proven to be an elegant residual stress measurement technique, providing 2D stress data for a range of components. However, one of the factors limiting the accuracy of these measurements has been the inability to sufficiently describe the measured surface of the cut component. This problem has been most apparent in samples where sharp, localised, features have been present. The bivariate spline algorithms used previously have often suffered from either under-fitting of sharp features or over-fitting remotely to these features as they relied on a single knot spacing throughout the surface. Often a manual selection has also been required on the best knot spacing for a particular measurement, limiting the reproducibility of the technique.

This work describes the use of a modified bivariate spline algorithm to estimate displacement of surface contours and demonstrates its advantages for measuring residual stresses using the contour method. The raw data is mapped onto a variable grid, where the local densities and locations of vertices are determined by analysing the distribution of the surface contour measurements. A grid fitting algorithm is included to minimise the edge effect commonly seen when the surface contour is extrapolated near the perimeter of the sample and fourier power spectrum analysis allows the optimal number of spline knots to be set by identifying and removing noise from surface measurements.

The effectiveness of the algorithm is demonstrated by comparing its results to those achieved with a uniform knot spacing. The new algorithm performs particularly well when both broad and narrow features are present in the same sample, describing the surface contour reliably while suppress the measurement noise. The use of efficient data analysis methods, such as FFT also allows to the technique to operate with much less CPU time than other fitting algorithms that rely on smoothing optimisation.