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**Title:**

# Optimization of the multiaxial racetrack filter for non-proportional loading histories

**Authors & affiliations:**

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**Abstract:** (Your abstract must use **Normal style** and must fit in this box. Your abstract should be no longer than 300 words. The box will 'expand' over 2 pages as you add text/diagrams into it.)

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1. The title should be as brief as possible but long enough to indicate clearly the nature of the study. Capitalise the first letter of the first word ONLY (place names excluded). No full stop at the end.
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To properly measure a load signal, it is necessary to oversample the digitized data at a rate high enough not to distort the signal. Thus, an important practical issue in multiaxial fatigue analyses is how to filter a load history to decrease their intrinsically high computational cost. Like in the 1D case, it might seem a good idea to first remove from the multiaxial variable amplitude loading (VAL) history all data points that are not peaks or valleys of any of their stress or strain components.

But this simple filtering practice is not recommended in multiaxial analyses, for two reasons: first, the path between two load reversals is needed to evaluate the path-equivalent stress or strain associated with each rainflow count, e.g. using a convex-enclosure method. And second because the reversal points obtained from a multiaxial rainflow algorithm might not occur at the reversal of one of the stress or strain components.

To avoid these issues, some metric, such as the von Mises stress or strain, must be used to evaluate how much a measured multiaxial VAL path deviates from its course. This is needed to avoid filtering out important counting points for multiaxial rainflow algorithms, or significant paths that can affect the calculation of a path-equivalent stress or strain.

In this work, a multiaxial version of the traditional racetrack filter is discussed. While only requiring a single user-defined scalar filter amplitude, this filter is able to eliminate non-damaging events without changing the overall shape of the original multiaxial load path. The filter is optimized through the introduction of a pre-processing "partitioning" operation on the load history data. Oversampled experimental data from tension-torsion experiments in 316L stainless steel tubular specimens under non-proportional (NP) load paths are used to verify the efficiency and robustness of the proposed optimized multiaxial racetrack filter.

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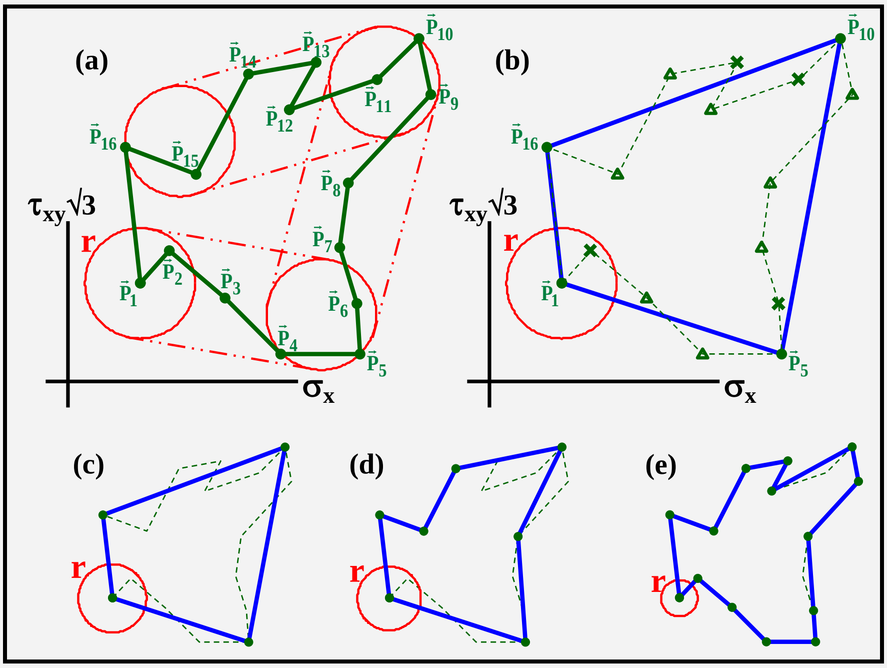


Fig. 1: Multiaxial racetrack filter applied to a tension-torsion history path with 16 points, showing (a) the translating hyper-spheres involved in the algorithm, (b) the static and dynamically filtered points (respectively × and triangles), and the effect of decreasing the filter amplitude r, resulting in histories with (c) four, (d) seven, and (e) fourteen points.

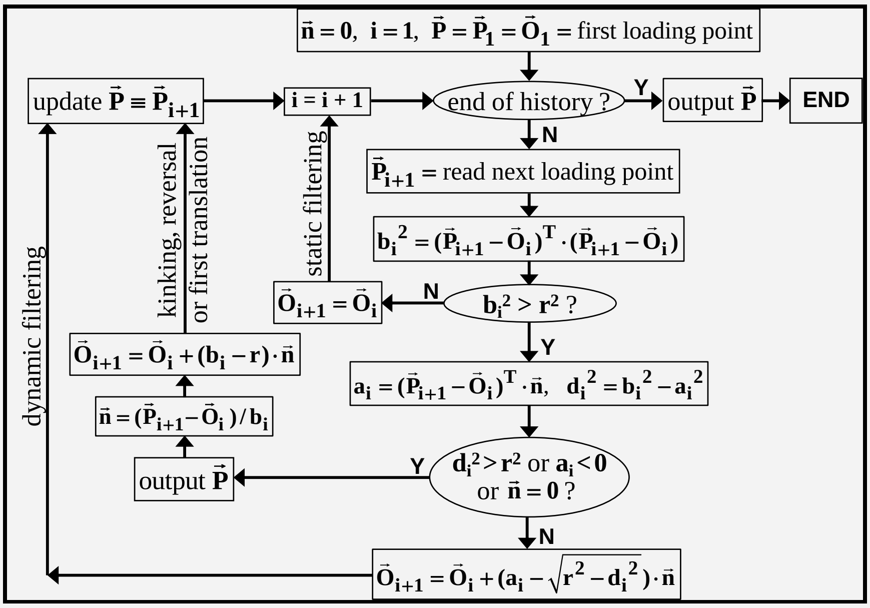


Fig. 2: Multiaxial racetrack algorithm, with the filtered history resulting from the $\vec{P}$ output values, where $\vec{n}$ is the hyper-sphere translation direction.