WashU

Office of Technology Management

COMPUTER-IMPLEMENTED METHOD FOR MEASURING STRAINS

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T-014090

Published date: 1/7/2025

Value Proposition: *Accurate, efficient 2D strain mapping with robust detection of strain localization.*

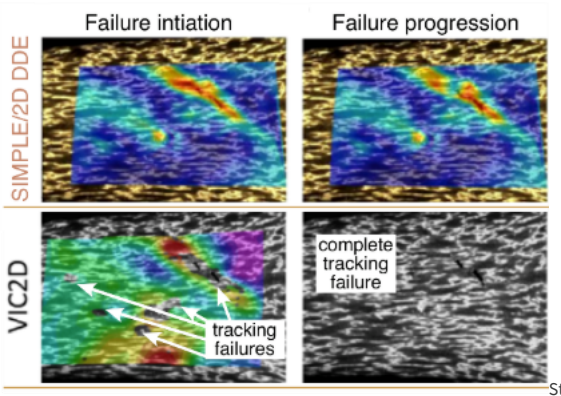
Technology Description

Researchers at Washington University in St. Louis have developed a novel method using 2D Direct Deformation Estimation (2D-DDE) and SIMPLE (Strain Interference with Measures of Probable Local Elevation) to calculate local strain and crack propagation. Tracking deformation and strains is challenging during fractures, when strains are elevated in a localized region, and for large strains experienced in organs, tissues, and cells. Tracking elevated strains from time-resolved imaging and microscopy is a pressing need for the next generation of diagnostic, mechanobiological and civil engineering tools.

Compared to the commercially available VIC-2D, 2D-DDE improves accuracy of local strain estimates when deformation gradient fields are non-linear and can estimate deformation gradient fields directly from warping parameters derived during image registration and therefore does not require strain estimation following image registration. Additionally, a new technique, SIMPLE, determines where strain fields over various domain sizes have high gradients. This gradient detection is a robust detector of strain localization and verifies the reliability of estimates of elevated strain. SIMPLE is also able to continue tracking through fracture and failure.

Stage of Research

The inventors have validated the algorithms by analyzing four different model systems: PDMS scaffold, collagen scaffold, plastic wrap and embryonic wound healing. DDE provided strain analysis that was 10x more accurate and precise than Least Square Fit methods (sensitivity sufficient to differences in strain as small as 0.001). SIMPLE detected strain concentrations on the order of 0.005, long before they were evident using XCOR.



Strain near a material tear is visualized by SIMPLE/2D DDE and VIC-2D. As the tear progresses, SIMPLE/2D DDE successfully tracks the strain concentrations near the developing tear (upper left panel). In contrast, VIC-2D fails to track strain in the vicinity of the tear (lower left panel). As the tear progresses, SIMPLE/2D DDE continues to track strain concentrations near and around the tear (upper right panel). In contrast, VIC-2D fails to track strain anywhere in the sample after the tear becomes large (lower right panel).

Publications

- Boyle, J. J., Kume, M., Wyczalkowski, M. A., Taber, L. A., Pless, R. B., Xia, Y., ... & Thomopoulos, S. (2014). Simple and accurate methods for quantifying deformation, disruption, and development in biological tissues. Journal of the Royal Society Interface, 11(100), 20140685.

Applications

- Strain measurement

Key Advantages

- Improves accuracy of strain estimation by 10% when strain fields are non-linear compared to the commercially available VIC-2D
- Distinguishes noise from the true regions of large strains
- Improves efficiency by removing deformation estimation following image registration
- SIMPLE can robustly identify regions of strain localization which can be tracked during material failure

Patents

System and method for quantifying deformation, disruption, and development in a sample (U.S. Patent No. 10,072,924)

Related Web Links – Guy Genin Profile; Genin Lab