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Automated Registration of Polarized Light Microscopy Images Using Deep Learning Techniques

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Studies have identified a connection between the microtexture regions (MTRs) found in certain titanium alloys and early onset creep fatigue failure of rotating turbomachinery. Microtexture regions are defined by their size and orientation, which can be characterized via scanning electron microscopy (SEM) Electron Backscatter Diffraction (EBSD). However, doing so is impractical at the component-scale. A novel method of characterizing MTRs is needed to qualify new engine components. Researchers in the Air Force Research Lab Materials and Manufacturing Directorate have proposed fusion of two inspection methods (eddy current testing (ECT) and scanning acoustic microscopy (SAM)) to achieve the goal of MTR characterization, which proves to be a significant challenge to minimal literature in the area.

Our research focuses on development of a Convolutional Neural Network (CNN) to automatically register two polarized light microscopy (PLM) images. Polarized light microscopy is a surrogate ground-truth method that provides data similar to EBSD for this inspection scenario. The baseline single-modality CNN will then be adapted to jointly train and register the SAM and ECT images for MTR characterization. The method proposed CNN in this work involves receiving two PLM images as input, one an unaltered copy known as the moving image (i.e., the image to be transformed) and the other an artificially transformed copy known as the fixed image (i.e., reference for image registration). The objective of the CNN is to evaluate the moving image with the fixed image and output parameters to produce an affine transformation matrix that registers both.

Keywords

deep learning, image registration, imaging, convolutional neural networks

Classification

Both methodology and application

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