Automated Sample Extraction and Semantic Segmentation of industrial Charpy V-notch specimens

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In this poster a novel workflow for the automated analysis of Charpy V-notch impact test specimens using semantic segmentation, postprocessing, and pixel-wise evaluation is presented. The workflow begins with the extraction of individual sample bundles, each containing three specimens of one material, sampling position in the weld and same test temperature in one compartment of a sample box. These bundles are identified from digital images of industrial sample boxes, overcoming challenges such as varying lighting and sharpness. With recent advances in machine learning for fractography [1], this work applies semantic segmentation, using a DenseNet backbone, to the extracted sample bundles to evaluate fracture surfaces. The algorithm demonstrates high accuracy in segmenting sample bundles as well as individual samples after postprocessing. Furthermore, pixel-wise evaluation of the segmentation results compared to ground truth evaluations of experts not only offers deeper insights into the algorithm's performance but also reveals potential biases in the segmentation process. This approach bridges the gap between previous work on small-scale, high-resolution specimen imaging and the challenges posed by large-scale, industrial sample processing using lower-resolution images. The findings emphasize the importance of robust evaluation strategies in developing machine learning methods for automated material characterization workflows.

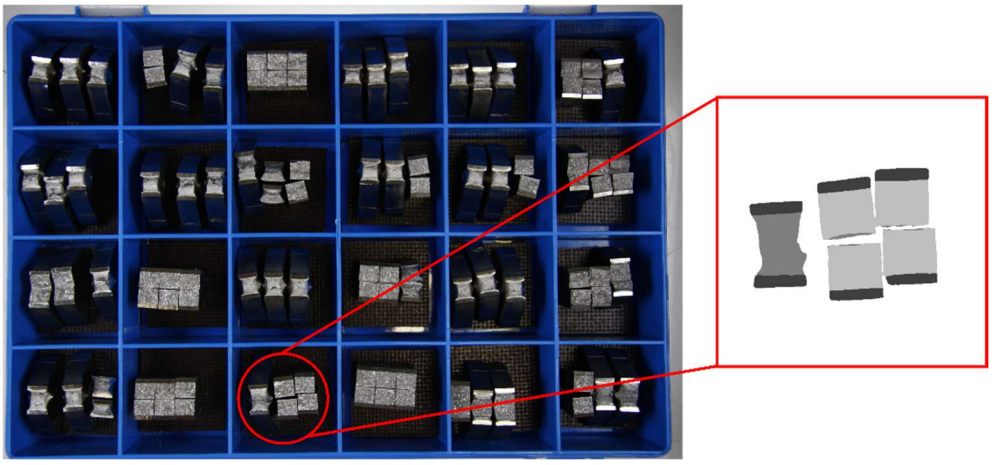

Figure 1: Sample Bundle Extraction and Semantic Segmentation of Charpy V-notch specimens in a sample box.

References:

[1] J. Rosenberger, J. Tlatlik, and S. Münstermann, “Deep learning based initial crack size measurements utilizing macroscale fracture surface segmentation,” Eng Fract Mech, vol. 293, Dec. 2023, doi: 10.1016/j.engfracmech.2023.109686.