Generating Large-Scale Segmentation Data from Sparse Annotations using 3D Reconstruction and Gaussian Splatting

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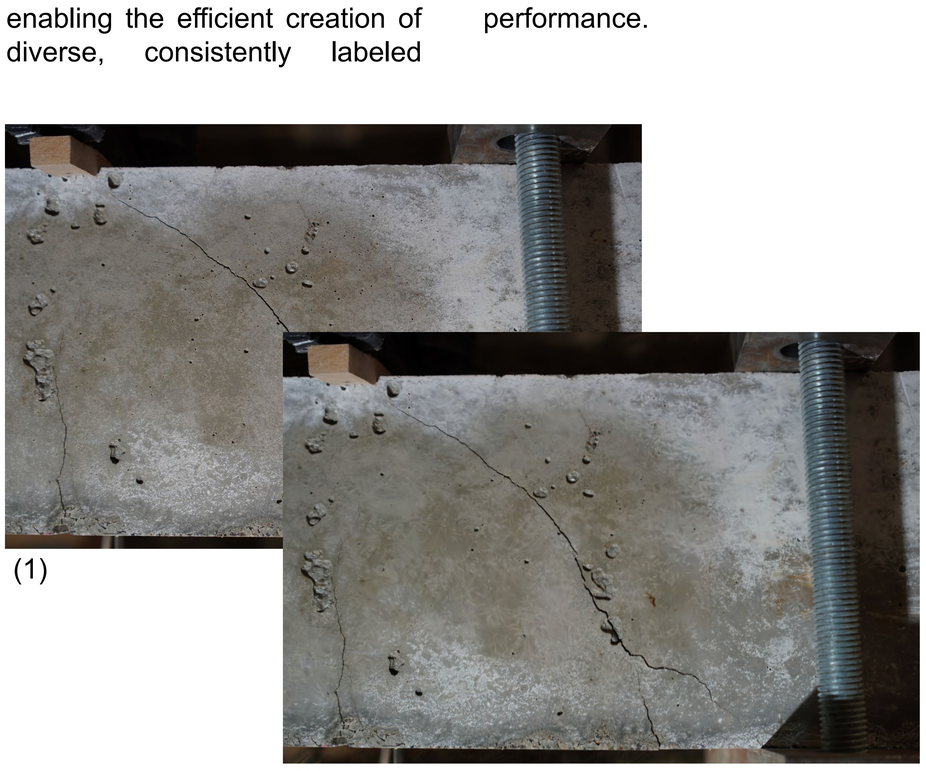
Methodology

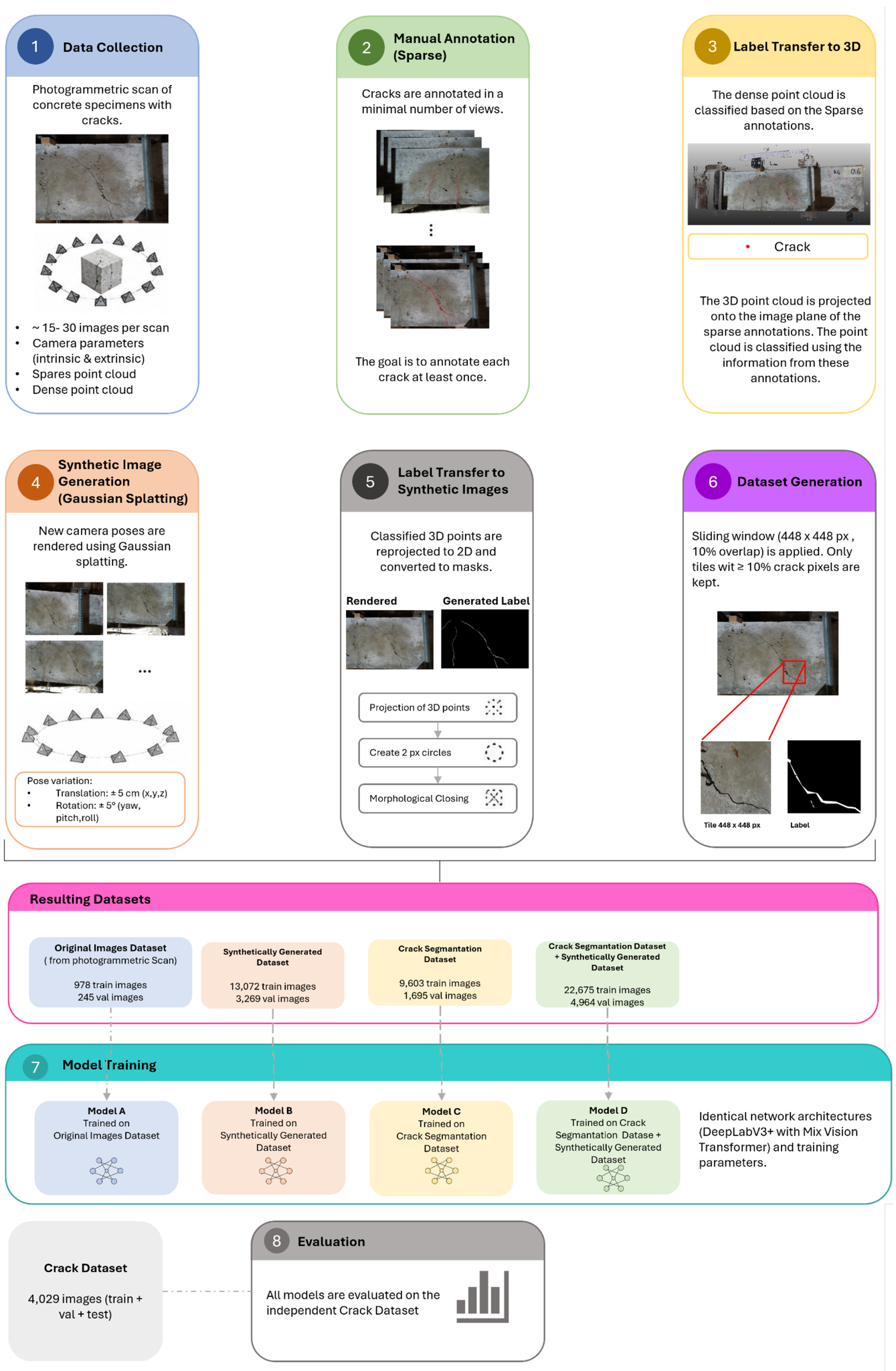
Pixel-wise annotations remain a major bottleneck for training modern semantic segmentation models. This paper introduces a geometry-aware pipeline for amplifying sparse manual annotations into large-scale pixel-wise training datasets using 3D reconstruction and Gaussian splatting. The proposed approach transfers limited 2D annotations into a shared 3D representation, enabling the generation of geometrically consistent novel views with automatically derived labels.The pipeline significantly reduces manual annotation effort while enabling the efficient creation of diverse, consistently labeled datasets. In an example application, we expand a dataset by a factor of 222 using only 24 manually annotated images. We evaluate the proposed method on crack segmentation, a challenging task characterized by thin and irregular structures. Experimental results on an independent test dataset show that models trained on synthetically generated data achieve performance comparable to models trained on fully manually annotated datasets. Furthermore, combining synthetic and real data improves segmentation performance.



(1)

(2)

Figure 1 shows an original photogrammetric image of a test specimen with cracks. Figure 2 shows the same representation of the scene using Gaussian splatting.



Testing

Four models' with a DeepLabV3+ decoder and a Mixed Vision Transformer encoder were trained using the same setup and differs only in terms of the training data. Based on the different training data, the models produce different performance metrics. Evaluation was always performed on a consistent, independent validation dataset.

	Intersection over Union Arithmetic mean	Intersection over Union Standard deviation
Original Images Dataset	0.3801	± 0.1807
Synthetically generated Dataset	0.5317	± 0.1466
Crack Segmentation Dataset	0.5345	± 0.1752
Crack Segmentation Dataset & Synthetically generated Dataset	0.5498	± 0.1551