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| **Resize** |
| All images are resized to a uniform size (e.g., 256 × 256 pixels). | |
| Ensures consistency across datasets; required by most machine learning and deep learning models. | | |

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| Images become the same shape, simplifying batch processing and model training. | |
| **Grayscale Conversion** |

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| Convert the 3-channel RGB image to a single-channel grayscale image. | | | | | | | | | |
| Reduces computational complexity by removing color information (not needed for crack detection). | | | | | | | | | | |
| Retains essential texture and intensity details for cracks while reducing data size. | | | | | | | | |
| **Normalization** | | | | | | |
| Pixel values are scaled from [0, 255] to [0, 1]. | | | | | |
| Standardizes image intensity; speeds up convergence in neural networks. | | | | |
| Improves stability and performance in machine learning models. | | | |
| **Gaussian Blur** | | |
| Apply a Gaussian filter to smooth the image. | |
| Reduces random noise and small artifacts, helping to highlight significant structural features, such as cracks. | | | | | | | |
| Makes cracks more distinguishable by softening background noise. |