```
# Install necessary dependencies
!pip install -q opencv-python-headless
!pip install -q matplotlib
!pip install -q numpy
!pip install -q scikit-image
!pip install -q tensorflow
!pip install -q albumentations

import os
import cv2
import numpy as np
import matplotlib.pyplot as plt
from google.colab import files
from sklearn.cluster import KMeans
from skimage import exposure, filters, color
import random
from typing import List, Tuple, Dict, Any, Optional
import glob
import time

# Set random seeds for reproducibility
np.random.seed(42)
random.seed(42)

class CarDamagePreprocessor:

    def __init__(self,
                 target_size: Tuple[int, int] = (512, 512),
                 normalize: bool = True,
                 clahe_clip_limit: float = 2.0,
                 clahe_grid_size: Tuple[int, int] = (8, 8)):

        self.target_size = target_size
        self.normalize = normalize
        self.clahe = cv2.createCLAHE(clipLimit=clahe_clip_limit,
                                     tileGridSize=clahe_grid_size)

    def load_image(self, image_path: str) -> np.ndarray:

        image = cv2.imread('/content/managed car img.jpg.jpeg')
        if image is None:
            raise ValueError(f"Failed to load image from {image_path}")
        return cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

    def standardize_image(self, image: np.ndarray) -> np.ndarray:

        # Resize to target size
        resized = cv2.resize(image, (self.target_size[1], self.target_size[0]))

        # Normalize pixel values if requested
        if self.normalize:
            return resized.astype(np.float32) / 255.0
        return resized

    def remove_background(self, image: np.ndarray,
                          threshold: int = 25,
                          blur_size: int = 5) -> Tuple[np.ndarray, np.ndarray]:

        # Create a copy of the image
        img = image.copy()

        # Convert to RGB if needed
        if len(img.shape) == 2:
            img = cv2.cvtColor(img, cv2.COLOR_GRAY2RGB)

        # Ensure image is uint8 for GrabCut (required by OpenCV)
        if img.dtype == np.float32:
            img = (img * 255).astype(np.uint8)
        elif img.dtype != np.uint8:
            img = img.astype(np.uint8)

        # Initial mask creation
        mask = np.zeros(img.shape[:2], np.uint8)

        # Background and foreground models
        bgd_model = np.zeros((1, 65), np.float64)
        fgd_model = np.zeros((1, 65), np.float64)

        # Define rough ROI around the image center assuming car is in the middle
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            margin = 50
            rect = (margin, margin, img.shape[1]-2*margin, img.shape[0]-2*margin)

            try:
                # Apply GrabCut
                cv2.grabCut(img, mask, rect, bgd_model, fgd_model, 5, cv2.GC_INIT_WITH_RECT)

                # Convert mask
                mask2 = np.where((mask==2) | (mask==0), 0, 1).astype('uint8')
            except cv2.error:
                # Fallback if GrabCut fails
                print("GrabCut failed. Using basic thresholding as fallback.")
                gray = cv2.cvtColor(img, cv2.COLOR_RGB2GRAY)
                blurred = cv2.GaussianBlur(gray, (blur_size, blur_size), 0)
                _, mask2 = cv2.threshold(blurred, threshold, 1, cv2.THRESH_BINARY)

            # Apply the mask to the image
            result = img * mask2[:, :, np.newaxis]

            # Convert back to original format if needed
            if image.dtype == np.float32:
                result = result.astype(np.float32) / 255.0

            return result, mask2

        def detect_roi(self, image: np.ndarray,
                       mask: Optional[np.ndarray] = None) -> Tuple[np.ndarray, Tuple[int, int, int, int]]:

            # If mask is provided, use it to find contours
            if mask is not None:
                contours, _ = cv2.findContours(mask, cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)
                if contours:
                    # Find the largest contour (assumed to be the car)
                    largest_contour = max(contours, key=cv2.contourArea)
                    x, y, w, h = cv2.boundingRect(largest_contour)

                    # Add some padding
                    padding = 10
                    x = max(0, x - padding)
                    y = max(0, y - padding)
                    w = min(image.shape[1] - x, w + 2*padding)
                    h = min(image.shape[0] - y, h + 2*padding)

                    # Crop the image to the bounding box
                    cropped = image[y:y+h, x:x+w]
                    return cropped, (x, y, w, h)

            # If no mask or no contours found, use edge detection as fallback
            gray = cv2.cvtColor(image, cv2.COLOR_RGB2GRAY) if len(image.shape) > 2 else image
            blurred = cv2.GaussianBlur(gray, (5, 5), 0)
            edges = cv2.Canny(blurred, 50, 150)

            # Find contours in the edge map
            contours, _ = cv2.findContours(edges, cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)

            if contours:
                # Combine all contours to find the overall bounding box
                all_points = np.concatenate([cnt for cnt in contours])
                x, y, w, h = cv2.boundingRect(all_points)

                # Add some padding
                padding = 20
                x = max(0, x - padding)
                y = max(0, y - padding)
                w = min(image.shape[1] - x, w + 2*padding)
                h = min(image.shape[0] - y, h + 2*padding)

                # Crop the image to the bounding box
                cropped = image[y:y+h, x:x+w]
                return cropped, (x, y, w, h)

            # If all else fails, return the original image
            return image, (0, 0, image.shape[1], image.shape[0])

        def reduce_noise(self, image: np.ndarray,
                         method: str = 'gaussian',
                         kernel_size: int = 5) -> np.ndarray:

            if method == 'gaussian':
                return cv2.GaussianBlur(image, (kernel_size, kernel_size), 0)
            elif method == 'median':
                return cv2.medianBlur(image, kernel_size)
            elif method == 'bilateral':
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            if len(image.shape) > 2 and image.dtype == np.float32:
                # Convert to 8-bit for bilateral filter
                temp = (image * 255).astype(np.uint8)
                result = cv2.bilateralFilter(temp, kernel_size, 75, 75)
                return result.astype(np.float32) / 255.0
            else:
                return cv2.bilateralFilter(image, kernel_size, 75, 75)
        else:
            raise ValueError(f"Unknown noise reduction method: {method}")

    def enhance_contrast(self, image: np.ndarray,
                         method: str = 'clahe') -> np.ndarray:

        # Convert to grayscale if image is RGB
        if len(image.shape) > 2:
            gray = cv2.cvtColor(image, cv2.COLOR_RGB2GRAY)
        else:
            gray = image.copy()

        # Scale to 0-255 if normalized
        if gray.dtype == np.float32:
            gray = (gray * 255).astype(np.uint8)

        if method == 'clahe':
            enhanced = self.clahe.apply(gray)
        elif method == 'histeq':
            enhanced = cv2.equalizeHist(gray)
        elif method == 'adapthist':
            enhanced = exposure.equalize_adapthist(gray, clip_limit=0.03)
            enhanced = (enhanced * 255).astype(np.uint8)
        else:
            raise ValueError(f"Unknown contrast enhancement method: {method}")

        # If input was RGB, convert back to RGB
        if len(image.shape) > 2:
            # Create a 3-channel image where each channel has the enhanced data
            enhanced_rgb = np.zeros_like(image)
            if image.dtype == np.float32:
                enhanced_rgb[:,:,0] = enhanced.astype(np.float32) / 255.0
                enhanced_rgb[:,:,1] = enhanced.astype(np.float32) / 255.0
                enhanced_rgb[:,:,2] = enhanced.astype(np.float32) / 255.0
            else:
                enhanced_rgb[:,:,0] = enhanced
                enhanced_rgb[:,:,1] = enhanced
                enhanced_rgb[:,:,2] = enhanced
            return enhanced_rgb

        # Return the enhanced grayscale image
        if image.dtype == np.float32:
            return enhanced.astype(np.float32) / 255.0
        return enhanced

    def detect_edges(self, image: np.ndarray,
                     method: str = 'canny',
                     low_threshold: int = 50,
                     high_threshold: int = 150) -> np.ndarray:

        # Convert to grayscale if image is RGB
        if len(image.shape) > 2:
            gray = cv2.cvtColor(image, cv2.COLOR_RGB2GRAY)
        else:
            gray = image.copy()

        # Scale to 0-255 if normalized
        if gray.dtype == np.float32:
            gray = (gray * 255).astype(np.uint8)

        # Apply Gaussian blur to reduce noise
        blurred = cv2.GaussianBlur(gray, (5, 5), 0)

        if method == 'canny':
            edges = cv2.Canny(blurred, low_threshold, high_threshold)
        elif method == 'sobel':
            sobelx = cv2.Sobel(blurred, cv2.CV_64F, 1, 0, ksize=3)
            sobely = cv2.Sobel(blurred, cv2.CV_64F, 0, 1, ksize=3)
            edges = np.sqrt(sobelx**2 + sobely**2)
            edges = cv2.normalize(edges, None, 0, 255, cv2.NORM_MINMAX, cv2.CV_8U)
        elif method == 'scharr':
            scharrx = cv2.Scharr(blurred, cv2.CV_64F, 1, 0)
            scharry = cv2.Scharr(blurred, cv2.CV_64F, 0, 1)
            edges = np.sqrt(scharrx**2 + scharry**2)
            edges = cv2.normalize(edges, None, 0, 255, cv2.NORM_MINMAX, cv2.CV_8U)
        else:
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            else:
                raise ValueError(f"Unknown edge detection method: {method}")

            # Return the edge map
            if image.dtype == np.float32:
                return edges.astype(np.float32) / 255.0
            return edges

        def segment_damage(self, image: np.ndarray,
                           edge_map: np.ndarray = None,
                           threshold: float = 0.3) -> np.ndarray:

            if edge_map is None:
                edge_map = self.detect_edges(image)

            # Threshold the edge map to get binary mask
            if edge_map.dtype == np.float32:
                mask = (edge_map > threshold).astype(np.uint8)
            else:
                mask = (edge_map > threshold * 255).astype(np.uint8)

            # Apply morphological operations to clean up the mask
            kernel = np.ones((5, 5), np.uint8)
            mask = cv2.morphologyEx(mask, cv2.MORPH_CLOSE, kernel)
            mask = cv2.morphologyEx(mask, cv2.MORPH_OPEN, kernel)

            # Label connected components
            num_labels, labels = cv2.connectedComponents(mask)

            # Filter out small regions
            min_size = 50
            for i in range(1, num_labels):
                if np.sum(labels == i) < min_size:
                    mask[labels == i] = 0

            return mask

        def extract_features(self, image: np.ndarray,
                             mask: Optional[np.ndarray] = None) -> Dict[str, Any]:

            # Convert to grayscale if image is RGB
            if len(image.shape) > 2:
                gray = cv2.cvtColor(image, cv2.COLOR_RGB2GRAY)
            else:
                gray = image.copy()

            # Apply mask if provided
            if mask is not None:
                masked_gray = cv2.bitwise_and(gray, gray, mask=mask)
            else:
                masked_gray = gray

            # Scale to 0-255 if normalized
            if masked_gray.dtype == np.float32:
                masked_gray = (masked_gray * 255).astype(np.uint8)

            # Extract features
            features = {}

            # Basic statistics
            if np.any(masked_gray > 0):
                features['mean'] = np.mean(masked_gray[masked_gray > 0])
                features['std'] = np.std(masked_gray[masked_gray > 0])
                features['min'] = np.min(masked_gray[masked_gray > 0])
                features['max'] = np.max(masked_gray[masked_gray > 0])
            else:
                features['mean'] = 0
                features['std'] = 0
                features['min'] = 0
                features['max'] = 0

            # Histogram
            hist = cv2.calcHist([masked_gray], [0], None, [256], [0, 256])
            features['histogram'] = hist.flatten()

            # Texture features using Haralick texture features (calculated manually)
            if np.any(masked_gray > 0):
                # Convert to uint8 for texture analysis
                masked_gray_uint8 = masked_gray.astype(np.uint8)

                # Calculate gradient magnitude as a simple texture feature
                sobelx = cv2.Sobel(masked_gray_uint8, cv2.CV_64F, 1, 0, ksize=3)
                sobely = cv2.Sobel(masked_gray_uint8, cv2.CV_64F, 0, 1, ksize=3)
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            gradient_magnitude = np.sqrt(sobelx**2 + sobely**2)

            features['gradient_mean'] = np.mean(gradient_magnitude)
            features['gradient_std'] = np.std(gradient_magnitude)

            # Calculate local binary pattern (simple version)
            def local_binary_pattern(image, points=8, radius=1):
                rows, cols = image.shape
                result = np.zeros((rows-2*radius, cols-2*radius), dtype=np.uint8)
                for i in range(radius, rows-radius):
                    for j in range(radius, cols-radius):
                        center = image[i, j]
                        pattern = 0
                        for p in range(points):
                            angle = 2 * np.pi * p / points
                            x = j + int(round(radius * np.cos(angle)))
                            y = i + int(round(radius * np.sin(angle)))
                            if image[y, x] >= center:
                                pattern |= (1 << p)
                        result[i-radius, j-radius] = pattern
                return result

            try:
                # Only compute LBP on a smaller region if image is large
                if masked_gray_uint8.shape[0] > 100 and masked_gray_uint8.shape[1] > 100:
                    center_y, center_x = masked_gray_uint8.shape[0] // 2, masked_gray_uint8.shape[1] // 2
                    roi_size = 50
                    roi = masked_gray_uint8[
                        max(0, center_y - roi_size):min(masked_gray_uint8.shape[0], center_y + roi_size),
                        max(0, center_x - roi_size):min(masked_gray_uint8.shape[1], center_x + roi_size)
                    ]
                    lbp = local_binary_pattern(roi)
                else:
                    lbp = local_binary_pattern(masked_gray_uint8)

                lbp_hist = cv2.calcHist([lbp], [0], None, [256], [0, 256])
                features['lbp_histogram'] = lbp_hist.flatten()
                features['lbp_entropy'] = -np.sum((lbp_hist / np.sum(lbp_hist)) *
                                                  np.log2(lbp_hist / np.sum(lbp_hist) + 1e-10))
            except Exception as e:
                print(f"LBP calculation error: {e}")
                features['lbp_histogram'] = np.zeros(256)
                features['lbp_entropy'] = 0
        else:
            features['gradient_mean'] = 0
            features['gradient_std'] = 0
            features['lbp_histogram'] = np.zeros(256)
            features['lbp_entropy'] = 0

        # SIFT features (keypoints)
        try:
            if np.any(masked_gray > 0):
                sift = cv2.SIFT_create()
                keypoints, descriptors = sift.detectAndCompute(masked_gray, None)
                features['num_keypoints'] = len(keypoints)
                features['keypoints'] = keypoints
                features['descriptors'] = descriptors if descriptors is not None else np.array([])
            else:
                features['num_keypoints'] = 0
                features['keypoints'] = []
                features['descriptors'] = np.array([])
        except Exception as e:
            print(f"SIFT feature extraction error: {e}")
            features['num_keypoints'] = 0
            features['keypoints'] = []
            features['descriptors'] = np.array([])

        return features

    def augment_data(self, image: np.ndarray,
                     num_augmentations: int = 5) -> List[np.ndarray]:

        augmented_images = []

        # Define some augmentation functions
        def random_brightness_contrast(img, brightness_range=(-0.2, 0.2), contrast_range=(-0.2, 0.2)):
            # Brightness adjustment
            brightness = np.random.uniform(brightness_range[0], brightness_range[1])
            adjusted = img.astype(np.float32) + brightness

            # Contrast adjustment
            contrast = np.random.uniform(contrast_range[0], contrast_range[1]) + 1.0
            adjusted = adjusted * contrast
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            # Clip values to valid range
            adjusted = np.clip(adjusted, 0, 1.0 if img.dtype == np.float32 else 255)
            return adjusted.astype(img.dtype)

        def random_noise(img, var=0.01):
            # Add Gaussian noise
            if img.dtype == np.float32:
                noise = np.random.normal(0, var**0.5, img.shape)
                noisy = img + noise
                return np.clip(noisy, 0, 1.0).astype(np.float32)
            else:
                noise = np.random.normal(0, var**0.5 * 255, img.shape).astype(np.int16)
                noisy = img.astype(np.int16) + noise
                return np.clip(noisy, 0, 255).astype(np.uint8)

        def random_rotation(img, angle_range=(-15, 15)):
            # Random rotation
            angle = np.random.uniform(angle_range[0], angle_range[1])
            rows, cols = img.shape[:2]
            M = cv2.getRotationMatrix2D((cols/2, rows/2), angle, 1)
            return cv2.warpAffine(img, M, (cols, rows))

        def random_flip(img):
            # Random horizontal flip
            if np.random.random() > 0.5:
                return cv2.flip(img, 1)
            return img

        def random_crop(img, crop_factor_range=(0.8, 0.95)):
            factor = np.random.uniform(crop_factor_range[0], crop_factor_range[1])
            h, w = img.shape[:2]
            crop_h, crop_w = int(h * factor), int(w * factor)
            start_h = np.random.randint(0, h - crop_h + 1)
            start_w = np.random.randint(0, w - crop_w + 1)
            cropped = img[start_h:start_h+crop_h, start_w:start_w+crop_w]
            return cv2.resize(cropped, (w, h))

        # Define augmentation pipeline with probabilities
        augmentation_functions = [
            (random_brightness_contrast, 0.7),
            (random_noise, 0.5),
            (random_rotation, 0.5),
            (random_flip, 0.5),
            (random_crop, 0.5)
        ]

        for _ in range(num_augmentations):
            # Start with a copy of the original image
            augmented = image.copy()

            # Apply random augmentations based on probability
            for aug_func, prob in augmentation_functions:
                if np.random.random() < prob:
                    augmented = aug_func(augmented)

            augmented_images.append(augmented)

        return augmented_images

    def visualize_preprocessing(self, original: np.ndarray,
                                processed_results: Dict[str, np.ndarray]) -> None:

        # Determine number of steps
        n_steps = len(processed_results) + 1  # +1 for original

        # Create figure with subplots
        fig, axes = plt.subplots(1, n_steps, figsize=(20, 5))

        # Plot original image
        axes[0].imshow(original)
        axes[0].set_title('Original')
        axes[0].axis('off')

        # Plot processed results
        for i, (title, img) in enumerate(processed_results.items(), 1):
            # Handle different image types
            if len(img.shape) == 2:  # Grayscale or mask
                if img.dtype == bool:
                    img = img.astype(np.uint8) * 255

                # Display as grayscale
                axes[i].imshow(img, cmap='gray')
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            else:
                # Display as RGB
                if img.dtype == np.float32 and np.max(img) <= 1.0:
                    axes[i].imshow(img)
                else:
                    axes[i].imshow(img.astype(np.uint8))

            axes[i].set_title(title)
            axes[i].axis('off')

        plt.tight_layout()
        plt.show()

    def process_image(self, image: np.ndarray,
                      visualize: bool = False) -> Dict[str, Any]:

        results = {}

        # Standardize image
        std_image = self.standardize_image(image)
        results['standardized'] = std_image

        # Remove background
        bg_removed, mask = self.remove_background(std_image)
        results['background_removed'] = bg_removed
        results['background_mask'] = mask

        # Detect ROI
        roi, bbox = self.detect_roi(bg_removed, mask)
        results['roi'] = roi
        results['bbox'] = bbox

        # Reduce noise
        denoised = self.reduce_noise(roi, method='bilateral')
        results['denoised'] = denoised

        # Enhance contrast
        enhanced = self.enhance_contrast(denoised)
        results['enhanced'] = enhanced

        # Detect edges
        edges = self.detect_edges(enhanced)
        results['edges'] = edges

        # Segment damage
        damage_mask = self.segment_damage(enhanced, edges)
        results['damage_mask'] = damage_mask

        # Extract features
        features = self.extract_features(enhanced, damage_mask)
        results['features'] = features

        # Visualize if requested
        if visualize:
            vis_results = {
                'Background Removed': bg_removed,
                'ROI': roi,
                'Denoised': denoised,
                'Enhanced': enhanced,
                'Edges': edges,
                'Damage Mask': damage_mask
            }
            self.visualize_preprocessing(image, vis_results)

        return results

    def process_directory(self, directory_path: str,
                          output_dir: str = None,
                          visualize: bool = False) -> Dict[str, Dict[str, Any]]:

        # Create output directory if specified
        if output_dir is not None:
            os.makedirs(output_dir, exist_ok=True)

        results = {}

        # Get all image files
        image_files = []
        for ext in ['*.jpg', '*.jpeg', '*.png', '*.bmp']:
            image_files.extend(glob.glob(os.path.join(directory_path, ext)))
            image_files.extend(glob.glob(os.path.join(directory_path, ext.upper())))
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            print(f"Found {len(image_files)} images in {directory_path}")

            # Process each image
            for image_file in image_files:
                try:
                    # Load image
                    image = self.load_image(image_file)

                    # Process image
                    result = self.process_image(image, visualize=visualize)

                    # Save processed images if output directory is specified
                    if output_dir is not None:
                        # Get base filename without extension
                        basename = os.path.splitext(os.path.basename(image_file))[0]

                        # Save each processed image
                        for name, img in result.items():
                            if isinstance(img, np.ndarray):
                                # Create image file path
                                img_path = os.path.join(output_dir, f"{basename}_{name}.png")

                                # Convert to uint8 if needed
                                if img.dtype == np.float32:
                                    img = (img * 255).astype(np.uint8)

                                # Save the image
                                if len(img.shape) == 2:
                                    cv2.imwrite(img_path, img)
                                else:
                                    cv2.imwrite(img_path, cv2.cvtColor(img, cv2.COLOR_RGB2BGR))

                    # Store results
                    results[os.path.basename(image_file)] = result

                except Exception as e:
                    print(f"Error processing {image_file}: {e}")

            return results

    # Example usage
    def main():
        """
        Example usage of the CarDamagePreprocessor.
        """
        # Create preprocessor
        preprocessor = CarDamagePreprocessor()

        # Check if images already exist in the environment
        import os
        existing_images = [f for f in os.listdir() if f.lower().endswith(('.png', '.jpg', '.jpeg', '.bmp'))]

        if existing_images:
            print(f"Found {len(existing_images)} images in the current directory.")
            image_files = existing_images
        else:
            # Allow user to upload images
            print("Please upload one or more damaged car images.")
            uploaded = files.upload()
            image_files = list(uploaded.keys())

        # Process images
        for filename in image_files:
            try:
                print(f"Processing {filename}...")

                # Load image
                image = cv2.imread(filename)
                if image is None:
                    print(f"Error: Could not read image {filename}")
                    continue

                image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

                # Process image with error handling
                try:
                    result = preprocessor.process_image(image, visualize=True)

                    # Display features
                    print(f"Image features:")
                    for key, value in result['features'].items():
                        if key in ['histogram', 'keypoints', 'descriptors']:
                            if isinstance(value, np.ndarray):
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                            print(f"  {key}: [array with shape {value.shape}]")
                        else:
                            print(f"  {key}: [array with {len(value)} elements]")
                    else:
                        print(f"  {key}: {value}")

                print("\n")

                # Demonstrate augmentation with the first successful image
                print("Generating data augmentations...")
                augmented_images = preprocessor.augment_data(image, num_augmentations=5)

                # Display augmented images
                plt.figure(figsize=(15, 10))
                plt.subplot(2, 3, 1)
                plt.imshow(image)
                plt.title("Original")
                plt.axis('off')

                for i, aug_img in enumerate(augmented_images, 1):
                    plt.subplot(2, 3, i+1)
                    plt.imshow(aug_img)
                    plt.title(f"Augmentation {i}")
                    plt.axis('off')

                plt.tight_layout()
                plt.show()

                # Only process one image for demonstration
                break

            except Exception as e:
                print(f"Error during image processing: {str(e)}")
                import traceback
                traceback.print_exc()

        except Exception as e:
            print(f"Error with image {filename}: {str(e)}")
            import traceback
            traceback.print_exc()

if __name__ == "__main__":
    main()
```
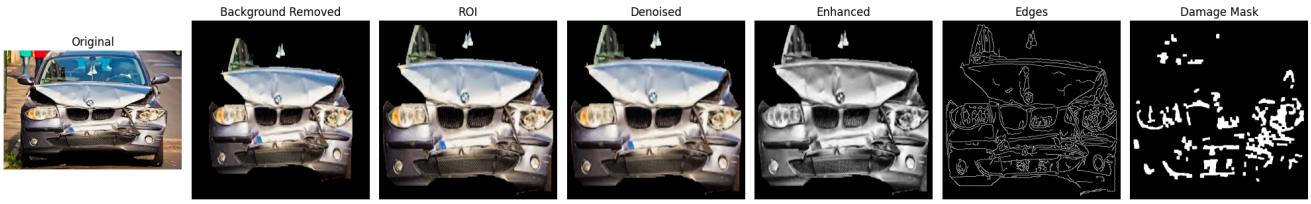

```
Found 2 images in the current directory.
Processing danaged car img.jpg.jpeg...
```




```
Image features:
  mean: 115.43490496173784
  std: 51.84796047855531
  min: 1
  max: 247
  histogram: [array with shape (256,)]
  gradient_mean: 40.489245615856674
  gradient_std: 127.95870300335605
  lbp_histogram: [4.800e+01 4.100e+01 3.000e+00 8.000e+00 5.000e+01 0.000e+00 2.300e+01
 6.000e+01 6.000e+00 2.000e+00 0.000e+00 0.000e+00 3.000e+01 2.000e+00
 2.600e+01 6.400e+01 3.200e+01 1.400e+01 1.000e+00 0.000e+00 0.000e+00
 0.000e+00 3.000e+00 2.000e+00 1.600e+01 2.000e+00 0.000e+00 2.000e+00
 6.500e+01 1.000e+00 9.400e+01 3.700e+01 4.000e+00 7.000e+00 2.000e+00
 1.000e+00 1.000e+00 0.000e+00 2.000e+00 1.000e+00 0.000e+00 0.000e+00
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 1.000e+00 0.000e+00 0.000e+00 0.000e+00 2.000e+00 1.000e+00 1.000e+00
 2.300e+01 8.000e+01 0.000e+00 2.900e+01 1.000e+00 0.000e+00 0.000e+00
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 0.000e+00 0.000e+00 0.000e+00 4.700e+01 9.000e+00 0.000e+00 3.100e+01
 1.600e+01 2.000e+00 8.000e+00 7.688e+03]
  lbp_entropy: 1.8702993392944336
  num_keypoints: 668
  keypoints: [array with 668 elements]
  descriptors: [array with shape (668, 128)]


Generating data augmentations...
```