

# Function Documentation: `piecewise_linear_transformation`

## 1 Description

The `piecewise_linear_transformation` function applies a piecewise linear transformation to pixel values. It inverts the pixel values if specified, clips them at given thresholds, scales them linearly to a range of  $[0, 1]$ , and optionally inverts the scaled values back.

## 2 Function Definition

```
def piecewise_linear_transformation(pixel_values_in, lower_threshold, upper_threshold):
    invert = True

    # Invert it
    pixel_values = 1 - pixel_values_in if invert else pixel_values_in

    # Clip values at the lower and upper thresholds
    clipped_values = np.clip(pixel_values, lower_threshold, upper_threshold)

    # Linear scaling
    # Scale the range [lower_threshold, upper_threshold] to [0, 1]
    scale = 1.0 / (upper_threshold - lower_threshold)
    transformed = (clipped_values - lower_threshold) * scale

    # Invert it back
    transformed = 1 - transformed if invert else transformed

    return transformed
```

## 3 Function Explanation

### 3.1 Step-by-Step Breakdown

#### Function 1: Invert Pixel Values

Invert the pixel values if the `invert` flag is set to `True`.

```
# Invert it
pixel_values = 1 - pixel_values_in if invert else pixel_values_in
```

**Explanation:** If the `invert` flag is set to `True`, the pixel values are inverted by subtracting them from 1. This step prepares the pixel values for subsequent transformations.

#### Function 2: Clip Values

Clip the pixel values to lie within the specified `lower_threshold` and `upper_threshold`.

```
# Clip values at the lower and upper thresholds
clipped_values = np.clip(pixel_values, lower_threshold, upper_threshold)
```

**Explanation:** The pixel values are clipped to ensure they fall within the specified threshold range. This prevents values outside the specified bounds from affecting the linear scaling.

#### Function 3: Linear Scaling

Scale the clipped pixel values from the range `[lower_threshold, upper_threshold]` to `[0, 1]`.

```
# Linear scaling
# Scale the range [lower_threshold, upper_threshold] to [0, 1]
scale = 1.0 / (upper_threshold - lower_threshold)
transformed = (clipped_values - lower_threshold) * scale
```

**Explanation:** The clipped pixel values are scaled to the `[0, 1]` range. This is done by first computing a scaling factor and then applying this factor to adjust the values accordingly.

#### Function 4: Invert Back

Invert the scaled pixel values back if the `invert` flag is set to `True`.

```
# Invert it back
transformed = 1 - transformed if invert else transformed
```

**Explanation:** If the `invert` flag was set to `True` initially, the scaled values are inverted back by subtracting them from 1. This restores the original inversion state if needed.

## 4 Conclusion

The `piecewise_linear_transformation` function processes pixel values by applying an inversion, clipping, linear scaling, and optional inversion. This function is useful for adjusting image contrast and brightness through piecewise linear transformations.