Image Processing

Image Classification and Correction using MATLAB

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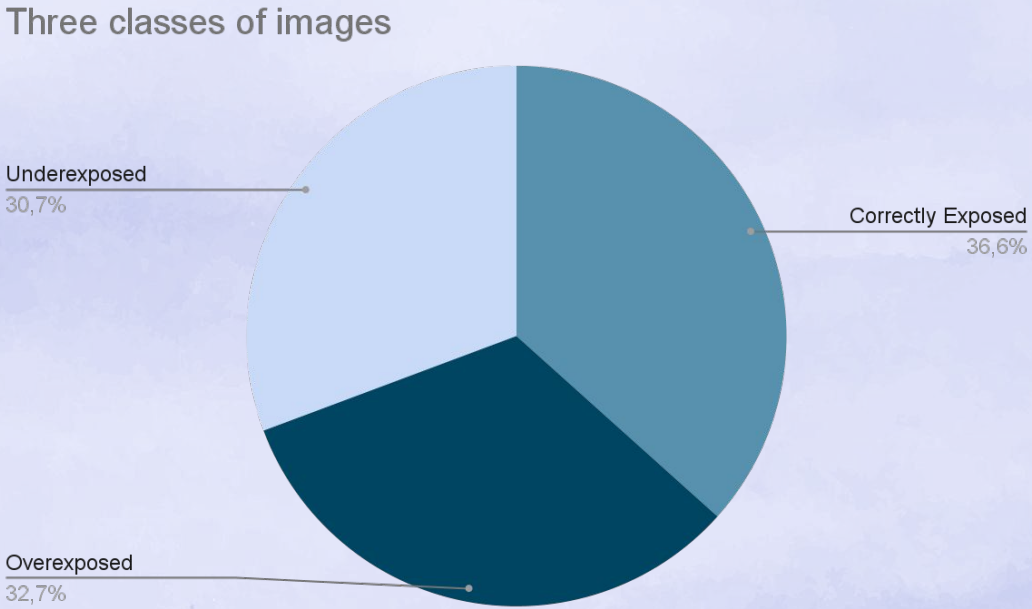
DATA COLLECTION



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PREPROCESSING

Conversion to Grayscale

Speeds up calculations, reduces memory usage

Simplifies data representation

Resizing

All images resized to [640, 480] for consistency

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LOW-LEVEL FEATURE EXTRACTION

Provides a basis for classification summarizing key characteristics

Features Extracted:

- **Mean intensity** provides a measure of the overall brightness.
- **Variance** indicates the spread or dispersion of pixel intensities.
- **Skewness** shows the asymmetry of the pixel intensity distribution.
- **Kurtosis** reflects the peakedness or flatness of the distribution.
- **Percentiles** summarize the distribution of pixel values.

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CLASSIFICATION PROCESS

01 | **SVM**

Uses ECOC for multiclass

02 | **Decision Tree**

Recursive data splitting based on features

Each model (SVM, Decision Tree) uses the same training and testing sets for each fold, ensuring a fair comparison.

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EVALUATION

5-Fold Cross-Validation

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Same training and testing sets are used for each fold to allow for fair comparison. Predictions and true labels are accumulated across all folds to compute overall accuracy and confusion matrices.

Performance Comparison

- **Overall Accuracy:** The ratio of correctly predicted labels to the total number of labels.
  - SVM Accuracy: 89.11%
  - Decision Tree Accuracy: 90.10%

- **Confusion Matrix:** A table used to describe the performance of a classification model by comparing the actual labels with the predicted labels.

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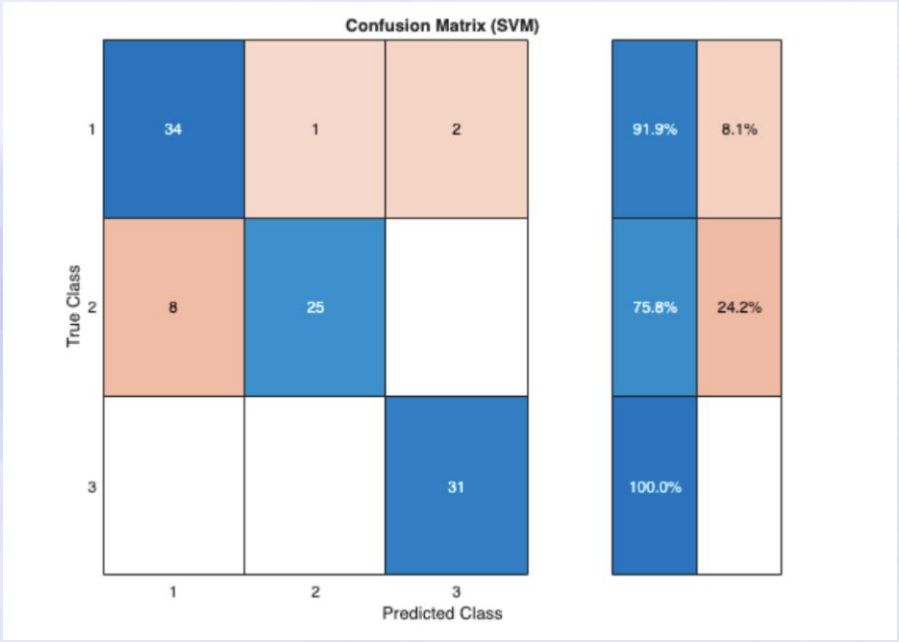
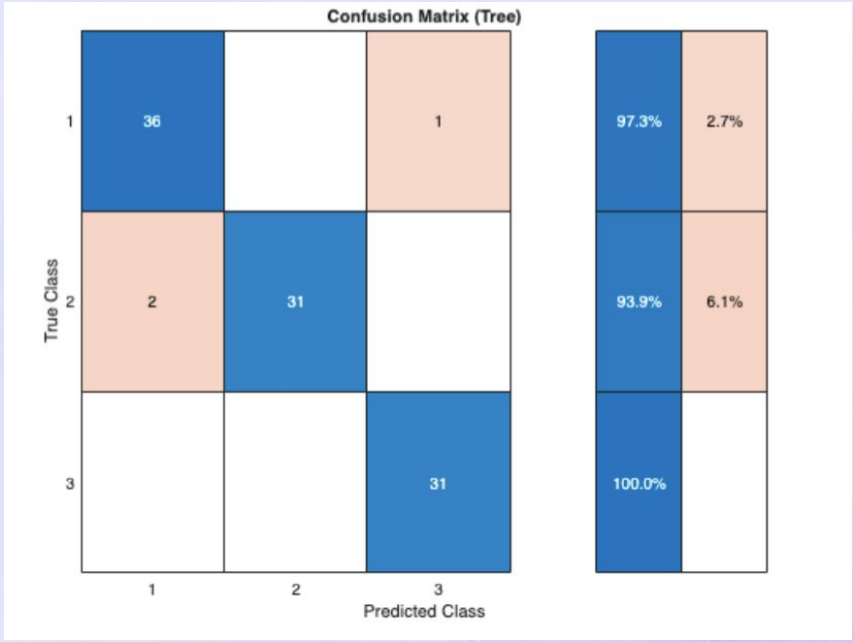

Confusion Matrix (SVM)
True Class
Predicted Class
1
2
3
34
1
2
8
25
31
91.9%
8.1%
75.8%
24.2%
100.0%


Confusion Matrix (Tree)
True Class
Predicted Class
1
2
3
36
1
2
31
31
97.3%
2.7%
93.9%
6.1%
100.0%

GAMMA CORRECTION

Gamma correction ensures that images are neither too dark nor too bright

1. **Determine Gamma Value**
   a. Iterative gamma adjustments to modify image brightness.
   b. Depending on these adjustments, a specific gamma value is calculated to adjust the image exposure

2. **Apply Gamma Value**
   a. The gamma value is used to adjust the pixel values of the image
   b. This process is repeated iteratively until the image meets the criteria for being correctly exposed or the maximum number (35) of iterations is reached.

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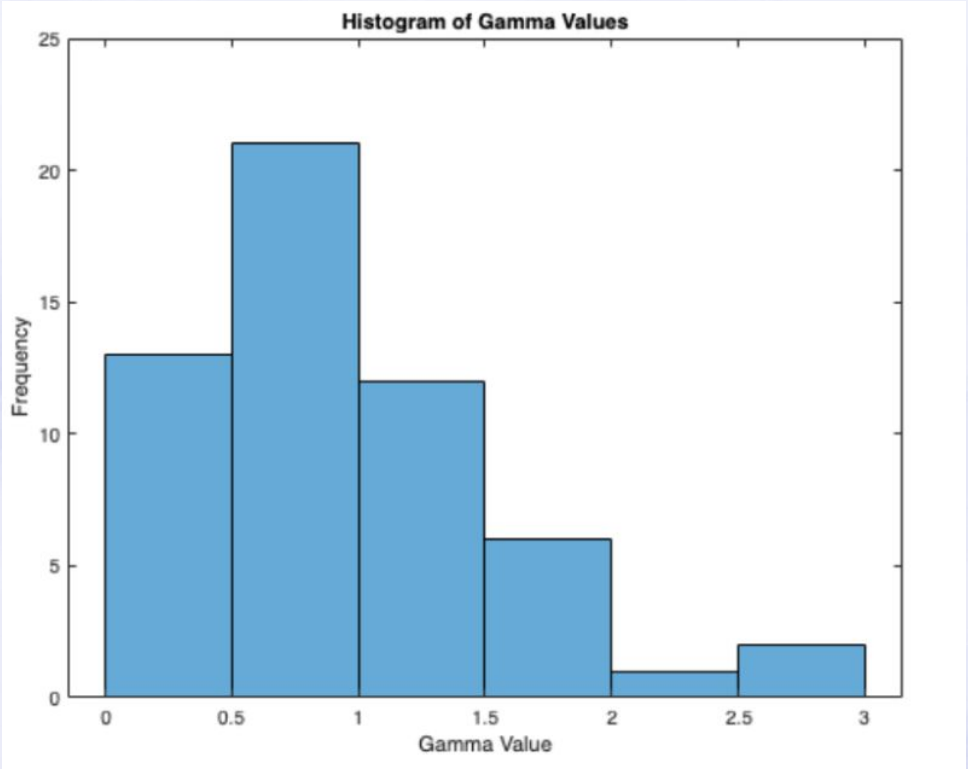
Histogram of Gamma Values
Frequency
Gamma Value
0
5
10
15
20
25
0
0.5
1
1.5
2
2.5
3

FINAL CLASSIFICATION

Decision Tree

The Decision Tree model, which was identified as the best performing model, is loaded for classifying the corrected images.

We extracted the feature from each image and predict its exposure category

Outcome: high percentage (86%) of correctly exposed images indicates that the gamma correction process was successful in adjusting the exposure levels to an optimal state.

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CORRECTION EVALUATION: HISTOGRAM ANALYSIS

Analysis Overview:
The skewness analysis of gamma-corrected images reveals a nuanced distribution.
The chosen 80% confidence interval (CI) spans from 0.26 to 9.40, focusing on central tendency.

Mean Skewness:
Mean skewness of 3.37 indicates a high right-skewness, showing gamma correction biases towards brighter values. Presence of high skewness values contributes to an elevated mean, reflecting varied correction impacts.

Median Skewness:
Median skewness of 1.85 indicates half of images have lower skewness values.
Disparity with mean highlights a right-skewed distribution with outliers and significant brightness adjustments.

Visual Analysis:
Histograms show skewness values cluster around lower levels with extension towards higher values.
Confirms gamma correction adjusts brightness effectively but responses vary among images.

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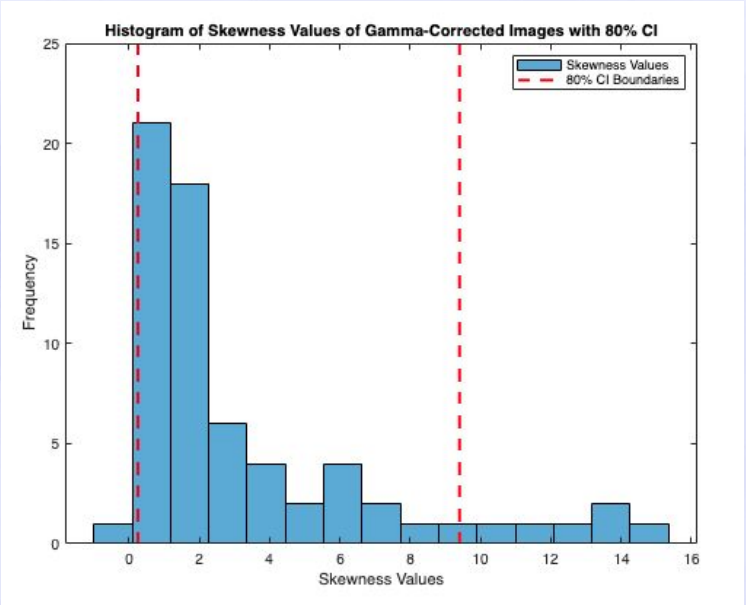

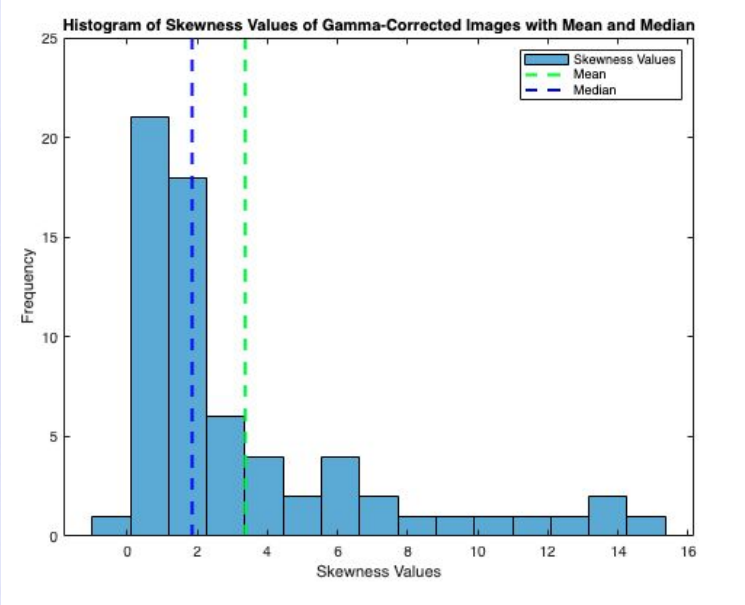

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CONCLUSION

Limitation: the iteration limit (35), even if relatively high, may not be optimal for all datasets or image types. Dataset not optimal at all, with very high differences between images.

Reliance on Mean Intensity and Variance: our method heavily depends on these metrics, which may not fully capture an image's exposure.

Grayscale Conversion: always converting images to grayscale may hinder performance where color information is important.

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