Adaptive Brightness and Contrast Enhancement for Dark Images Using a Parabolic Model

Rhythm Jain, AI Team, Dharohar

Abstract

This paper presents an automated method for enhancing the brightness and contrast of dark manuscript images from archival collections. The proposed approach utilizes a parabolic model to dynamically adjust the image contrast based on image brightness, ensuring consistent visual quality across varying image conditions.

1. Introduction

Archival manuscript image collections are often hard to read due to low brightness and contrast of the scanned images. Manual enhancement of each image is impractical for large datasets. This study introduces a mathematical model for automatic contrast adjustment using Python and OpenCV, tailored for colour manuscript images with varying luminance levels.

2. Methodology

The enhancement process relies on the cv2.convertScaleAbs() function in OpenCV, which applies a linear transformation to image pixels:

dst(I) = saturate_cast<uchar>(src(I) * α + β)

Where:
- α is the contrast scaling factor,
- β is the brightness offset (set to 0),
- saturate_cast ensures pixel values remain within the 0–255 range.

To automate contrast adjustment, the image is converted to grayscale and its mean intensity M is computed. A parabolic equation is then used to determine α:

$$\alpha = (\alpha_{max} - \alpha_{min}) * (1 - M/255)^2 + \alpha_{min}$$

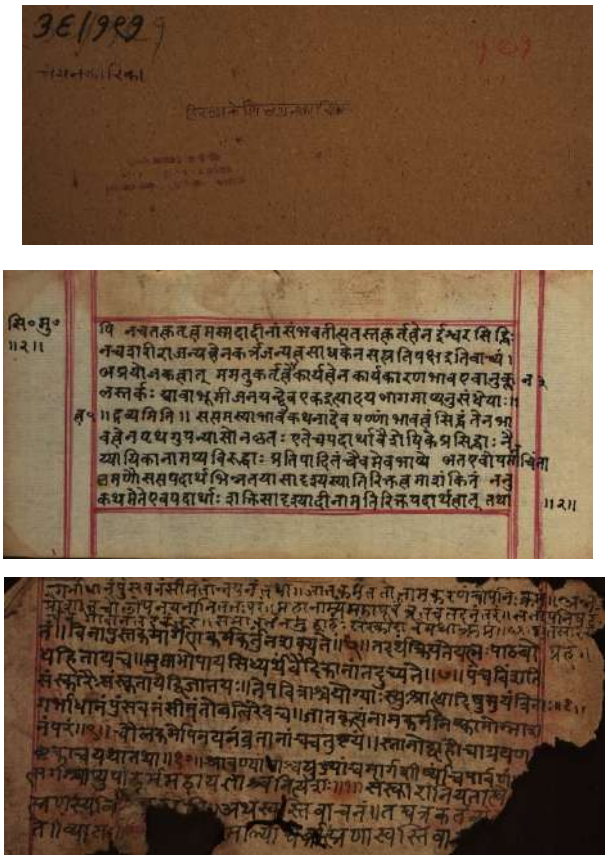
This ensures higher contrast for darker images and lower contrast for brighter ones.

3. Results

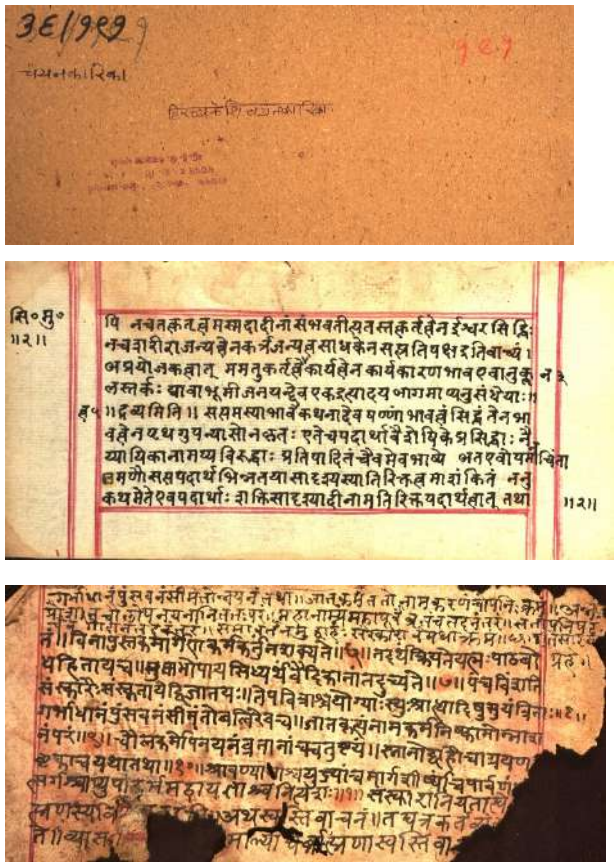
The proposed method successfully normalized contrast across a diverse set of images from the BISM library.

The processing was quick and automatic. Image readability could be improved at the rate of more than 5 images per second.

Visual inspection confirmed improved readability and consistency, demonstrating the effectiveness of the parabolic model. Some before and after images are given below.



Before



After

4. Conclusion

The adaptive contrast enhancement technique provides a robust solution for improving image visibility in archival datasets. Future work may explore extensions to color images and integration with deep learning-based enhancement methods.