Satellite Cyclone Image Enhancement for Weather Analysis

Introduction

1. Purpose: Enhance Cyclone Satellite images for better weather analysis.

This project focuses on enhancing the visual clarity of these images to aid weather analysts in better understanding cyclone structures.

Dataset

- **Number of Images**: 20 satellite images of cyclones.
- **Image Format**: JPEG/PNG, in RGB and grayscale.
- **Source**: Tropical Storm Rafael from Kaggle.

Methodology

1. Loading Images

- Images were loaded using Python's OpenCV library.
- All images were verified for proper loading and compatibility.

2. Analyzing Brightness and Contrast

- Brightness and contrast were calculated for each image using statistical measures:
    - **Brightness**: Average pixel intensity.

    - **Contrast**: Standard deviation of pixel intensity.

- The analysis identified images with low brightness or contrast for further enhancement.

3. Image Enhancement

- **Histogram Equalization** was applied to improve image contrast.
- **Gaussian Filters** was applied for smoothing the images by reducing noise and softening Details.
- **BIlateral Filters** were considered for edge-preserving smoothing, enabling noise reduction without blurring cyclone boundaries.These filters effectively balance clarity and noise suppression in image enhancement.
- **Convolutional Filter** was applied to enhance image features by using predefined kernels to emphasize specific patterns, such as edges and textures, in the satellite cyclone images.
- **Canny Edge Detection** was used to highlight cyclone boundaries, making them more distinct for analysis.

4. Comparison and Saving

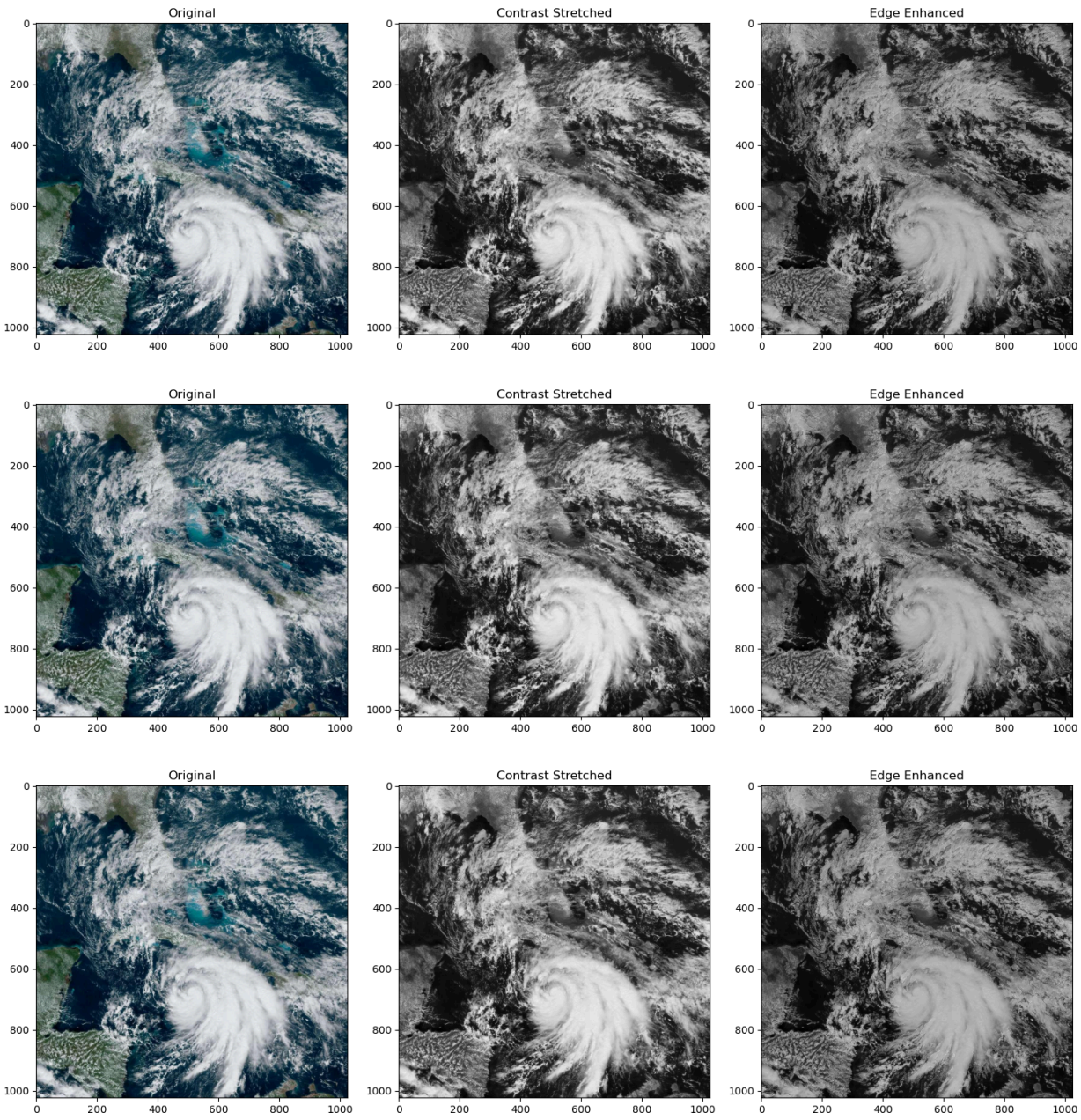
- Enhanced images were saved alongside original images.

- Side-by-side comparison visuals were generated to demonstrate improvements.

Results

Brightness and Contrast Analysis

Image ID	Brightness	Contrast	Enhanced Contrast
Image 1	111.50	66.24	45.7
Image 2	112.28	66.34	40.3
Image3.	.112,82..	.66.74	. 40.1.



Visual Comparisons

- Cyclone boundaries became significantly clearer in enhanced images.
- Improved contrast enhanced the visibility of key features in the cyclone structures.

Conclusion

The image enhancement techniques applied in this project successfully improved the visibility of cyclone boundaries and overall image clarity. We have tested multiple filters to balance clarity and noise suppression and confined edges of the image boundaries.The results demonstrate the utility of preprocessing in weather analysis and disaster management. Future work may include automating the process for larger datasets and exploring advanced image processing techniques.