# Satellite Image Dehazing using Dark Channel Prior and Retinex Algorithms

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March 30, 2025

**Abstract**

This project aims to enhance the quality of satellite imagery by removing haze and improving contrast and visibility using two well-known image processing techniques: Dark Channel Prior (DCP) and Retinex (both MSR and SSR variants). Python was used to implement and experiment with both algorithms, and the results were evaluated on real satellite imagery in TIFF format.

## 1 Introduction

Hazy satellite images often suffer from low contrast, poor visibility, and faded details due to atmospheric conditions such as dust, fog, and moisture. Enhancing these images is essential in applications like agriculture, environmental monitoring, and remote sensing. This project explores two dehazing and enhancement techniques:

- **Dark Channel Prior (DCP)** - focuses on haze removal by estimating atmospheric light and transmission map.
- **Retinex (MSR and SSR)** - improves image illumination and contrast using logarithmic color channel processing.

## 2 Tools and Environment

- **Programming Language:** Python 3.11
- **Development Environment:** Jupyter Notebook
- **Libraries:** OpenCV, NumPy, Matplotlib
- **Input Format:** TIFF (.tif), PNG, JPG
- **Project Structure:**

```
satellite-dehazing/
 data/           ← input images
 results/        ← output images
 src/            ← algorithm scripts (DCP, Retinex)
 DehazingDemo.ipynb ← experimentation notebook
 README.md
```

# 3 Algorithms Overview

## 3.1 Dark Channel Prior (DCP)

DCP is based on the observation that in most non-sky image patches, at least one color channel has some pixels with very low intensity. DCP involves the following steps:

1. Compute the dark channel of the image.
2. Estimate the atmospheric light.
3. Estimate the transmission map.
4. Refine the transmission map with a guided filter.
5. Recover the haze-free image.

## 3.2 Retinex Algorithm

The Retinex algorithm enhances image illumination by applying a logarithmic function to the image and subtracting a blurred version of it. Two variants were used:

- **SSR (Single Scale Retinex)**: uses a single Gaussian scale.
- **MSR (Multi Scale Retinex)**: combines several Gaussian scales.

# 4 Input Data

We tested the algorithms on high-resolution satellite images in TIFF format:

| Image Name | Size | Notes |
|---|---|---|
| `aoi0.tif` | 31.7 MB | High haze intensity |
| `aoi1.tif` | 18 MB | Light haze |
| `aoi2.tif` | 11.8 MB | Low haze, more clarity |

Table 1: Input Satellite Images

# 5 Results and Visualization

The algorithms were applied, and the results were saved and visualized using Matplotlib. Below is a visual comparison:

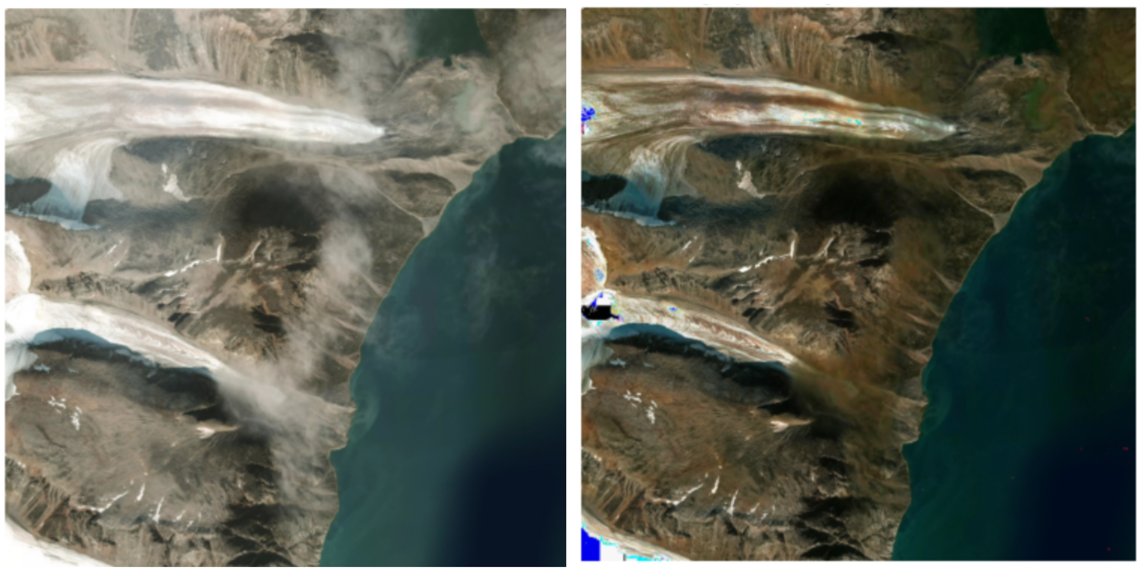

Figure 1: Original Image (Left) vs DCP Result (Right)

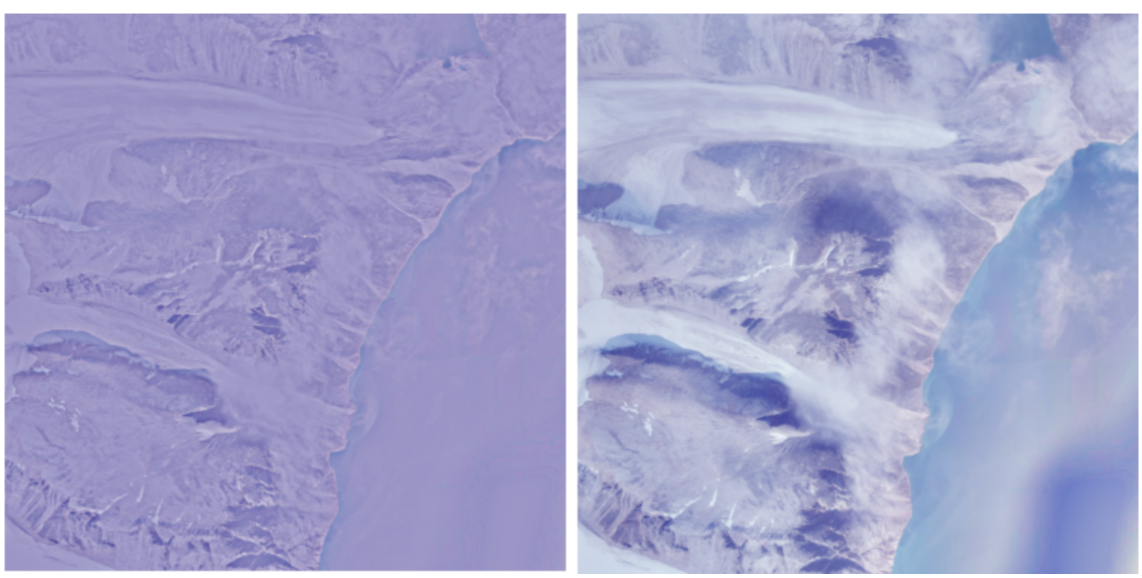

Figure 2: MSR (Left) vs SSR (Right)

# 6 Comparison of Methods

| **Criterion** | **DCP** | **Retinex (MSR/SSR)** |
|---|---|---|
| Haze removal | Excellent | Limited |
| Illumination enhancement | Moderate | Excellent |
| Processing speed | Slower | Faster |
| Implementation complexity | Higher | Lower |

Table 2: Comparison between DCP and Retinex

# 7 Conclusion

The project demonstrated that Dark Channel Prior is highly effective in removing haze from satellite images, while Retinex significantly enhances brightness and contrast. A hybrid approach combining both could provide balanced results and is suggested as future work.

# 8 References


- He, Kaiming, et al. "Single image haze removal using dark channel prior." CVPR 2009.
- `https://github.com/Mohit-3430/Minor_Project`
- `https://github.com/younggguncho/awesome-dehazing`