Homework 6 Report: Image Similarity and Object Detection

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1. Task Explanation and Dataset Summary (10 points)

Task A – Image Similarity

Compare Bright_Tree and Dark_Tree images using:

- MSE (Mean Squared Error)
- PSNR (Peak Signal-to-Noise Ratio)
- SSIM (Structural Similarity Index)

Task B – Object Detection

Use a pre-trained Faster R-CNN model to detect objects in:

- Kitchen.jpg
- StreetView.jpg
- Zebra.jpg

Dataset Overview

Image	Type	Approx. Size	Description
Bright_Tree	PNG	768×576 px	Tree in bright daylight
Dark_Tree	PNG	768×576 px	Same tree in dimmer lighting
Kitchen	JPG	1024×768 px	Indoor kitchen
StreetView	JPG	1280×720 px	Urban street scene
Zebra	JPG	800×600 px	Wildlife photo with zebras

2. Model Description (20 points)

Task A – Image Similarity

- Resized both images to a common shape
- Converted to grayscale for SSIM calculation
- Computed metrics with and without histogram matching

Metrics Used:

- MSE: Measures average pixel difference
- PSNR: Measures signal degradation in dB
- SSIM: Measures perceptual similarity

Task B – Object Detection

Model: fasterrcnn_resnet50_fpn
Library: PyTorch (torchvision.models.detection)
Pre-trained on: COCO dataset
Confidence threshold: 0.7

Used default weights and visualized results with bounding boxes + labels.

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3. Results Presentation (10 points)

Task A – Image Similarity Metrics

Metric	Original	After Histogram Matching
MSE	0.0209	0.0131
PSNR	16.81 dB	18.83 dB
SSIM	0.7371	0.7720

Insight: Histogram matching improved all metrics, especially SSIM and PSNR.

Task B – Object Detection Summary

Image	Detected Objects (≥ 0.7 confidence)
Kitchen	bottle, cup, potted plant, dining table, chair
StreetView	car, person, bus
Zebra	zebra ×2 (100% confidence)

Visuals confirmed high-confidence detection and good bounding box placement.

Conclusion

- Evaluated both structural and perceptual image similarity successfully.
- Implemented modern deep learning techniques for object detection.
- All results were documented and visualized using Jupyter Notebooks.