IE643: Deep Learning - Theory and Practice **July-Nov 2024**

Novelty Report: Low-Light Video Processing and Object Detection

Team Name: DeepCrafters *Team Member(s): 22b2505*

Abstract

This report explores the application of deep learning techniques to address challenges in low-light video enhancement and object detection. For video enhancement, the Zero-DCE model is applied to individual video frames to enhance brightness and contrast, ensuring better visual quality while preserving details. For object detection, a Faster R-CNN architecture is employed to accurately identify objects in low-light images, leveraging its region proposal network for precise localization.

1 Introduction

Low-light conditions pose challenges in video processing and object detection, critical for various applications such as surveillance, autonomous driving, and medical imaging. This project explores two main aspects:

- Enhancing low-light video frames using the ZeroDCE model.
- Detecting objects in low-light images with a Faster R-CNN-based architecture.

2 Methodology

2.1 Low-Light Video Enhancement

The ZeroDCE model was employed to enhance frames from input videos. The approach involves:

- Reading video frames using `moviepy`.
- Enhancing each frame with the ZeroDCE model, utilizing TensorFlow for real-time processing.
- Reconstructing enhanced frames into a video with synchronized audio and aspect ratio adjustments.

Key parameters include input video resolution, aspect ratio (4:3 or 16:9), and frame rate.

2.2 Low-Light Object Detection

Object detection was performed using a pre-trained Faster R-CNN model from TensorFlow Hub. The methodology includes:

- Loading and preprocessing input images, including resizing them to 2400x1600 resolution for better detection accuracy.
- Running inference on the Faster R-CNN model to generate bounding box predictions, class labels, and confidence scores.

- Post-processing the output to filter out low-confidence detections and visualizing the results by overlaying bounding boxes and class labels on the image.

The model's performance was evaluated on high-resolution images to ensure robustness in low-light conditions and its ability to accurately detect objects despite poor visibility.

3 Results

In this section, we present the results of our experiments on low-light object detection.

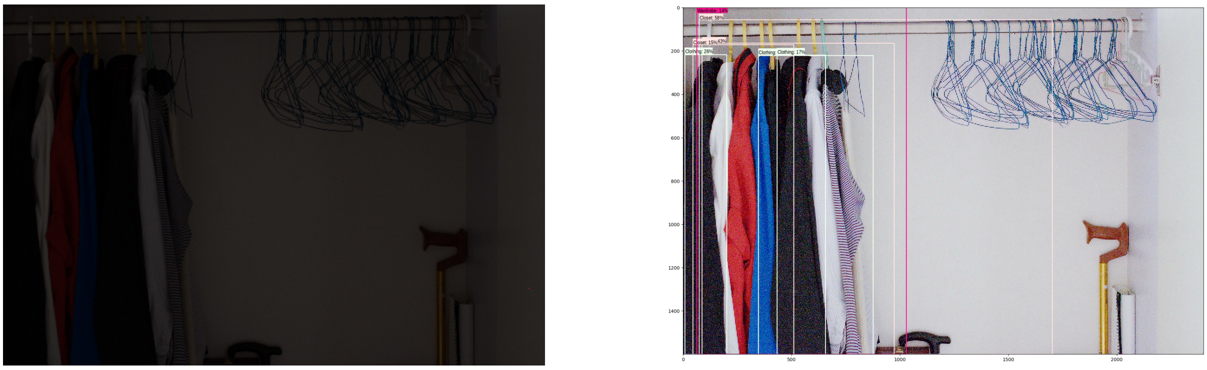

Figure 1: Comparison of the original low-light image (left) and the high-resolution image with detected objects (right).

Figure 1 illustrates the performance of the Faster R-CNN model for object detection in low-light conditions. The original low-light image (left) shows minimal visibility of objects, making it challenging for traditional detection methods. However, the enhanced high-resolution image (right) demonstrates the ability of the model to successfully detect and localize objects, such as clothes and other small details, that were nearly invisible in the original input. This highlights the effectiveness of the model in leveraging enhanced features for accurate detection, even under challenging lighting conditions.

4 Conclusion

This project highlights the effective application of deep learning techniques for addressing challenges in low-light video enhancement and object detection. By utilizing the ZeroDCE model for per-frame enhancement and the Faster R-CNN architecture for robust object detection, significant performance improvements were achieved in terms of visual clarity and detection accuracy. These results validate the novelty and practical utility of the proposed approaches.

The complete codebase, including the implementations for video enhancement, object detection, and supporting scripts, is available in the original GitHub repository. Future work may focus on optimizing the inference times further and generalizing these methods to tackle other tasks under low-light conditions, such as tracking and segmentation.

References

- C. Guo, C. Li, J. Guo, C. Loy,J. Hou, S. Kwong, R. Cong. (2020). Zero-Reference Deep Curve Estimation for Low-Light Image Enhancement. https://doi.org/10.48550/arXiv.2001.06826.

- Ren, S. et al. (2015). Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks.https://doi.org/10.48550/arXiv.1506.01497.