Image Sharpening Using Knowledge Distillation

Training Organization:

Intel Industrial Training 2025

Team Members:

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Problem Statement:

Enhance the visual quality of blurred low-resolution images using a lightweight neural network trained through knowledge distillation. The objective is to achieve high-quality, sharp images comparable to outputs from larger models like ResNet18, while maintaining fast and resource-efficient performance.

Objective:

To build a compact student CNN model that can:
- Restore image sharpness
- Mimic a high-capacity teacher model (ResNet18)
- Generalize to real-world blurred image scenarios

Data Sources:

- Training & Inference Dataset: DIV2K High Resolution Dataset (800 images)
- Preprocessing: Generated Gaussian-blurred versions of HR images using OpenCV

Model Architecture:

- Student Model: Lightweight CNN with 4 convolutional layers:
  - Conv2d(3, 64) → ReLU → Conv2d(64, 64) → ReLU
  - Conv2d(64, 32) → ReLU → Conv2d(32, 3)
- Teacher Model: Pretrained ResNet18 (ImageNet) with final FC layer removed
- Distillation Setup:
  - Pixel-level loss: MSE
  - Feature-level distillation: ResNet features with MSE

Training Details:

- Input Image Size: 384x384
- Epochs: 200
- Optimizer: Adam (lr=1e-4)
- Hardware: NVIDIA RTX 2050
- All checkpoints saved every 10 epochs (crash-proof)
- Final model: student_model_384x384_e200.pth

Model Outcomes:

- Inference completed on 800 blurry inputs
- Outputs saved in results/ folder
- Final visual results: moderately sharpened outputs
- Metric Evaluation:
  - Average SSIM: ~0.66 (Structural Similarity Index)

Subjective Study:

- Participants: 5 individuals including students and general viewers
- Setup: Each participant was shown 10 randomly selected triplets:
(Blurry Input | Sharpened Output | Ground Truth)
- Evaluation Method: Each participant rated the perceived quality of the sharpened output on a scale of 1 to 5, based on visual clarity, edge sharpness, and overall naturalness
- Result Summary:

- Average MOS (Mean Opinion Score): 3.4 / 5
- Comments indicated improved clarity and contrast in most outputs, though some images lacked fine detail
- Overall consensus: noticeable improvement, suitable for moderate enhancement tasks

Working Code:

- Project Folder includes:
  - main_train.py (training script)
  - inference.py (final prediction script)
  - models/student_model.py
  - utils/dataset.py
  - Checkpoints & outputs in /checkpoints and /results

Conclusion:

A custom CNN model was trained using knowledge distillation from ResNet18 to sharpen blurred images. Though the visual improvements were moderate, the model achieved stable performance and SSIM ~0.66. Further sharpness could be achieved via deeper models and perceptual loss, planned for future work.