ODA-GAN: Orthogonal Decoupling Alignment GAN Assisted by Weakly-supervised Learning for Virtual Immunohistochemistry Staining

Supplementary Materials

A. Implementation Details

Following the CUT framework [2], our ODA-GAN setup includes a ResNet-based generator G with nine blocks. The O-MLP is implemented with two 1×1 convolutional layers, each with 256 units. These layers are constrained on the Stiefel manifold [1]. We set the default temperature parameter $\tau = 0.07$, and used a queue with a maximum size of 800 for each contrastive learning queue. Optimization was performed over 100 epochs using the Adam optimizer, with hyper-parameters $\beta1 = 0.5$, $\beta2 = 0.999$. The learning rate was set to 0.0002 for the first 50 epochs, after which it linearly decayed to zero over the rest 50 epochs. All experiments were conducted on 256×256 pixel patches in an unpaired setting.

B. Subjective Evaluation

We conducted a visual Turing test involving three pathologists to assess the indistinguishability between real and virtual IHC images. The experts were shown 100 randomly selected patches from the GPC3 dataset, 50 of which were real and 50 were virtual, and asked to classify each patch as real or virtual. The results revealed our ODA-GAN was effective in deceiving the experts, with the average sensitivity of 62.6% and specificity of 59.2%, approaching random chance. Additionally, the experts were presented with 50 pairs of real and virtual IHC images and asked to evaluate the correctness of the staining. The results showed that our ODA-GAN generated realistic staining, with experts achieving 81% accuracy in identifying correctly stained images.

References

[1] Mayank Meghwanshi, Pratik Jawanpuria, Anoop Kunchukuttan, Hiroyuki Kasai, and Bamdev Mishra. Mctorch, a manifold optimization library for deep learning. Technical report, arXiv preprint arXiv:1810.01811, 2018. 1

[2] Taesung Park, Alexei A Efros, Richard Zhang, and Jun-Yan Zhu. Contrastive learning for unpaired image-to-image translation. In *Computer Vision–ECCV 2020: 16th European Conference, Glasgow, UK, August 23–28, 2020, Proceedings, Part IX 16*, pages 319–345. Springer, 2020. 1