Colorization: Using Deep Learning to Colorize DigiFace Images

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CSCI 1430

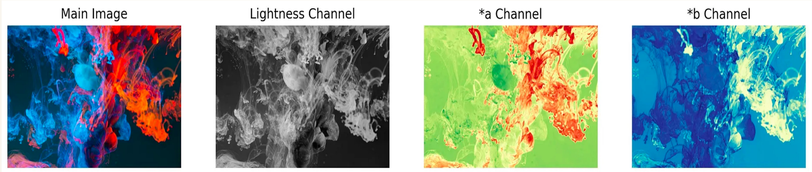
Motivation

Traditionally, colorizing historical black and white images is done manually and requires significant time and research. A face alone requires 20 layers of pink, blue, and green shades [1]. Deep learning can automate and accelerate this process.

Data and Image Representation

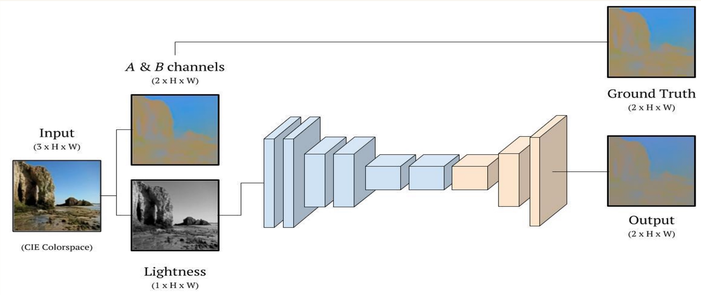
We are working with AI generated images from DigiFace-1M.

We use images in LABSpace. These have 3 channels: L, a*, b*.



Goal

Given the L (lightness) channel of an image, we want our model to output predictions for the a* (green-red) and b* (yellow-blue) channels.



3 Models: CNN, ResNet + CNN, GAN

CNN

We began by creating a simple CNN based on an encoder-decoder architecture. We first apply a series of convolution layers to extract features from the L channel, and then apply a series of deconvolution layers to upsample these features to form the a* and b* image channels.

ResNet + CNN

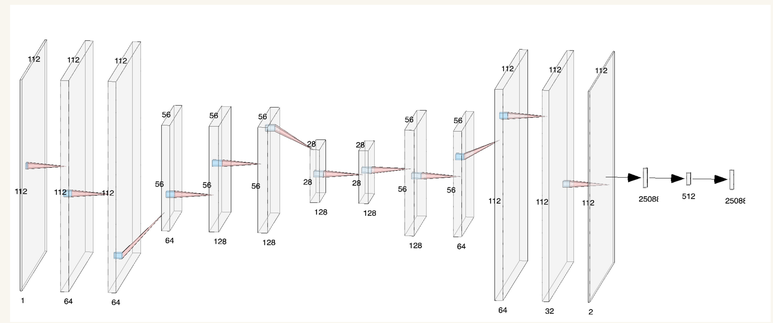
We then replaced our encoder with ResNet-50 for better feature extraction. In this model, we passed the L channel as an input, with ResNet-50 returning 2048 4x4 features. Our decoder uses these features to reconstruct the a* and b* image channels.

GAN

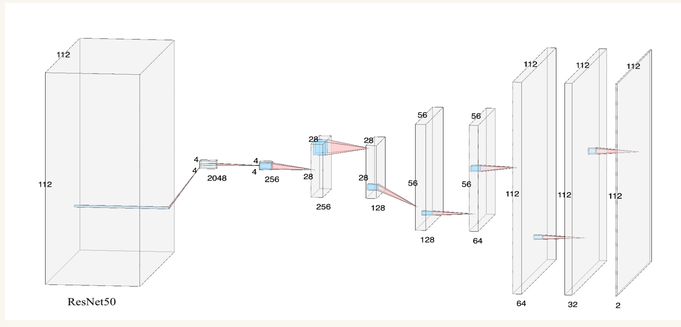
We noticed that both our CNN models tended to err towards more grey-ish/less vibrant colors. To tackle this issue, we used a GAN with our ResNet + CNN model as the generator. We used another CNN as the discriminator which dynamically changed the loss function for our generator.

Architectures

CNN Architecture



ResNet CNN Architecture (GAN Generator)



GAN Discriminator

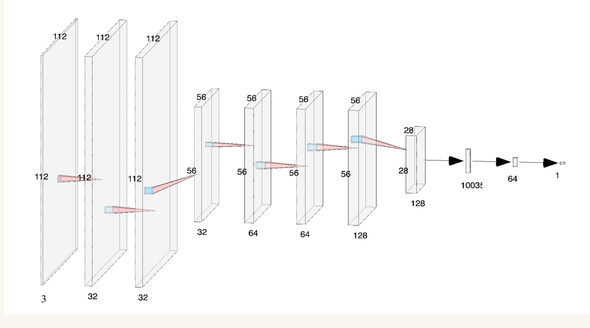
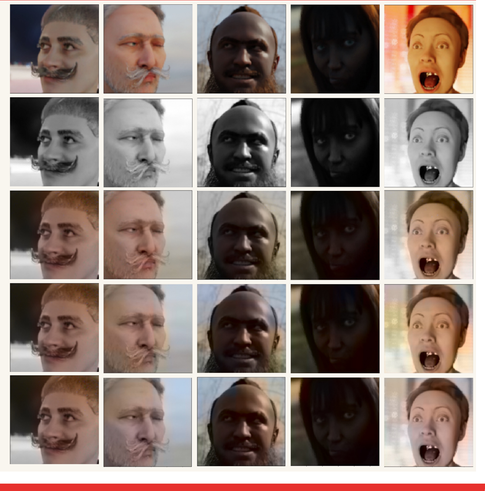
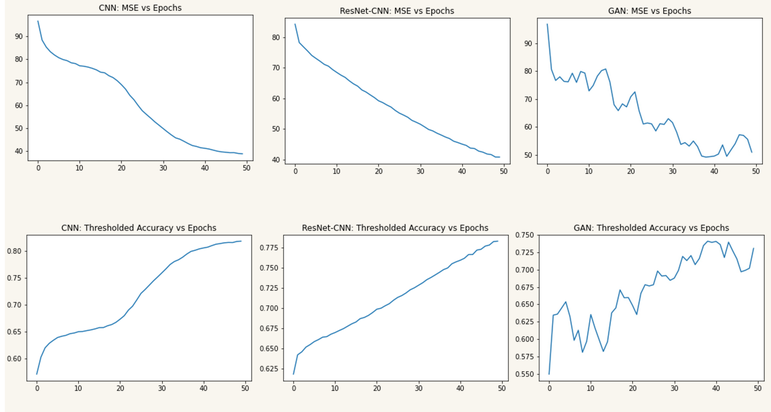


Image Results



Models' MSE and Threshold Losses



References

[1] Wallner, E. (2022, August 27). How to colorize black & white photos with just 100 lines of Neural Network Code. Medium. https://emilwallner.medium.com/colorize-b-w-photos-with-a-100-line-neural-network-53d9b4449f8d
[2] Zhang, R., Isola, P., & Efros, A. A. (n.d.). Colorful Image Colorization. https://doi.org/10.48550/arXiv.1603.08511
[3] Luke Melas. Image colorization with convolutional neural networks. (n.d.). https://lukemelas.github.io/image-colorization.html
[4] Shariatnia, M. (2020, November 18). Colorizing Black & white images with U-Net and conditional Gan-A tutorial. Medium. https://towardsdatascience.com/colorizing-black-white-images-with-u-net-and-conditional-gan-a-tutorial-81b2df111cd8

Acknowledgements

We would like to thank our TA Emily Wang, Professor James Tompkin, and the CS1430 course staff.