Utilizing Cross-Channel Autoencoders for Deep Learning Image Colorization

Names: Tyler Kaye, Harry Heffernan, Mitch Hamburger COS429: Computer Vision

Goal/Motivation

- Giving color to original black-and-white images
  - Give life to historical photographs.
  - Provide a more authentic and vivid memory for people old enough to have taken B&W photos.
- Goal: create a highly specialized cross-channel autoencoder capable of excellent performance on a small and controlled subset of images.
  - Accurately colorize landscapes, a common subject for old photographs.

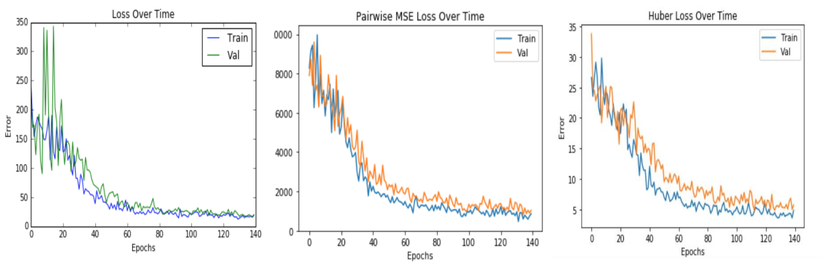
Related Work

- Research into the use of deep learning to colorize black-and-white images began in 2014, with largely unsatisfactory results.
  - Dahl used an inadequate loss function, produced sepia-toned colorizations.
  - Hwang et al. had success with the Huber loss function, but built a far larger and less specialized model than ours.
  - Zhang et al. took a specialized approach in attempting to learn a probability distribution, but an excessively large network spoiled their results.

Approach/Implementation

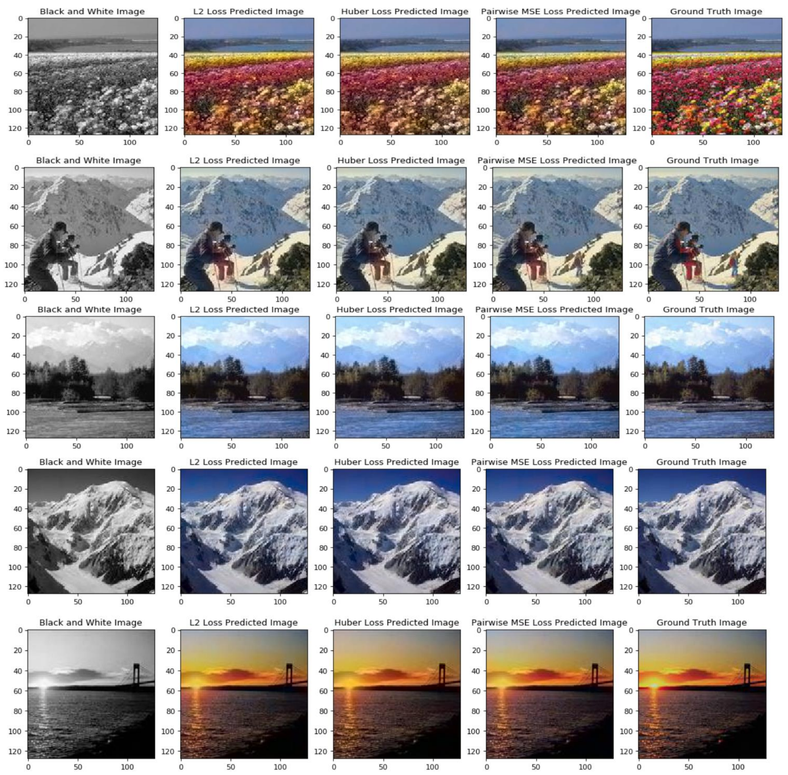
- We used the MIT CVCL Urban and Natural Scene dataset for richly colored and detailed images.
- The LAB color space allowed us to easily discretize the black-and-white and color elements of the image, using the L and AB channels, respectively.
- Standardizing and reducing the image size before training reduced the computational demands of our model.
- After first attempting the project using MATLAB and MatConvNet, we eventually switched to python and used TensorFlow to construct custom loss functions.
- We used an autoencoder, which takes as input the black-and-white version of an image, and outputs a colorization prediction that is then plugged into a loss function with the ground-truth
- To optimize the model, we implemented the cross-channel autoencoder with several different loss functions

Loss Function Performance

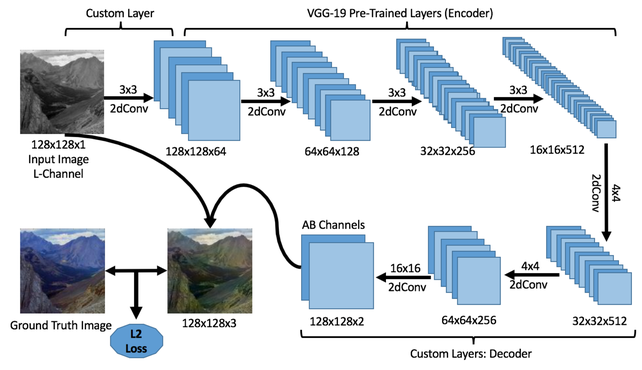


LAB Color Space

Results:



L2-Loss Network Architecture



Discussion:

- Many of the loss functions struggled with the colorization of background features and objects in bunches, such as the patch of flowers.
- The pairwise mean squared error demonstrated a visible advantage over the other loss functions in its ability to output more vibrant colorizations for secondary objects in the images.

True Black-and-White Images