IMAGE COLOURIZATION VIA CONVOLUTIONAL NEURAL NETWORKS AND DEEP LEARNING

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ABSTRACT

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1 INTRODUCTION

While the colour photography processes first emerged in the 1890s, colour photography did not become widely accessible until the 1970s Science & Museum (2020). As a result, most historic photographs are black and white and lack the visual richness that modern viewers are accustomed to. In addition, individuals who have their cataracts removed as a part of vision restoration processes have shown to struggle with identifying objects in black and white images Vogelsang et al. (2024), making most historic photographs inaccessible to them. This project aims to use deep learning to automatically colorize black and white images, with the goal of restoring visual information and making historical imagery more accessible for all audiences. Traditional, non deep-learning based colorization methods often produce desaturated results and rely heavily on human guidance Cheng et al. (2016), making them non-scalable. Conversely, deep networks such as CNNs effectively capture spatial and semantic features and produce realistic colourized images without user interaction Zhang et al. (2016), making deep learning an ideal approach for image colorization.

1.1 BACKGROUND & RELATED WORK

The challenge of image colourization has been approached in a wide variety of ways. Even within solutions involving deep learning techniques, there numerous unique design choices. One grouping method Zěger et al. (2021) results in five categories: simple colourization neural networks, user-guided colourization neural networks, diverse colourization neural networks, multi-path colourization neural networks, and examplar-based neural networks.

Simple colourization neural networks use feedforward CNNs to map grayscale inputs to colour outputs. One of the foremost solutions proposed by Zhang et al. Zhang et al. (2016) used a fully convolutional network to predict the a and b channels of the CIELAB colour space from grayscale images. Their architecture is composed of several convulational layers, each followed by a ReLU activation function and a batch normailization layer.

User-guided colourization neural networks use user input to guide the colourization process. One such solution Zhang et al. (2017) uses a fully convolutional network to predict the a and b channels of the CIELAB colour space from grayscale images, but also takes user input in the form of user-provided colour scribbles. The network is trained to minimize the difference between the predicted and user-provided colours, allowing it to learn to colourize images in a way that is consistent with the user's input.

Diverse colourization networks produce multiple colourization outputs for a given grayscale input. One such solution Vitoria et al. (2020) uses a generative adversarial network (GAN) to produce multiple colourization outputs for a given grayscale input. The GAN is trained to minimize the difference between the predicted and ground truth colours, allowing it to learn to produce diverse colourization outputs.

Multi-path colourization neural networks differentiate features at different scales. Iizuka et al. Iizuka et al. (2016) proposed a multi-path colourization neural network that uses multiple convolutional layers to extract features at different scales. The network is trained to minimize the difference between the predicted and ground truth colours, allowing it to learn to produce colourization outputs that are consistent with the features at different scales.

Exemplar-based neural networks use a set of exemplar images to guide the colourization process. In Su et al Su et al. (2020), example images are used to trasnfer the colour to the target image. Each instance is ouput to two different colourization networks which fuse to yield the final result. This group of solutions is easier to implement, as learning to colourize instances is significantly easier than learning to colourize an entire image.

2 Methodology

2.1 Data Processing

2.2 Architecture

2.3 Baseline Model

3 Ethical Considerations

4 Project Plan

4.1 Team Communication & Coordination

5 Risk Register

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