IMAGE COLOURIZATION VIA CONVOLUTIONAL NEURAL NETWORKS AND DEEP LEARNING

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ABSTRACT

This project addresses the challenge of automated colourization for 256×256 grayscale images using a dataset of 12,600 image pairs, balanced across human subjects, animals, and natural scenery. We frame colourization as a supervised learning problem in the CIELAB colour space, where a model predicts chrominance channels (a^*, b^*) from the luminance channel (L^*). A shallow convolutional neural network (CNN) provides the baseline performance, while our primary solution employs a deeper convolutional encoder-decoder architecture. This design captures high-level semantic features and spatial context, addressing limitations of shallow networks in perceptual realism. All source code, datasets, and results are publicly available here. —-Total Pages: 2

1 INTRODUCTION

While colour photography processes first emerged in the 1890s, colour photography did not become widely accessible until the 1970s (Science & Museum, 2020). Consequently, most historical photographs remain in black and white, lacking the visual richness that modern viewers are accustomed to. Moreover, individuals who undergo cataract removal as part of vision restoration procedures often struggle to interpret grayscale images, rendering many historical photographs inaccessible to them Vogelsang et al. (2024). This project aims to leverage deep learning to automatically colourize black and white images, with the goal of restoring visual information and improving accessibility for all audiences. Traditional, non-deep learning colourization methods tend to produce desaturated results and require extensive human input, limiting their scalability (Cheng et al., 2016). In contrast, deep neural networks such as convolutional neural networks (CNNs) can effectively learn spatial and semantic features, enabling realistic colourization without user intervention (Zhang et al., 2016). This makes deep learning a promising and scalable solution for image colourization.

2 CONTRIBUTIONS

Harkirpa	Peter	Thulasi	Youssef
24%	23%	26%	27%

Throughout the project, I was responsible for several important tasks that helped move the work forward. I conducted all the preliminary background research needed for the proposal, which helped define the project's scope and goals. I also helped create the project's Gantt chart to manage the timeline and track key milestones. One of my main contributions was designing and implementing the baseline colourization model, including coding and debugging. I wrote a large part of the progress report to clearly document our work and challenges.

I researched various colourization methods to explore ways to improve the model and implemented many of these techniques to add new features. I completed most of the final report, explaining our results and progress. I also prepared most of the content for the final presentation, focusing on communicating our work clearly. Additionally, I regularly helped organize and document the minutes from weekly team meetings to keep track of decisions and discussions. Throughout the project, I worked closely with my teammates to support our development process.

Some tasks were not completed as planned. Although I researched many diverse colourization methods, the full implementation of all these techniques was not finished on time. Some debugging and polishing of advanced methods remain unfinished.

REFERENCES

Zezhou Cheng, Qingxiong Yang, and Bin Sheng. Deep colorization, 2016. URL https://arxiv.org/abs/1605.00075.

National Science and Media Museum. A short history of colour photography, Jul 2020. URL https://www.scienceandmediamuseum.org.uk/objects-and-stories/history-colour-photography.

Marin Vogelsang, Lukas Vogelsang, Priti Gupta, Tapan K. Gandhi, Pragya Shah, Piyush Swami, Sharon Gilad-Gutnick, Shlomit Ben-Ami, Sidney Diamond, Suma Ganesh, and Pawan Sinha. Impact of early visual experience on later usage of color cues. *Science*, 384(6698):907–912, 2024. doi: 10.1126/science.adk9587. URL https://www.science.org/doi/abs/10.1126/science.adk9587.

Richard Zhang, Phillip Isola, and Alexei A Efros. Colorful image colorization. *European conference on computer vision*, 2016.