Internship Report: Generative AI for Image Colorization

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Company: NULL Class EDUTech PVT ltd

1. Introduction

This report summarizes the work completed during my internship, which focused on image colorization using generative AI and interactive interfaces. The primary aim was to explore various techniques to colorize grayscale or domain-transformed images (e.g., sketches, infrared) through custom models implemented in TensorFlow, Keras, and PyTorch. Each task was designed to challenge and expand my understanding of computer vision, model development, and user interaction.

2. Background

Image colorization is a computer vision technique where grayscale or domain-specific images are automatically or semi-automatically transformed into color images. It is useful in restoration, satellite imaging, art, and scientific visualization. Modern approaches allow generative AI networks to learn meaningful color mappings and apply them under various constraints. This internship aimed to implement five distinct tasks ranging from basic colorization to advanced cross-domain colorization, all using custom-built models rather than pretrained solutions.

3. Learning Objectives

- Develop and train custom image colorization models using generative AI frameworks
- Integrate segmentation and user feedback for targeted and conditional colorization
- Design interactive GUIs with Streamlit for user-driven colorization control
- Experiment with different domains such as sketches and infrared
- Evaluate models using image similarity metrics like MSE and PSNR

4. Activities and Tasks

Task 1: Basic Image Colorization

- Implemented a custom CNN model using TensorFlow/Keras to colorize grayscale images
- Focused on generating realistic outputs using L channel as input and predicting ab channels

Task 2: Semantic Segmentation for Targeted Colorization

- Combined U-Net-based segmentation with a PyTorch colorization model

- Enabled colorization of specific regions (foreground/background/entire image)
- Created a Streamlit GUI for upload, segmentation visualization, and result downloads

Task 3: Conditional Image Colorization

- Allowed user-defined region selection and color criteria
- Built a generative model that respects user color constraints during prediction
- Integrated a flexible GUI for interactive assignment of color regions

Task 4: Interactive User-Guided Colorization

- Enhanced GUI interactivity with live preview and adjustable color strength
- Designed custom color blending logic preserving grayscale luminance
- Enabled real-time region editing and dynamic user feedback

Task 5: Cross-Domain Image Colorization

- Developed a robust framework for colorizing sketches, infrared, and standard images
- Incorporated both generative AI and statistical color models
- Built a full Streamlit app for training, testing, and multi-domain conversion

5. Skills and Competencies Developed

- Proficiency in TensorFlow, Keras, and PyTorch for building custom models
- Experience with OpenCV, NumPy, Matplotlib, and Scikit-learn
- GUI development with Streamlit
- Application of segmentation, edge detection, and color mapping techniques
- Model evaluation using PSNR, MSE, color histogram correlation, and confusion matrices
- Understanding of color spaces and transformation techniques

6. Feedback and Evidence

- Successfully implemented all tasks with functioning GUIs
- Colorization results demonstrate clear model learning and adaptation
- Regular code reviews improved implementation quality and user interface design

7. Challenges and Solutions

Challenge	Solution
Ensuring dimensional consistency between input and output tensors	Adopted padding techniques and careful resizing
Making models interactive without slowing down processing	Used session states and caching in Streamlit, resized images for preview
Handling various image domains with consistent quality	Developed domain-specific algorithms and fine-tuned them with smaller datasets
Training generative models from scratch without pretrained components	Created custom architectures with appropriate parameter sizes and implemented data augmentation techniques
Balancing image quality with processing speed	Implemented progressive resolution techniques and optimized model architecture

8. Outcomes and Impact

- Delivered a fully functional multi-task system covering modern colorization techniques
- Learned to balance computational complexity with interactive user experience
- Created reusable modules for future research or deployment
- Gained deep insights into image translation problems and model-user interface synergy
- Developed expertise in building complete image processing pipelines from data preparation to result evaluation

9. Conclusion

This internship allowed me to gain hands-on experience in a specialized domain of computer vision. From basic generative models to complex, multi-modal systems, I learned to conceptualize, implement, and deliver solutions for real-world colorization problems. Working with custom architectures rather than pretrained models deepened my understanding of the underlying principles and techniques. The knowledge and tools I acquired will support my future work in AI and image processing.