Internship Completion Report

Role: Data Science Intern

Company: NullClasse

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Introduction

This internship report outlines the activities and achievements during my role as a Data Science Intern at NullClasses. The work was centered on developing advanced image and video colorization systems using deep learning and computer vision.

Over the 2-month internship period (07-07-2025 to 07-09-2025), I worked on five major tasks that explored different aspects of colorization and interactivity.

The primary objectives included:

- Creating visualization techniques to better understand model behavior,
- Designing real-time video colorization pipelines for live streams and webcams,
- Incorporating conditional rules to guide the colorization process,
- Developing an interactive user-guided colorization system for region-based personalization, and
- Applying semantic segmentation for multi-object real-time colorization.

Through these tasks, I gained both theoretical insights and practical experience in building end-to-end AI solutions that balance performance, interactivity, and usability.

Background

Image and video colorization is a challenging domain in computer vision that aims to convert grayscale inputs into natural and visually appealing colored outputs.

Its applications span across historical photo restoration, film enhancement, creative arts, gaming, augmented/virtual reality, and real-time video systems.

The internship projects explored this domain in depth, moving beyond static colorization to real-time, user-guided, and multi-object systems. This not only required understanding deep learning models but also designing interactive GUIs and optimizing solutions for efficiency.

Learning Objectives

1. To visualize intermediate stages of colorization for model explainability and debugging.
2. To develop a real-time video colorization system capable of handling webcam feeds and video streams.
3. To implement conditional colorization, where users can influence the process with color-specific rules.
4. To design an interactive user-guided system, enabling users to select regions and assign colors dynamically.
5. To integrate semantic segmentation for real-time multi-object detection and

targeted colorization.

6. To strengthen skills in Python, deep learning frameworks (PyTorch/TensorFlow), OpenCV, and GUI development.

Activities and Tasks

1. Visualizing the Colorization Process

- Implemented visualization of intermediate stages of the model pipeline.
- Used feature maps and hidden layer activations to track how grayscale images gradually transform into colored outputs.
- Improved interpretability of the system, enabling more informed debugging and model optimization.

2. Real-time Video Colorization

- Designed and deployed a real-time system that colorizes live webcam feeds and video streams.
- Implemented an interactive GUI to display results in real time.
- Added functionality to switch between multiple trained models during execution for comparison and experimentation.

3. Conditional Image Colorization

- Built a model that supports user-defined conditions, such as enforcing blue skies or green grass.
- Developed a GUI where users could select or enter color preferences for targeted regions.
- Integrated these preferences into the pipeline so that user feedback directly shaped the output.

4. Interactive User-Guided Colorization

- Created a highly interactive system that allowed users to manually select specific image regions.
- Designed a GUI for image upload, region selection, and custom color assignment.
- Ensured outputs dynamically updated in real time, giving users a personalized and controllable colorization experience.

5. Real-time Multi-Object Colorization with Semantic Segmentation

- Implemented a semantic segmentation-based system to detect and colorize multiple objects in real time (e.g., cars, trees, people, buildings).
- Applied predefined and consistent color schemes to maintain visual quality.
- Designed a GUI to let users upload or stream video while observing simultaneous multi-object colorization in real time.

Skills and Competencies

1. Proficiency in Python programming and ML frameworks (TensorFlow, PyTorch).
2. Experience in computer vision and image processing (OpenCV).
3. Understanding of deep learning architectures for colorization and segmentation.
4. GUI development experience with Tkinter, PyQt, and Streamlit for building real-time and interactive applications.
5. Strong problem-solving and debugging skills for real-time ML systems.
6. Familiarity with Git/GitHub and handling large datasets with preprocessing pipelines.

Feedback and Evidence

- Regular mentor feedback refined the scope and improved methodologies.
- Code reviews and testing cycles ensured robust performance and usability.
- Demonstrations of real-time systems and interactive GUIs validated the practical utility of the developed solutions.

Challenges and Solutions

- Challenge: Maintaining accuracy across diverse images and videos. Solution: Used data augmentation and trained with diverse datasets for broader generalization.
- Challenge: Meeting real-time speed requirements without losing quality. Solution: Applied model optimization techniques such as pruning and quantization to accelerate inference.
- Challenge: Designing intuitive GUIs for interactive and conditional tasks. Solution: Conducted user testing and refined designs iteratively to ensure usability.

1. **Challenge**: Balancing model complexity with real-time performance requirements. **Solution**: Utilized model optimization techniques such as quantization and pruning to improve inference speed.
2. **Challenge**: Creating an intuitive user interface for the interactive colorization system. **Solution**: Conducted user testing and iteratively refined the GUI based on feedback to ensure ease of use.

Outcomes and Impact

- Successfully developed five distinct colorization models.
- Improved accuracy and robustness with augmentation.
- Designed GUIs for targeted and real-time applications.
- Achieved accuracy >70% across tasks.
- Strengthened ML and CV expertise with real-world use cases.

Conclusion

This internship provided invaluable hands-on experience in developing advanced image colorization systems using state-of-the-art machine learning techniques. The projects undertaken challenged me to apply theoretical knowledge to real-world problems, enhancing my skills in deep learning, computer vision, and software development. The experience gained during this internship has significantly contributed to my professional growth and has prepared me for future endeavors in the field of artificial intelligence and computer vision.