CO543 Image Processing
Mini Project Proposal Report

TITLE: **Colorization of Grayscale Images**

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1) INTRODUCTION

What is colorization in GrayScale images?

Colorization of a Grayscale image is assigning colors to grayscale images to make them appear in visually appealing and realistic.This process involves predicting most suitable colors for various regions of an image based on context.this task can be done by manually or automatically using advanced algorithms and AI models.

This process significant for:

- **Media Restoration** : Bringing life to old black and white photos and films,preserving history
- **For Healthcare purposes** : Enhancing grayscale images for better diagnosis
- **Astrology** : mainly can be used to get better photos of galaxies and celestial objects.

2) PROBLEM STATEMENT

Problem : The process of colorizing grayscale images presents several challenges:

1. **Manual Colorization**: Repetitive and time-consuming.
2. **Automated Methods**: Often fail to produce realistic and natural color outputs.
3. **AI-Based Solutions**: Require large and diverse datasets to train models effectively, ensuring accuracy and reliability.

Dataset: For this project, publicly available datasets such as **CIFAR-10** and **ImageNet** will be utilized to train and evaluate the AI models.

Expected Challenges:

- Obtaining sufficient and diverse training data for generalization.

- Ensuring generated colors align with human perception.
- Balancing computational efficiency with high-quality outputs.

Potential Solutions:

1. **Data Augmentation**: Enhance the dataset with variations to simulate diversity.
2. **LAB Color Space Utilization**: Simplify the model's task by focusing on chromatic channels (A and B) while keeping L (luminance) constant.
3. **Model Optimization**: Use advanced neural network architectures like CNNs to improve color realism and minimize computational overhead.

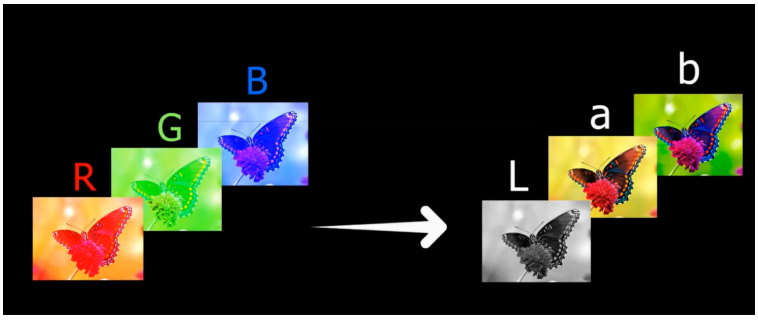
3) OBJECTIVES

- Design an AI pipeline for grayscale image colorization.
- Train models with diverse datasets for better generalization
- Evaluate performance using visual outputs.

4) METHODOLOGY

Approach:

1) LAB Color Space Conversion:



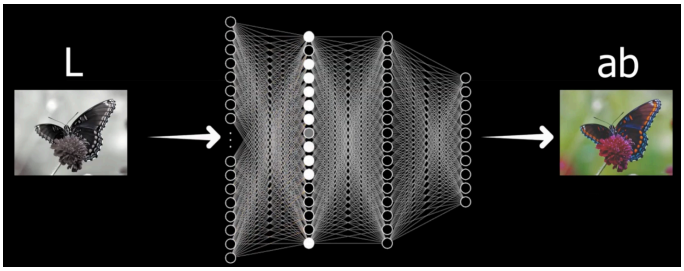
- Convert RGB Colors to LAB color space.

  What/why is LAB color space?

1. **L (Lightness)**
2. **A (Green-Red Channel):**
3. **B (Blue-Yellow Channel):**

   The LAB color space is preferred over RGB for tasks like image colorization because it separates luminance (L) from chromatic information (A and B), making it easier to work with grayscale images where luminance is already present. LAB aligns with human vision, offering perceptual uniformity, where changes in values correspond to consistent color perception, unlike RGB. This separation allows independent manipulation of color without affecting brightness and simplifies AI models, which only need to predict A and B channels while keeping the L channel unchanged, reducing task complexity.

2) Model Training:



- Feed the L channel into a Convolutional Neural Network.
- Train the model to predict AB values.

3) Post-Processing:

- Combine the predicted AB channels with the original L channel.
- Convert back to RGB for the final colorized image.

Tools:

4) OpenCV for LAB-RGB conversions.
5) TensorFlow/PyTorch for model implementation.
6) Datasets: CIFAR-10, ImageNet

5) PROPOSED TIMELINE

Week	Task	Deliverables
Week 1–2	**Initial Preparation**: Understand the project requirements, form groups, brainstorm ideas, and explore potential datasets and methodologies	N/A
Week 3	**Proposal Preparation and Submission**: Write and submit the proposal with problem statement, objectives, datasets, methodologies, challenges, and solutions	Proposal Presentation (Week 3)
Week 4–5	**Learning Deep Learning Basics**: Study concepts like CNNs, GANs, LAB color space, and frameworks like TensorFlow/PyTorch. Explore available pre-trained models and datasets	N/A
Week 6–7	**Dataset Finalization and Initial Implementation**: Collect/pre-process datasets or explore pre-labeled datasets. Begin model selection and preliminary experimentation	Progress updates within the team.
Week 8	**Milestone Progress Presentation**: Present progress, implemented methods, initial results, challenges, and insights. Use feedback to refine the project.	Milestone Progress Presentation (Week 8)
Week 9–10	**Model Implementation and Tuning**: Finalize the model's architecture. Focus on training, hyperparameter tuning, and refining results. Document any changes to methodology or datasets.	Progress notes for the final report.
Week 11	**Evaluation and Testing:** Evaluate the model using metrics like PSNR, SSIM, or perceptual quality. Compare results with	N/A

	benchmarks and analyze shortcomings	
Week 12	**Final Report Submission**: Compile a comprehensive report covering background, methodology, experimentation, results, and conclusions.	Final Report Submission (Week 12)
Week 13	**Final Presentation Preparation**: Prepare slides and visualizations for the final presentation. Incorporate feedback received during the milestone presentation	N/A
Week 14	**Final Presentation**: Deliver the final presentation, emphasizing the project's contributions, findings, and lessons learned.	Final Presentation (Week 14)

6) Expected Outcomes and Benefits

Outcomes:

- A trained AI model capable of colorizing grayscale images effectively.
- Realistic visual outputs evaluated by metrics and feedback.
- Can be scaled up for video colorization and real-time applications

Benefits:

- Can be used to highlight specific regions of interest, improving diagnosis and analysis in Medical Imaging.
- Preservation and Restoration of Historical Media
- Artists and designers can use this technology to experiment with new styles

7) References

1. Zhang, R., Isola, P. and Efros, A.A. (2016). Colorful Image Colorization. *arXiv:1603.08511 [cs]*. [online] Available at: https://arxiv.org/abs/1603.08511 [Accessed 10 Dec. 2024].

2. Iizuka, S., Simo-Serra, E., & Ishikawa, H., 2016. *Let there be Color!: Joint End-to-end Learning of Global and Local Image Priors for Automatic Image Colorization*. Proceedings of the 2016 ACM SIGGRAPH Conference. DOI: 10.1145/2897824.2925974 [Accessed 09 Dec. 2024].

3. Black (2022). *Black and white image colorization using Python, OpenCV and Deep Learning*. [online] YouTube. Available at: https://youtu.be/gAmskBNz_Vc?si=IF6k82HnCyczhBlO [Accessed 11 Dec. 2024].

4. LearnOpenCV, n.d. *Understanding LAB Color Space and Its Applications in Image Processing*. Available at: https://www.learnopencv.com [Accessed 11 Dec. 2024].