2024S-T3 BDM 3035 - Big Data Capstone Project 01
(DSMM Group 1 & Group 3)

Milestone 1

AI Image Remastering

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3. Introduction

3.1 Overview of the Project

The rapid advancement of technology has heightened the demand for high-quality images in various fields, including medical imaging, satellite imaging, and photography. However, obtaining high-resolution images can often be challenging due to limitations in imaging hardware, environmental conditions, or data transmission constraints. To address this issue, our project focuses on enhancing the resolution of low-quality images using state-of-the-art deep learning techniques.

3.2 Project Objectives

The primary objective of this project is to develop a robust and efficient image enhancement pipeline that can transform low-resolution images into high-resolution counterparts with improved visual quality. By leveraging the power of convolutional neural networks (CNNs) and pre-trained models such as SRGAN, ESRGAN, Real-ESRGAN, and GFPGAN, we aim to achieve superior image quality enhancement that surpasses traditional methods.

3.3 Significance of the Project

This project is significant because it has the potential to revolutionize various industries by enabling the enhancement of images where high-resolution data is critical. Enhanced image resolution can lead to more accurate medical diagnoses, improved satellite image analysis, and better-quality photographs, thereby contributing to advancements in these fields.

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4. Progress Report

4.1 Summary of Tasks Completed

Since the project initiation on 7 May 2024, we have made substantial progress. The key tasks completed so far include:

- **Dataset Acquisition:** We downloaded a comprehensive dataset from Kaggle, containing high-resolution images that serve as our ground truth.
- **Image Preprocessing:** We ensured that all images have consistent dimensions and aspect ratios. This preprocessing step is crucial for the training of our models.

- **Image Degradation:** To simulate low-resolution images, we applied various types of random noise and blur to the high-resolution images. These low-resolution images were saved in a separate folder for training purposes.
- **Model Development:** We developed a simple Convolutional Neural Network (CNN) model aimed at predicting high-resolution images from low-resolution counterparts.
- **Model Training:** The CNN model was trained using the preprocessed dataset. Initial results showed slight improvements in image quality, indicating the need for further refinement and more advanced techniques.

4.2 Key Achievements and Milestones Reached

- **Successful Data Preparation:** The dataset was successfully downloaded, and preprocessing was completed, ensuring uniform image dimensions and aspect ratios.
- **Generation of Training Data:** Low-resolution images were generated by adding noise and blur, providing a robust dataset for training.
- **Initial Model Training:** The simple CNN model was implemented and trained, yielding initial insights into the challenges of image enhancement.

4.3 Deviations from the Original Plan

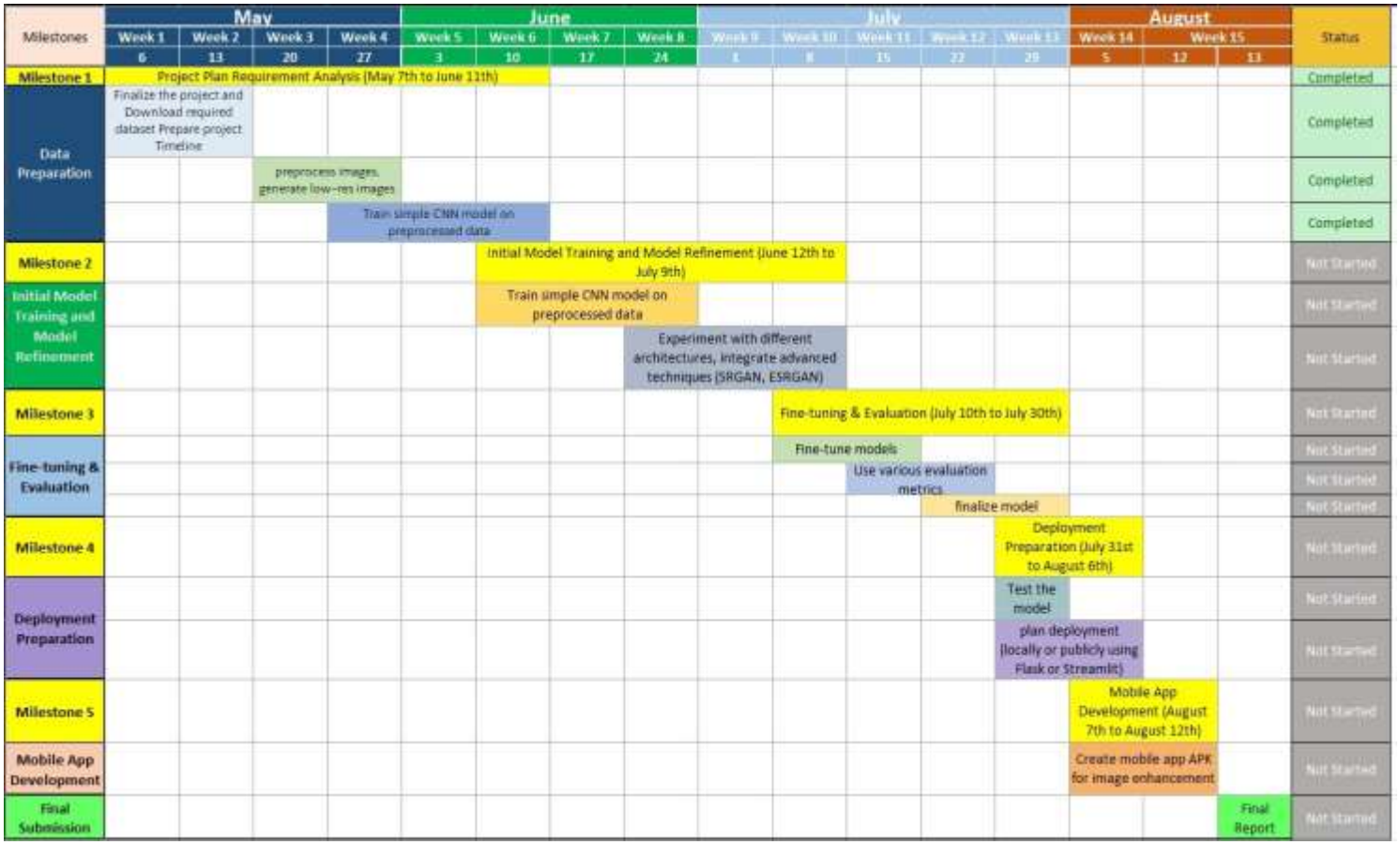
During the initial phase, we encountered a few deviations from our original plan:

- **Model Performance:** The initial CNN model did not achieve the desired level of image quality enhancement. The results were only marginally better than the low-resolution images, necessitating a shift towards more sophisticated models.
- **Time Allocation:** More time was required for data preprocessing and model training than initially anticipated. This adjustment was necessary to ensure the quality and consistency of our dataset.

To address these deviations, we have decided to incorporate pre-trained models such as SRGAN, ESRGAN, Real-ESRGAN, and GFPGAN into our workflow. These models, trained on extensive datasets, are expected to provide better performance and more significant improvements in image quality.

Git Repo Link: https://github.com/shanmugapriyan357/Big-Data-Capstone-Project-AI-Image-Remastering-/tree/Dev

5. Modified Timeline Table



Link for Timeline Excel: [Project Timeline.xlsx]

6. Next Steps

A Brief Description of Tasks to be Undertaken

The upcoming steps in our project involve the following tasks:

- **Implementation of Pre-trained Models:** We will integrate and fine-tune pre-trained models such as SRGAN, ESRGAN, Real-ESRGAN, and GFPGAN to enhance the resolution of low-quality images.
- **Model Evaluation and Comparison:** We will evaluate the performance of these pre-trained models using various metrics like PSNR (Peak Signal-to-Noise Ratio) and SSIM (Structural Similarity Index) to determine the best-performing model.
- **Fine-tuning Models:** Based on initial evaluations, we will fine-tune the best-performing models to further improve their accuracy and effectiveness.
- **Validation and Testing:** We will validate the fine-tuned models using a separate validation dataset and perform extensive testing to ensure the robustness of the models.
- **Deployment:** We will deploy the final model using Flask or Streamlit to create a web application for image enhancement. If possible, we will also create a mobile app APK to enable the use of our enhancement tool on mobile devices.

Expected Outcomes and Goals for the Next Phase

- **High-Quality Image Enhancement:** We aim to achieve significant improvements in image quality, making low-resolution images visually comparable to high-resolution ones.
- **Model Selection:** Identification and fine-tuning of the best-performing pre-trained model for our specific use case.
- **Successful Deployment:** Creation of a user-friendly web application and, potentially, a mobile app for easy access to our image enhancement tool.
- **Comprehensive Evaluation:** Detailed analysis and documentation of model performance to guide future improvements and applications.

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7. Challenges Faced

During the initial phase of the project, we encountered several challenges:

- **Model Performance:** The initial simple CNN model did not achieve the desired level of image quality enhancement. The results were only slightly better than the low-resolution images.
- **Data Preprocessing:** Ensuring consistent dimensions and aspect ratios for all images was more time-consuming than anticipated.
- **Resource Constraints:** Training advanced models requires significant computational resources, which limited the speed of our initial experiments.

To address these challenges, we pivoted to using pre-trained models, which are expected to offer better performance. We also allocated additional time for data preprocessing to ensure high-quality input data for training.

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8. Lessons Learned

From the work completed so far, we have gained several key insights:

- **Importance of Preprocessing:** High-quality and consistent preprocessing of data is crucial for the success of image enhancement models.
- **Model Complexity:** Simple CNNs may not be sufficient for high-quality image enhancement, highlighting the need for more advanced models.
- **Resource Management:** Effective planning and allocation of computational resources are essential to manage the demands of training advanced models.
- **Flexibility:** Being flexible and open to modifying the original plan is important to address unexpected challenges and improve project outcomes.

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9. Conclusion

The project is currently on track, with significant progress made in data preparation and initial model training. While we encountered some challenges, we have adapted by shifting to more advanced pre-trained models. The next steps involve implementing and fine-tuning these models, validating their performance, and deploying the best-performing model through a web application and potentially a mobile app. By continuing to build on our progress and addressing any new challenges that arise, we are confident in our ability to achieve our project objectives by the final deadline.

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10. References

- https://www.kaggle.com/code/amarlove/low-resolution-images-to-high-resolution
- https://github.com/TencentARC/GFPGAN/blob/master/gfpgan/data/ffhq_degradation_dataset.py

- https://ieeexplore.ieee.org/document/8878706
- https://medium.com/axinc-ai/real-esrgan-super-resolution-model-enhanced-for-denoising-dd581b2702a8