Synthetic Human Face Generation Using Deep Convolutional Generative Adversarial Networks (DCGAN)

R Thaneesh Varma | P Nikhil Krishna | S Jatin Chandra | K Pranav

Dr. Rajib Debnath

Department of Computer Science & Engineering

ABSTRACT

The project involves using a Deep Convolutional Generative Adversarial Network (DCGAN) to generate realistic human faces. DCGANs are a type of generative model that learns to create images by training on a dataset of real images. The goal is to train the DCGAN on a dataset of human faces and then use the trained model to generate new, realistic-looking faces that do not correspond to any specific individual but capture the overall characteristics of human faces. DCGANs consist of a generator that creates new images and a discriminator that distinguishes between real and fake images. By incorporating convolutional layers, DCGANs effectively capture spatial hierarchies and patterns to produce high-quality images. The project begins with collecting a diverse dataset of real human faces, which is then preprocessed and used to train the DCGAN. Through iterative training, the generator improves its ability to create realistic faces, while the discriminator becomes better at distinguishing between real and generated images.

INTRODUCTION

Introduction

The project focuses on developing a system for synthetic human face generation using Deep Convolutional Generative Adversarial Networks (DCGAN). DCGANs have shown significant success in producing realistic, detailed images, particularly in the area of human face generation, which is valuable for a range of applications such as virtual avatars, digital entertainment, and therapeutic uses in mental health.

Objectives

- Primary Goal: Enable the generation of new, artificial faces that do not correspond to any specific individual but maintain the lifelike characteristics observed in real-world images.
- Diversity and Realism: Ensure the generated faces are natural, convincing, and capture a broad variety of demographics, including ethnicity, age, and gender.

Challenges

- Training Instability: DCGANs can be unstable during training.
- Mode Collapse: The model may fail to produce a wide variety of outputs, repeating a limited set of images.

Solutions

- Advanced GAN Architectures: Experiment with different training strategies and adopt advanced GAN architectures such as StyleGAN or Conditional GAN.
- Diverse Datasets: Integrate diverse datasets like CelebA, AR, and MS1MV2 to enhance model robustness and mitigate bias.
- Techniques: Employ data augmentation and hyperparameter tuning to stabilize training and improve performance.

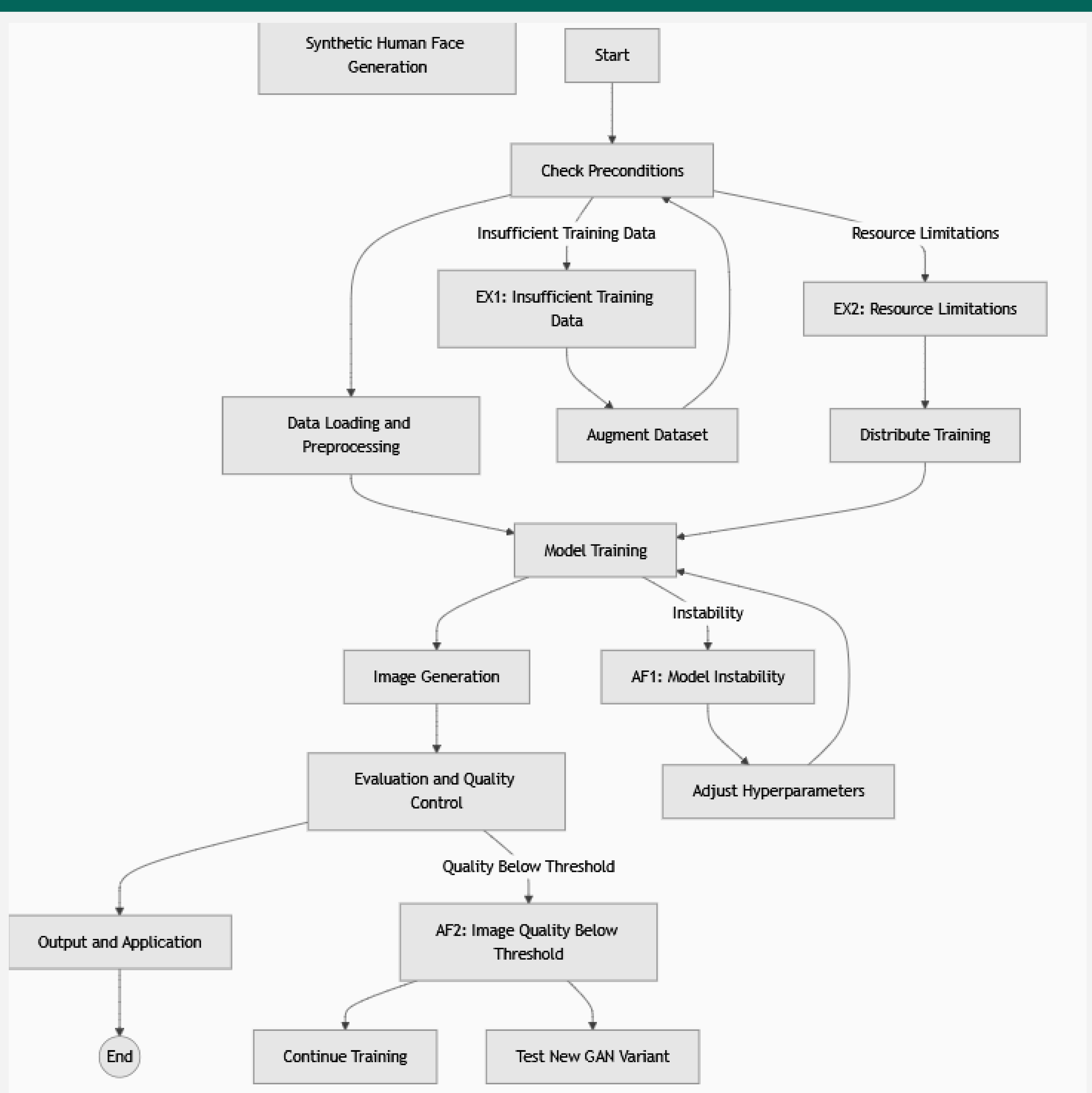
Contributions

- Advancements in GAN-based Synthesis: Contribute to the broader field of generative modeling.
- Applications: Potential use in industries ranging from entertainment to mental health, where realistic digital avatars can play therapeutic roles.

Future Work

- Exploration: Lay the groundwork for future explorations into more sophisticated models and optimized training techniques.
- Impact: Push the boundaries of what is achievable in realistic image generation.

METHODOLOGY

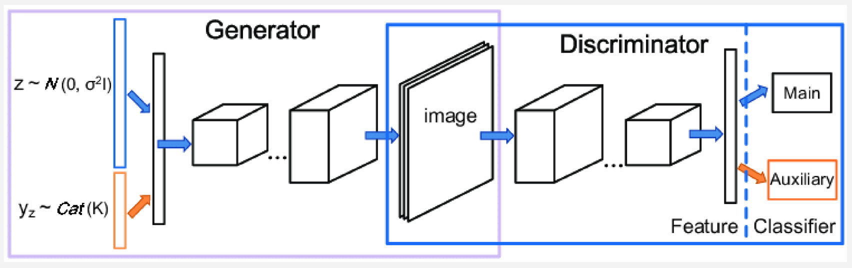


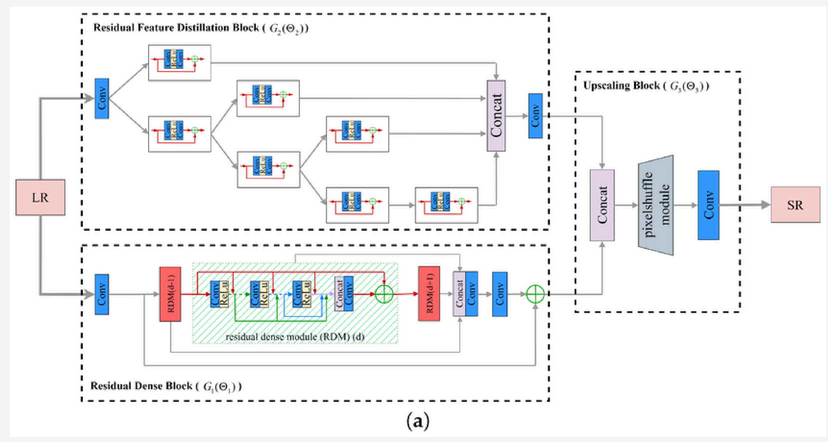
ALGORITHMS

Initial Model - Simple GAN: The project started with a basic Generative Adversarial Network (GAN) model to generate initial synthetic face images. This model consists of two components: a Generator that creates new images, and a Discriminator that distinguishes between real and generated images. The two networks train together in a competitive process, gradually improving the quality of the generated faces.

Future Models - StyleGAN: To enhance image realism and attribute control, the project is considering StyleGAN, an advanced GAN architecture. StyleGAN offers more precise control over various facial attributes, allowing for high-quality outputs with a rich diversity in expressions, features, and textures.

Alternative Option - TL-GAN: Another option under consideration is TL-GAN (Transfer Learning GAN), which leverages pre-trained GAN models and fine-tunes them for specific tasks. This approach can improve training stability and reduce computational demands, while still producing high-quality, diverse synthetic faces.





RESULTS

Figures 1, 2, and 3 present key outcomes of our model training and image generation process. Figure 1 shows the combined loss values of the generator and discriminator during training, highlighting the progression of learning. Figure 2 displays real images from the dataset, serving as a quality reference, while Figure 3 presents fake images generated by our simple GAN model.

The generated images in Figure 3 demonstrate the model's initial capacity for synthetic face creation, though they lack some details compared to the real images in Figure 2. These results establish a foundation for further refinement with advanced GAN architectures.

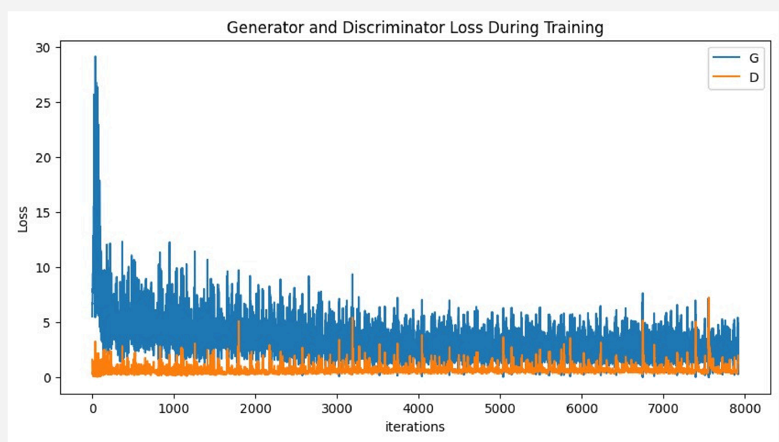


Fig 1 (Analysis)

Fig 2 (Real Images)

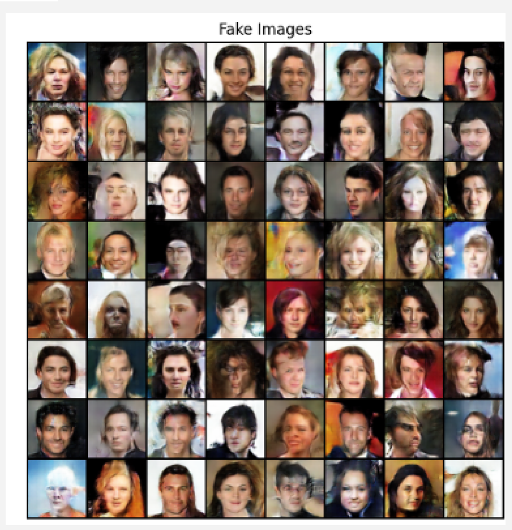


Fig 3 (Generated Images)

CONCLUSION

This project demonstrates the potential of generative adversarial networks (GANs) for realistic human face generation. By starting with a simple GAN model and considering advanced architectures like StyleGAN and TL-GAN, we aim to overcome initial limitations in image quality and diversity. These advanced models offer greater control over facial attributes, enabling the generation of lifelike and diverse faces. Our research highlights both the promise and challenges of GAN-based synthetic image creation and sets a foundation for future work focused on stability, bias reduction, and application across industries such as entertainment and digital identity.

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