"FreeU: Free Lunch in Diffusion U-Net"

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1 Brief Overview

This paper presents a novel method called **FreeU**, which enhances the quality of image generation in diffusion models without requiring additional training or fine-tuning. By strategically re-weighting the contributions from the U-Net's skip connections and backbone feature maps, FreeU significantly improves the generation quality while maintaining computational efficiency.

The GitHub repository for this project can be found at:
`https://github.com/ChenyangSi/FreeU`.

2 Dataset Description

There is no specific dataset required for this paper. I will be using the different pre-trained diffusion models and integrate the FreeU code in them to show the improved results. I have used the pre-trained **Stable Diffusion** model and generated around 60 propmts for testing it. The prompts are written in the main.ipynb as a list named **examples**. We are free to test on any other prompt that is simple enough for the model by adding it to the examples.

3 Implementation Details

The training strategy outlined in the paper focuses on optimizing the denoising capabilities of the U-Net architecture by introducing two modulation factors during inference:

- **Backbone Feature Factors**: These amplify the backbone feature maps to enhance denoising.
- **Skip Feature Scaling Factors**: These mitigate potential oversmoothing of textures by adjusting the contribution of skip connections.

These factors corresponds to 4 variables b1,b2,s1 and s2 in the code. We can fine tune these factors for best results. After a few testings I found these values to be b1=1.3, b2=1.2, s1=0.5 and s2=0.5 which closely resembles with the values given for this model in the paper.

With these values the paper provides a comprehensive experimental evaluation demonstrating that FreeU can be effectively integrated into various diffusion models, leading to significant improvements in sample quality without incurring extra computational costs.

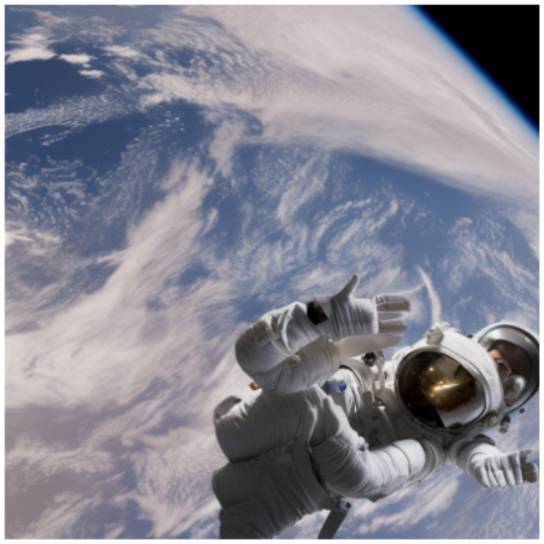
4 Results

In the paper, for the quantitative evaluation authors have conducted a study with 120 participants and gave them some prompts as well as the two corresponding generated images one from SD and another from SD+FreeU. Around 85% participants voted for SD+FreeU. I did the similar study with some of the students and found the results to be same.

I have presented few prompts as well as there corresponding generated images below that shows significant improvement after using FreeU.

An astronaut floating in space, gazing at Earth below.

Standard Diffusion

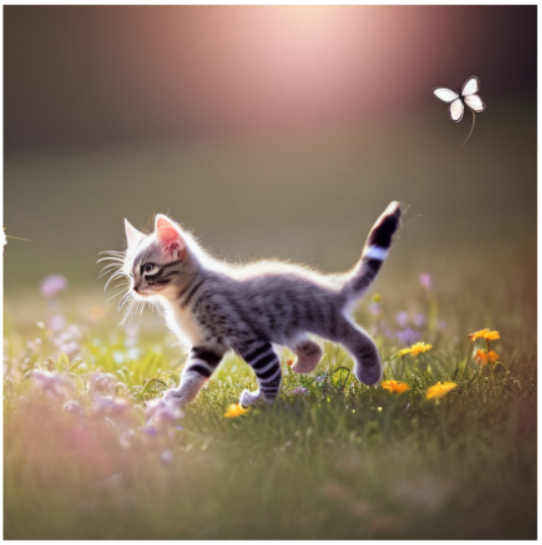


FreeU Enhanced

A playful kitten chasing butterflies in a sunny meadow.

Standard Diffusion

FreeU Enhanced



An idyllic vineyard during harvest season, ripe grapes hanging from vines.

Standard Diffusion

FreeU Enhanced