Frequency-Aware Flow Matching for High-Quality Image Generation

Supplementary Material

Appendix

The supplementary material includes the following additional information:

- Sec. A details the model variants of FreqFlow.
- Sec. B details the hyper-parameters for FreqFlow.
- Sec. C provides additional ablation studies.
- Sec. D includes the limitations and discussion.
- Sec. E presents visualizations of low- and high-frequency components (from the frequency branch) and final outputs (from the spatial branch) generated by FreqFlow.
- Sec. F provides additional visualization samples from the spatial branch of FreqFlow.

A. Model Variants

Tab. 1 presents the architectural details of our model variants: FreqFlow-B, FreqFlow-L, and FreqFlow-H.

model	depth	hidden size	#params
FreqFlow-B	(15, 12)	(768, 384)	134M
FreqFlow-L	(39, 20)	(960, 480)	507M
FreqFlow-H	(57, 29)	(1152, 576)	1.08B

Table 1. **FreqFlow model variants.** We provide detailed model configurations, including the depth and hidden size of the frequency and spatial branches. The first number in parentheses represents the design of the frequency branch, while the second corresponds to the spatial branch.

B. Hyper-parameters for FreqFlow

We detail the hyper-parameters of FreqFlow in Tab. 2.

config	value
optimizer	AdamW [1, 2]
optimizer momentum	(0.99, 0.99)
weight decay	0.03
batch size	2048
learning rate schedule	constant
peak learning rate	2e-4
total epochs	800
warmup epochs	5
class label dropout rate	0.1
σ_L	8
σ_H	2
inference mode	ODE
inference steps	250

Table 2. **Detailed Hyper-parameters of FreqFlow Models.**

C. Additional Ablation Studies

In FreqFlow's frequency branch, we adopt a unified frequency branch f_{freq} that processes both low- and high-frequency components simultaneously. An alternative design, as discussed in Equation (8) of the main paper, involves using separate networks f_{low} and f_{high} to handle low- and high-frequency components individually. In Tab. 3, we ablate this design choice, showing that the unified frequency branch improves FID by 0.49 compared to the separate architecture, demonstrating its effectiveness.

frequency branch design	FID ↓	IS↑
separate f_{low} and f_{high}	3.44	210.2
unified f_{freq}	2.95	231.5

Table 3. **Ablation on frequency branch architecture.** Our final setting is labeled in gray.

D. Limitations and Discussion

While our proposed FreqFlow achieves notable improvements over existing approaches on ImageNet, the largest FreqFlow-H only has about 1B parameters due to constraints on computational resources. We leave further scaling FreqFlow as future work.

E. Visualization of Generated Low-/High-frequency and Final Outputs

We provide additional visualizations of low- and high-frequency components (from the frequency branch) and the final output (from the spatial branch) in Fig. 1 to Fig. 3.

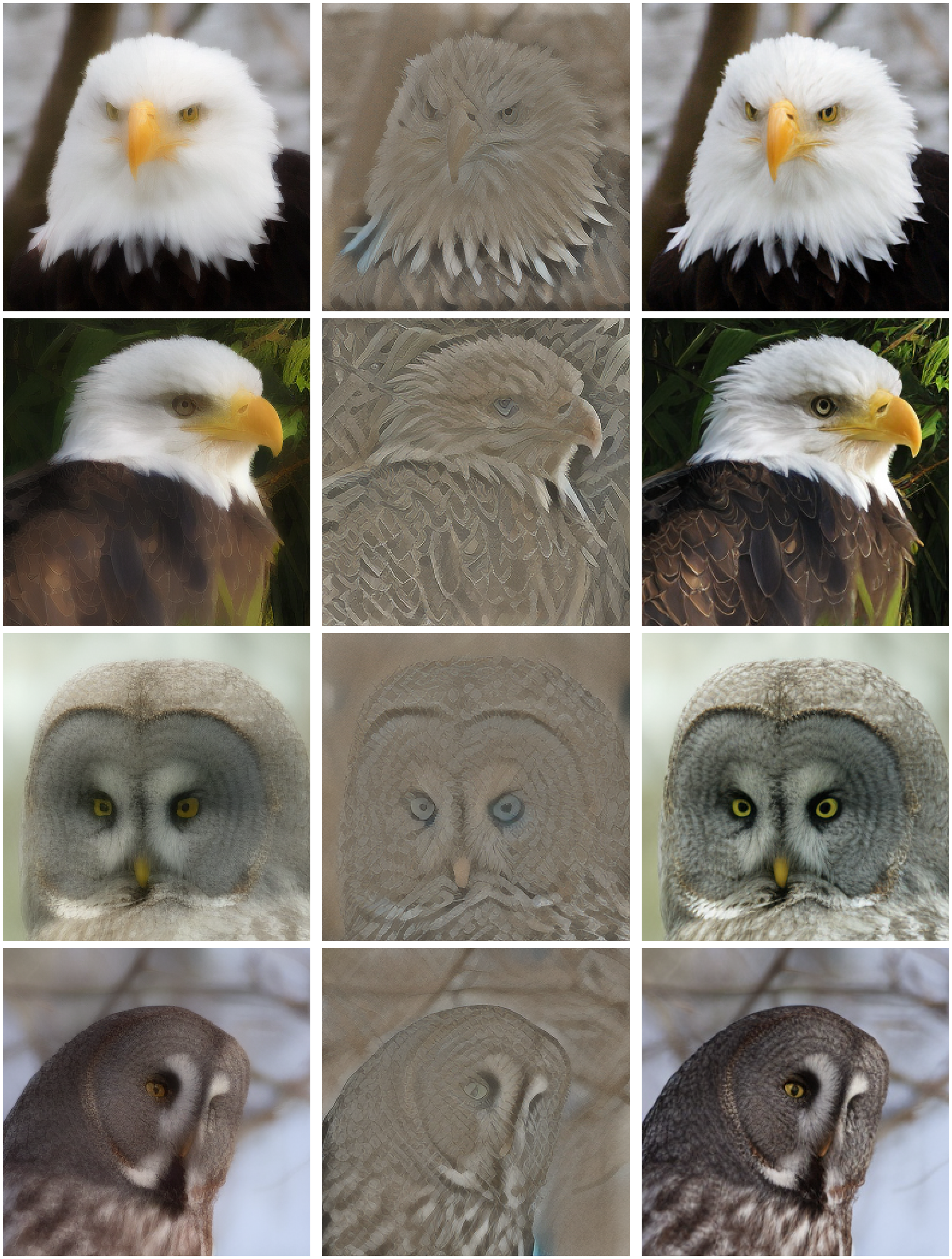
F. Visualization of Generated Samples

We provide additional visualization results from the spatial branch of FreqFlow in Fig. 4 to Fig. 7.

References

[1] Diederik P Kingma and Jimmy Ba. Adam: A method for stochastic optimization. In *ICLR*, 2015. 1

[2] Ilya Loshchilov and Frank Hutter. Decoupled weight decay regularization. *arXiv preprint arXiv:1711.05101*, 2017. 1



Low-frequency Output High-frequency Output Final Output

Figure 1. **Visualization of generated low-, high-frequency and final outputs.** The final output from the spatial branch is enhanced by the low- and high-frequency information provided by the frequency branch.

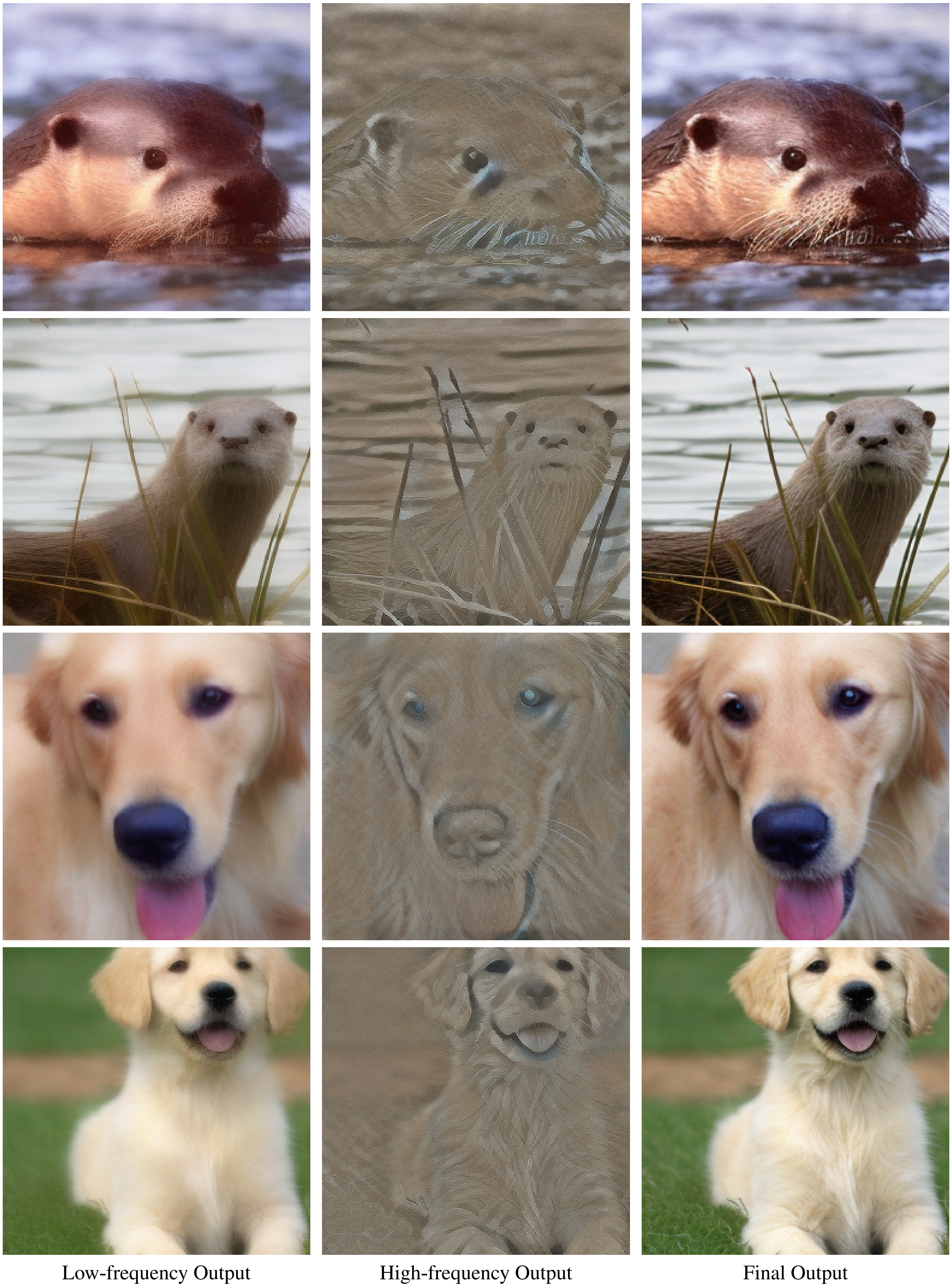


Figure 2. **Visualization of generated low-, high-frequency and final outputs.** The final output from the spatial branch is enhanced by the low- and high-frequency information provided by the frequency branch.

Figure 3. **Visualization of generated low-, high-frequency and final outputs.** The final output from the spatial branch is enhanced by the low- and high-frequency information provided by the frequency branch.

Figure 4. **Generated Samples from FreqFlow.** FreqFlow is able to generate high-quality golden retriever (88) images.

Figure 5. **Generated Samples from FreqFlow.** FreqFlow is able to generate high-quality golden retriever (207) images.

Figure 6. **Generated Samples from FreqFlow.** FreqFlow is able to generate high-quality golden retriever (979) images.

Figure 7. **Generated Samples from FreqFlow.** FreqFlow is able to generate high-quality golden retriever (980) images.