Università degli Studi di Padova

CSC Centro di Sonologia Computazionale

DAFx 25 Digital Audio Effects Conference 2025

TORCHFX: A MODERN APPROACH TO AUDIO DSP WITH PYTORCH AND GPU ACCELERATION

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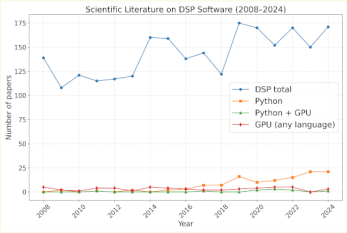


01 BACKGROUND

- Modern DSP applications in telecommunications, multimedia, and AI require real-time processing and GPU-optimized algorithms.
- Existing Python DSP libraries (NumPy, SciPy [1], julius, etc.) often lack GPU acceleration, provide low-level interfaces, or are not designed for seamless AI integration.
- Our literature review considering the time span 2008–2024 found 2431 DSP libraries, but only 10 with GPU support, designed for specific purposes [2, 3].
- This leaves a gap: researchers must rely on cumbersome tools or custom implementations that underutilize GPUs.

02 TORCHFX API

1. GPU-accelerated DSP built on PyTorch
2. Suite of filters and common audio effects optimized for multichannel audio
3. Seamless integration with AI workflows (nn.Module compatible)
4. Operator overloading for chaining filters intuitively

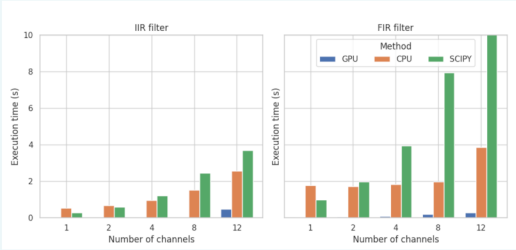
```
from torchfx import (
    Wave,
    effect,
    filter,
)

audio = Wave.from_file('audio.mp3')
output = (
    audio
    | effect.Reverb()
    | filter.HiButterworth(100)
    | effect.Normalize()
)
```

03 PERFORMANCE EVALUATION

- We compared TorchFX (CPU & GPU) vs SciPy
- Benchmarked on signals up to 10 minutes, 12 channels

Results:

- For short and single-channel signals SciPy is competitive
- With longer, multi-channel audio TorchFX on GPU performs >100× faster than SciPy
- TorchFX CPU also outperforms SciPy due to its multicore optimizations



04 CONCLUSION

- Existing Python DSP libraries often lack efficiency and flexibility
- Benchmarking results show that TorchFX is much faster than SciPy,
- Intutive API thanks to operators overloading
- At the moment only NVIDIA GPU are supported

References:

1. Virtanen et al. *SciPy 1.0: Fundamental Algorithms for Scientific Computing in Python*, Nature Methods, 2020
2. Yang et al. *Torchaudio: Building Blocks for Audio and Speech Processing*, ICASSP 2022
3. Lee et al. *Grafx: An open-source library for audio processing graphs in pytorch*, DAFx 2024