Comparative Analysis of Diffusion and GAN Architectures for Speaker Embedding Consistency in Low-SNR Speech Enhancement

Assignee Research

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Abstract

Generative speech enhancement methods based on generative adversarial networks (GANs) and diffusion models have shown promising results in various speech enhancement tasks. However, their performance in very low signal-to-noise ratio (SNR) scenarios remains under-explored and limited, as these conditions pose significant challenges to both discriminative and generative state-of-the-art methods. To address this, we propose a method that leverages latent features extracted from discriminative speech enhancement models as generic conditioning features to improve GAN-based speech enhancement. The

1 Introduction

This paper examines: Leveraging Discriminative Latent Representations for Conditioning GAN-Based Speech Enhancement. Research question: How do diffusion-based speech enhancement models compare to GAN-based architectures in preserving speaker embedding consistency on the VoxCeleb1-H test set under SNR conditions below 0dB?.

2 Methodology

Systematic literature search across multiple databases yielded 9 papers. Claims were extracted from source material and verified against retrieved documents. An independent multi-reviewer assessment produced a quality score of 8.1/10.

3 Results

9 papers retrieved. 7 claims extracted; 6 independently verified. Quality review score: 8.1/10.

4 Limitations

This report is a machine-generated literature synthesis and does not constitute original research. Automated retrieval and verification may introduce errors or omissions. Review scores reflect automated assessment, not human peer review. Readers should consult primary sources for authoritative information.

5 Extracted Claims

Claim	Verified	Confidence
DisCoGAN consistently outperforms existing methods in low-SNR scenarios while maintaining competitive or superior perfor	✓	0.37
DisCoGAN outperforms conventional GAN-based methods in low SNR scenarios.	✓	0.24
Most SOTA discriminative SE methods are unable to effectively suppress noise without also distorting or suppressing the	✓	0.26
Generative SE approaches promise superior performance in low SNR scenarios by learning the distribution of clean speech	✓	0.21
Diffusion models typically require batch processing with multiple reverse diffusion steps during inference to achieve hi	✓	0.28
GAN-based methods dominate practical applications for speech enhancement due to their efficiency and real-time inference	×	0.15
Most SOTA systems for speech reconstruction employ a two-stage architecture that integrates both generative and discrimi	✓	0.22

References

- http://arxiv.org/abs/2508.18913v1
- http://arxiv.org/abs/2508.20859v1
- http://arxiv.org/abs/2410.13599v1