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Multi-Stage Hybrid Filtering Framework for Robust ECG Denoising Using an Unbiased Adaptive Model

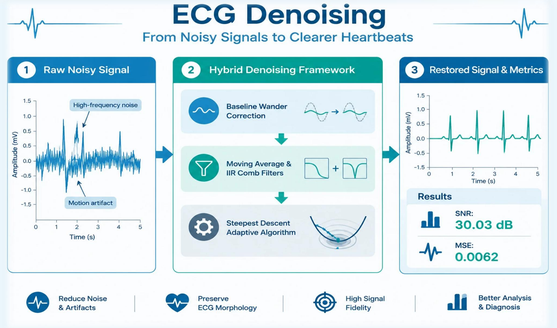




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Backgrounds

- **The Challenge:** ECG signals are essential for cardiac diagnostics but are frequently compromised by environmental noise (baseline wander, powerline interference, and EMG artifacts). This distortion degrades QRS morphology, leading to high misdiagnosis rates and "alarm fatigue" in critical care settings.
- **Our Solution:** We introduce a multi-stage hybrid filtering framework. By combining adaptive modeling with precise morphological preservation, our method effectively suppresses noise while maintaining signal fidelity. This robust approach significantly enhances diagnostic reliability for modern ICU monitoring and ambulatory health systems.

Methods

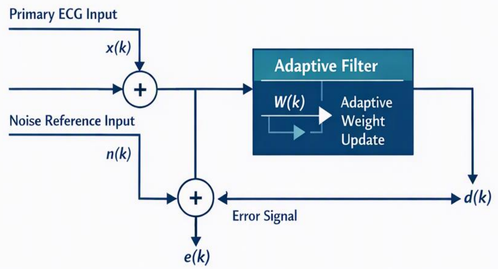
Multi-Stage Hybrid Pipeline



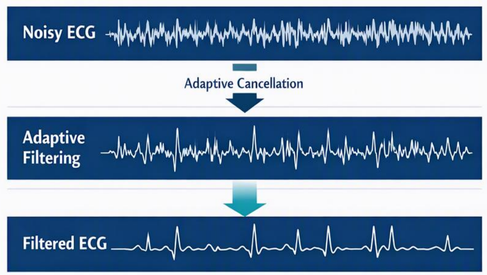
Findings

Adaptive Mechanism & Noise Suppression

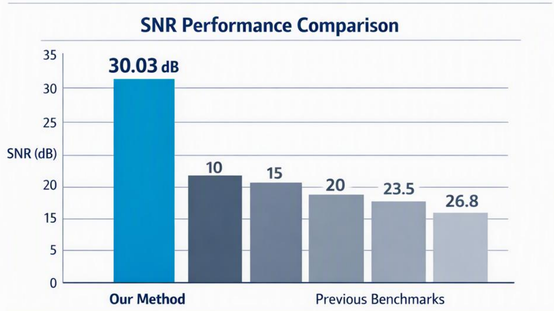
Steepest Descent Adaptive Filter (Adaptive Noise Cancellation)



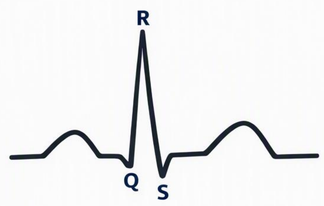
Signal Waveform Comparison



Quantitative Benchmark & Waveform Fidelity



MSE: 0.0062 **PSNR: 18.10 dB**



Conclusion



References

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