Leaky LMS algorithm based low complexity Adaptive Noise Cancellation

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INTRODUCTION/ABSTRACT

Widespread neurodegenerative diseases are characterised by a progressive deterioration of symptoms that increasingly impair everyday functioning and general wellbeing. Among the neurodegenerative conditions that impair movement and frequently result in speech difficulties is Parkinson's disease. Communication becomes more difficult over time as those who have the condition may notice that their voice becomes quieter or that their speech becomes slurred. Globally, more than 15 million people have been affected by Parkinson's. Using acoustic signals such as speech, ultrasound, and PCG signals, these neurological disorders related to speech are frequently diagnosed. The presence of background noise in the signal frequently results in a less precise diagnosis. Researchers often use signal processing techniques to lessen the impact of noise. The suggested Leaky LMS algorithm is less complicated than the current approaches.

MOTIVATION

- The accuracy of speech signals in medical diagnostics is affected by noise.
- Speech-processing systems perform worse when speech signals are distorted.
- Techniques like wavelet transforms, deep learning and EMD work but are computationally expensive and unsuitable for real-time systems.
- Current approaches are too complicated and computationally demanding for real-time applications

PROBLEM STATEMENT/ OBJECTIVE

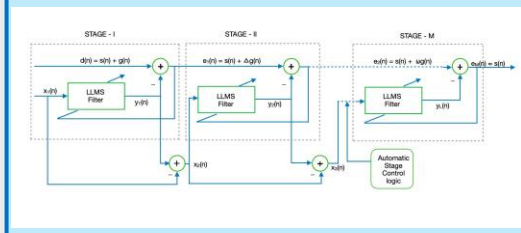
Objective:

- To design and implement a computationally efficient Leaky LMS adaptive filtering algorithm for denoising.
- To improve signal clarity while preserving its original characteristics.

Problem Statement :

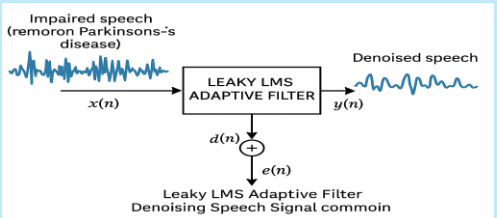
Recorded speech signals are often corrupted by background noise, which degrades the accuracy of speech feature extraction and hinders effective signal processing for disease detection.

METHODOLOGY/BLOCK DIAGRAM



Multi-stage Leaky LMS Adaptive Filter

DESIGN



REALISTIC CONSTRAINTS

- **Economic:** Demands significant processing power, which increases the cost, for systems that need real-time capabilities.
- **Environmental:** The performance of the system can be influenced by environmental factors, which could affect the consistency and quality of the results.
- **Social:** It impacts communication, safety, and accessibility. It helps society by improving speech recognition, enhancing noise detection, and providing better audio diagnostics for medical applications
- **Manufacturability :** The system can be fabricated and replicated using Field Programmable Gate Arrays (FPGAs).
- **Sustainability:** Materials used in the project, such as silicon and epoxy packaging, are largely non-recoverable, which may have an impact on resource sustainability over time.

ENGINEERING STANDARDS

- IEEE 802.11 (Wi-Fi Standards): Defines methods for signal processing in wireless communication, ensuring effective filtering and noise management in networks.
- IEC 61672 (Electroacoustic Measurement Standards): Provides guidelines for measuring the performance of audio and acoustic signal processing equipment, which is essential for filter accuracy.
- ISO 9001 (Quality Management): Ensures that signal processing systems, meet consistent quality standards for reliability and performance.

RESULTS & INFERENCE

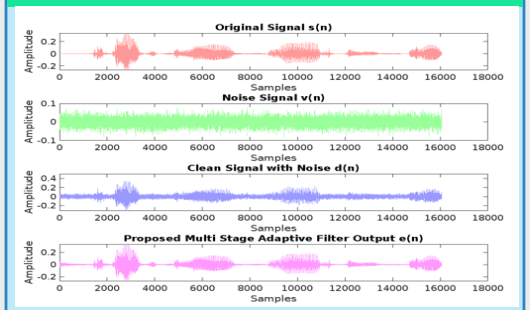


Fig 1: Speech Signal with gaussian noise using Multistage Leaky LMS

STAGE NUMBER	MSE	SNR	CORRELATION COEFFICIENT
Stage 1	0.00010871	20.2909 dB	0.10078
Stage 2	8.199e-05	21.2149 dB	0.092204
Stage 3	3.452e-06	27.4779 dB	0.029336
Stage 4	6.4288e-06	31.3624 dB	0.029206

Table 1:Speech signals with added Gaussian noise using LEAKY LMS Input SNR: 5 dB

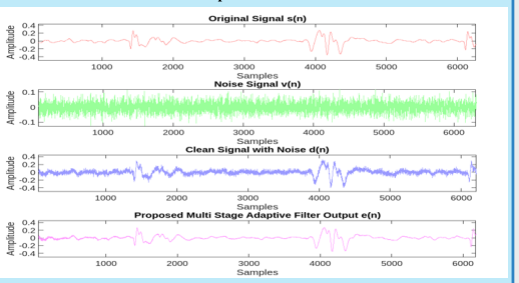


Fig 2: PCG Signal with gaussian noise using Multistage Leaky LMS

STAGE NUMBER	MSE	SNR	CORRELATION COEFFICIENT
Stage 1	0.00011662	17.3809 dB	0.13525
Stage 2	6.1511e-05	19.553 dB	0.10459
Stage 3	1.8372e-05	24.3425 dB	0.055864
Stage 4	7.1978e-06	28.3122 dB	0.030841

Table 2: PCG signals with added Gaussian noise using LEAKY LMS Input SNR: 5 dB

CONCLUSION

This study's suggested approach shows that the Multistage Leaky Least Mean Square algorithm performs better than current methods. The solution is more efficient because it reduces complexity and produces more accurate results. The algorithm also attains a higher Signal-to-Noise Ratio (SNR), which improves its capacity to identify Parkinson's disease early on. By streamlining the detection process and increasing diagnostic accuracy, this method provides a more dependable and efficient means of identifying the illness.

REFERENCES

1. H. Deng and M. Doroslovacki, "A New Adaptive Noise Cancellation Scheme for Speech Enhancement," IEEE Transactions on Signal Processing, vol. 53, no. 7, pp. 2341-2351, July 2005.
2. Yang Liu, A Noise Reduction Method Based on LMS Adaptive Filter of Audio Signals, 3rd International Conference on Multimedia Technology, ICMT, 2013.
3. S. Shahidi and M. Mirzaei, "Performance Analysis of Adaptive Filters for Noise Cancellation in Various Environments," IEEE Transactions on Signal Processing, vol. 54, no. 8, pp. 2952-2962, Aug. 2006, doi: 10.1109/TSP.2006.870888.
4. Sayed A.H.: Fundamentals of adaptive Filtering. First Edition. Wiley Interscience, (2003).
5. Maurya, A.K.: Cascade-cascade Least Mean Square LMS Adaptive Noise Cancellation. Cir-cuits Syst. Signal Process. 37(9), 3785-3926 (2018).
6. Pauline, S.H., Dhanalakshmi, S.: A low-cost automatic switched adaptive filtering technique for denoising impaired speech signals. Multidimensional Systems and Signal Processing 33, 1387-1408 (2022).

CONFERENCE /JOURNAL PUBLICATION

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