Suppression of Acoustic Noise in Speech Using Spectral Subtraction

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AIM

- To develop a noise suppression algorithm using Spectral Subtraction.
- Reducing the error obtained after implementing the spectral subtraction algorithm using various methods.

Applications or importance of the task

1) It is one of the first algorithm that was developed for noise cancellation.

2) The algorithm makes the voice quality improved, expressed as a substantial reduction in noise.

3) Used in noise cancellation headphones.

Challenges

Challanges in the error reduction methods:

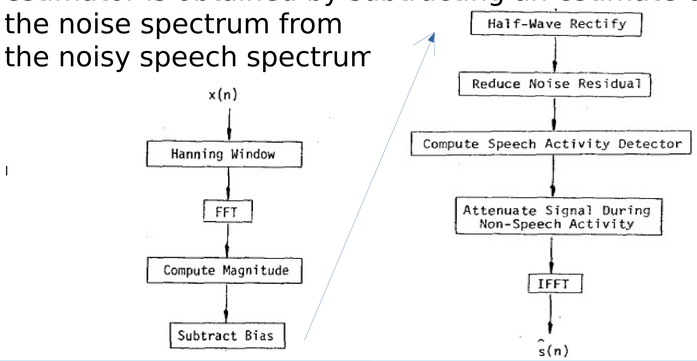
1) Speech is non-stationary, so in case of magnitude averaging, averaging over a longer period of time will decrease intelligibility.

2) In half wave rectification, areas where the noisy speech at a given frequency is less the than estimated noise, the speech information gets incorrectly removed at that frequency.

3) In residual noise reduction, more storage is required to store the minimum magnitude values of the adjacent frames.

Method /Algorithms/ important concepts

Spectral subtraction is a computationally efficient way to arrive at effective digital speech analysis.An estimator is obtained by subtracting an estimate of the noise spectrum from the noisy speech spectrum



Any relevant discussion

Spectral error is given by:

$$\epsilon(e^{jw}) = \hat{S}(e^{jw}) - S(e^{jw}) = N(e^{jw}) - \mu(e^{jw})e^{j\theta_x}$$

Spectral error can be reduced by the following methods:

1) Magnitude averaging - Replacing the windowed noisy signal by it's locally averaged values.

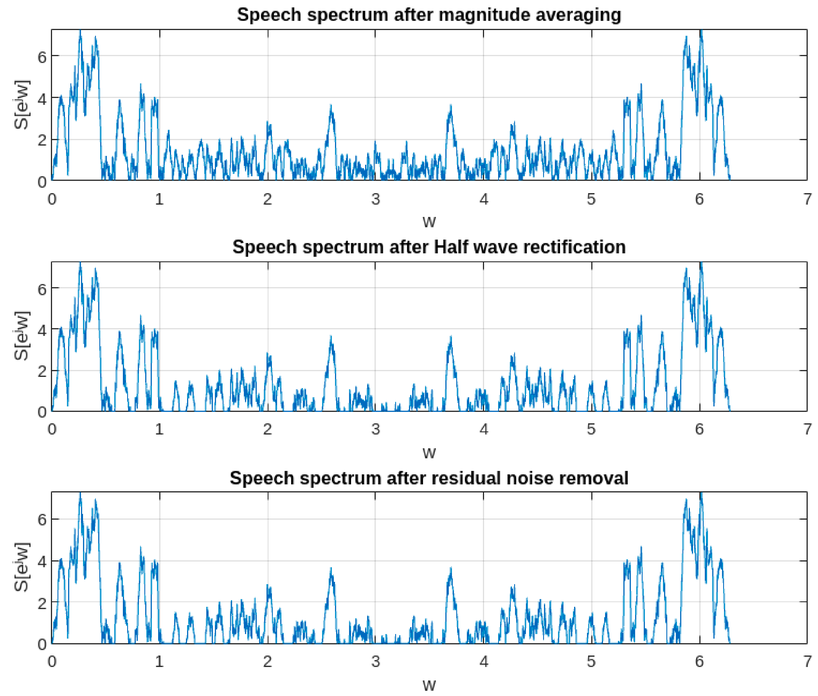
2) Half wave rectifictaion – The nagative values of the speechestimate is replaced with zero.

3) Residual noise reduction – The residual noise which is random from frame to frame is removed by taking it's minimum value from three adjacent frames.

4) Additional signal attenuation – Power of the signal is considerably low when there is no speech activity, hence it is replaced by an attenuated value.

Results/ MATLAB plots

After obtaining the noisy signal and performing spectral subtraction, the following error reduction methods are impleted step by step to decrease the spectral error and obtain the noise reduced speech:



Conclusion

The study includes methods for removing noise from noisy speeches using Spectral Subtraction.

Results indicate overall significant improvements in quality and intelligibility.

References

[1] Cole, C., Karam, M., & Aglan, H. (2008), " Spectral Subtraction of Noise in Speech Processing Applications" IEEE

[2] S. F. Boll, "Suppression of noise in speech using the SABER method," in Proc. ZEEE Znt. Conf. on Acoust., Speech, Signal Processing, Tulsa, OK, Apr. 1978, pp. 606-609.

[3] To check the reference/bibliography please open sci-hub, search you paper there and click on (") and write in the format as mentioned above.