Technical Documentation

ANR 2.x - Overview

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IMPORTANT NOTICE

Change History

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Notes

(1) Creation.
(2) Update version number to 1.0.
(3) Change field status of the document.
(4) Added ANR 2.1.
(5) Updates.
(6) Changes done in 2.2 not updated in absence of change info.
(7) Inserted Fields in the File properties and header so that it’s updated automatically. History table updated version 1.2 renamed to 2.0, 1.3 renamed to 2.1.

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List of Figures and Tables

List of References

[1] L1D_AS118-1, TRD for the Ambient Noise Reduction – ANR 2.x
[2] L1D_AS111-1 – ANR 2.0 – API Definition
[3] L1D_AS111-2 – ANR 2.1 – API Definition

1 Introduction

This document is an overview about the Ambient Noise Reduction (ANR) algorithm. This document applies to ANR 2.0 and next upgrades ANR 2.x. A first part presents the ANR problem generally speaking, its issues and its rules in the GSM audio processing chain. A second part is dedicated to the ANR 2.0 [2] and ANR 2.13 [3] signal processing constraints, the algorithm strategy adopted its main advantages.

2 The Ambient Noise Problem

Audio quality is still one of the most important parameter that the end-user evaluates in a mobile phone. It is then very important to provide audio algorithm which can improve this quality.

When the mobile phone operates in a noisy acoustic environment or when cheap components are used that generate internal noise, the speech intelligibility is damaged and the conversation between the far end and the near end speakers becomes unpleasant. In addition, a low Signal to Noise Ratio (SNR) context is unfavorable to the vocoder and speech recognition tasks and thus degrades the overall performances of the handset.

In the aim to increase the SNR, an ambient noise reduction signal processing algorithm is necessary to remove the undesirable noise part of the handset downlink signal as much as of the terminal uplink signal.

3 The ANR Signal Processing Strategy

Several constraints are rising on the choice of the ANR algorithm [1]. First, noise rejection must be completed on the downlink and the uplink noise corrupted signal without introducing any undesirable artifacts or speech distortion. Second, due to the mobile phone context, not any noise reference signal is available because only one microphone is used on each side of the communication. Third, the real time constraints and the limited power computation and consumption inherent in the embedded digital signal processor of the mobile phone imply to resort to low complexity algorithms.

3.1 ANR 2.0 Signal Processing Strategy

In consideration of the aforementioned constraints, the signal processing strategy adopted to implement the ANR 2.0 module rely on a Time Domain Attenuation (TDA) acting in synergy with a spectral subtraction technique.

The functional scheme is the following: the ANR 2.0 input signal frames are computed in the frequency domain using the Fast Fourier Transform (FFT) algorithm. The corresponding spectrum frames are subtracted with the last estimated noise spectrum frames. The subtraction result is transformed in the time domain using the inverse FFT (iFFT) algorithm which delivers the ANR output signal. The last signal processing step is achieved with the TDA which attenuates the out coming signal using a variable gain depending on the VAD decisions (Figure 3-1).

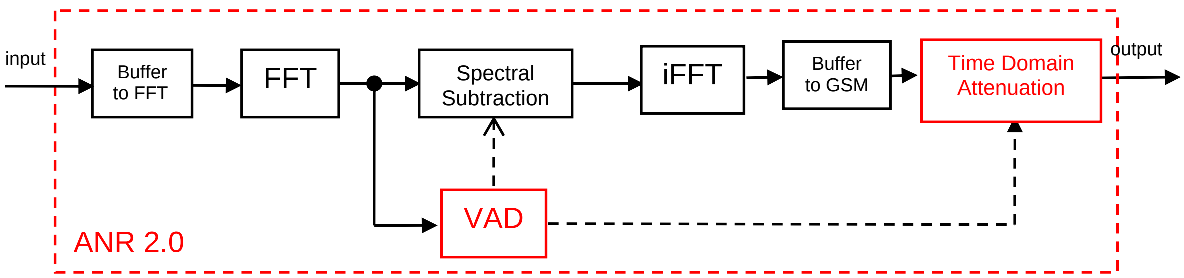

Figure 3-1 The ANR 2.0 Block Diagram

Such a signal processing strategy presents the advantages to remove the noise during the speech occurrences in the corrupted signal with few distortions and without the need of a noise reference signal. Thus far, the implemented algorithms have a reasonable overall complexity.

The main drawback of the TDA coupled with the spectral subtraction technique is the need for a Voice Activity Detector (VAD) which increases the algorithm complexity. The VAD rule consists in discerning between the speech frames and the noise frames for the noise estimation (NES) and for the TDA gain controlling. Consequently, the ANR performances are in a great dependency with the VAD decision errors.

In the ANR 2.0, the use of a TDA driven by the VAD decisions lead to sudden attenuation application on the signal. This generates audible noise and speech fluctuation. In low SNR situation, this can be very annoying.

Secondly, the ANR 2.0 reveals to be sensitive to some Full-Type Agreement (FTA) tests signal preventing to pass successfully the releases 99 and 4 sending distortion test.

To correct these two issues, the ANR 2.0 was upgraded to ANR 2.1.

3.2 The ANR 2.1 Signal Processing Strategy

In the ANR 2.1, the TDA has been removed and the internal frequency domain VAD has been replaced by an external time-domain VAD 1.x. In addition, a tone detector has been added. Its aim is to detect pure test tones and to let them pass through the ANR 2.1 for FTA tests. This gives the functional scheme as presented below (Figure 3-2).

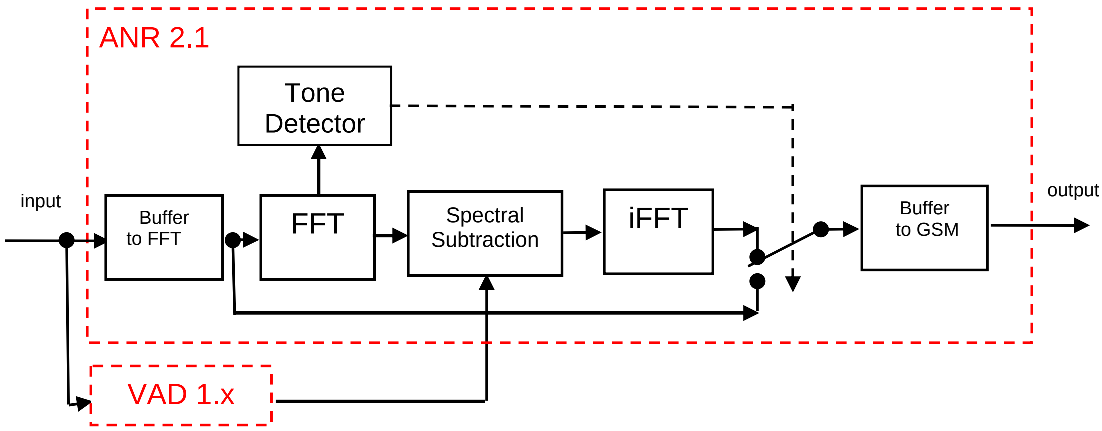

Figure 3-2 The ANR 2.1 Block Diagram

The TDA will no more leads to strong non-linear artifact.

Appendices

A. Acronyms

ANR	Ambient Noise Rejection / Reduction
GSM	Global System for Mobile
SNR	Signal to Noise Ratio
FFT	Fast Fourier Transform
iFFT	Inverse Fast Fourier Transform
VAD	Voice Activity Detector / Detection
NES	Noise Estimator / Estimation
TDA	Time Domain Attenuation
FTA	Full Type Agreement

B. Glossary