Technical Documentation

ECHO SUPPRESSOR - OVERVIEW

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Glossary

ES	Echo Suppressor/Suppression
AEC	Acoustic Echo Canceller/Cancellation
TCS	TI's Chipset Solution
DL	Downlink
UL	Uplink
VAD	Voice Activity Detector/Detection
TCL	Terminal Coupling Loss
NSF/NFA	Noise Floor Adjustment
ALS	Attenuation Level Smoothing
CNG	Comfort Noise Generator

References

[1] L1D_AS088 – Audio Enhancement SW PRD
[2] ITU-T Recommendation P340, "Transmission Characteristics and Speech Quality Parameters of Hands-free Terminals", May 2000.

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List of Figures and Tables

1 Introduction

This document provides an overview of the Echo Suppressor (ES) module implemented beside the Acoustic Echo Canceller (AEC) for the TCS3.1 delivery and further [1]. A first chapter deals with the ES role beside the AEC. A second chapter is dedicated to a top level description of the ES module.

2 Echo Suppressor Role

The ES role is to control the residual echo in a speakerphone application, where the AEC is unable to cancel the entire echo in the uplink due to non-ideal acoustical environment such as a non-linear loudspeaker response for example (Figure 2.1).

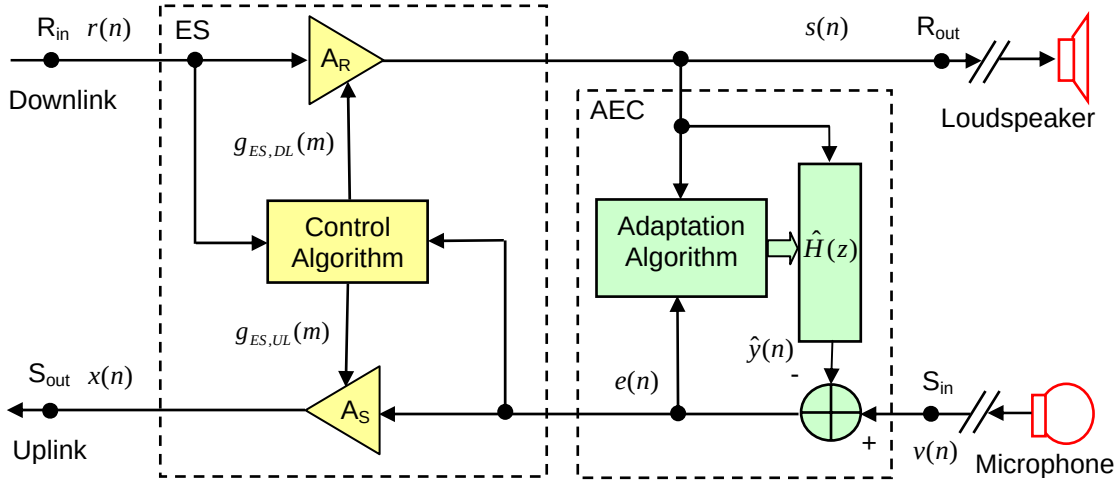

Figure 2.1 The Conventional AEC/ES Block Diagram

The primary goal is to achieve significant attenuation to S_{out} when only the far-end speaker is talking, to reduce residual echo, with no attenuation or distortion of S_{out} during near-end speech only. In double-talk situations, both paths are attenuated to control echo while still allowing both speakers to be heard. In idle, both signals can be passed through to preserve background noise characteristics, or S_{out} can be attenuated to reduce idle noise.

3 Echo Suppressor Description

The ES implemented in the TCS3.x delivery is acting both in the DL and in the UL. The ES processing is based on 20ms frame duration. The ES can be configured to provide various degrees of full, partial or half-duplex communication modes. The ES can be seen as a system made up of a downlink and an uplink Voice Activity Detector (VAD), a Terminal Coupling Loss (TCL) estimator, a Control Algorithm and a Comfort Noise Generator (CNG).

3.1 Embedded Voice Activity Detector

The embedded voice activity detectors act both in the DL and in the UL to provide information to the ES control algorithm. The VADs decisions are based on frame and noise energy estimations of the current 20ms frames compared to predefined thresholds. The VAD algorithm is the same DL and UL.

3.2 Terminal Coupling Loss Estimator

In addition to the VADs decisions, the ES uses the TCL estimation. TCL is estimated with downlink signal s(n) and AEC output e(n).

3.3 Echo Suppressor Control Algorithm

From the VADs decisions and from the TCL estimation, the ES control algorithm performs the states estimation on the current frame. The ES gain computation is based on four states: Idle, Double-Talk, Far-end and Near-end.

In each state, there is a desired attenuation level for both directions: receive out (R_{out}) and send out (S_{out}) depending on the selected communication mode: full-duplex, partial-duplex or half-duplex as specified in the ITU recommendation [2](Chap. 8).

The ES control algorithm can involve some optional options to improve the subjective audio quality: NSF/NFA (Noise Floor Adjustment) in UL and Attenuation Level Smoothing (ALS) independently in UL an in DL.

The NSF/NFA option allows the ES attenuation to be lowered by the estimated noise level and so reduces the noise frames chopping in the UL. The ALS options leads to DL and UL gains smoothing and so reduces the fast variations of the speech level in the ES outputs.

3.4 Comfort Noise Generator

The Comfort Noise Generation (CNG) acting in UL is another optional feature of the ES. The CNG can be activated as an alternative option to the NSF/NFA. The CNG adds random noise in the ES output and so masks the noise frames chopping in the UL.

4 Conclusion

The echo suppressor implemented in the TCS3.x solutions is based on voice activity detection in downlink and in uplink, terminal coupling loss and states estimation. The computation is based on 20ms frames. The ES modules can be configured either of full-duplex, partial-duplex or half-duplex communication mode. Embedded optional features can be activated to improve the subjective audio quality in the outputs.