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iSceneDetect

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APPLICATION NOTE

INTRODUCTION

iSceneDetect is a new feature unique to ON Semiconductor's high end preconfigured product portfolio. This feature allows hearing-aid operation using a single program memory that functions in any listening situation. When enabled, iSceneDetect continually analyzes the acoustic environment and automatically adjusts the selected algorithms without the need for user intervention. The iSceneDetect feature simplifies user controls while improving audibility, comfort and listening experience according to specific user preferences.

This information note explains the principles of operation of iSceneDetect and describes how individual algorithmic features are controlled.

PRINCIPLES OF OPERATION

iSceneDetect uses sophisticated algorithms to analyze the microphone signals and classify the listening environment. Four types of acoustic characteristics are used in the classification process:

- Absolute sound levels
- Signal envelope
- Spectral content
- Directional microphone information

These characteristics are analysed and used together to determine the appropriate classification for a given acoustic environment. Six separate environments are supported by iSceneDetect: quiet, speech in quiet, noise, speech in noise, music and wind. Knowledge of the detected environment is used by iSceneDetect to adjust the settings of the other features for optimum audio performance. iSceneDetect currently controls the FBC, NR, WDRC and the ADM features. The specific control provided for each feature is described in more detail below.

iSceneDetect performs careful analysis of the acoustic signals prior to making a classification. This analysis requires a certain amount of elapsed time to ensure a robust classification. The recognition time required for each environment is different and is not user adjustable. In addition, significant variability in recognition time may be observed under different conditions. Table 1 provides approximate guidelines for recognition times under nominal conditions. Actual recognition times will vary.

Table 1. RECOGNITION TIMES IN DIFFERENT ENVIRONMENTS

Environment	Recognition Time (secs)
Quiet	5-10
Speech in Quiet	5-10
Noise	5-10
Speech in Noise	5-10
Music	10-30
Wind	1-2

Figure 1 summarizes the environment classes and the algorithms controlled by iSceneDetect.

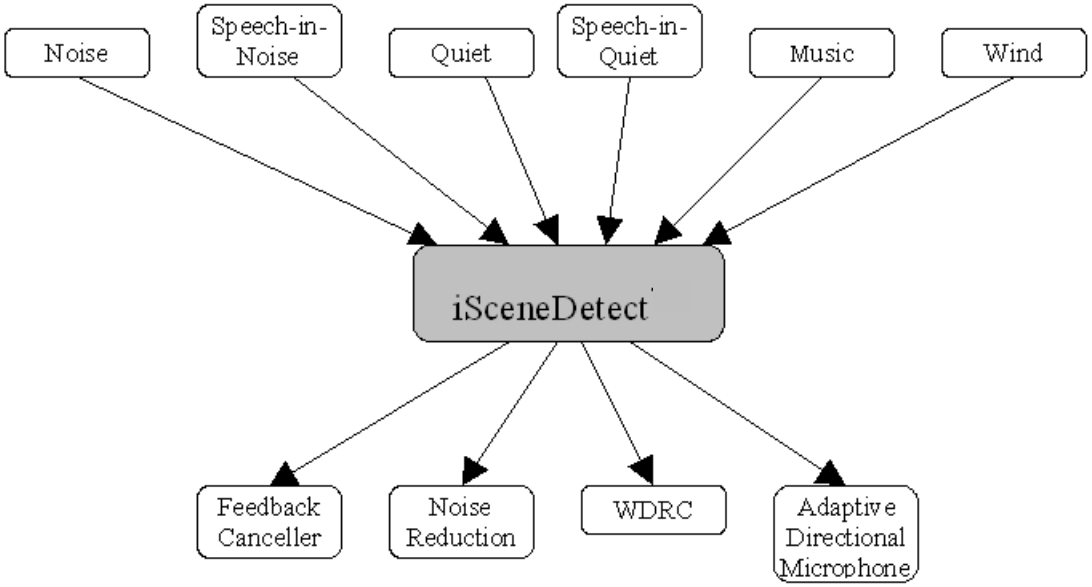

Figure 1. Scope of iSceneDetect Algorithm

Once a classification decision is made by iSceneDetect, the individual setting changes are initiated. In order to prevent abrupt hearing aid behaviour transitions, iSceneDetect makes adjustments to the various algorithm settings in a gradual fashion over time. The duration of the transition interval is controlled by the *EC_TransSpeed* parameter (refer to section Configuring iSceneDetect in IDS for more details).

NOTE: The speed at which the iSceneDetect algorithm recognizes a change in environment is independent from the transition speed parameter.

ALGORITHM CONTROL

iSceneDetect provides control for the Feedback Canceller, Noise Reduction, WDRC, and Adaptive Directional Microphone. Table 2 provides a summary of how iSceneDetect controls the hearing aid's algorithms for the various environment classes.

Table 2. iSceneDetect CONTROL OF ALGORITHMS IN DIFFERENT ENVIRONMENTS

Environment	Algorithm Settings			
	Noise Reduction	Feedback Canceller	Directional Microphone	Wide Dynamic Range Compression
Quiet, or Speech-in-Quiet	Adaptive Noise Reduction level constraint	FBC normal	Adaptive	Multi-band level detection
Noise, or Speech- in-Noise	Adaptive Noise Reduction level constraint	FBC normal	Adaptive	Multi-band level detection
Music	Disabled	FBC slow	Omni	Combination of Wideband and Multi-band level detection
Wind	Noise Reduction level constraint set to 12 dB	FBC normal	Omni	Multi-band level detection

Noise Reduction Adjustments

iSceneDetect controls the amount of noise reduction applied in different environments. When music is detected, iSceneDetect sets the reduction level to 0 dB, effectively disabling noise reduction. When wind is detected, iSceneDetect sets the reduction level to 12 dB, resulting in aggressive noise reduction. In all other detected environments, the reduction level is adaptively set based on an environment noise estimate, with minimum and maximum constraints placed on the noise reduction level. The absolute noise level estimate is used to determine the amount of noise reduction needed. In these environments (Quiet, Speech-in-Quiet, Noise, or Speech-in-Noise), iSceneDetect continually estimates the ambient noise level, carefully separating desired signal from the noise estimate.

For noise levels at or below the Low-Noise Level Threshold, the minimum noise reduction setting is used. For noise levels at or above the High Noise Level Threshold, the maximum noise reduction setting is used. For noise levels in between the low and high thresholds, the amount of noise reduction is adjusted in direct proportion to the noise level. This is illustrated in Figure 2.

The minimum and maximum noise reduction settings are constrained to lie within the range specified by the iSceneDetect Min NR and Max NR parameters. These parameters can be controlled from IDS (see section Configuring iSceneDetect in IDS).

The Low Noise Level Threshold is fixed at −75 dB full scale RMS, while the High Noise Level Threshold is fixed at −50 dB full scale RMS.

NOTE: These thresholds are fixed relative to the digital full−scale voltage. Digital full scale can be converted to input−referred dBV by subtracting 6 dB, for the analog−to−digital converter gain, and the current preamplifier gain (3, 9, 15 or 21 dB). A further conversion to dBSPL requires knowledge of the microphone sensitivity.

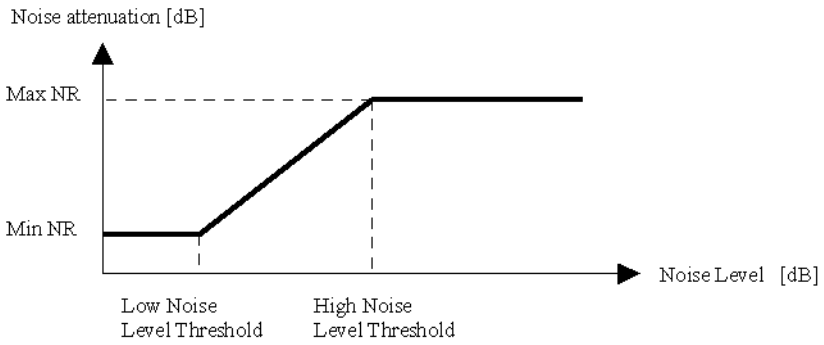

Figure 2. Noise Reduction level setting in Quiet, Speech−in−Quiet, Noise, and Speech−in−Noise Environments

Feedback Canceller Adjustments

The Feedback Canceller operates nominally in all environments except for Music. In this case, the Feedback Canceller adaptation speed is reduced. This slows down the FBC and helps to preserve sound fidelity.

Adaptive Directional Microphone Control

Adaptation of the Adaptive Directional Microphone (ADM) is enabled in all environments except for the Music and Wind environments. In these cases, the ADM is forced into an omni-directional state. The use of a steady omni-directional microphone pattern is optimum for preserving sound fidelity when listening to music. As for a windy environment, a directional microphone poses the risk of amplifying the wind noise. Therefore, it is preferable to avoid microphone directionality in the presence of wind by once again forcing the ADM into a steady omni-directional state

In Quiet, Speech-in-Quiet, Noise, and Speech-in-Noise environments, the Adaptive Directional Microphone is allowed to adapt as if the Auto ADM Front End mode was selected. This usually means that the Adaptive Directional Microphone will adapt and transition into the omni-directional state when operating in Quiet or Speech-in-Quiet environments, although this isn't strictly enforced by iSceneDetect. In Noise or Speech-in-Noise environments, the Adaptive Directional Microphone will tend to adapt to a directional state, although, again, this isn't strictly enforced.

WDRC

The WDRC operates nominally (using multi-band level detectors) in all environments except for the Music environment. When a Music environment is detected, iSceneDetect directs the WDRC to use a combination of the multi-band level detectors and the wideband level detector. The combination weighting is dictated by the WB Weight parameter. This parameter can take on a value anywhere from 0% (all multi-band detection) to 100% (all wide-band detection) – see section Configuring iSceneDetect in IDS. By emphasizing wideband detection, the hearing aid behaves more like a single channel device which is considered preferable for listening to music.

CONFIGURING iSceneDetect IN IDS

The parameter controls for iSceneDetect in IDS are in effect only for those memories where iSceneDetect is the selected Front End Mode (FEMode selection on the *Front End* tab). The iSceneDetect parameters are all located on the *Front End* tab and are shown in Figure 3.

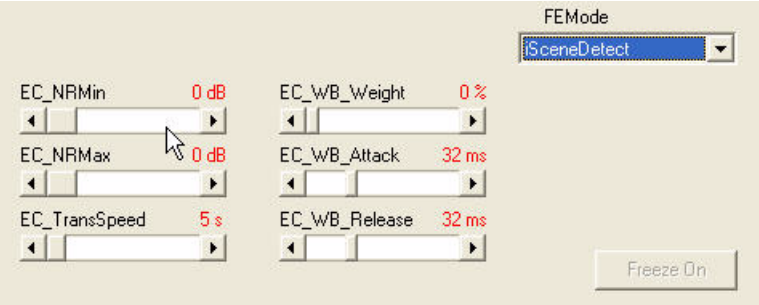

Figure 3. ISceneDetect Parameter Controls in IDS

EC_NRMin: This parameter controls the minimum level of noise reduction allowed by the iSceneDetect algorithm. This value can be anywhere from 0 dB to 12 dB but EC_NRMin must always be less or equal than EC_NRMax.

NOTE: The *Noise Reduction* parameter control on the *Adv. Features* tab is ignored whenever iSceneDetect is selected as the FE Mode for a particular memory.

EC_NRMax: This parameter controls the maximum level of noise reduction allowed by the iSceneDetect algorithm. This value can be anywhere from 0 dB to 12 dB but EC_NRMin must always be less or equal than EC_NRMax.

NOTE: The *Noise Reduction* parameter control on the *Adv. Features* tab is ignored whenever iSceneDetect is selected as the FE Mode for a particular memory.

EC_TransSpeed: This parameter controls the speed with which iSceneDetect transitions the various algorithm settings under its control, such as the Noise Reduction level, the Adaptive Directional Microphone state, and the WDRC multi−band/wideband level detectors' combination weights. The speed at which the iSceneDetect algorithm recognizes a change in environment is independent from the transition speed parameter. The transition speed parameter specifies the time constant employed for transitioning the Noise Reduction level settings and the WDRC level detector's combination weights. The transition speed parameter can take on a value between 5 and 40 seconds in 5 seconds increments. This parameter also sets the Adaptive Directional Microphone state transition period to 4 seconds for settings of 25 seconds or below, and to 8 seconds for settings greater than 25 seconds.

EC_WB_Weight: This parameter controls the WDRC multi−band/wideband level detectors' combination weights when the environment is classified as Music. In other environments, only the multi−channel level detectors are used. This parameter can take on a value anywhere from 0% (all multi−band detection) to 100% (all wide−band detection). By emphasizing wideband detection, the hearing aid behaves more like a single channel device. There is evidence to suggest that this may improve music quality.

EC_WB_Attack: This parameter controls the attack time of the wideband level detector. The wideband attack and release times serve the same purpose as the individual channel attack and release times; to control the aggressiveness or smoothness of the compressor algorithm.

EB_WB_Release: This parameter controls the release time of the wideband level detector. The wideband attack and release times serve the same purpose as the individual channel attack and release times; to control the aggressiveness or smoothness of the compressor algorithm.

1 Microphone iSceneDetect

For hearing instruments with only one microphone present, iSceneDetect can be configured to work with a single mic input. This can be done by selecting the "iSceneDetect single mic" option in the Front End Mode selection menu on the Front End tab in IDS (see Figure 4).

When enabled, iSceneDetect will still detect noise, speech, speech in noise, speech in quiet and music environments and make the appropriate adjustments. Wind will not be detected and the Automatic Directional Microphone system will be deactivated.

Figure 4. Single Mic iScene

Static Directional iScene

On products that support it, it is possible to select a static directional microphone system with iSceneDetect. When enabled, it will work in a similar way as iSceneDetect. The algorithm will function in the same way as the standard iSceneDetect feature other than the Automatic Directional Microphone algorithm does not work. When wind is detected it will transition from static directional to omni and back again. The polar pattern for static directional is set by the Beta value in IDS.

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