|  |  |  |
| --- | --- | --- |
| INTERNATIONAL TELECOMMUNICATION UNION | | **Focus Group On Car Communication** |
| **TELECOMMUNICATION STANDARDIZATION SECTOR**  STUDY PERIOD 2009-2012 | | **FG CarCOM-C-34rev1** |
| **English only**  **Original: English** |
|  |  | Detroit, 16-17 July 2012 |
| **CONTRIBUTION** | | |
| **Source:** | Volkswagen AG, Technische Universität Braunschweig | |
| **Title:** | Proposal of a Reference-free SNR Measurement | |

This contribution reports the current state of the reference-free SNR measurement approach which was proposed in the FG CarCOM meeting held in Braunschweig, Germany, on Dec. 8-9, 2011. An approach developed for wideband signals only was already published on the DAGA 2012 conference [1]. Since then, the approach has been enhanced to work consistently with narrowband signals, too. Slight modifications of the original algorithm turned out to show improved quality for narrowband signals. The new modified approach is even simpler than the original one.

The new consistent approach is accepted for publication at the ITG Conference on Speech Communication [2] which will be held in Braunschweig, Germany, on Sep. 26-28, 2012 (see attachment), offering online access to the paper for interested readers over IEEE Xplore.

According to the decisions taken by the group at the Braunschweig meeting (Dec. 8-9, 2011), we now evaluated the approach with P.501 speech samples and a measurement duration *T*meas = 32 s (not documented in the paper). The performance of the new algorithm at this measurement duration is shown in the Tables below. As can be seen, the approach shows a good correlation to the P.56 reference measurement, all correlation coefficients exceed the value of 0.99. Based on a measurement duration of 32 s, the absolute estimation errors are smaller than 1 dB in at least 74% and 88% of the measurements for narrowband and wideband signals, respectively.

|  |  |  |
| --- | --- | --- |
| *T*meas = 32 s | *fs*= 8 kHz | *fs*= 16 kHz |
| Correlation coefficient | 0.9958 | 0.9948 |
| Abs. meas. error ≤ 2dB | 89.8% | 97.3% |
| Abs. meas. error ≤ 1dB | 74.4% | 88.3% |

Table 1. Correlation coefficients, absolute estimation errors and their frequency for narrowband and wideband signals. The measurement duration was 32 s.

Table 2 is given just for further information, documenting the performance for a measurement duration of 64 s. As can be seen, the approach shows a good correlation to the P.56 reference measurement, all correlation coefficients exceed the value of 0.998. Based on a measurement duration of 64 s, the absolute estimation errors are smaller than 1 dB in at least 77% and 93% of the measurements for narrowband and wideband signals, respectively, and smaller than 2 dB in more than 91% and 99%, respectively.

|  |  |  |
| --- | --- | --- |
| *T*meas = 64 s | *fs*= 8 kHz | *fs*= 16 kHz |
| Correlation coefficient | 0.9981 | 0.9993 |
| Abs. meas. error ≤ 2dB | 91.2% | 99.0% |
| Abs. meas. error ≤ 1dB | 77.6% | 93.2% |

Table 2. Correlation coefficients, absolute estimation errors and their frequency for narrowband and wideband signals. The measurement duration was 64 s.

References:

[1] Fodor, B.; Fingscheidt, T. “Reference-free SNR Measurement for Stationary Noises”, in Proc. of DAGA, Darmstadt, Germany, Mar 2012.

[2] Fodor, B.; Fingscheidt, T., “Reference-free SNR Measurement for Narrowband and Wideband Speech Signals in Car Noise”, in Proc. of ITG Conference on Speech Communication, Braunschweig, Germany, Sep 2012, accepted for publication.

We propose to change the Draft Recommendation text as follows:

On page 25 of the Draft Recommendation the literature reference should be cited:

“…

**8.2.1.1.4.1 Parameter description**

The SNR measurement is based on individual broadband estimations of the speech signal power and the noise signal power and is performed using the reference-free measurement method described in [28].

NOTE 1 – It is recognized that fan noise, which varies from car to car and depends upon the relative positioning of the microphone and fan, may contribute significantly to the noise perceived by the far end user. In order to determine the impact of the level and spectral content of this noise under different operating conditions, a noise test as described below may be used.

The microphone signal to noise ration SNRM is measured at the test point (S1a) or the test point (S2). Test point (S2) should only be used if test point (S1a) is not accessible.

**8.2.1.1.4.2 Test**

1) The test arrangement is according to clause 8.1.

2) The speech test signal used is a concatenation of four English test sentences described in Annex B of ITU-T Recommendation P.501 [11] each with a length of 8s, resulting in a measurement duration of 32s. To account for the Lombard effect, the test signal level is adjusted to the level as specified in clause 8.1, the test signal level is measured as "active speech level" according to [13].

3) For the measurement speech and background noise are recorded simultaneously while driving.

4) A reference measurement is conducted at 20 cm in front of the MRP. The reference microphone output signal is filtered by a highpass filter with 100 Hz and 24 dB/oct.

5) The actual measurement is conducted with the hands-free microphone.

6) The SNR is calculated according to [28] for both microphones.

7) The SNR difference between the hands-free microphone and the reference microphone is determined:

SNRD = SNRM - SNRRef

Note: If different microphones or different positions are to be compared the measurements shall be conducted simultaneously.

…”

On page 2 of the Draft Recommendation a new reference [28] should be added:

“…

**2) References**

…

[28] Fodor, B.; Fingscheidt, T., “Reference-free SNR Measurement for Narrowband and Wideband Speech Signals in Car Noise”, in Proc. of ITG Conference on Speech Communication, Braunschweig, Germany, Sep 2012.”

Attachment:



\_\_\_\_\_\_\_\_\_\_\_\_