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Digitalni celiļ ni telekomunikacijski sistem (faza 2+) ï Govor s poloviļ no hitrostjo ï Detektor govornih dejavnosti (VAD) pri prometnih kanalih s poloviļ no hitrostjo govora (GSM 06.42, razliļ ica 8.0.1, izdaja 1999)

Digital cellular telecommunications system (Phase 2+) (GSM); Half rate speech; Voice Activity Detector (VAD) for half rate speech traffic channels (GSM 06.42 version 8.0.1 Release 1999)

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Digital cellular telecommunications system (Phase 2+); Half rate speech; Voice Activity Detector (VAD) for half rate speech traffic channels (GSM 06.42 version 8.0.1 Release 1999)

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Special Mobile Group (SMG).

The present document specifies the Voice Activity Detector (VAD) to be used in the Discontinuous Transmission (DTX) within the digital cellular telecommunications system. The present document is part of a series covering the half rate speech traffic channels as described below:

GSM 06.02 "Digital cellular telecommunications system (Phase 2+); Half rate speech; Half rate speech processing functions".

GSM 06.06 "Digital cellular telecommunications system (Phase 2+); Half rate speech; ANSI-C code for the GSM half rate speech codec".

GSM 06.07 "Digital cellular telecommunications system (Phase 2+); Half rate speech; Test sequences for the GSM half rate speech codec".

GSM 06.20 "Digital cellular telecommunications system (Phase 2+); Half rate speech; Half rate speech transcoding".

GSM 06.21 "Digital cellular telecommunications system (Phase 2+); Half rate speech; Substitution and muting of lost frames for half rate speech traffic channels".

GSM 06.22 "Digital cellular telecommunications system (Phase 2+); Half rate speech; Comfort noise aspects for half rate speech traffic channels".

GSM 06.41 "Digital cellular telecommunications system (Phase 2+); Half rate speech; Discontinuous Transmission (DTX) for half rate speech traffic channels".

GSM 06.42 "Digital cellular telecommunications system (Phase 2+); Half rate speech; Voice Activity Detector (VAD) for half rate speech traffic channels".

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The contents of the present document is subject to continuing work within SMG and may change following formal SMG approval. Should SMG modify the contents of the present document it will be re-released with an identifying change of release date and an increase in version number as follows:

Version 8.x.y

where:

8 indicates Release 1999 of GSM Phase 2+.

x the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

y the third digit is incremented when editorial only changes have been incorporated in the specification.

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1 Scope

The present document specifies the Voice Activity Detector (VAD) to be used in the Discontinuous Transmission (DTX) as described in GSM 06.41 [4]. It also specifies the test methods to be used to verify that a VAD implementation complies with the present document.

The requirements are mandatory on any VAD to be used either in GSM Mobile Stations (MS)s or Base Station Systems (BSS)s that utilize the half-rate GSM speech traffic channel.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.
- For this Release 1999 document, references to GSM documents are for Release 1999 versions (version 8.x.y).

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[1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 06.20: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Half rate speech transcoding".

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[3] GSM 06.22: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Comfort noise aspects for half rate speech traffic channels".

[4] GSM 06.41: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Discontinuous Transmission (DTX) for half rate speech traffic channels".

[5] GSM 06.06: "Digital cellular telecommunications system (Phase 2+); Half rate speech; ANSI C code for the GSM half rate speech codec".

[6] GSM 06.07: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Test sequences for the GSM half rate speech codec".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

mobile environment: any environment in which MSs may be used.

noise: signal component resulting from acoustic environmental noise.

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3.2 Symbols

For the purposes of the present document, the following symbols apply:

3.2.1 Variables

aav1	filter predictor values, see clause 5.2.3
acf	the ACF vector which is calculated in the speech encoder (GSM 06.20 [2])
adaptcount	secondary hangover counter, see clause 5.2.6
av0	averaged ACF vector, see clause 5.2.2
av1	a previous value of av0, see clause 5.2.2
burstcount	speech burst length counter, see clause 5.2.7
den	denominator of left hand side of equation 8 in annex C, see clause 5.2.5
difference	difference between consecutive values of dm, see clause 5.2.4
dm	spectral distortion measure, see clause 5.2.4
hangcount	primary hangover counter, see clause 5.2.7
lagcount	number of subframes in current frame meeting periodicity criterion, see clause 5.2.9
lastdm	previous value of dm, see clause 5.2.4
lags	the open loop long term predictor lags for the four speech encoder subframes (GSM 06.20 [2].)
num	numerator of left hand side of equation 8 in annex C, see clause 5.2.5
oldlagcount	previous value of lagcount, see clause 5.2.9
prederr	fourth order short term prediction error, see clause 5.2.5
ptch	Boolean flag indicating the presence of a periodic signal component, see clause 5.2.9
pvad	energy in the current filtered signal frame, see clause 5.2.1
rav1	autocorrelation vector obtained from av1, see clause 5.2.3
rc	the first four unquantized reflection coefficients calculated in the speech encoder (GSM 06.20 [2])
rvad	autocorrelation vector of the adaptive filter predictor values, see clause 5.2.6
smallag	difference between consecutive lag values, see clause 5.2.9
stat	Boolean flag indicating that the frequency spectrum of the input signal is stationary, see clause 5.2.4
thvad	adaptive primary VAD threshold, see clause 5.2.6
tone	Boolean flag indicating the presence of an information tone, see clause 5.2.5
vadflag	Boolean VAD decision with hangover included, see clause 5.2.8
veryoldlagcount	previous value of oldlagcount, see clause 5.2.9
vvad	Boolean VAD decision before hangover, see clause 5.2.7

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3.2.2 Constants

adp	number of frames of hangover for secondary VAD, see clause 5.2.6
burstconst	minimum length of speech burst to which hangover is added, see clause 5.2.8
dec	determines rate of decrease in adaptive threshold, see clause 5.2.6
fac	determines steady state adaptive threshold, see clause 5.2.6
frames	number of frames over which av0 and av1 are calculated, see clause 5.2.2
freqth	threshold for pole frequency decision, see clause 5.2.5
hangconst	number of frames of hangover for primary VAD, see clause 5.2.8
inc	determines rate of increase in adaptive threshold, see clause 5.2.6
lthresh	lag difference threshold for periodicity decision, see clause 5.2.9
margin	determines upper limit for adaptive threshold, see clause 5.2.6
nthresh	frame count threshold for periodicity decision, see clause 5.2.9
plev	lower limit for adaptive threshold, see clause 5.2.6
predth	threshold for short term prediction error, see clause 5.2.5
pth	energy threshold, see clause 5.2.6
thresh	decision threshold for evaluation of stat flag, clause 5.2.4

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3.2.3 Functions

+	addition
-	subtraction
*	multiplication
/	division
| x |	absolute value of x
AND	Boolean AND
OR	Boolean OR
b MULT(x(i)) i=a	the product of the series x(i) for i=a to b
b SUM(x(i)) i=a	the sum of the series x(i) for i=a to b

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACF	Autocorrelation Function
AFLAT	Autocorrelation Fixed point LAttice Technique
ANSI	American National Standards Institute
DTX	Discontinuous Transmission
LTP	Long Term Predictor
TX	Transmission
VAD	Voice Activity Detector

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For abbreviations not given in this clause see GSM 01.04 [1].

4 General

The function of the VAD is to indicate whether each 20 ms frame produced by the speech encoder contains speech or not. The output is a Boolean flag (vadflag) which is used by the Transmit (TX) DTX handler defined in GSM 06.41 [4].

The present document is organized as follows.

Clause 5 describes the principles of operation of the VAD. Clause 6 provides an overview of the computational description of the VAD. The computational details necessary for the fixed point implementation of the VAD algorithm are given in the form of an American National Standards Institute (ANSI) C program contained in GSM 06.06 [5].

The verification of the VAD is based on the use of digital test sequences which are described in GSM 06.07 [6].

The performance of the VAD algorithm is characterized by the amount of audible speech clipping it introduces and the percentage activity it indicates. The characteristics for the VAD defined in the present document have been established by extensive testing under a wide range of operating conditions. The results are summarized in annex A.

5 Functional description

The purpose of this clause is to give the reader an understanding of the principles of operation of the VAD, whereas GSM 06.06 [5] contains the fixed point computational description of the VAD. In the case of discrepancy between the two descriptions, the description in GSM 06.06 [5] will prevail.

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5.1 Overview and principles of operation

The function of the VAD is to distinguish between noise with speech present and noise without speech present. This is achieved by comparing the energy of a filtered version of the input signal with a threshold. The presence of speech is indicated whenever the threshold is exceeded.

The detection of speech in mobile environments is difficult due to the low speech/noise ratios which are encountered, particularly in moving vehicles. To increase the probability of detecting speech, the input signal is adaptively filtered (see clause 5.2.1) to reduce its noise content before the voice activity decision is made (see clause 5.2.7).

The frequency spectrum and level of the noise may vary within a given environment as well as between different environments. It is therefore necessary to adapt the input filter coefficients and energy threshold at regular intervals as described in clause 5.2.6.

5.2 Algorithm description

The block diagram of the VAD algorithm is shown in figure 1. The individual blocks are described in the following clauses. The global variables shown in the block diagram are described in table 1.

Table 1: Description of variables in figure 1

Var	Description
acf	The ACF vector which is calculated in the speech encoder (GSM 06.20 [2]).
av0	Averaged ACF vector.
av1	A previous value of av0.
lags	The open loop long term predictor lags for the four speech encoder subframes (GSM 06.20 [2]).
ptch	Boolean flag indicating the presence of a periodic signal component.
pvad	Energy in the current filtered signal frame.
rav1	Autocorrelation vector obtained from av1.
rc	The first four unquantized reflection coefficients calculated in the speech encoder (GSM 06.20 [2]).
rvad	Autocorrelation vector of the adaptive filter predictor values.
stat	Boolean flag indicating that the frequency spectrum of the input signal is stationary.
thvad	Adaptive primary VAD threshold.
tone	Boolean flag indicating the presence of an information tone.
vadflag	Boolean VAD decision with hangover included.
vvad	Boolean VAD decision before hangover.

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