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SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

International telephone connections and circuits –
Software tools for transmission systems

Software tools for speech and audio coding standardization

Recommendation ITU-T G.191



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Recommendation ITU-T G.191

Software tools for speech and audio coding standardization

Summary

This revision only introduces changes to ITU-T G.191 Annex A, which describes the ITU-T Software Tools (STL) containing a high-quality, portable C code library for speech processing applications. This new release of the STL – dubbed STL2009 – incorporates many changes in software and manual. The new sets of tools added are: ITU-T G.728 fixed-/floating-point executables, basic ITU-T G.722 frame-erasure concealments (G.722 PLC0 and PLC1), program ROM counting, floating point complexity evaluation, stereo operation and bitstream truncation. There have been also updates such as addition of new filters to rate change tools, more options added for frequency response calculations, adaptation of error-insertion device to embedded-variable bitstream, addition of impulse responses to the reverberation processing tool and update to make ITU-T G.722/ITU-T G.192 compliant. Corrections of several known problems have also been implemented. The associated STL user's manual has also been updated.

This Recommendation includes an electronic attachment containing STL2009 Software Tool Library and manual.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.191	1993-03-12	XV
2.0	ITU-T G.191	1996-11-11	15
3.0	ITU-T G.191	2000-11-17	16
4.0	ITU-T G.191	2005-09-13	16
5.0	ITU-T G.191	2010-03-29	16

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

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Electronic attachment: STL2009 Software Tool Library and manual

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Software tools for speech and audio coding standardization

1 General

In the process of generating speech and audio coding standards, the following situations often happen:

- a) In many cases, experimental results generated with different software tools may not be directly compared.
- b) Software tools used by different organizations may not perfectly conform to related ITU-T Recommendations, which may delay ITU-T standardization processes.
- c) ITU-T Recommendations may leave scope for different implementations.
- d) New speech and audio coding standards are increasing in complexity, leading to non-bitexact specifications; furthermore, appropriate testing procedures to assure interoperability of different implementations are needed.

The need for a common set of tools has been recognized in past ITU-T standardization activities of speech algorithms. As a consequence, a library of portable, interworkable and reliable software routines has been established.

2 Software tools

To clarify the use of the set of software tools, arranged as a software tool library, the ITU-T makes the following recommendations:

- 1) The software tools specified in Annex A should be used as building modules of signal processing blocks to be used in the process of generation of ITU-T Recommendations, particularly those concerned with speech and audio coding algorithms.
- 2) Some of the tools shall be used in procedures for the verification of interoperability of ITU-T standards, mainly of speech and audio coding algorithms whose description is in terms of non-bitexact specifications.
- 3) The use of these modules should be made strictly in accordance with the technical instructions of their attached documentation, and should respect the following terms.

3 License and copyright

The modules in the ITU-T Software Tool Library (STL) are free software; they can be redistributed and/or modified under the terms of the "ITU-T software tools General Public License" of Annex B, as published by the ITU-T; this applies to any of the versions of the modules in the STL.

The STL has been carefully tested and it is believed that both the modules and the example programs on their usage conform to their description documents. Nevertheless, the ITU-T STL is provided "as is", in the hope that it will be useful, but without any warranty.

The STL is intended to help the scientific community to achieve new standards in telecommunications more efficiently, and for such must not be sold, entirely or in parts. The original developers, except where otherwise noted, retain ownership of their copyright, and allow their use under the terms and conditions of the "ITU-T software tools General Public License".

Annex A

List of software tools available

(This annex forms an integral part of this Recommendation)

This annex contains a list with a short description of the software tools available in the ITU-T Software Tool Library. This is referred to in the associated documentation as the Software Tool Library release 2009, or STL2009. All the routines in the modules are written in C.

a) *Example programs available*

Associated header file: ugstdemo.h

The following programs are examples of the use of the modules:

g711demo.c	on the use of the ITU-T G.711 module.
g726demo.c	on the use of the ITU-T G.726 module.
g727demo.c	on the use of the ITU-T G.727 module
g722demo.c	on the use of the ITU-T G.722 module.
g728enc.c	on the use of the ITU-T G.728 floating-point encoder.
g728dec.c	on the use of the ITU-T G.728 floating-point decoder.
g728fpenc.c	on the use of the ITU-T G.728 fixed-point encoder.
g728fpdec.c	on the use of the ITU-T G.728 fixed-point decoder.
rpedemo.c	on the use of the full-rate GSM 06.10 speech codec module.
sv56demo.c	on the use of the speech voltmeter module, and also the gain/loss routine.
eiddemo.c	on the use of the error insertion device for bit error insertion and frame erasure.
eid-ev.c	on the use of the error insertion device for bit error insertion for layered bitstreams, which can be used to apply errors to individual layers in layered bitstreams such as ITU-T G.718 or ITU-T G.729.1.
gen-patt.c	on the use of generating bit error pattern files for error insertion in ITU-T G.192-compliant serial bitstreams encoded files.
gen_rate_profile.c	on the use of fast switching rate profile generation tool.
firdemo.c	on the use of the FIR (finite impulse response) high-quality low-pass and band-pass filters and of the FIR-IRS filters, associated with the rate change module.
pcmdemo.c	on the use of the ITU-T G.712 (standard PCM) IIR (infinite impulse response) filters, associated with the rate change module.
filter.c	on the use of both the IIR and the FIR filters available in the rate change module.
mnrudemo.c	on the use of the narrow-band and wideband modulated noise reference unity (ITU-T P.81) module.

<code>spdemo.c</code>	on the use of the serialization and parallelization routines of the utility module.
<code>g711iplc.c</code>	on the use of Appendix I/G.711 Packet Loss Concealment module.
<code>reverb.c</code>	on the use of the reverberation module.
<code>truncate.c</code>	on the use of the bitstream truncation module.
<code>freqresp.c</code>	on the use of the frequency response computation tool.
<code>stereoop.c</code>	on the use of stereo file operations.

NOTE – The module for the Basic Operators does not have a demo program but it is supplemented by two tools: one to evaluate program ROM complexity for fixed-point code (`basop_cnt.c`), and another to evaluate complexity (including program ROM) of floating-point implementations (`flc_example.c`). Both reside in the Basic Operators module.

b) *Rate change module with FIR (finite impulse response) routines*

Name: `firflt.c`

Associated header file: `firflt.h`

Functions included:

<code>delta_sm_16khz_init</code>	initialize 16 kHz 1:1 ÄSM weighting filter.
<code>hq_down_2_to_1_init</code>	initialize 2:1 low-pass down-sampling filter.
<code>hq_down_3_to_1_init</code>	initialize 3:1 low-pass down-sampling filter.
<code>hq_up_1_to_2_init</code>	initialize 1:2 low-pass up-sampling filter.
<code>hq_up_1_to_3_init</code>	initialize 1:3 low-pass up-sampling filter.
<code>irs_8khz_init</code>	initialize 8-kHz P.48 IRS weighting filter.
<code>irs_16khz_init</code>	initialize 16-kHz P.48 IRS weighting filter.
<code>linear_phase_pb_2_to_1_init</code>	initialize 2:1 bandpass down-sampling filter.
<code>linear_phase_pb_1_to_2_init</code>	initialize 1:2 bandpass up-sampling filter.
<code>linear_phase_pb_1_to_1_init</code>	initialize 1:1 bandpass filter.
<code>mod_irs_16khz_init</code>	initialize 16-kHz send-side modified IRS weighting filter.
<code>mod_irs_48khz_init</code>	initialize 48-kHz send-side modified IRS weighting filter.
<code>psophometric_8khz_init</code>	initialize 1:1 ITU-T O.41 psophometric weighting filter.
<code>p341_16khz_init</code>	initialize 1:1 ITU-T P.341 send-part weighting filter for data sampled at 16 kHz.
<code>rx_mod_irs_16khz_init</code>	initialize 16-kHz modified IRS receive-side weighting filter.
<code>rx_mod_irs_8khz_init</code>	initialize 8-kHz modified IRS receive-side weighting filter.
<code>tia_irs_8khz_init</code>	initialize 8-kHz IRS weighting filter using the TIA coefficients.
<code>ht_irs_16khz_init</code>	initialize 16-kHz IRS weighting filter with a half-tilt inclination within the ITU-T P.48 mask.
<code>msin_16khz_init</code>	initialize mobile station weighting filter.
<code>bp5k_16khz_init</code>	initialize 50-Hz to 5-kHz-bandpass filter (16 kHz sampling).